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

TANGRI RIVER

VOL 6/7

EMPLOYER

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

(A GOVERNMENT OF INDIA ENTERPRISES)

MINISTRY OF RAILWAYS

COUNTRY : INDIA

Tangri River		
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PREFACE

This volume contains the report on detailed geotechnical investigation work for bridge on Tangri River on the Dedicated Freight Corridor alignment.

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1. INTRODUCTION

Dedicated Freight Corridor Corporation India Limited (A Govt. of India Enterprise),Ambala awarded the Geotechnical investigation work along with preparation of GADs for 3 river locations vide their letter no.-UMB/EN/Tender.GI dated -04.08.2012 to M/S Arkitechno Consultants (India) Pvt. Ltd., Bhubaneswar. On receipt of the work order, ATCPL mobilized required resources at the site and carried out necessary field works. The samples collected during the field tests were sent to the testing laboratory of ATCPL of Bhubaneswar for testing.

2. SITE DESCRIPTION

The project site is located in the state of Haryana.

The project site is located in Zone-IV of Seismic zone of India as specified in IS-1893(PT-1).

3. METHODOLOGY OF INVESTIGATION

The geotechnical Investigation work broadly encompasses the following activities:-

- Making boreholes, at specified locations, conducting SPT & collecting samples there form.
- Conducting various laboratory tests on samples to assess their physical/engineering properties.
- Tabulation of all observations made at the site as well as during laboratory tests in standard format.
- Analysis of observations / test results.

4. SUMMARY OF FIELD WORK

4.1 Exploratory boreholes have been drilled at the following locations & their details are presented in Appendix-1 of this report.

Table No. - 1- Borehole location and depth

Borehole No's	Depth of Boring (m)
Tangri River	
BH-1(A1)	50.0
BH-2(P1)	50.0
BH-3(P2)	50.0
BH-4(A2)	50.0

5. SUMMARY OF LABORATORY TESTS

Soil samples have been tested for various properties as per the provision of latest versions of I.S. codes. The particulars of test are presented in Table no 2 of this report.

Table no-2

SL. NO.	PARTICULARS OF TEST	IS CODE REFERENCE
FOR SOIL SAMPLE		
1.	Natural Moisture Content & Bulk Density	IS 2720 (Part - 7)
2.	Grain Size Analysis (Sieve)	IS 2720 (Part - 4)
3.	Liquid Limit and Plastic Limits	IS 2720 (Part - 5)
4.	Hydrometer Analysis	IS 2720 (Part -4)
5.	Specific Gravity	IS 2720 (Part -3)
6.	Direct Shear Test	IS 2720 (Part -13)
7.	Free Swell Index	IS 2720 (Part - 40)
8.	Unconfined compressive strength of soil	IS 2720 (Part-10)
9.	Shrinkage Limit	IS 2720 (Part -6)
10.	Triaxial Shear Test	IS 2720 (Part -11)
11.	Swell Pressure	IS 2720 (Part -41)
12.	Consolidation	IS 2720 (Part-15)

Summary of laboratory tests done on Soil samples are presented below in table no-3.

SUMMERY SHEET RESULTS LABORATORY TEST OF SOIL SAMPLE (TABLE NO.-3)

