डेडीकेटेड फ्रेट कोरीडोर

DESIGN AND CONSTRUCTION OF CIVIL, STRUCTURES AND TRACK WORKS FOR SINGLE LINE RAILWAY INVOLVING FORMATION IN EMBANKMENTS/CUTTINGS, BALLAST ON FORMATION, TRACK WORKS, BRIDGES, STRUCTURES, BUILDINGS, YARDS, INTEGRATION WITH IR EXISTING RAILWAY SYSTEM AND TESTING & COMMISSIONING ON DESIGN-BUILD LUMP SUM BASIS FOR SAHNEWAL - PILKHANI SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

Contract Package: 301

ICB No. HQ/EN/EC/D-B/SAHNEWAL - PILKHANI

PART - 4 - REFERENCE DOCUMENT

GEO TECH DATA - VOLUME - 3

SAHNEWAL TO PILKHANI

From Km. 360.200 to Km. 187.500

GEO TECH DATA

From Km. 250.000 to Km. 270.000

VOL 2/7

EMPLOYER

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

(A GOVERNMENT OF INDIA ENTERPRISES)

MINISTRY OF RAILWAYS

COUNTRY : INDIA

Geotech Data (Km 250 - Km 270)					
S.No	Chainage	IR KM	Exist. No.	Prop. No.	Page Numbers
1	Appendix				0885-0891
Bridges Locations					
2	79952	270/33-35	311	87	0892-0903
3	79154	270/5-7	310	85	0904-0915
4	78984	269/29-31	309	83	0916-0927
5	78183	NA	308	82	0928-0939
6	77797	268/21-23	305	80	0940-0951
7	76413	267/11-13	303	78	0952-0963
8	73695	264/33-35	301	76	0964-0975
9	72637	263/21-23	299	74	0976-0987
10	62309	254/5-7	292	63	0987-0999
11	76908	267/25-27	304	79	1000-1020
12	75644	266/19-21	302	77	1021-1041
13	73445	264/21-23	300	75	1042-1064
14	65481	257/7-13	294	65	1065-1082
15	64372	256/5-9	293	64	1083-1099
16	62017	253/23-25	291	62	1100-1118
17	61240	253/1-3	290	61	1119-1160
18	59410	251/5-7	289	60	1161-1182
Alignment & Ambala Detour					
19		265/19-21			1183-1194
20		262/800			1195-1209
21		68600 (Bore Log)			1213
22		69080 (Bore Log)			1214-1215
23		259/11-13			1216-1229
24		258/15-17			1230-1245
25		255/5-7			1246-1268
26		252/5-7			1269-1280
27		250/7-9			1281-1292
28	70955 (14800)	Ambala Detour		73	1293-1304
29	69905 (13750)	Ambala Detour		70	1305-1316
30	68805 (12650)	Ambala Detour		69	1317-1337
31	68595 (12450)	Ambala Detour		68	1338-1358
32	68041 (11800)	Ambala Detour		66	1359-1370

Disclaimer : This Booklet does not contain Page Numbers from 1210 to 1215 & 1371 to 1593 as these are not relevant to this section and have been deleted.

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.

(LUDHIANA TO AMBALA)

PART - III OF PART A
RAILWAY KM. 270.00-250.00
SAHNEWAL (LUDHIANA) TO SIRHIND SECTION

DETAIL FOR DEPTH OF BOREHOLES

Minor Bridges :	108.00	m
MajorBridges :	510.00	m
Alingnment :	84.00	m
Detour Section:	156.00	m
Total Depth :	858.00	m

CONTENTS

MINOR BRIDGES

S.No	Chapter No.	Bridge No.	Chainage	Bore hole No.	Depth of Borehole (m)	Date	Page No.
1	118	311	270/27-29	1	12.00	06.12.2009	
2	119	310	270/5-7	1	12.00	06.12.2009	
3	120	309	269/35-37	1	12.00	07.12.2009	
4	121	308	269/5-6	1	12.00	07.12.2009	
5	122	305	268/21-23	1	12.00	08.12.2009	
6	123	303	267/6-7	1	12.00	08.12.2009	
7	124	301	264/33-35	1	12.00	09.12.2009	
8	125	299	263/21-23	1	12.00	10.12.2009	
9	126	292	254/5-7	1	12.00	27.07.2009	
Total Depth Detail of Minor Bridge					108.00		

MAJOR BRIDGES

S.No	Chapter No.	Bridge No.	Location	Bore hole No.	Depth of Borehole	Date	Page No.
10	127	304	267/25-27	A1	30.00	05.12.2009 - 06.12.2009	
				A2	30.00	06.12.2009	
11	128	302	266/19-21	A1	30.00	07.12.2009	
				A2	30.00	08.12.2009	
12	129	300	264/21-23	A1	30.00	09.12.2009	
				A2	30.00	10.12.2009	
13	130	294	257/300	A1	30.00	13.12.2009 - 15.12.2009	
				P1 - P2	30.00	16.12.2009	
				A2	30.00	09.12.2009	
14	131	293	256/5-7	A1	30.00	18.12.2009	
				A2	30.00	10.12.2009	
15	132	291	253/23-25	A1	30.00	25.07.2009-26.07.2009	
				A2	30.00	24.07.2009-25.07.2009	
16	133	290	253/1-3	A1	30.00	21.07.2009-22.07.2009	
				P2	30.00	22.07.2009-23.07.2009	
17	134	289	251/5-7	A1	30.00	16.12.2009	
				A2	30.00	10.12.2009	
Total Depth Detail of Major Bridge					510.00		

ALIGNMENT							
S.No	Chapter No.	Bridge No.	Location	Bore hole No.	Depth of Borehole	Date	Page No.
18	135		265/19-21	1	12.00	09.12.2009	
19	136		262/800	1	12.00	09.12.2009	
20	137		259/11-13	1	12.00	12.12.2009	
21	138		258/15-17	1	12.00	12.12.2009	
22	139		255/5-7	1	12.00	16.12.2009	
23	140		252/5-7	1	12.00	24.07.2009	
24	141		250/7-9	1	12.00	21.07.2009	
Total Depth Detail of Alignment					84.00		
DETOUR SECTION							
S.No	Chapter No.	Bridge	Location	Bore hole No.	Depth of Borehole	Date	Page No.
27	142	Proposed Minor Bridge	14800	1	12.00	11.12.2009	
28	143	Inter Dist.	13750	1	12.00	11.12.2009	
29	144	Proposed RFO (ROR)	12650	A1	30.00	12.12.2009	
				A2	30.00	13.12.2009	
30	145	Proposed RUB on NH - 1	12450	A1	30.00	14.12.2009	
				A2	30.00	15.12.2009	
31	146	Proposed Minor Bridge	11800	1	12.00	12.12.2009	
Total Depth Detail of Detour Section					156.00		
Total Depth Detail of Part - III of Part - A					858.00		

APPENDIX – C : GEOTECHNICAL SUBSURFACE PROFILE AND FOUNDATION DETAILS AT A GLANCE
PART - III (CH. 270.00 - 250.00)

Minor Bridges

S.No.	Bridge No.	Chainage	Proposed Bridge Detail		No. of Bore-hole	Bore-hole Identification	BH Level (m)	Depth of Bore-hole Actual	Ground Water Table Position (m.)	Sub Soil Strata Profile	Recommended Net SBC (t/m2)	Pile Load Carrying Capacity (t)		Expected Depth of Foundation	Type of expected Foundation
			Span Length	Type of Super Structure								1.0m Dia	1.20 m Dia		
1	311	270/27-29	1 x 3 x 3	Box	1	BH-1	266.165	12.00	2.00	0.00-4.50m - Sandy Silt with Clay 4.50-7.50m - Clayey Silt with Sand 7.50-12.00m - Clayey Silt	1.50m - 10.40 3.00m – 14.00 4.50m – 15.00 6.00m – 16.00	-	-	Below 4.50m from EGL	Open
2	310	270/5-7	1 x 3.05	Slab	1	BH-1	267.131	12.00	7.00	0.00-4.50m - Sandy Silt with Clay 4.50-12.00m - Clayey Silt with Sand Below 12.00m - Sitly Sand	1.50m - 9.50 3.00m – 14.00 4.50m – 18.00 6.00m – 19.00	-	-	Below 4.50m from EGL	Open
3	309	269/35-37	1 x 3 x 2	Box	1	BH-1	267.536	12.00	7.00	0.00-1.50m. - Filled up Strata 1.50-10.50m - Sandy Silt with Clay 10.50-12.00m - Sandy Silt	1.50m - 09.00 3.00m – 14.00 4.50m – 15.00 6.00m – 16.00	-	-	Below 4.50m from EGL	Open
4	308	269/5-7	1 x 2 x 1.2	Box	1	BH-1	268.687	12.00	6.00	0.00-1.50m. - Filled up Strata 1.50-10.50m - Sandy Silt with Clay 10.50-12.00m - Sandy Silt Below 12.00m - Sandy Silt with Clay	1.50m - 08.00 3.00m – 10.50 4.50m – 11.50 6.00m – 13.00	-	-	Below 6.00m from EGL	Open
5	305	268/21-23	1 x 3 x 3	Box	1	BH-1	268.095	12.00	8.00	0.00-1.50m. - Filled up Strata 1.50-12.00m - Sandy Silt with Clay	1.50m - 08.00 3.00m – 11.00 4.50m – 12.00 6.00m – 13.00	-	-	Below 6.00m from EGL	Open
6	303	267/6-7	1 x 2 x 2	Box	1	BH-1	267.602	12.00	8.00	0.00-12.00m - Sandy Silt with Clay	1.50m - 8.00 3.00m – 11.00 4.50m – 12.00 6.00m – 13.50	-	-	Below 6.00m from EGL	Open
7	301	264/33-35	2 x 6.10	Slab	1	BH-1	268.437	12.00	1.80	0.00-12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 09.50 4.50m – 10.50 6.00m – 11.00	-	-	Below 6.00m from EGL	Open
8	299	263/21-23	3 x 6.10	Steel Girder	1	BH-1	267.325	12.00	1.00	0.00-3.00m - Sandy Silt with Clay 3.00-12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 10.00 4.50m – 10.50 6.00m – 11.00	-	-	Below 6.00m from EGL	Open
9	292	254/5-7	1 x 3 x 3	Box	1	BH-1	268.545	12.00	Below 15.00	0.00-4.50m. - Clayey Silt with Sand 4.50-12.00m - Clayey Silt	1.50m - 06.00 3.00m – 09.00 4.50m – 11.00 6.00m – 11.50	-	-	Below 6.00m from EGL	Open
					9			108.00							

Major Bridges

10	304	267/25-27	3 x 6.1	Slab	2	A1	268.726	30.00	10.00	0.00-4.50m - Clayey Silt 4.50-10.50m - Sandy Silt with Clay 10.50-19.50m - Silty Sand 19.50-30.00m - Clayey Silt	1.50m - 08.00 3.00m – 11.50 4.50m – 12.00 6.00m – 13.00	17.00m - 130.00 20.00m - 160.00 23.00m - 190.00	17.00m - 160.00 20.00m - 190.00 23.00m - 230.00	-	Pile
						A2	267.251	30.00	10.00	0.00-7.50m - Clayey Silt 7.50-13.50m - Sandy Silt with Clay 13.50-19.50m - Silty Sand 19.50-30.00m - Clayey Silt	1.50m - 07.00 3.00m – 10.00 4.50m – 11.00 6.00m – 13.00	17.00m - 115.00 20.00m - 140.00 23.00m - 170.00	17.00m - 140.00 20.00m - 170.00 23.00m - 200.00	-	Pile
11	302	266/19-21	4 x 12.20	Slab	2	A1	267.327	30.00	8.00	0.00-1.50m - Silty Sand with Clay 1.00-3.00m - Silty Sand 3.00-12.00m - Clayey Silt 12.00-30.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 10.50 4.50m – 11.50 6.00m – 12.00	17.00m - 100.00 20.00m - 130.00 23.00m - 170.00	17.00m - 120.00 20.00m - 160.00 23.00m - 210.00	-	Pile
						A2	268.558	30.00	8.00	0.00-4.50m - Sandy Silt with Clay 4.50-12.00m - Clayey Silt with Sand 12.00-13.50m - Sandy Silt with Clay 13.50-24.00m - Clayey Silt with Sand 24.00-25.50m - Sandy Silt 25.50-30.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 12.00 4.50m – 13.00 6.00m – 14.00	17.00m - 90.00 20.00m - 120.00 23.00m - 135.00	17.00m - 110.00 20.00m - 140.00 23.00m - 160.00	-	Pile
12	300	264/21-23	3 x 6.1	Slab	2	A1	268.315	30.00	1.50	0.00-1.50m - Filled up Strata 1.50-4.50m - Sandy Silt with Clay 4.50-7.50m - Silty Sand 7.50-30.00m - Clayey Silt with Sand	1.50m - 08.50 3.00m – 12.00 4.50m – 08.00 6.00m – 08.50	17.00m - 100.00 20.00m - 135.00 23.00m - 175.00	17.00m - 120.00 20.00m - 160.00 23.00m - 210.00	-	Pile
						A2	267.458	30.00	1.50	0.00-1.50m - Filled up Strata 1.50-7.50m - Sandy Silt with Clay 7.50-19.50m - Clayey Silt with Sand 19.50-25.50m - Sandy Silt with Clay 25.50-30.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 10.50 4.50m – 11.50 6.00m – 12.50	17.00m - 90.00 20.00m - 120.00 23.00m - 160.00	17.00m - 110.00 20.00m - 150.00 23.00m - 190.00	-	Pile
13	294	257/5-17	3 x 47.5	Triangular Girder Through Type	3	A1	270.196	30.00	8.00	0.00-12.00m - Silty Sand 12.00-30.00m - Clayey Silt with Sand	1.50m - 10.00 3.00m – 11.00 4.50m – 11.50 6.00m – 12.00	17.00m - 110.00 20.00m - 140.00 23.00m - 170.00	17.00m - 130.00 20.00m - 170.00 23.00m - 200.00	-	Pile
						P1-P2	267.561	30.00	10.00	0.00-9.00m - Silty Sand 9.00-10.50m - Sandy Silt with Clay 10.50-30.00m - Clayey Silt with Sand	-	-	-	-	Pile
						A2	270.300	30.00	9.50	0.00-3.00m - Sandy Silt 3.00-12.00m - Silty Sand 12.00-16.50m - Clayey Silt 16.50-30.00m - Clayey Silt with Sand	1.50m - 09.00 3.00m – 10.50 4.50m – 11.00 6.00m – 11.50	17.00m - 100.00 20.00m - 130.00 23.00m - 170.00	17.00m - 120.00 20.00m - 160.00 23.00m - 200.00	-	Pile
14	293	256/5-7	1 x 30.50	Tringular Girder Halt Through	2	A1	270.315	30.00	7.50	0.00-6.00m - Silty Sand 6.00-7.50m - Clayey Silt with Sand 7.50-10.50m - Silty Sand 10.50-21.00m - Clayey Silt with Sand 21.00-25.50m - Silty Sand 25.50-30.00m - Clayey Silt Below 30.00m - Clayey Silt with Sand	1.50m - 09.00 3.00m – 09.50 4.50m – 10.00 6.00m – 11.00	17.00m - 100.00 20.00m - 135.00 23.00m - 180.00	17.00m - 120.00 20.00m - 160.00 23.00m - 210.00	-	Pile
						A2	268.532	30.00	8.00	0.00-16.50m - Silty Sand 16.50-24.00m - Clayey Silt with Sand 24.00-30.00m - Clayey Silt	1.50m - 11.00 3.00m – 12.00 4.50m – 13.00 6.00m – 14.00	17.00m - 130.00 20.00m - 160.00 23.00m - 200.00	17.00m - 150.00 20.00m - 200.00 23.00m - 250.00	-	Pile