Bore Hole No	Depth (m)	Type of Sample	Density		Natural Moisture Content (%)	Gradation				Consistency			Soil		Specific gravity	Shrinkage Limit (%)	Swell Pressure(kg/cm^2)	Free Swell Index (%)	Unconfined Compressive Strength(kg/cm^2)	SHEAR PARAMETERS			One Dimensional Consolidation Test		Void Ratio
			Bulk Density (gm/cc)	Dry Density (gm/cc)		Gravel content (%)	Sand Content (%)	Silt content (%)	Clay content (%)	LL (%)	PL (%)	PI (%)	IS Classification	Description						TYPE OF TEST	Cohesion (Kg/cm2)	Angle of internal Friction Ø(Degree)	C_c	C_v (cm^2 /min)	
BH-1(Tangri River-Saharanpur)	0.5	UDS	1.93	1.61	19.64	0	5.39	26.46	68.15	30	17	13	CL	Clayey Silt	2.66		0.22	12	0.31	TST	0.16	8	0.138	0.0126	0.652
	1.5	SPT	1.94	1.61	20.61	0	6.24	27.16	66.60	29	16	13	CL		2.66		-	-	-						0.662
	3.0	SPT				0	62.81	37.19		18	NP	-	SM	Sandy Silt	2.65		Nil	-	0.29	DST	0.11	14			
	4.5	SPT	1.88	1.66	13.28	2.81	6.3	19.86	71.03	31	17	14	CL	Clay with few amount of Kankar	2.69		-	-	-						0.630
	6.0	SPT	1.96	1.71	14.93	1.42	5.98	92.60		30	17	13	CL		2.68		0.18	-	-						0.576
	6.5	UDS	2.01	1.72	16.85	2.72	6.43	90.85		31	16	15	CL		2.69		0.21	8	0.36				0.136	0.0124	0.563
	7.5	SPT	2.02	1.72	17.64	2.55	8.96	21.73	66.76	30	15	15	CL		2.68		-	-	-						0.567
	9.0	SPT				0	67.8	32.20		19	NP	-	SM	Silty Sand	2.65		0.17	-	0.34	DST	0.13	12			
	12.0	SPT	1.86	1.65	12.42	0	66.19	33.81		20	NP	-	SM		2.65		-	-	-						0.606
	13.0	SPT				0	0.32	19.31	80.37	38	17	21	CI	Clay	2.70	9.73	0.21	-	0.41						
	14.0	UDS	2.03	1.68	20.88	0	0.16	31.57	68.27	35	17	18	CI		2.71		0.18	15	0.39	TST	0.18	8	0.163	0.0122	0.622
	17.0	UDS	2.05	1.69	21.36	0	0.29	30.09	69.62	36	18	18	CI		2.69		0.19	17	0.38	TST	0.19	8	0.164	0.0131	0.601
	20.0	UDS	2.08	1.71	21.86	0	0.41	99.59		4 0	19	21	CI		2.70		0.21	18	0.42	TST	0.2	9	0.188	0.0142	0.588
	23.0	UDS	2.09	1.73	20.76										2.69		0.18	16	0.41	TST	0.21	10	0.186	0.0135	0.554
	24.0	SPT	2.06	1.69	22.21	0	0.25	32.7	67.05	36	17	19	CI		2.68	8.11	-	-	-		-	-		-	0.610
	26.0	UDS	2.08	1.71	21.36	0	0.63	31.84	67.53	37	18	19	CI		2.69		0.2	17	0.43	TST	0.21	10	0.173	0.0129	0.573
	27.0	SPT	2.09	1.73	20.89	0	0.47	99.53		39	20	19	CI		2.69	9.33	-	-	-		0.22	9		-	0.563
	29.0	UDS	2.11	1.75	20.73										2.69		0.19	15	0.44	TST	0.22	10	0.181	0.0133	0.545
	32.0	UDS	2.16	1.78	21.54	0	0.32	29.91	69.77	37	17	20	CI		2.68		0.21	17	0.43	TST	0.19	10	0.184	0.0131	0.514
	33.0	SPT	2.16	1.77	22.15	0	0.52	30.78	68.70	36	17	19	CI		2.69	10.16	-	-	-		-	-		-	0.537
	35.0	UDS	2.15	1.77	21.71										2.70		0.18	16	0.44	TST	0.21	11	0.186	0.0121	0.534
	39.0	SPT	2.18	1.78	22.70	0	0.18	99.82		40	20	20	CI		2.70	9.77	0.2	-	-		-	-	-	-	0.525
	45.0	SPT	2.19	1.83	19.54	0	6.27	93.73		32	18	14	CL	Silty Clay	2.67	10.81	0.2	-	0.28		-	-	-	-	0.459
	48.0	SPT	2.18	1.80	20.84	0	5.89	25.64	68.47	33	17	16	CL		2.71	9.73	0.2	-	-		-	-	-	-	0.505

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SUMMERY SHEET RESULTS LABORATORY TEST OF SOIL SAMPLE (TABLE NO.-3)