15	291	253/23-25	1 x 24.4	Steel Girder	2	A1	267.507	30.00	13.30	0.00-3.00m - Clayey Silt with Sand 3.00-22.50m - Clayey Silt 22.50-24.00m - Clayey Silt with Sand 24.00-25.50m - Clayey Silt 25.50-30.0m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 09.00 4.50m – 10.00 6.00m – 10.50	17.00m - 90.00 20.00m - 110.00 23.00m - 140.00	17.00m - 110.00 20.00m - 140.00 23.00m - 170.00	-	Pile
						A2	264.485	30.00	14.00	0.00-7.50m - Silty Sand 7.50-10.50m - Sandy Silt 10.50-12.00m - Clayey Silt 12.00-25.50m - Clayey Silt with Sand 25.50-30.00m - Clayey Silt	1.50m - 12.50 3.00m – 13.50 4.50m – 14.50 6.00m – 15.50	17.00m - 70.00 20.00m - 90.00 23.00m - 120.00	17.00m - 90.00 20.00m - 110.00 23.00m - 140.00	-	Pile
16	290	253/1-3	1 x 24.4	Steel Girder	2	A1	267.467	30.00	13.50	0.00-3.00m - Clayey Silt with Sand 3.00-13.50m - Clayey Silt 13.50-16.50m - Clayey Silt with Sand 16.50-19.50m - Clayey Silt 19.50-22.50m - Clayey Silt with Sand 22.50-28.50m - Clayey Silt 28.50-30.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 08.00 4.50m – 08.50 6.00m – 09.50	17.00m - 80.00 20.00m - 110.00 23.00m - 140.00	17.00m - 100.00 20.00m - 130.00 23.00m - 170.00	-	Pile
						A2	267.436	30.00	13.50	0.00-3.00m - Clayey Silt with Sand 3.00-7.50m - Clayey Silt 7.50-10.50m - Clayey Silt with Sand 10.50-30.00m - Clayey Silt	1.50m - 07.00 3.00m – 08.50 4.50m – 09.50 6.00m – 10.00	17.00m - 80.00 20.00m - 100.00 23.00m - 130.00	17.00m - 90.00 20.00m - 120.00 23.00m - 150.00	-	Pile
17	289	251/5-7	5 x 6.10	Slab	2	A1	267.373	30.00	8.00	0.00-3.00m - Sandy Silt with Clay 3.00-10.50m - Clayey Silt with Sand 10.50-12.00m - Silty Sand 12.00-13.50m - Clayey Silt with Sand 13.50-30.00m - Clayey Silt	1.50m - 08.00 3.00m – 09.00 4.50m – 10.00 6.00m – 10.50	17.00m - 100.00 20.00m - 135.00 23.00m - 170.00	17.00m - 120.00 20.00m - 160.00 23.00m - 210.00	-	Pile
						A2	267.294	30.00	7.00	0.00-3.00m - Clayey Silt with Sand 3.00-4.50m - Sandy Silt with Clay 4.50-12.00m - Silty Sand 12.00-19.50m - Clayey Silt with Sand 19.50-30.00m - Clayey Silt	1.50m - 08.50 3.00m – 09.50 4.50m – 10.50 6.00m – 11.50	17.00m - 120.00 20.00m - 150.00 23.00m - 180.00	17.00m - 140.00 20.00m - 180.00 23.00m - 220.00	-	Pile
					17			**510.00**						

Alignment															
18		265/19-21			1	BH-1	269.269	12.00	8.00	0.00-1.50m - Filled up Strata 1.50-12.00m - Sandy Silt with Clay	1.50m - 06.00 3.00m – 10.00 4.50m – 11.00 6.00m – 12.00	-	-	Below 6.00m from EGL	Open
19		262/800			1	BH-1	270.378	12.00	7.00	0.00-3.00m - Sandy Silt 3.00-6.00m - Sandy Silt with Clay 6.00-12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 13.00 4.50m – 14.00 6.00m – 15.00	-	-	Below 3.00m from EGL	Open
20		259/11-13			1	BH-1	269.431	12.00	6.00	0.00-4.50m - Silty Sand 4.50-12.00m - Clayey Silt with Sand	1.50m - 05.00 3.00m – 05.00 4.50m – 11.00 6.00m – 11.50	-	-	Below 6.00m from EGL	Open
21		258/15-17			1	BH-1	269.721	12.00	6.00	0.00-3.00m - Silty Sand 3.00-6.00m - Clayey Silt with Sand 6.00-7.50m - Silty Sand 7.50-12.00m - Clayey Silt with Sand	1.50m - 06.00 3.00m – 09.50 4.50m – 10.00 6.00m – 10.00	-	-	Below 6.00m from EGL	Open
22		255/5-7			1	BH-1	270.927	12.00	7.00	0.00-10.50m - Clayey Silt with Sand 10.50-12.00m - Silty Sand Below 12.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 11.00 4.50m – 12.00 6.00m – 13.00	-	-	Below 4.50m from EGL	Open
23		252/5-7			1	BH-1	268.897	12.00	Below 12.00	0.00-3.00m - Clayey Silt 3.00-7.50m - Clayey Silt with Sand 7.50-10.50m - Clayey Silt 10.50-12.00m - Sandy Silt Below 12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 10.00 4.50m – 12.00 6.00m – 13.00	-	-	Below 4.50m from EGL	Open
24		250/7-9			1	BH-1	269.045	12.00	Below 12.00	0.00-12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 10.00 4.50m – 13.00 6.00m – 14.00	-	-	Below 4.50m from EGL	Open
					7			**84.00**							

Detour Section															
25		14800			1	BH-1	268.221	12.00	6.50	0.00-7.50m - Clayey Silt with Sand 7.50-10.50m - Silty Sand 10.50-12.00m - Clayey Silt with Sand	1.50m - 07.00 3.00m – 10.00 4.50m – 10.50 6.00m – 11.50	-	-	Below 6.00m from EGL	Open
26		13750			1	BH-1	267.501	12.00	8.00	0.00-12.00m - Clayey Silt	1.50m - 08.50 3.00m – 10.50 4.50m – 11.50 6.00m – 12.50	-	-	Below 6.00m from EGL	Open
27		12650			2	A1	268.072	30.00	12.00	0.00-4.50m - Clayey Silt 4.50-9.00m - Clayey Silt with Sand 9.00-10.50m - Silty Sand with Clay 10.50-16.50m - Clayey Silt with Sand 16.50-19.50m - Clayey Silt 19.50-30.00m - Clayey Silt with Sand	1.50m - 07.50 3.00m – 10.00 4.50m – 10.50 6.00m – 11.50	17.00m - 105.00 20.00m - 140.00 23.00m - 175.00	17.00m - 130.00 20.00m - 170.00 23.00m - 210.00	-	Pile
						A2	268.673	30.00	12.00	0.00-3.00m - Silty Sand with Clay 3.00-7.50m - Clayey Silt with Sand 7.50-16.50m - Silty Sand 16.50-19.50m - Clayey Silt with Sand 19.50-24.00m - Silty Sand 24.00-25.50m - Clayey Silt 25.50-30.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 11.00 4.50m – 11.50 6.00m – 12.50	17.00m - 150.00 20.00m - 170.00 23.00m - 195.00	20.00m - 200.00 23.00m - 230.00	-	
28		12450			2	A1	269.580	30.00	12.00	0.00-1.50m - Filled up Strata 1.50-4.50m - Sandy Silt with Clay 4.50-18.00m - Clayey Silt with Sand 18.00-25.50m - Clayey Silt 25.50-30.00m - Clayey Silt with Sand	1.50m - 08.00 3.00m – 12.00 4.50m – 13.00 6.00m – 13.50	17.00m - 80.00 20.00m - 105.00 23.00m - 130.00	17.00m - 100.00 20.00m - 130.00 23.00m - 160.00	-	Pile
						A2	268.323	30.00	12.00	0.00-1.50m - Silty Sand with Clay 1.50-3.00m - Silty Sand 3.00-12.00m - Clayey Silt with Sand 12.00-13.50m - Silty Sand 13.50-30.00m - Clayey Silt with Sand	1.50m - 07.50 3.00m – 09.00 4.50m – 09.50 6.00m – 10.50	17.00m - 95.00 20.00m - 125.00 23.00m - 140.00	17.00m - 115.00 20.00m - 150.00 23.00m - 170.00	-	
29		11800			1	BH-1	269.373	12.00	6.00	0.00-4.50m - Sandy Silt with Clay 4.50-7.50m - Clayey Silt with Sand 7.50-12.00m - Silty Sand	1.50m - 06.00 3.00m – 08.00 4.50m – 09.00 6.00m – 10.00	-	-	Below 6.00m from EGL	Open
					7			**156**							
Total Borehole Depth & Borehole of Part - III					**40.00**			**858.00**							

CHAPTER – 118

"Minor Bridge No. 311",

Location – Existing Km. - 270/27-29

118.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x3x3

118.2 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 02.00m 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	Sandy Silt with Clay	Loose
	4.50 to 7.50	Clayey Silt with Sand	Medium Dense
	7.50 to 12.00	Clayey Silt	Medium Dense

118.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.40	NIL	0.0024	NIL	0.0013	0.092
	6.00	8.90	0.010	0.0038	NIL	0.0014	0.139

118.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	11.00
	6.00	22.00

118.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.1	119	94	153	842	0.2	2.5	1023	666
Requirement as per IS: 456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

118.6 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	10.40
	3.00	14.00
	4.50	15.00
	6.00	16.00

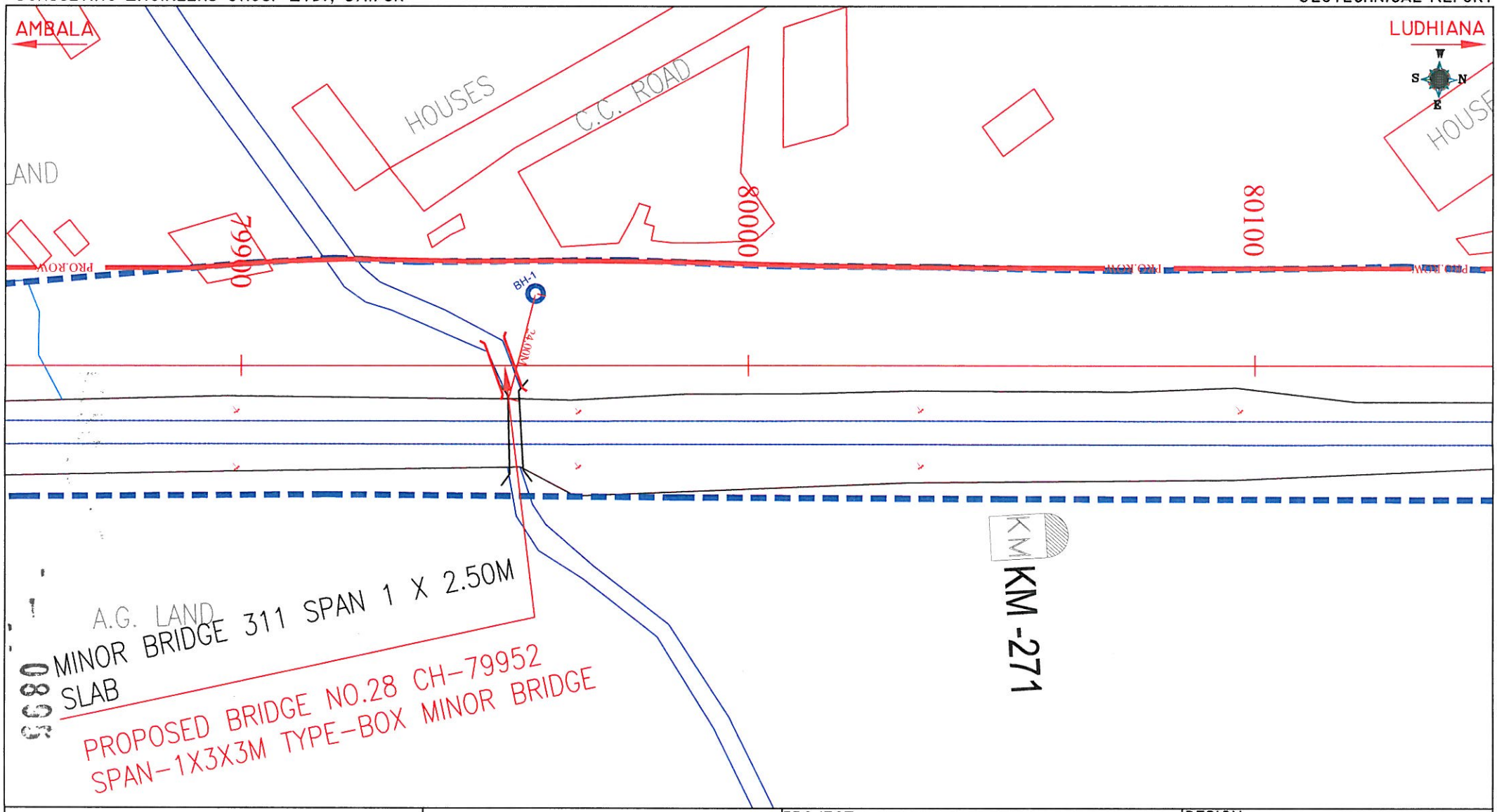
118.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

118.8 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-270/27-29	RL OF BH-I = 266.165	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. 311 AT CHAINAGE 270/27-29

Project :	Chainage 270/27-29 Bridge No. 311			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				06.12.2009 to 06.12.2009	1	1 (LHS)	02.00 m.	12.00mtr	266.165

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	-	-	-	Sandy Silt with Clay	11.15	68.23	18.95	0.49	0.63	0.55	0.00	27	17	10	-	-	-	-	-	-
1.50	6	1.40	8.40	Sandy Silt with Clay	9.68	73.87	15.41	0.38	0.23	0.43	0.00	25	16	9	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	9.25	70.72	19.35	0.43	0.25	0.00	0.00	25	16	9	1.80	15.60	1.58	2.66	0.10	21.0
4.50	10	1.03	10.30	Clayey Silt with Sand	20.52	64.42	6.20	4.79	3.47	0.60	0.00	38	20	18	-	-	-	-	-	-
6.00	UDS	-	-	Clayey Silt with Sand	22.14	69.28	6.11	1.55	0.52	0.40	0.00	39	20	19	1.86	15.83	1.60	2.65	0.22	15.0
7.50	13	0.86	11.18	Clayey Silt	28.93	66.58	1.62	0.78	1.02	1.07	0.00	51	25	26	-	-	-	-	-	-
10.50	18	0.74	13.32	Clayey Silt	14.88	81.84	2.78	0.50	0.00	0.00	0.00	34	21	13	-	-	-	-	-	-
12.00	24	0.70	15.90	Clayey Silt	16.68	81.13	1.94	0.25	0.00	0.00	0.00	35	21	14	-	-	-	-	-	-

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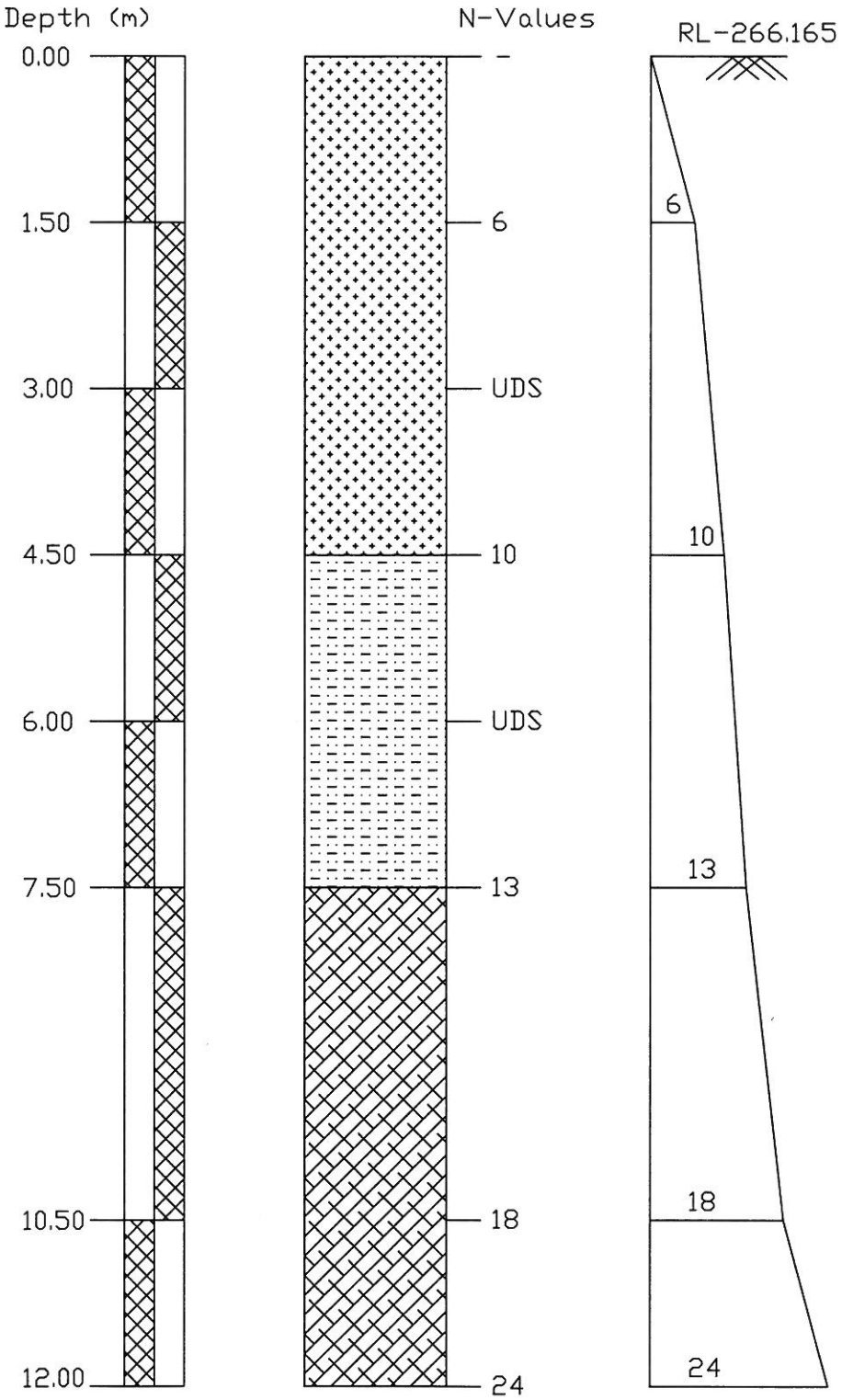
BORELOG OF BH–1 AT EXISTING KM–270/27–29 FOR MINOR BRIDGE NO.–311,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	SANDY SILT WITH CLAY
	CLAYEY SILT WITH SAND
	CLAYEY SILT

ANNEXURE - III

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

INPUT DATA

Ch 270 27-29 **BH-1**

Type of footing

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

Angle of internal friction (ϕ°)	15.00
Cohesion (c in t/m2)	2.20
Void ratio (e)	0.65
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.80
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
3	4.50	3.00	8.00
4	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.

ANNEXURE - III

Bearing capacity factors :

ϕ	15.00
N_c	10.98
N_q	3.94
N_γ	2.65

ϕ'	10.18
N'_c	8.44
N'_q	2.52
N'_γ	1.27

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
3	3.00	8.00	1.08	1.08	0.85
4	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	1.13	1.07	1.07
2	3.00	3.00	1.26	1.13	1.13
3	4.50	3.00	1.39	1.20	1.20
4	6.00	3.00	1.52	1.26	1.26

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
3	4.50	3.00	-1.00	0.50
4	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	1.50	3.00	8.00	13.73	7.02	10.37
2	3.00	3.00	8.00	18.13	9.29	13.71
3	4.50	3.00	8.00	19.68	10.08	14.88
4	6.00	3.00	8.00	21.22	10.87	16.04

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 27-29**

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	=	7.125	t/m^2
Concentrated load *P*		=	10.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.1	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.29474	

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

S_f = 0.03488 m

= 34.8783 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.31

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 = N.A.

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

S_{f2} = **25** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 27-29**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	9.975	t/m^2
Concentrated load *P*		=	13.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.8	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.28421	

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

S_f = 0.03378 m

= 33.776 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

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

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.83

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **22.4** **mm**

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 27-29**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	12.825	t/m^2
Concentrated load *P*		=	15.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	3.2	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.24561	

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

S_f = 0.02966 m

= 29.6556 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.92

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.74

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **17.6** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 27-29**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	15.675	t/m^2
Concentrated load *P*		=	16.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	3.4	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.21435	

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

S_f = 0.02622 m

= 26.2237 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.82

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.68

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **14.3** **mm**

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CHAPTER – 119

"Minor Bridge No. 310",

Location – Existing Km. - 270/05-07

119.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x3.05

119.2 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 07.00m 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	Sandy Silt with Clay	Loose
	4.50 to 12.00	Clayey Silt with Sand	Medium Dense
	Below 12.00	Silty Sand	Medium Dense

119.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.70	0.005	0.0041	NIL	0.0014	0.159
	6.00	9.00	0.012	0.0038	NIL	0.0014	0.119

119.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	11.00
	6.00	13.00

119.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.2	119	108	170	760	0.1	2.3	963	618
Requirement as per IS:456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

119.6 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	18.00
	6.00	19.00

119.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

119.8 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.

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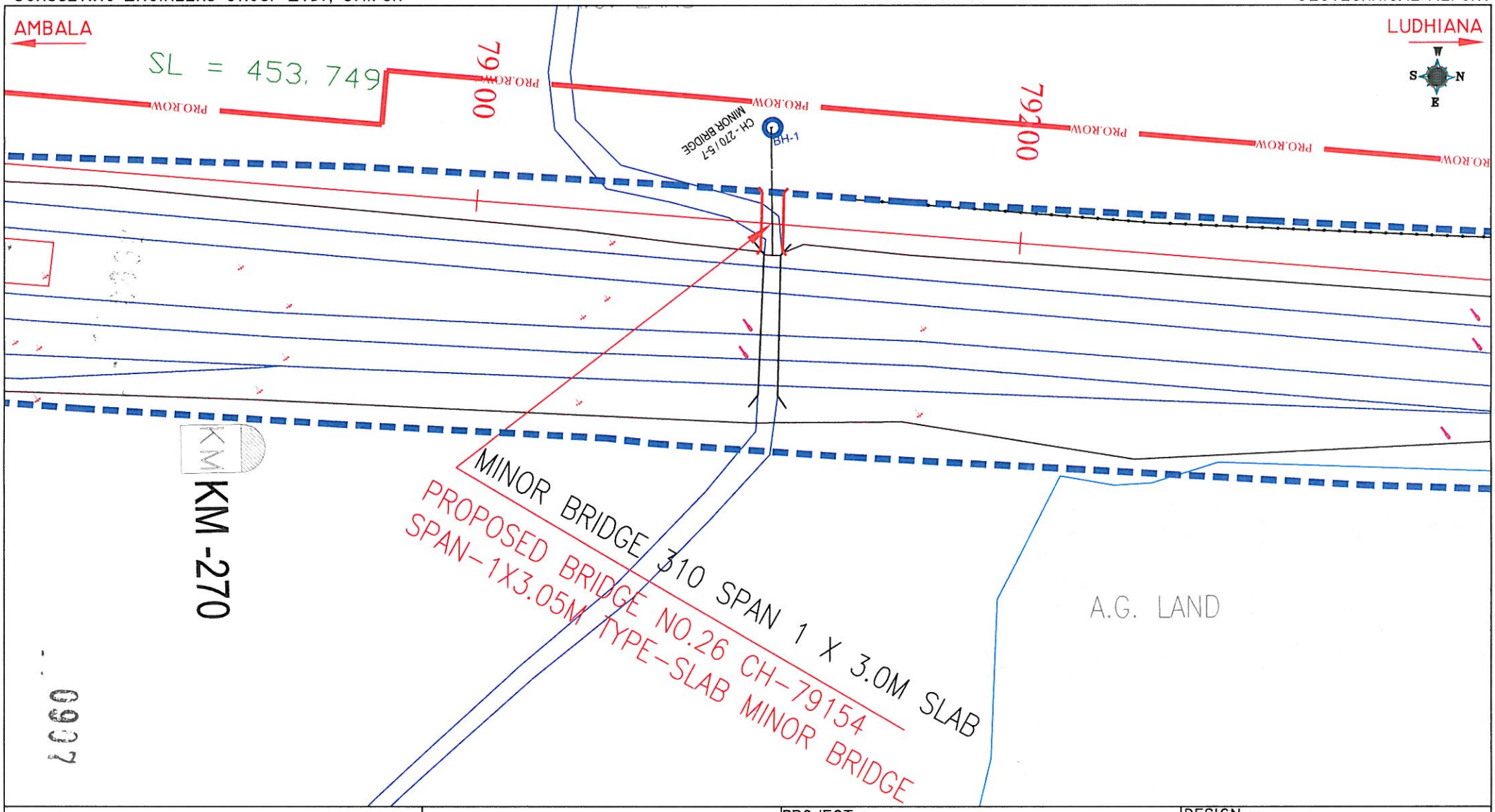

ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE CH-270/5-7	RL OF BH-I = 267.131	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 310 AT CHAINAGE 270/5-7

Project :	Chainage 270/5-7 Bridge No. 310			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				06.12.2009 to 06.12.2009	1	1 (LHS)	07.00 m.	12.00mtr	267.131

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	-	-	-	Sandy Silt with Clay	10.68	53.71	22.59	5.22	3.15	4.65	0.00	28	18	10	-	-	-	-	-	-
1.50	5	1.43	7.15	Sandy Silt with Clay	13.52	56.06	20.20	4.04	2.06	4.12	0.00	29	17	12	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	9.42	81.27	8.92	0.39	0.00	0.00	0.00	27	18	9	1.85	15.36	1.60	2.65	0.10	21.0
4.50	13	1.06	13.78	Clayey Silt with Sand	12.41	76.41	10.04	0.59	0.32	0.23	0.00	29	18	11	-	-	-	-	-	-
6.00	UDS	-	-	Clayey Silt with Sand	12.65	70.94	10.52	3.00	1.31	1.58	0.00	29	18	11	1.94	18.91	1.63	2.70	0.11	21.0
7.50	16	0.89	14.24	Clayey Silt with Sand	15.42	75.14	7.91	0.87	0.56	0.10	0.00	31	18	13	-	-	-	-	-	-
10.50	22	0.77	15.97	Clayey Silt with Sand	14.83	69.85	7.35	2.93	2.26	2.78	0.00	31	18	13	-	-	-	-	-	-
12.00	31	0.73	18.82	Silty Sand	3.58	41.78	53.79	0.39	0.23	0.23	0.00	26	NIL	NP	-	-	-	-	-	-