Bore Hole No	Depth (m)	Type of Sample	Density		Natural Moisture Content (%)	Gradation				Consistency			Soil		Specific gravity	Shrinkage Limit (%)	Swell Pressure(kg/cm^2)	Free Swell Index (%)	Unconfined Compressive Strength(kg/cm^2)	SHEAR PARAMETERS			One Dimensional Consolidation Test		Void Ratio
			Bulk Density (gm/cc)	Dry Density (gm/cc)		Gravel content (%)	Sand Content (%)	Silt content (%)	Clay content (%)	LL (%)	PL (%)	PI (%)	IS Classification	Description						TYPE OF TEST	Cohesion (Kg/cm2)	Angle of internal Friction Ø(Degree)	C_c	C_v (cm^2/min)	
BH-2(Tangri River-Saharanpur)	3.0	SPT	1.82	1.63	11.64	0	64.92	35.08		19	NP	-	SM	Sandy Silt	2.65	-	-	-	0.22	TST	0.11	8	-	-	0.62
	4.5	SPT				0	5.17	26.59	68.24	34	18	16	CL	Silty Clay	-	3.84	-	-	-		-		-	-	-
	5.0	UDS	2.05	1.70	20.45	0	5.65	28.41	65.94	32	16	16	CL		2.66	-	0.28	5	0.24	TST	0.14	7	0.138	0.0126	0.56
	6.0	SPT				0	5.59	28.63	65.78	32	17	15	CL		2.66	4.37	-	-	-		-	-	-	-	-
	8.0	UDS				0	6.12	27.22	66.66	33	18	15	CL		2.66	-	0.31	3	0.26	TST	0.16	8	0.143	0.0131	-
	9.0	SPT	1.99	1.64	21.16	0	4	96.00		31	16	15	CL		2.67	3.92	0.3	-			-	-	-	-	0.63
	10.5	UDS	2.06	1.72	19.51	0									2.66	-	0.33	5	0.25	TST	0.14	7	0.138	0.0122	0.54
	13.5	UDS				0	6.08	27.81	66.11	32	18	14			-	-	0.31	5	0.24	TST	0.15	8	0.136	0.0131	-
	15.0	SPT	1.99	1.62	23.01	0	0.56	99.44		40	20	20	CI	Clay	2.67	6.84	-	-	-		-	-	-	-	0.66
	16.5	UDS	2.00	1.64	22.16	0	0.87	99.13		39	20	19	CI		2.69	-	0.26	15	0.31	TST	0.16	9	0.149	0.0114	0.65
	18.0	SPT	2.02	1.64	23.42	0	0.25	28.43	71.32	40	19	21	CI		2.69	10.28	0.39	-	-		-	-	-	-	0.65
	19.5	UDS	2.04	1.68	21.72	0	0.83	29.65	69.52	38	18	20	CI		2.68	-	0.38	17	0.33	TST	0.15	10	0.163	0.0122	0.60
	22.5	UDS	1.99	1.63	22.30	0									2.69	-	0.38	15	0.36	TST	0.14	9	0.158	0.121	0.61
	24.0	SPT	2.11	1.69	24.78	0	0.62	31.18	68.20	36	18	18	CI		2.68	8.76	-	-	-		-	-	-	-	0.58
	25.5	UDS	2.06	1.71	20.27	0	0.91	29.72	69.37	37	17	20	CI		2.68	-	0.36	16	0.38	TST	0.12	9	0.161	0.0119	0.56
	27.0	SPT	2.01	1.65	21.82	0	0.38	34.27	65.35	35	17	18	CI		2.67	9.34	-		-		-	-	-	-	0.63
	28.5	UDS				0	0.73	32.06	67.21	37	18	19	CI		2.68	-	0.38	18	0.36	TST	0.13	10	0.173	0.0113	-
	30.0	SPT				0	0.42	31.38	68.20	37	19	18	CI		2.68	10.81	-	-	-		-	-	-	-	-
	31.5	UDS	2.07	1.69	22.80	0	0.76	30.74	68.50	38	19	19	CI		2.68	-	0.38	17	0.38	TST	0.13	9	0.169	0.0114	0.59
	33.0	SPT	2.16	1.74	23.91	0	0.19	28.55	71.26	40	20	20	CI		2.69	9.73	-		-		-	-	-	-	0.55
	34.5	UDS				0	0.24	99.76		39	20	19	CI		2.69	-	0.38	16	0.39	TST	0.16	10	0.189	0.0113	-
	43.5	SPT	2.19	1.80	21.94	0	0.34	30.831	68.83	38	18	20	CI		2.68	10.84	-		-	-	-	-	-	-	0.49
	45.0	SPT	2.20	1.80	22.07	0	0.6	32.69	66.71	37	18	19	CI		2.69	9.36	0.38		0.36	-	-	-	-	-	0.49
	50.0	SPT				0	0.48	33.04	66.48	36	17	19	CI			10.44	0.38		-	-	-	-	-	-	-

SUMMERY SHEET RESULTS LABORATORY TEST OF SOIL SAMPLE (TABLE NO.-3)

Bore Hole No	Depth (m)	Type of Sample	Density		Natural Moisture Content (%)	Gradation				Consistency			Soil		Specific gravity	Shrinkage Limit (%)	Swell Pressure(kg/cm^2)	Free Swell Index (%)	Unconfined Compressive Strength(kg/cm^2)	SHEAR PARAMETERS			One Dimensional Consolidation Test		Void Ratio
			Bulk Density (gm/cc)	Dry Density (gm/cc)		Gravel content (%)	Sand Content (%)	Silt content (%)	Clay content (%)	LL (%)	PL (%)	PI (%)	IS Classification	Description						TYPE OF TEST	Cohesion (Kg/cm2)	Angle of internal Friction Ø(Degree)	C_c	C_v (cm^2 /min)	
BH-3(Tangri River-Ambala)	1.5	SPT	1.96	1.76	11.64	0	62.04	37.96		18	NP	_	S.M	Sandy Silt	2.66					DST	0.06	14			0.52
	3.0	SPT				0	45.51	54.49		19	NP	_	S.M		2.65										
	6.0	SPT	2.03	1.77	14.86	0	0.14	99.86		32	17	15	CL	Silty Clay	2.65	2.86	0.11								0.50
	7.0	UDS	2.01	1.76	14.28	0	5.61	27.82	66.57	31	17	14	CL		2.66		0.13	5	0.230	TST	0.13	8	0.128	0.0211	0.51
	9.0	SPT				0	0.12	99.88		33	18	15	CL			2.31									
	10.0	UDS	2.06	1.77	16.33	0	4.89	29.43	65.68	32	18	14	CL		2.66		0.14	5	0.220	TST	0.13	9	0.127	0.0198	0.50
	12.0	SPT	1.99	1.72	15.48	0	5.17	28.71	66.12	34	19	15	CL		2.65	2.64									0.54
	13.0	UDS				0	6.01	26.52	67.47	35	19	16	CL				0.13	8	0.240	TST	0.16	10	0.142	0.0183	
	16.0	UDS	2.01	1.73	16.41					33	18	15	CL		2.64		0.12	8	0.220	TST	0.17	11	0.138	0.0144	0.53
	18.0	SPT				0	4.76	27.38	67.86	32	17	15	CL			2.55	0.16								
	19.0	UDS	2.16	1.83	18.32	0	5.24	26.45	68.31	34	18	16	CL				0.15	6	0.260	TST	0.17	10	0.137	0.0138	
	21.0	SPT	2.14	1.82	17.53	0	2.87	18.32	78.81	35	18	17	CI	Clay	2.69	7.44									0.48
	22.0	UDS	2.18	1.84	18.74	0	0.93	31.42	67.65	39	18	21	CI				0.28	15	0.330	TST	0.21	10	0.218	0.0127	
	25.0	UDS	2.21	1.86	18.66	0	0.76	29.65	69.59	37	17	20	CI		2.68		0.31	16	0.320	TST	0.21	9	0.223	0.0131	0.44
	27.0	SPT	2.19	1.83	19.71	0	0.51	99.49		38	18	20	CI		2.69	8.26									0.47
	28.0	UDS	2.18	1.84	18.48	0	0.97	32.73	66.30	36	17	19	CI				0.29	16	0.340	TST	0.22	10	0.222	0.0141	
	30.0	SPT	2.24	1.89	18.73	0	5.40	18.41	76.19	40	20	20	CI		2.68	8.34					0.22	9			0.42
	31.0	UDS	2.19	1.86	17.51	0	1.07	34.52	64.41	35	17	18	CI		2.69		0.31	17	0.380	TST	0.23	9	0.231	0.0138	0.44
	36.0	SPT				0	0.79	99.21		39	20	19	CI			7.31	0.28								
	39.0	SPT				0	0.19	21.17	78.64	40	19	21	CI			8.18	0.31	15	0.410						
	45.0	SPT	2.23	1.91	16.92	0	0.65	99.35		39	19	20	CI		2.69	9.73		17	0.440						0.41
	50.0	SPT	2.22	1.89	17.51	0	0.34	31.63	68.03	37	18	19	CI		2.68	11.21									0.42