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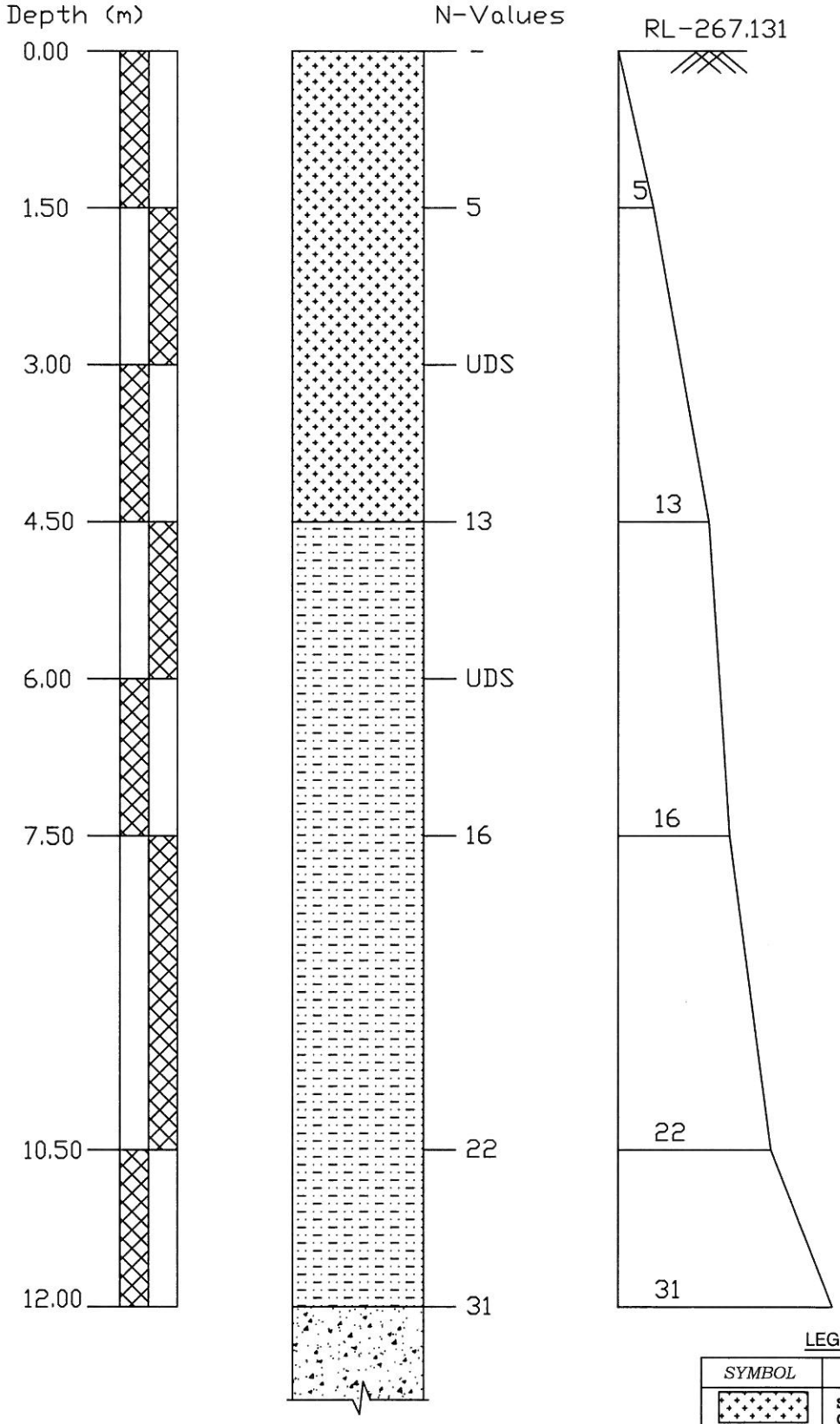
BORELOG OF BH–1 AT EXISTING KM–270/5–7 FOR MINOR BRIDGE NO.–310,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

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

0909

ANNEXURE - III

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

INPUT DATA

	Ch 270 5-7	BH-1	
Type of footing			
1	Continuous Strip		
2	Rectangular	***Rectangular***	**2**
3	Square		
4	Circular		

Angle of internal friction (ϕ°)	21.00
Cohesion (c in t/m2)	1.00
Void ratio (e)	0.65
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.85
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
3	4.50	3.00	8.00
4	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.

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ANNEXURE - III

Bearing capacity factors :

ϕ	21.00
N_c	16.01
N_q	7.25
N_γ	6.49

ϕ'	14.42
N'_c	10.68
N'_q	3.77
N'_γ	2.49

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
3	3.00	8.00	1.08	1.08	0.85
4	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	1.29	1.15	1.15
3	4.50	3.00	1.44	1.22	1.22
4	6.00	3.00	1.58	1.29	1.29

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
3	4.50	3.00	-1.00	0.50
4	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	1.50	3.00	8.00	15.44	6.69	11.06
2	3.00	3.00	8.00	23.42	10.21	16.81
3	4.50	3.00	8.00	25.27	11.02	18.14
4	6.00	3.00	8.00	27.12	11.83	19.48

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 5-7**

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	=	6.9375	t/m^2
Concentrated load *P*		=	9.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.0	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.28757	

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

S_f = 0.03413 m

= 34.1285 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.31

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 = N.A.

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

S_{f2} = **24.8** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 5-7**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	9.7125	t/m^2
Concentrated load *P*		=	14.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.9	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.3027	

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

S_f = 0.03571 m

= 35.7065 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

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

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.83

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **23.7** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 5-7**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	12.4875	t/m^2
Concentrated load *P*		=	18.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	3.8	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.3027	

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

S_f = 0.03571 m

= 35.7065 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.92

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.74

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **21.1** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.270/ 5-7**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	15.2625	t/m^2
Concentrated load *P*		=	19.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	4.0	t/m^2
Compression Index	Cc	=	0.114	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.65	
	$\frac{Po + \Delta p}{Po}$	=	1.26143	

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

S_f = 0.03136 m

= 31.3587 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.82

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.68

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **17.1** **mm**

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CHAPTER – 120

"Minor Bridge No. 309",

Location – Existing Km. - 269/35-37

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120.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x3x2

120.2 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 07.00m 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	Filled up Strata	Loose
	1.50 to 7.50	Sandy Silt with Clay	Loose
	7.50 to 10.50	Sandy Silt with Clay	Medium Dense
	10.50 to 12.00	Sandy Silt	Medium Dense

120.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	9.10	0.0011	0.0028	NIL	0.0014	0.0111
	6.00	9.50	0.015	0.0031	NIL	0.0015	0.098

120.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	12.00
	6.00	13.00

120.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.2	119	125	176	842	0.2	2.1	1046	638
Requirement as per IS: 456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

120.6 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	09.00
	3.00	14.00
	4.50	15.00
	6.00	16.00

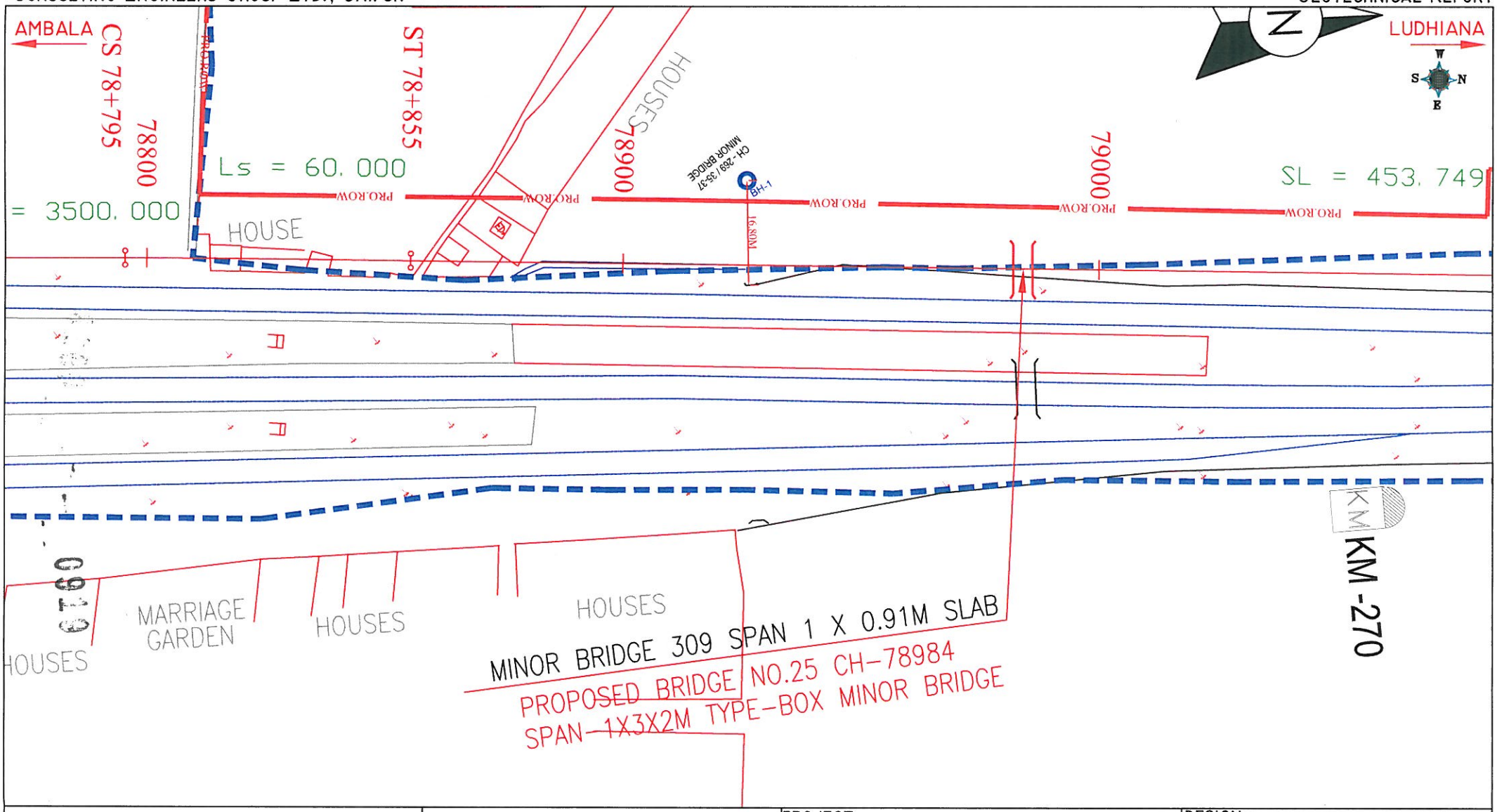
120.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

120.8 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-269/35-37	RL OF BH-I = 267.536	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. 309 AT CHAINAGE 269/35-37

Project :	Chainage 269/35-37 Bridge No. 309			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				07.12.2009 to 07.12.2009	1	1	07.00 m.	12.00mtr	267.536

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	-	-	-	Filled up strata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.50	4	1.42	5.68	Sandy Silt with Clay	8.35	78.43	10.36	1.36	0.25	1.25	0.00	27	19	8	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	11.35	71.01	15.26	0.58	0.45	1.35	0.00	29	19	10	1.80	14.35	1.57	2.65	0.12	20.0
4.50	7	1.05	7.35	Sandy Silt with Clay	9.68	73.04	14.36	1.88	0.35	0.69	0.00	29	20	9	-	-	-	-	-	-
6.00	UDS	-	-	Sandy Silt with Clay	13.25	64.06	19.68	2.25	0.48	0.28	0.00	30	19	11	1.86	16.28	1.60	2.56	0.13	20.0
7.50	13	0.88	11.44	Sandy Silt with Clay	10.98	67.28	18.52	1.35	0.66	1.21	0.00	30	21	9	-	-	-	-	-	-
10.50	18	0.76	13.68	Sandy Silt	3.68	75.11	16.35	1.66	0.98	2.22	0.00	25	NIL	NP	-	-	-	-	-	-
12.00	23	0.72	15.78	Sandy Silt	2.15	80.15	15.33	0.69	1.15	0.53	0.00	22	NIL	NP	-	-	-	-	-	-

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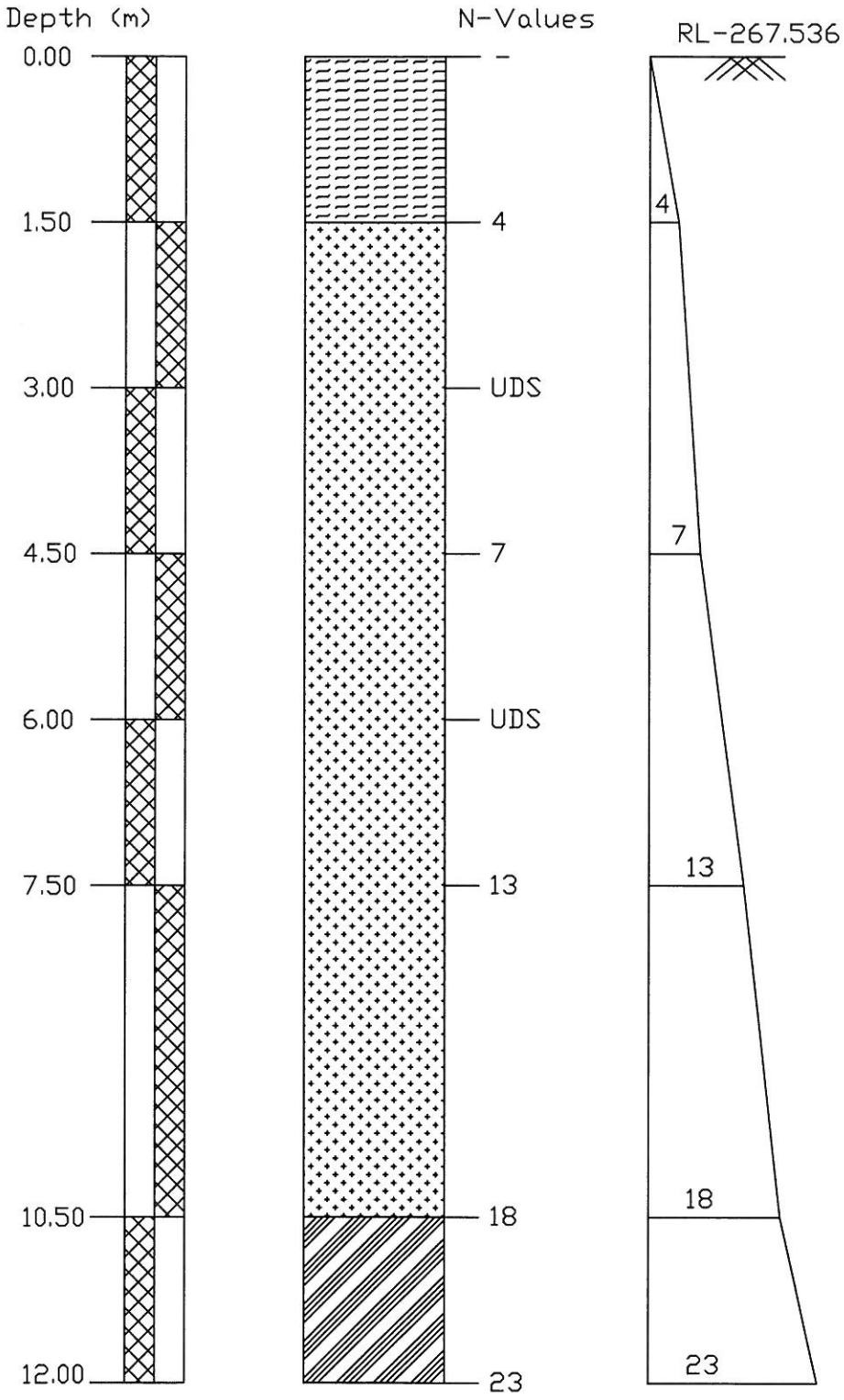
BORELOG OF BH–1 AT EXISTING KM–269/35–37 FOR MINOR BRIDGE NO.–309,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	FILLED UP STRATA
	SANDY SILT WITH CLAY
	SANDY SILT

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ANNEXURE - III

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

INPUT DATA

	Ch 269 35-37	**BH-1**
Type of footing		
1 Continuous Strip		
2 Rectangular	***Rectangular***	**2**
3 Square		
4 Circular		

Angle of internal friction (ϕ°)	20.00
Cohesion (c in t/m2)	1.20
Void ratio (e)	0.68
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.80
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
3	4.50	3.00	8.00
4	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.

ANNEXURE - III

Bearing capacity factors :

ϕ	20.00
N_c	14.83
N_q	6.40
N_γ	5.39

ϕ'	13.70
N'_c	10.30
N'_q	3.56
N'_γ	2.28

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
3	3.00	8.00	1.08	1.08	0.85
4	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	1.14	1.07	1.07
2	3.00	3.00	1.29	1.14	1.14
3	4.50	3.00	1.43	1.21	1.21
4	6.00	3.00	1.57	1.29	1.29

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
3	4.50	3.00	-1.00	0.50
4	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	1.50	3.00	8.00	14.78	6.81	9.60
2	3.00	3.00	8.00	21.83	10.14	14.23
3	4.50	3.00	8.00	23.59	10.95	15.38
4	6.00	3.00	8.00	25.36	11.77	16.53

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 35-37**

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	=	6.9375	t/m^2
Concentrated load *P*		=	9.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	1.9	t/m^2
Compression Index	Cc	=	0.12	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.68	
	$\frac{Po + \Delta p}{Po}$	=	1.27243	

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

S_f = 0.03363 m

= 33.6326 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.31

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 = N.A.

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

S_{f2} = **24.5** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 35-37**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	9.7125	t/m^2
Concentrated load *P*		=	14.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.9	t/m^2
Compression Index	Cc	=	0.12	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.68	
	$\frac{Po + \Delta p}{Po}$	=	1.3027	

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

S_f = 0.03691 m

= 36.9146 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

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

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.83

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **24.5** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 35-37**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	12.4875	t/m^2
Concentrated load *P*		=	15.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	3.2	t/m^2
Compression Index	Cc	=	0.12	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.68	
	$\frac{Po + \Delta p}{Po}$	=	1.25225	

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

S_f = 0.0314 m

= 31.4009 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.92

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.74

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **18.6** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 35-37**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	15.2625	t/m^2
Concentrated load *P*		=	16.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	3.4	t/m^2
Compression Index	Cc	=	0.12	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.68	
	$\frac{Po + \Delta p}{Po}$	=	1.22015	

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

S_f = 0.02778 m

= 27.7754 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.82

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.68

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **15.1** **mm**

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CHAPTER - 121

"Minor Bridge No. 308",

Location – Existing Km. - 269/05-06

121.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x2x1.2

121.2 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 06.00m 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	Filled up Strata	Loose
	1.50 to 4.50	Sandy Silt with Clay	Loose
	4.50 to 10.50	Sandy Silt with Clay	Medium Dense
	10.50 to 12.00	Sandy Silt	Medium Dense
	Below 12.00	Sandy Silt with Clay	Medium Dense

121.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	9.40	0.011	0.0028	NIL	0.0013	0.0086
	6.00	9.10	NIL	0.0031	NIL	0.0012	0.0091

121.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	12.00
	6.00	10.00

121.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.2	100	107	171	835	0.2	2.7	1023	672
Requirement as per IS:456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

121.6 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	08.00
	3.00	10.50
	4.50	11.50
	6.00	13.00

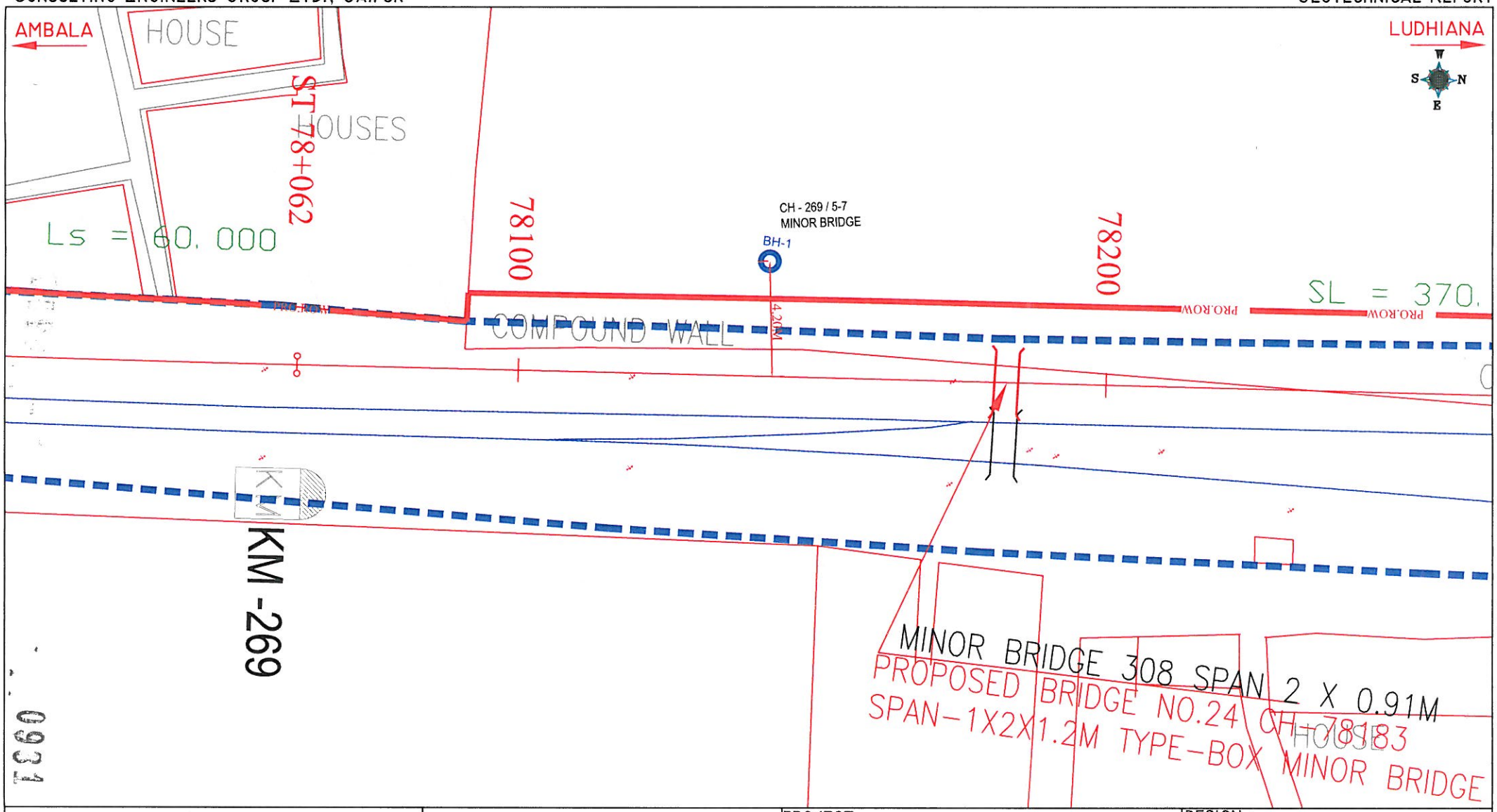
121.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

121.8 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 CH-269/5-7	RL OF BH-I = 268.687	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. 308 AT CHAINAGE 269/5-6

Project :	Chainage 269/5-6 Bridge No. 308			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				07.12.2009 to 07.12.2009	1	1	06.00 m.	12.00mtr	268.687

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	-	-	-	Filled Up strata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.50	6	1.42	8.52	Sandy Silt with Clay	10.55	78.54	10.43	0.38	0.10	0.00	0.00	28	18	10	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	10.14	71.00	16.35	1.26	0.56	0.69	0.00	28	19	9	1.78	13.59	1.57	2.65	0.11	20.0
4.50	11	1.06	11.66	Sandy Silt with Clay	8.26	66.22	22.91	1.41	0.52	0.68	0.00	25	17	8	-	-	-	-	-	-
6.00	UDS	-	-	Sandy Silt with Clay	10.68	69.36	17.52	0.85	0.34	1.25	0.00	27	18	9	1.86	18.25	1.57	2.65	0.10	21.0
7.50	14	0.88	12.32	Sandy Silt with Clay	9.21	74.24	15.43	0.69	0.18	0.25	0.00	26	18	8	-	-	-	-	-	-
10.50	18	0.77	13.86	Sandy Silt	2.65	65.38	26.77	1.94	0.78	2.48	0.00	23	NIL	NP	-	-	-	-	-	-
12.00	22	0.72	15.42	Sandy Silt with Clay	8.68	81.68	9.00	0.47	0.12	0.05	0.00	26	18	8	-	-	-	-	-	-

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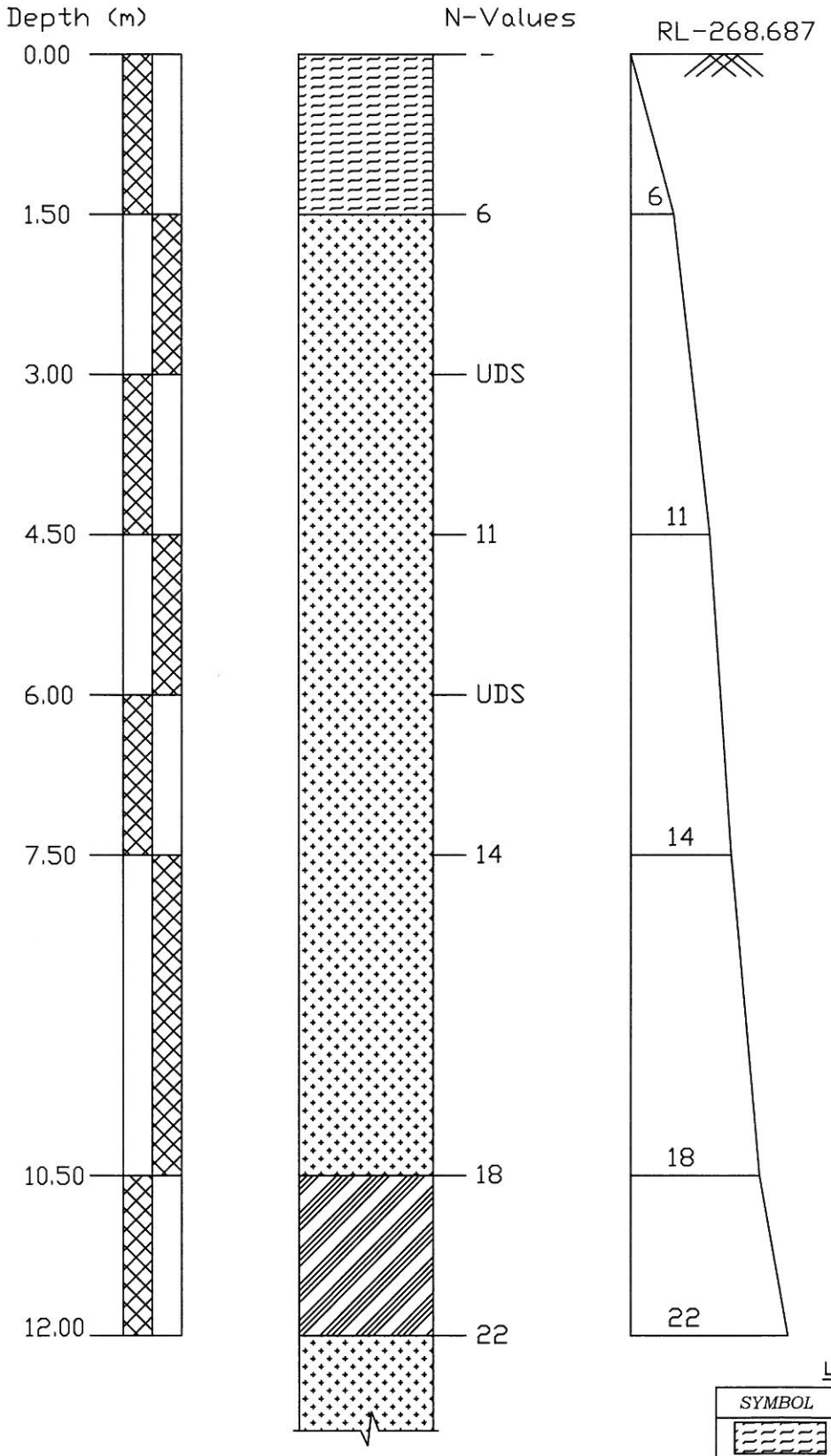
BORELOG OF BH–1 AT EXISTING KM–269/5–7 FOR MINOR BRIDGE NO.–308,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	FILLED UP STRATA
	SANDY SILT WITH CLAY
	SANDY SILT

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ANNEXURE - III

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

INPUT DATA

Ch 269 5-7 **BH-1**

Type of footing

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

Angle of internal friction (ϕ °)	20.00
Cohesion (c in t/m2)	1.10
Void ratio (e)	0.70
Direction of load with vertical (°)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.89
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	1.50	2.00	8.00
2	3.00	2.00	8.00
3	4.50	2.00	8.00
4	6.00	2.00	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.