SUMMERY SHEET RESULTS LABORATORY TEST OF SOIL SAMPLE (TABLE NO.-3)

Bore Hole No	Depth (m)	Type of Sample	Density		Natural Moisture Content (%)	Gradation				Consistency			Soil		Specific gravity	Shrinkage Limit (%)	Swell Pressure(kg/cm^2)	Free Swell Index (%)	Unconfined Compressive Strength(kg/cm^2)	SHEAR PARAMETERS			One Dimensional Consolidation Test		Void Ratio
			Bulk Density (gm/cc)	Dry Density (gm/cc)		Gravel content (%)	Sand Content (%)	Silt content (%)	Clay content (%)	LL (%)	PL (%)	PI (%)	IS Classification	Description						TYPE OF TEST	Cohesion (Kg/cm2)	Angle of internal Friction Ø(Degree)	C_c	C_v (cm^2/min)	
BH-4(Tangri River-Ambala)	0.5	UDS	2.03	1.70	19.73	0	6.87	32.60	60.53	32	17	15	CL	Clayey Silt	2.64		0.18	8	0.380	TST	0.18	8	0.138	0.0124	0.56
	1.5	SPT	2.07	1.72	20.42	0	12.37	31.39	56.07	30	16	14	CL		2.65										0.54
	3.0	SPT				0	63.40	36.60		19	NP	_	SM	Sandy Silt			0.21			DST	0.12	11			
	4.5	SPT	1.85	1.64	12.51	0	65.51	34.49		18	NP	_	SM		2.65		0.33	8	0.360						0.61
	9.0	SPT	1.89	1.69	11.95	0	56.14	43.86		20	NP	_	SM	Silty Sand	2.66					DST	0.11	10			0.58
	14.5	UDS	2.14	1.80	19.17	0	5.72	94.28						Silty Clay	2.65		0.38	5	0.380	TST			0.143	0.0116	0.48
	15.0	SPT	2.17	1.80	20.24	0	6.49	28.16	65.35						2.67	3.77									0.48
	17.5	UDS	2.09	1.76	18.96	0	5.93	29.33	64.74	33	18	15	CL		2.66		0.41	5	0.410	TST	0.21	10	0.168	0.0125	0.51
	19.0	SPT	1.87	1.65	13.04	0	66.51	33.49		19	NP	_	SM	Sandy Silt	2.65										0.60
	21.0	SPT				0	65.78	34.22									0.41	8	0.390	DST	0.11	12			
	24.0	SPT	1.89	1.66	14.16	0	25.30	26.75	47.95	18	NP	_	SM		2.65										0.60
	29.0	UDS	1.99	1.63	22.41	0	0.76	31.61	67.63	40	19	21	CI	Clay	2.68		16.00	16	0.420	TST	0.24	8	0.173	0.0141	0.65
	30.0	SPT	2.15	1.76	21.97	0	0.39	32.05	67.56				CI		2.68	8.93	0.38								0.52
	32.0	UDS	2.13	1.73	23.38	0	0.44	31.89	67.67	39	19	20	CI		2.69		0.38	15	0.440	TST	0.23	10	0.186	0.0133	0.56
	34.0	SPT				0	70.14	29.86		18	NP	_	SM	Silty Sand	2.65		0.42			DST	0.02	14			
	39.0	SPT	2.18	1.77	23.40	0	0.37	33.60	66.03	38	17	21	CI	Clay	2.68	0.71		17							0.52
	42.0	SPT	2.20	1.79	22.72	0	0.74	99.26		39	19	20	CI		2.70	11.24		14	0.440						0.51
	45.0	SPT				0	2.24	27.28	70.48	40	19	21	CI			11.71	0.44	16							
	48.0	SPT	2.21	1.78	24.31	0	1.13	34.01	64.86	38	18	20	CI		2.68	12.81			0.440						0.51

6. DESCRIPTION OF FIELD AND LABORATORY TESTS DONE AND DATA OBTAINED.

6.1 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPT) is conducted at different depths in these boreholes. SPT split spoon sampler of standard dimensions was driven into the soil from the borehole bottom at the depth of testing using 63.5 kg hammer falling from 75 cm height. The SPT weight was manually lifted to the specified height and allowed to fall freely on the anvil with the use of cathead winch with one to one and half turn of the drum. In this ways the number of blows required to penetrate the last two 15cm penetration is considered as "N" values. Blow count for the penetration of every 15cm was recorded and the N is reported as the blow count for 30cm penetration of the sampler leaving the first 15cm penetration as seating drive. When the number of blows exceeded 50 to penetrate the first or second 15cm length of the sampler, the SPT N is regarded as more than 100 as described in IS2131-1981.The test is terminated in such case and a record of penetration of the sampler under 50 blows is made.SPT refusal is recorded when there is no penetration of the sampler at any stage and also when a rebound of the sounding system is recorded. These tests were conducted at close intervals of 1.5m at various depths so that a continuous SPT N profile is available.

6.2 Laboratory tests on soil sample

6.2.1 Bulk Density

Bulk densities of soil samples are determined as per I.S 2720 (Part-9).

The in-situ bulk unit weight and dry unit weight of a soil sample is determined from the SPT sample collected from the site. It is the ratio of mass & volume. As per IS-2720 (Pt-II), the moisture content of the samples is determined.

Standard penetration tests have been conducted in bore hole locations at various depth. Split spoon samplers were used in SPT tests. The samples obtained from split spoon samplers were subjected to bulk unit weight and moisture content determination tests.

6.2.2 Natural moisture content

Moisture content of a soil is the ratio of the weights of water to the weight of dry soil. It is usually expressed as a percentage. Water content of samples collected from pits was determined as per procedure laid down in the I. S. 2720 (Part – 9). The data have been presented in the Laboratory Investigation Sheets.

6.2.3 Grain size analysis

The soil aggregate comprises of particles of different sizes in the different proportion. For classification of soil met at various depths of the boreholes, grain size analysis was conducted as per I.S 2720 (Part-4). The test results are enclosed in this report as summery of the laboratory test.

6.2.4 Hydrometer analysis

The tests have been conducted to determine the particle size distribution of soil particles. The tests have been conducted as per guidelines of IS 2720 (Part – 4). The detail procedure has been elaborated in IS: 2720(Part-4) and the test results are enclosed in this report.

6.2.5 Liquid limit, Plastic limits & Plastic index

This test is conducted to determine the consistency behavior of soil. The detail procedure has been elaborated in IS: 2720(Part -5).120g of soil sample is taken and passing it through 425 micron sieve. Thoroughly mix the soil sample with water in the evaporating dish. Place a portion of the paste in the cup of the device. & Squeeze to about 1cm at the point of maximum thickness. Cut the groove using the grooving tool. Operate the device by turning the crank at the rate of two revolutions /sec .The specimens shall be of such consistency that the number of drops required to close the groove shall be between 15 & 35 & the points on the flow curve are evenly distributed in this range.

For determination of plastic limit of soil samples, about 20g of soil sample is taken and passing it through 425 micron sieve. Then the soil sample is mix with distilled water and a soil mass is obtained. The soil mass is rolled in between the figure till the threads are 3mm diameter. At this stage soil is crumbled & reaches its plasticity. From this crumble piece water content is determined which represents the plastic limit of the sample.

6.2.6 Specific gravity

Specific gravity of the soil was determined as per I. S. (Part – 3). Values of the specific gravity of samples obtained during tests have been reported in the Laboratory Investigation Sheets.

6.2.7 Free swell index of soil

Free swell index is conducted to determine the free swell index of soil. The test is conducted as per IS 2720(Part-40). 2x10gms of oil sample taken in a two different graduated glass tube. One of the samples is filled with distilled water and another is filled with kerosene up to 60ml. & then it is allowed to attain equilibrium state of volume without change in the volume of soil. It is calculated as follows:

Free swell index, Percent $= \frac{V_{d-V_k}}{Vk} \times 100,$

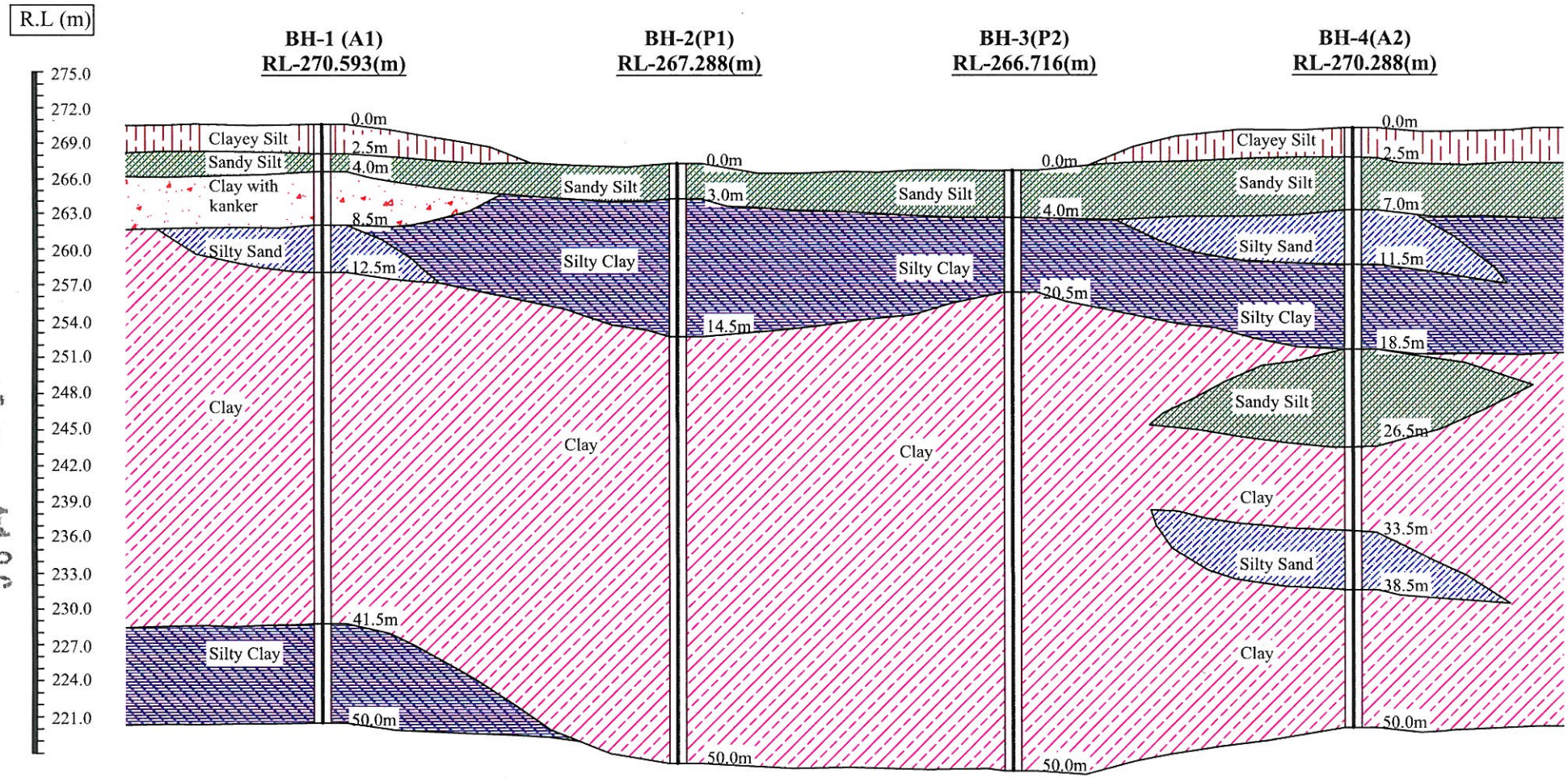
Where Vd = Volume of soil in water, Vk = Volume of soil in Kerosene.

7 Analysis of Results

a. Sub soil profile

Considering the bore log details of all boreholes, the sub-soil strata at proposed sites are presented in figure no-1

b. The soil profile as observed from the borelog details mainly consists of clayey silt, silty clay and sandy silt strata at the borehole locations. However no rock bed has been encountered within the depth of exploration.



SUB SOIL PROFILE OF TANGIRI RIVER
Fig No.-1

c. Ground water table

Ground water table has been encountered at the boreholes within the depth of boring during the period of exploration. However, seasonal & annual variation in the ground water table may occur. The depth of ground water is presented in table no.4.

Table no. – 4

Tangri River

Borehole No's	Termination Depth (m)	Depth of Ground Water Table from E.G.L (m)
BH-1(A1)	50.00	3.20
BH-2(P1)	50.00	1.75
BH-3(P2)	50.00	2.10
BH-4(A2)	50.00	6.75

8 DESIGN GEOTECHNICAL PARAMETER

The Design Geotechnical Parameters for all boreholes have been arrived at by analyzing the sub soil profiles and the same are presented in Table no.-5.

Table no.-5

DESIGN GEOTECHNICAL PARAMETERS

Reference Borehole - BH-1(A1)

Layer	Sub-strata	Depth below GL (m)	SPT 'N' value (Avg)	Cohesion, C (t/m2)	Angle of internal friction, Ø (degree)	Submerged density (t/m^3)
Layer-1	Clayey Silt/ Sandy Silt	GL to 4.0m	21	14.00	0	1
Layer-2	Clay with kankar	4.0m-8.5m	19	12.66	0	1
Layer-3	Silty Sand	8.5m-12.5m	19	0	33	1
Layer-4	Clay	12.5m-41.5m	29	19.33	0	1
Layer-5	Silty clay	41.5-50.m	47	20.00*	0	1

Note:-* Cohesion has been restricted to $20t/m^2$.

Reference Borehole - BH-2(P1)

Layer	Sub-strata	Depth below GL (m)	SPT 'N' value (Avg)	Cohesion, C (t/m2)	Angle of internal friction, Ø (degree)	Submerged density (t/m^3)
Layer-1	Clayey Silt	GL to 2.5m	25	16.66	0	1
Layer-2	Silty clay	3.0m-14.5m	18	12.00	0	1
Layer-3	Clay	14.5m-50.0m	39	20.00*	0	1

Note:-* Cohesion has been restricted to 20t/m^2.