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ANNEXURE - III

Bearing capacity factors :

ϕ	20.00
N_c	14.83
N_q	6.40
N_γ	5.39

ϕ'	13.70
N'_c	10.30
N'_q	3.56
N'_γ	2.28

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	2.00	8.00	1.05	1.05	0.90
2	2.00	8.00	1.05	1.05	0.90
3	2.00	8.00	1.05	1.05	0.90
4	2.00	8.00	1.05	1.05	0.90

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.50	2.00	1.21	1.11	1.11
2	3.00	2.00	1.43	1.21	1.21
3	4.50	2.00	1.64	1.32	1.32
4	6.00	2.00	1.86	1.43	1.43

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	2.00	0.00	0.50
2	3.00	2.00	-0.75	0.50
3	4.50	2.00	-1.50	0.50
4	6.00	2.00	-2.25	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	2.00	8.00	13.96	6.45	8.33
2	3.00	2.00	8.00	17.81	8.26	10.65
3	4.50	2.00	8.00	19.89	9.22	11.89
4	6.00	2.00	8.00	21.96	10.18	13.13

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 5-6**

BH No. (A1)

Depth of foundation		=	1.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	6.75	t/m^2
Concentrated load *P*		=	8.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	1.7	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.7	
	$\frac{Po + \Delta p}{Po}$	=	1.24889	

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

S_f = 0.03322 m

= 33.2155 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.38

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.88

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **23.4** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 5-6**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	9.71	t/m^2
Concentrated load *P*		=	10.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.2	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.7	
	$\frac{Po + \Delta p}{Po}$	=	1.22703	

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

S_f = 0.03058 m

= 30.5763 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.75

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.76

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **18.6** **mm**

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Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 5-6**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	12.5	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	=	0.21	
	ΔP	=	2.4	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.7	
	$\frac{Po + \Delta p}{Po}$	=	1.19339	

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

S_f = 0.02642 m

= 26.4226 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.89

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.73

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **15.4** **mm**

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.269/ 5-6**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	15.675	t/m^2
Concentrated load *P*		=	13.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.7	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.7	
	$\frac{Po + \Delta p}{Po}$	=	1.17416	

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

S_f = 0.02399 m

= 23.9947 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.67

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.70

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **13.4** **mm**

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CHAPTER – 122

"Minor Bridge No. 305",

Location – Existing Km. - 268/21-23

122.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x3x3

122.2 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 08.00m 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	Filled up Strata	Loose
	1.50 to 4.50	Sandy Silt with Clay	Loose
	4.50 to 12.00	Sandy Silt with Clay	Medium Dense

122.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.80	NIL	0.0027	NIL	0.0016	0.0088
	6.00	9.10	NIL	0.0025	NIL	0.0010	0.0096

122.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	13.00
	6.00	10.00

122.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.2	101	124	173	756	0.1	2.4	956	607
Requirement as per IS: 456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

122.6 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	08.00
	3.00	11.00
	4.50	12.00
	6.00	13.00

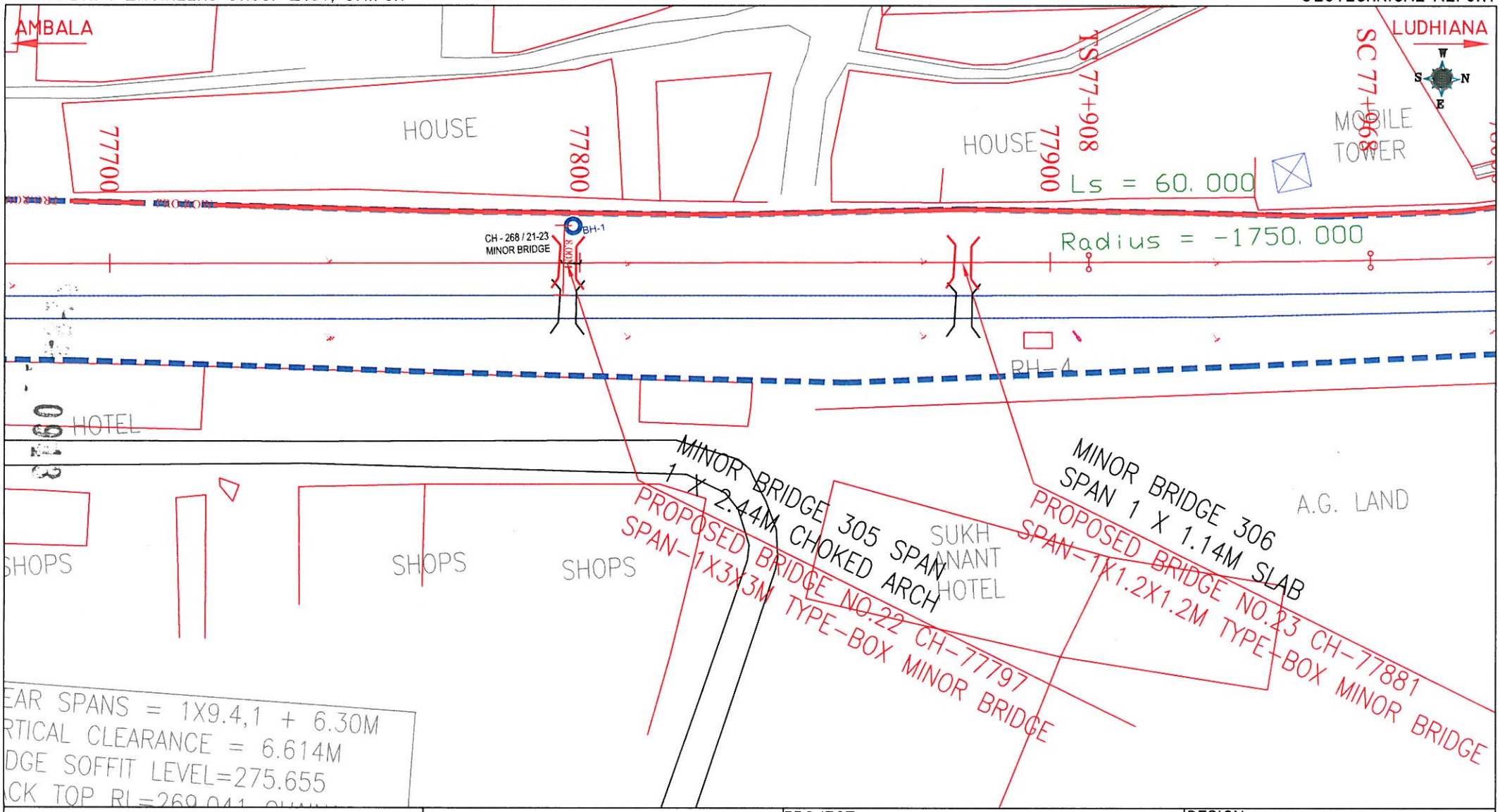
122.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

122.8 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 CH-268/21-23

RL OF BH-I = 268.095

PROJECT :-

LUDHIANA-AMBALA (DFCCIL)

DESIGN :-

CONSULTING ENGINEERS GROUP LTD.
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SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 305 AT CHAINAGE 268/21-23

Project :	Chainage 268/21-23 Bridge No. 305			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				08.12.2009 to 08.12.2009	1	1	08.00 m.	12.00mtr	268.095

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	-	-	-	Filled up strara	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.50	6	1.45	8.70	Sandy silt with clay	12.10	73.94	12.35	1.25	0.36	0.00	0.00	30	20	10	-	-	-	-	-	-
3.00	UDS	-	-	Sandy silt with clay	13.25	73.00	10.25	2.25	1.25	0.00	0.00	32	21	11	1.76	13.25	1.55	2.65	0.12	19.0
4.50	10	1.08	10.80	Sandy silt with clay	9.85	72.87	14.52	1.65	0.86	0.25	0.00	29	21	9	-	-	-	-	-	-
6.00	UDS	-	-	Sandy silt with clay	8.66	74.85	12.67	2.25	1.21	0.36	0.00	29	21	8	1.85	15.22	1.60	2.66	0.10	21.0
7.50	12	0.90	10.80	Sandy silt with clay	11.26	70.92	14.89	1.58	1.35	0.00	0.00	30	20	10	-	-	-	-	-	-
10.50	16	0.79	12.64	Sandy silt with clay	9.14	72.22	15.67	1.65	0.86	0.46	0.00	28	20	8	-	-	-	-	-	-
12.00	22	0.74	15.64	Sandy silt with clay	13.25	64.17	19.64	1.85	0.73	0.36	0.00	31	20	11	-	-	-	-	-	-

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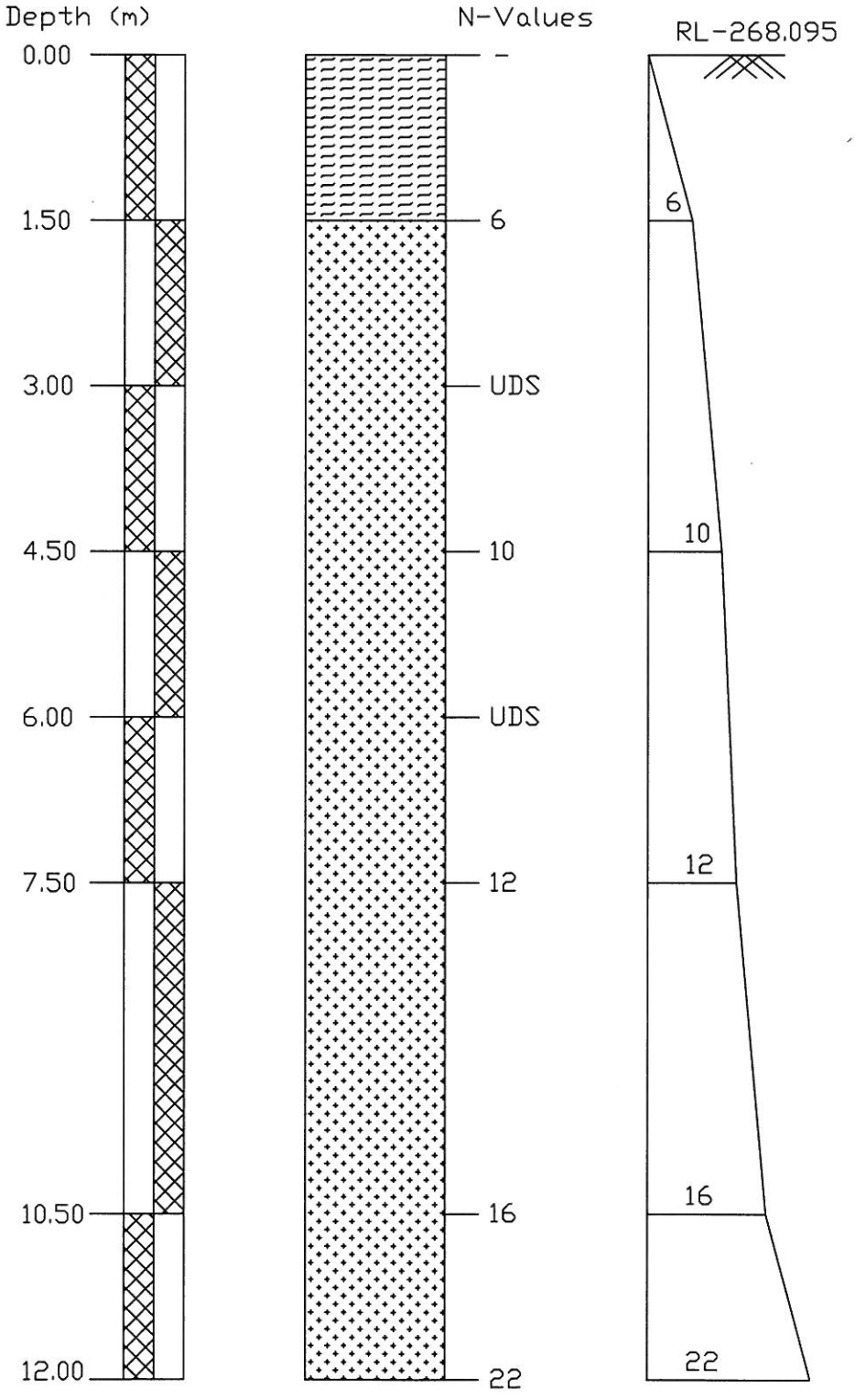
BORELOG OF BH–1 AT EXISTING KM–268/21–23 FOR MINOR BRIDGE NO.–305,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	FILLED UP STRATA
	SANDY SILT WITH CLAY

0915

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ANNEXURE - III

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

INPUT DATA

Ch 268 21-23 **BH-1**

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Rectangular **2**

Angle of internal friction (ϕ °)	19.00
Cohesion (c in t/m2)	1.20
Void ratio (e)	0.71
Direction of load with vertical (°)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.89
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
3	4.50	3.00	8.00
4	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 $\phi < 10^o$

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

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

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.