Reference Borehole - BH-3(P2)

Layer	Sub-strata	Depth below GL (m)	SPT 'N' value (Avg)	Cohesion, C (t/m2)	Angle of internal friction, Ø (degree)	Submerged density (t/m^3)
Layer-1	Sandy Silt	GL to 4.0m	21	14.00	0	1
Layer-2	Silty Clay	4.0m-20.5m	18	12.00	0	1
Layer-3	Clay	20.0m-32.5.m	23	15.33	0	1
Layer-3	Clay	32.5m-50.00m	46	20.00*	0	1

(Note:-* Cohesion has been restricted to 20t/m^2.

Reference Borehole - BH-4(A2)

Layer	Sub-strata	Depth below GL (m)	SPT 'N' value (Avg)	Cohesion, C (t/m2)	Angle of internal friction, Ø (degree)	Submerged density (t/m^3)
Layer-1	Clayey Silt	GL to 2.5m	16	12.66	0	1
Layer-2	Sandy Silt	2.5m-7.0m	29	19.33	0	1
Layer-3	Silty Sand	7.0m-11.5m	25**	0	35** (Restricted)	1
Layer-4	Silty clay	11.5m-18.5m	28	18.66	0	1
Layer-5	Sandy Silt	18.5m-26.5m	30	20.00	0	1
Layer-6	Clay	26.5m-33.5m	31	20.00*	0	1
Layer-7	Silty Sand	33.5m-38.5m	25**	0	35** (Restricted)	1
Layer-8	Clay	38.5m-50.0m	N>50	20.00*	0	1

Note:-* Cohesion has been restricted to 20t/m^2.

**** The value of Ø has been restricted to 35° which corresponds to N value of 25.**

9. RECOMMENDED FOUNDATION STRUCTURE

9.1 Considering the presence of clay soil & sandy soil layers & heavy weight transmitted by the bridge structure, it is recommended to provide well foundations to support the abutment & piers.

9.2 It is recommended to provide 9.0m dia well foundation at all these locations.

9.3 The safe bearing capacity (considering shear failure) & safe bearing pressure (considering 50 & 75mm settlement) of the well foundation structure have been computed as per the recommendations of IS-6403-1981 & IS-8009(Pt-1)-1976.

9.4 However the designer may adopted suitable foundation system considering the requirements of superstructure.

10. WELL FOUNDATION

10.1.1 As per the directive from the client the soil samples obtained from boreholes drilled subsequently were given to M/s Dr. Ghuman and Gupta Geotech Consultants, Chandigarh for silt factor calculation .The reports presented by M/s Dr.Ghuman and Gupta Geotech Consultants, Chandigarh along with the copy of letter from the client dated-27.12.2013 are enclosed with this report vide appendix no-IV

10.1.2 It is observed that silt factor data obtained from M/s Dr. Ghuman and Gupta Geotech Consultants do not cover all the borehole locations. In order to calculate the scour depth at the bridge site the minimum value of silt factor (0.71) as recommended by M/s Dr. Ghuman and Gupta Geotech Consultants has been adopted for calculation purposes in this report.

10.1.3 Considering the hydraulic data the maximum scour level has been found out & presented in table no.-6. In determination of SBC & SBP, soil strata in between EGL & maximum scour level has been taken to be ineffective.

Table No.-6

Tangiri River

Bore hole Location	Existing Ground Level(m)	Scour Depth(m)	Scour Level(m)
BH-1(A1)	270.593	13.10	259.96
BH-2(P1)	267.288	20.63	252.43
BH-3(P2)	266.716	20.63	252.43
BH-4(A2)	270.288	13.10	259.96

10.2 Determination of the depth of the well foundation has been done considering the criteria of provision of minimum grip length as per clause no-705-3.1 of IRC -78:2000.Acordingly the depth of well foundation satisfying these criteria shall be as follows-

Abutments -22.0m

Piers-22.0m

10.3 The SBC (shear failure) & SBP (50mm & 75mm settlement) for each location have been computed & Presented in table no.-7.

Table No.-7

Tangri River

Location	E.G.L (m)	Founding Depth (m)	Founding RL(m)	Founding stratum	SBC (shear failure) (t/m2)	Safe Bearing Pressure Considering Settlement of	
						50mm (t/m2)	75 mm (t/m2)
BH-1(A1)	270.593	22.0	248.593	Clay	64.73	25.88	38.83
BH-2(P1)	267.288	22.0	245.288	Clay	61.94	17.81	26.72
BH-3(P2)	266.716	22.0	244.716	Clay	48.01	18.89	28.33
BH-4(A2)	270.288	22.0	248.288	Sandy Silt	67.32	25.26	37.89

11. RECOMMENDATIONS

Based on the field and laboratory investigations, the following recommendations are made.

11.1 The project area lies in the Zone-IV of the seismic zone as per IS.1893 (pt- 1):2002.

11.2 Depending on the sub-surface formation, it is proposed to provide well foundation for the superstructure. It is recommended to provide well of 9.0m dia at all locations.

11.3 The allowable Bearing Pressure considering shear failure & settlement of 50mm/75mm for each location have been computed & presented in table no.-8.

11.4 However the designer may adopt suitable parameters for design of foundation considering the super structure requirements and economy aspects.