ANNEXURE - III

Bearing capacity factors :

ϕ	19.00	ϕ'	12.99
N_c	14.06	N'_c	9.92
N_q	5.91	N'_q	3.35
N_γ	4.84	N'_γ	2.08

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
3	3.00	8.00	1.08	1.08	0.85
4	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	1.14	1.07	1.07
2	3.00	3.00	1.28	1.14	1.14
3	4.50	3.00	1.42	1.21	1.21
4	6.00	3.00	1.56	1.28	1.28

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
3	4.50	3.00	-1.00	0.50
4	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	1.50	3.00	8.00	13.77	6.43	7.90
2	3.00	3.00	8.00	20.19	9.49	11.63
3	4.50	3.00	8.00	21.80	10.25	12.56
4	6.00	3.00	8.00	23.41	11.00	13.49

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.268/ 21-23**

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	=	6.75	t/m^2
Concentrated load *P*		=	8.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	1.7	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.24889	

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

S_f = 0.03302 m

= 33.0213 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.31

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 = N.A.

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

S_{f2} = **24.0** **mm**

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.268/ 21-23**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	9.7125	t/m^2
Concentrated load *P*		=	11.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.3	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.23784	

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

S_f = 0.0317 m

= 31.7008 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

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

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.83

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

= 0.8

Pore Pr. Correction = N.A.

Total Settlement = $S_f \times D.F. \times R.F.$

S_{f2} = **21.0 mm**

0919

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.268/ 21-23**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	12.4875	t/m^2
Concentrated load *P*		=	12.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.5	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.2018	

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

S_f = 0.02731 m

= 27.3112 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.92

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.74

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **16.2** **mm**

0950

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.268/ 21-23**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	15.68	t/m^2
Concentrated load *P*		=	13.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.7	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.17416	

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

S_f = 0.02385 m

= 23.8544 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.82

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.68

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **13.0 mm**

0951

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CHAPTER – 123

"Minor Bridge No. 303",

Location – Existing Km. - 267/06-07

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123.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x2x2

123.2 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 08.00m below EGL.

Subsurface profile at the site

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

123.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.70	0.007	0.0031	NIL	0.0012	0.080
	6.00	8.80	0.009	0.0035	NIL	0.0013	0.100

123.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	11.00
	6.00	12.00

123.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.1	121	101	165	780	0.2	2.0	982	638
Requirement as per IS:456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

123.6 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	08.00
	3.00	11.00
	4.50	12.00
	6.00	13.50

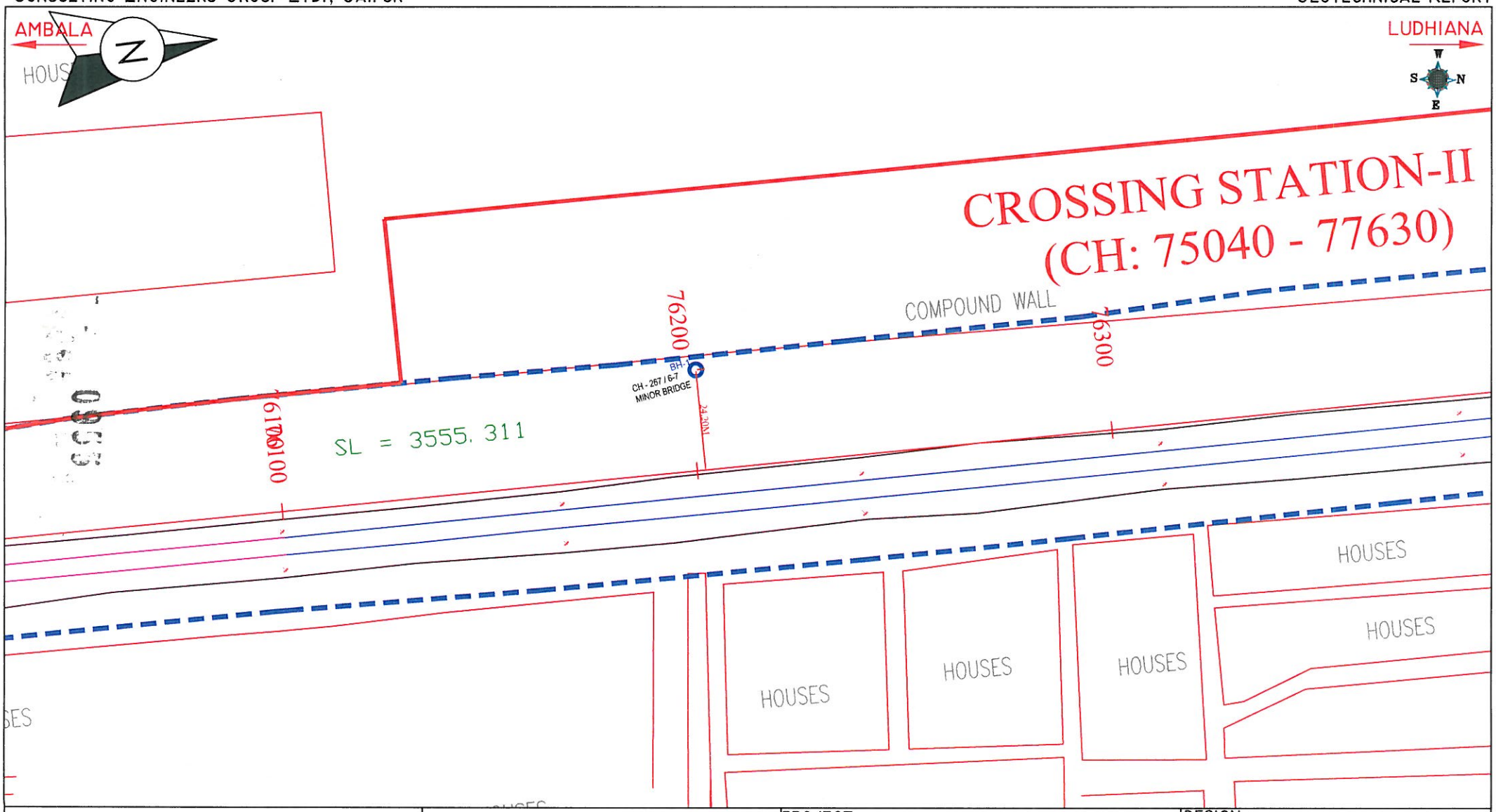
123.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

123.8 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		PROJECT :-	DESIGN :-
FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE CH-267/6-7	RL OF BH-I = 267.602	LUDHIANA-AMBALA (DFCCIL)	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. 303 AT CHAINAGE 267/6-7

Project :	Chainage 267/6-7 Bridge No. 304			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				08.12.2009 to 08.12.2009	1	1	08.00 m.	12.00mtr	267.602

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	-	-	-	Sandy Silt with Clay	8.15	77.79	13.25	0.56	0.25	0.00	0.00	26	18	8	-	-	-	-	-	-
1.50	5	1.44	7.20	Sandy Silt with Clay	7.11	80.73	11.36	0.70	0.10	0.00	0.00	25	18	7	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	10.42	71.07	17.57	0.17	0.77	0.00	0.00	30	21	9	1.80	14.52	1.57	2.66	0.11	20.0
4.50	9	1.07	9.63	Sandy Silt with Clay	7.22	79.23	13.04	0.31	0.14	0.06	0.00	27	20	7	-	-	-	-	-	-
6.00	UDS	-	-	Sandy Silt with Clay	9.89	73.51	15.26	0.66	0.68	0.00	0.00	29	20	9	1.90	15.68	1.65	2.67	0.11	20.0
7.50	14	0.89	12.46	Sandy Silt with Clay	12.25	70.05	16.38	0.58	0.74	0.00	0.00	31	21	10	-	-	-	-	-	-
10.50	17	0.78	13.26	Sandy Silt with Clay	8.58	71.69	18.59	0.48	0.66	0.00	0.00	28	20	8	-	-	-	-	-	-
12.00	20	0.73	14.60	Sandy Silt with Clay	12.88	68.46	17.53	0.65	0.48	0.00	0.00	31	20	11	-	-	-	-	-	-

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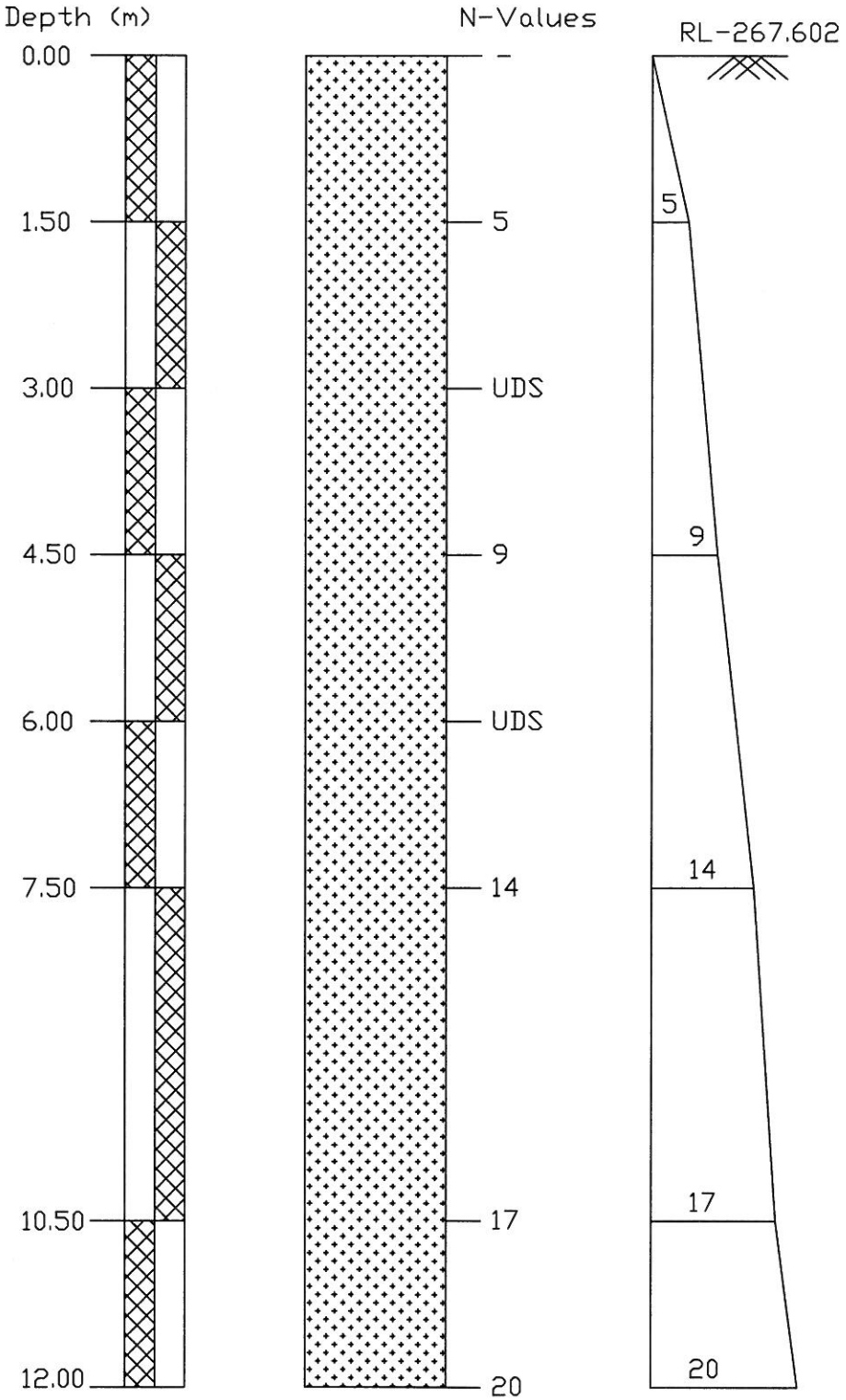
BORELOG OF BH–1 AT EXISTING KM–267/6–7 FOR MINOR BRIDGE NO.–303,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	SANDY SILT WITH CLAY

0957

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ANNEXURE - III

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

INPUT DATA

		Ch 267 6-7	BH-1
Type of footing			
1	Continuous Strip		
2	Rectangular	***Rectangular***	**2**
3	Square		
4	Circular		

Angle of internal friction (ϕ°)	20.00
Cohesion (c in t/m2)	1.10
Void ratio (e)	0.69
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.80
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	1.50	2.00	8.00
2	3.00	2.00	8.00
3	4.50	2.00	8.00
4	6.00	2.00	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.

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0958

ANNEXURE - III

Bearing capacity factors :

ϕ	20.00	ϕ'	13.70
N_c	14.83	N'_c	10.30
N_q	6.40	N'_q	3.56
N_γ	5.39	N'_γ	2.28

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	2.00	8.00	1.05	1.05	0.90
2	2.00	8.00	1.05	1.05	0.90
3	2.00	8.00	1.05	1.05	0.90
4	2.00	8.00	1.05	1.05	0.90

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.50	2.00	1.21	1.11	1.11
2	3.00	2.00	1.43	1.21	1.21
3	4.50	2.00	1.64	1.32	1.32
4	6.00	2.00	1.86	1.43	1.43

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	2.00	0.00	0.50
2	3.00	2.00	-0.75	0.50
3	4.50	2.00	-1.50	0.50
4	6.00	2.00	-2.25	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	2.00	8.00	13.88	6.42	8.66
2	3.00	2.00	8.00	17.73	8.22	11.07
3	4.50	2.00	8.00	19.79	9.18	12.36
4	6.00	2.00	8.00	21.86	10.14	13.65

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.267/ 6-7**

BH No. (A1)

Depth of foundation		=	1.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	6.9375	t/m^2
Concentrated load *P*		=	8.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	1.7	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.69	
	$\frac{Po + \Delta p}{Po}$	=	1.24216	

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

S_f = 0.0326 m

= 32.6002 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.38

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.88

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **23.0 mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.267/ 6-7**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	9.7125	t/m^2
Concentrated load *P*		=	11.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.3	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.69	
	$\frac{Po + \Delta p}{Po}$	=	1.23784	

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

S_f = 0.03208 m

= 32.0759 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.75

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.78

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **20.0 mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.267/ 6-7**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	12.4875	t/m^2
Concentrated load *P*		=	12.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.5	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.69	
	$\frac{Po + \Delta p}{Po}$	=	1.2018	

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

S_f = 0.02763 m

= 27.6344 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.89

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.73

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **16.1** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.267/ 6-7**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	2.0	m
Initial effective stress at mid of layer	Po	=	15.675	t/m^2
Concentrated load *P*		=	13.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.8	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.69	
	$\frac{Po + \Delta p}{Po}$	=	1.18086	

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

S_f = 0.02499 m

= 24.9919 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.67

D = Depth of Foundation

L/B = 4.00

Depth Factor = 0.71

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **14.2 mm**

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CHAPTER – 124

"Minor Bridge No. 301",

Location – Existing Km. - 264/33-35

124.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x6.10

124.2 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 01.80m below EGL.

Subsurface profile at the site

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

124.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	7.90	NIL	0.0024	NIL	0.0013	0.069
	6.00	8.10	NIL	0.0026	NIL	0.0015	0.075

124.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	23.00
	6.00	21.00

124.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.0	85	98	162	793	0.2	2.0	994	639
Requirement as per IS: 456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

124.6 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	09.50
	4.50	10.50
	6.00	11.00

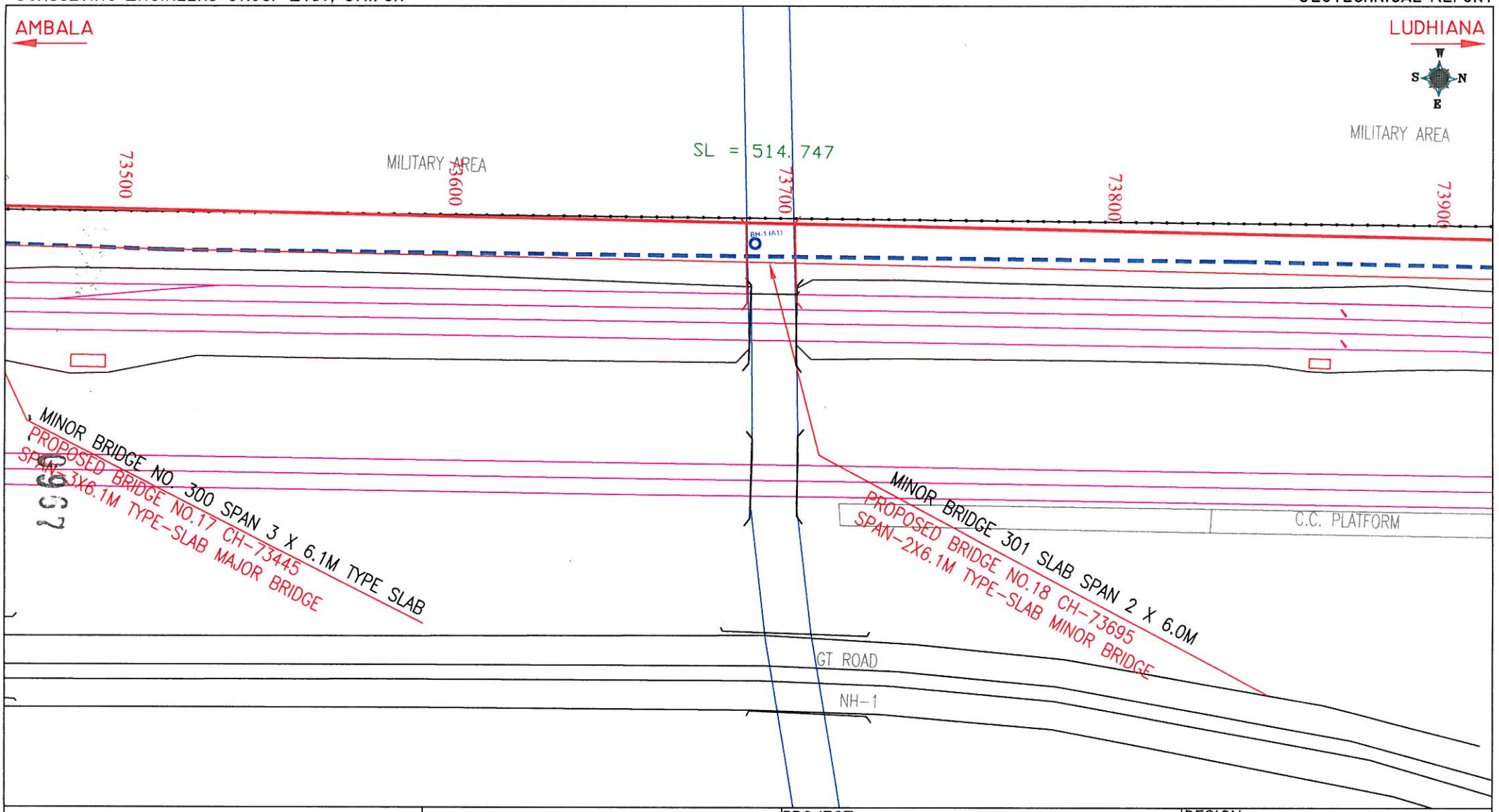
124.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

124.8 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 CH. 264/33-35	RL OF BH-I = 268.437	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. 301 AT CHAINAGE 264/33-35

Project :	Chainage 264/33-35 Bridge No. 301			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				09.12.2009 to 09.12.2009	1	1	01.80 m.	12.00mtr	268.437

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	17.52	66.10	13.41	2.14	0.58	0.25	0.00	34	19	15	-	-	-	-	-	-
1.50	7	1.43	10.01	Clayey Silt with Sand	18.89	62.32	16.99	1.18	0.46	0.16	0.00	35	18	17	-	-	-	-	-	-
3.00	UDS	-	-	Clayey Silt with Sand	23.25	71.48	4.77	0.50	0.00	0.00	0.00	43	23	20	1.86	18.56	1.57	2.68	0.22	13.0
4.50	9	1.06	9.54	Clayey Silt with Sand	22.14	69.33	6.16	0.91	0.67	0.79	0.00	42	22	20	-	-	-	-	-	-
6.00	UDS	-	-	Clayey Silt with Sand	20.99	68.67	8.55	0.85	0.58	0.36	0.00	40	21	19	1.93	19.86	1.61	2.68	0.20	15.0
7.50	13	0.89	11.57	Clayey Silt with Sand	19.58	68.34	10.26	0.62	0.74	0.46	0.00	37	19	18	-	-	-	-	-	-
10.50	14	0.77	10.78	Clayey Silt with Sand	21.89	66.40	9.45	0.89	0.82	0.55	0.00	41	21	20	-	-	-	-	-	-
12.00	18	0.73	13.14	Clayey Silt with Sand	18.46	70.19	8.59	1.21	0.92	0.63	0.00	36	20	16	-	-	-	-	-	-

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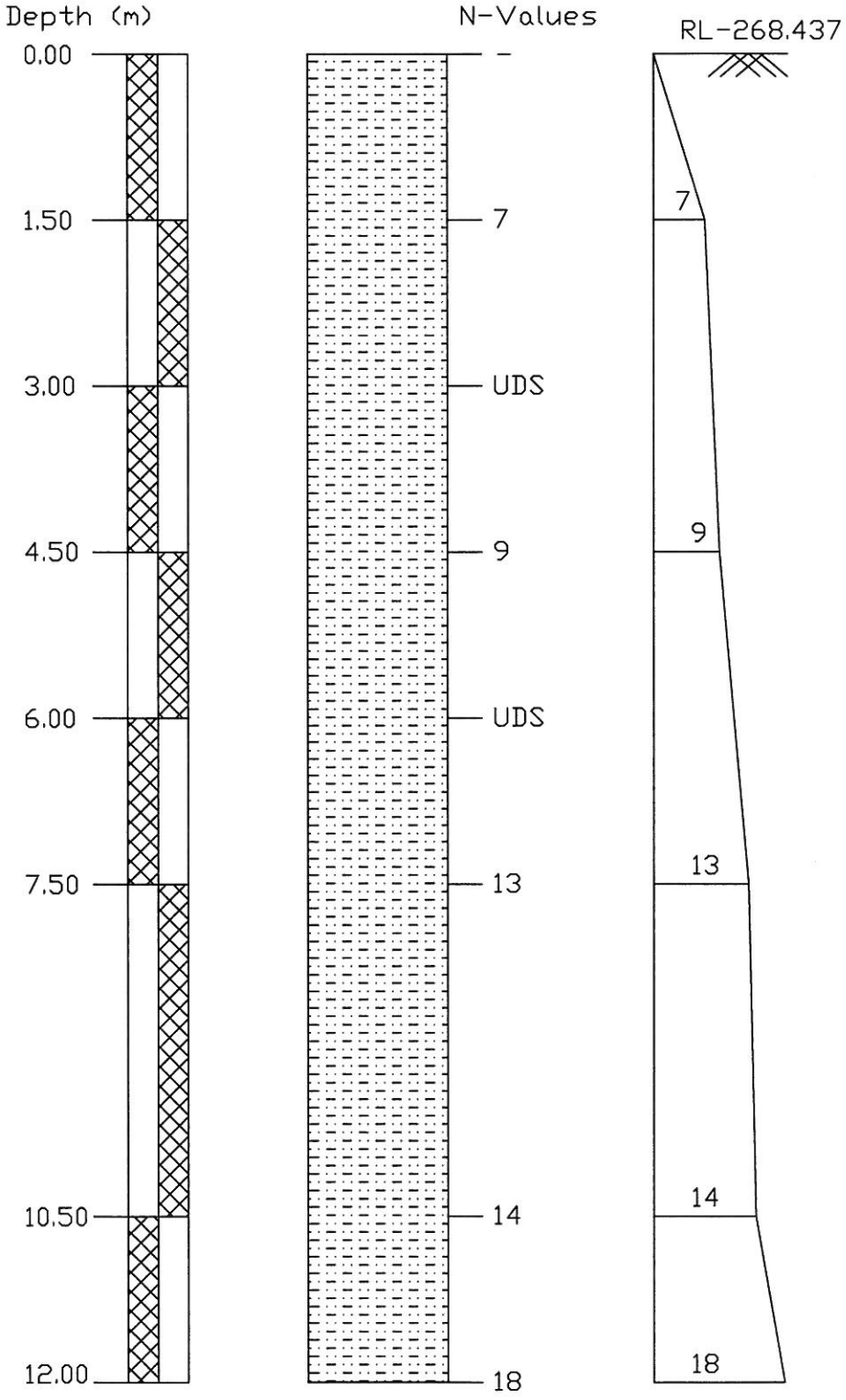
BORELOG OF BH–1 AT EXISTING KM–264/33–35 FOR MINOR BRIDGE NO.–301,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND

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ANNEXURE - III

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

INPUT DATA

Ch 264 33-35 **BH-1**

Type of footing

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

Angle of internal friction (ϕ°)	13.00
Cohesion (c in t/m2)	2.20
Void ratio (e)	0.71
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.86
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
3	4.50	3.00	8.00
4	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.

ANNEXURE - III

Bearing capacity factors :

ϕ	13.00	ϕ'	8.79
N_c	9.93	N'_c	7.90
N_q	3.35	N'_q	2.25
N_γ	2.08	N'_γ	1.03

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
3	3.00	8.00	1.08	1.08	0.85
4	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	1.13	1.06	1.06
2	3.00	3.00	1.25	1.13	1.13
3	4.50	3.00	1.38	1.19	1.19
4	6.00	3.00	1.50	1.25	1.25

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
3	4.50	3.00	-1.00	0.50
4	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	1.50	3.00	8.00	11.97	6.33	7.45
2	3.00	3.00	8.00	15.56	8.23	9.70
3	4.50	3.00	8.00	16.86	8.93	10.51
4	6.00	3.00	8.00	18.17	9.62	11.33

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.264/ 33-35**

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	=	6.75	t/m^2
Concentrated load *P*		=	7.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	1.5	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.21778	

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

S_f = 0.02927 m

= 29.2733 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$D/(LB)^{\wedge 0.5}$ = 0.31

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 = N.A.

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

S_{f2} = **21.3 mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.264/ 33-35**

BH No. (A1)

Depth of foundation		=	3.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	9.45	t/m^2
Concentrated load *P*		=	9.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.0	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.21111	

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

S_f = 0.02846 m

= 28.4577 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

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

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.83

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **18.9 mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.264/ 33-35**

BH No. (A1)

Depth of foundation		=	4.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	12.15	t/m^2
Concentrated load *P*		=	10.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.2	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.18148	

Settlement of clay layer

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

S_f = 0.02478 m

= 24.7776 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.92

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.74

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **14.7** **mm**

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ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Minor Bridge at Ch.264/ 33-35**

BH No. (A1)

Depth of foundation		=	6.0	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	15.68	t/m^2
Concentrated load *P*		=	11.00	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.21	
	ΔP	=	2.3	t/m^2
Compression Index	Cc	=	0.13	
Thickness of clay layer	H	=	4.5	m
Initial Void ratio	e_o	=	0.71	
	$\frac{Po + \Delta p}{Po}$	=	1.14737	

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

S_f = 0.02042 m

= 20.4247 mm

Correction for Depth,Rigidity of foundation and Pore Pr. on total settlement

Depth Factor Calculation

$(LB)^{\wedge 0.5}/D$ = 0.82

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.68

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

= 0.8

Pore Pr. Correction = N.A.

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

S_{f2} = **11.1 mm**

CHAPTER – 125

"Minor Bridge No. 299",

Location – Existing Km. - 263/21-23

125.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 3x6.10

125.2 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 01.00m below EGL.

Subsurface profile at the site

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

125.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.10	0.007	0.0028	NIL	0.0013	0.121
	6.00	8.60	0.005	0.0031	NIL	0.0014	0.109

125.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	12.00
	6.00	14.00

125.5 CHEMICAL ANALYSIS OF ENCOUNTERED WATER FROM BORE HOLE

Chemical Properties	pH Value	Chlorides mg/lit	Sulphate mg/lit	Organic Matter mg/lit	Inorganic Matter mg/lit	Acidity (ml)	Alkalinity (ml)	Total Disso. Solids (ppm)	Conductivity (µS/cm)
Test Result	7.3	112	99	148	789	0.1	2.0	973	640
Requirement as per IS:456 / Mosrth's	Not less then 6.0	2000 for CC and 500 for RCC	400	200	3000	5 ml of 0.02 normal NaoH	25 ml of 0.02 normal H_2SO_4	-	-

125.6 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	10.50
	6.00	11.00

125.7 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.
- Chemical contents of Water are within the safe limits for construction purpose.

125.8 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.