Table No-8

Tangri River

Location	E.G.L (m)	Founding Depth (m)	Founding RL(m)	Allowable Bearing Pressure Considering shear failure and Settlement of	
				50mm (t/m2)	75 mm (t/m2)
BH-1(A1)	270.593	22.0	248.593	25.0	38.0
BH-2(P1)	267.288	22.0	245.288	17.0	26.0
BH-3(P2)	266.716	22.0	244.716	18.0	28.0
BH-4(A2)	270.288	22.0	248.288	25.0	37.0

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(Dr. P.K.DASH)

Senior Consultant Geo-Technical

M/s ARKITECHNO Consultants (I) Pvt. ltd.

Bhubaneswar.

Appendix -I

(Field Borelog Details and SPT 'N' Correction)

12. REFERENCES.

Sl No	Code No	Title
1	IS: 1498 - 1970	Classification and Identification of Soils for general Engineering Purposes.
2	IS: 1892 - 1979	Code of Practice for Subsurface Investigation for Foundation.
3	IS: 1893 (P-1) - 2002	Criteria for earthquake Resistant Design of Structures
4	IS: 2131-1991 reaffirmed 1997)	Method of Standard Penetration Test for Soils.
5	IS: 2720 (Relevant parts)	Method of Test for Soils (Relevant Parts).
6	IS: 6403-1981(Reaffirmed 1997)	Code of practice for determination of Bearing capacity of Shallow foundations.
7	IS: 8009 (Part-I)-1976	Code of practice for calculation of settlements of foundations.
8	IS: 4968 (Part-III)	Method for Subsurface Sounding for Soils - Static Cone Penetration Test.
9	IRC 78-2000	Standard Specifications Code of Practice for Road Bridges Section -VII
10		**Bowles, J.E,** Foundation Analysis and design, McGraw-Hill, New York.
11		**Nayak, N.V,** Foundation design manual, DhanpatRai Publications, New Delhi.
12		**Tomlinson**, M.J, Foundation Design and Construction, ELBS,5TH edition.

BORE LOG DETAILS

Client	: DFCC	Existing Ground Lvl. (RL in Mtr)	: 270.593
Project	: G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 3.20
Bore Hole No.	: BH-1(A1)	Date of commencement	: 25.08.12
Location	: Tangri River,Towards Saharanpur, Near Abutment	Date of Completion	: 30.08.12
Type of Boring	: Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	: 150mm in soil		
Type of Sampler used	: UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
0.00	0.50	0.50	Clayey Silt		0.5	UDS											UDS Collected
0.50	1.00	0.50			1.0	DS											DS Taken
1.00	1.50	0.50			1.5	SPT	6	9	10	19							Sample Collected
1.50	2.00	0.50			2.0	DS											DS Taken
2.00	2.50	0.50			2.5	DS											DS Taken
2.50	3.00	0.50	Sandy Silt		3.0	SPT	10	11	13	24							Sample Collected
3.00	3.50	0.50			3.5	DS											DS Taken
3.50	4.00	0.50			4.0	DS											DS Taken
4.00	4.50	0.50	Clay with kankar		4.5	SPT	5	7	7	14							Sample Collected
4.50	5.00	0.50			5.0	DS											DS Taken
5.00	5.50	0.50			5.5	DS											DS Taken
5.50	6.00	0.50			6.0	SPT	5	8	9	17							Sample Collected
6.00	6.50	0.50			6.5	UDS											UDS Collected
6.50	7.00	0.50			7.0	DS											DS Taken
7.00	7.50	0.50			7.5	SPT	8	12	15	27							Sample Collected
7.50	8.00	0.50			8.0	DS											DS Taken
8.00	8.50	0.50			8.5	DS											DS Taken
8.50	9.00	0.50	Silty Sand		9.0	SPT	6	10	10	20	18						Sample Collected
9.00	9.50	0.50			9.5	DS											DS Taken
9.50	10.00	0.50			10.0	DS											DS Taken
10.00	10.50	0.50			10.5	DS											DS Taken
10.50	11.00	0.50			11.0	DS											DS Taken
11.00	11.50	0.50			11.5	DS											DS Taken
11.50	12.00	0.50			12.0	SPT	9	11	15	26	20						Sample Collected
12.00	12.50	0.50			12.5	DS											DS Taken
12.50	13.00	0.50	Clay		13.0	SPT	7	10	12	22							Sample Collected
13.00	13.50	0.50			13.5	DS											DS Taken
13.50	14.00	0.50			14.0	UDS											UDS Collected
14.00	14.50	0.50			14.5	DS											DS Taken
14.50	15.00	0.50			15.0	SPT	10	10	15	25							Sample Collected
15.00	15.50	0.50			15.5	DS											DS Taken
15.50	16.00	0.50			16.0	DS											DS Taken

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BORE LOG DETAILS

Client	: DFCC	Existing Ground Lvl. (RL in Mtr)	: 270.593
Project	: G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 3.20
Bore Hole No.	: BH-1(A1)	Date of commencement	: 25.08.12
Location	: Tangri River,Towards Saharanpur, Near Abutment	Date of Completion	: 30.08.12
Type of Boring	: Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	: 150mm in soil		
Type of Sampler used	: UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
16.00	16.50	0.50			16.5	DS											DS Taken
16.50	17.00	0.50			17.0	UDS											UDS Collected
17.00	17.50	0.50			17.5	DS											DS Taken
17.50	18.00	0.50			18.0	SPT	7	8	10	18							Sample Collected
18.00	18.50	0.50			18.5	DS											DS Taken
18.50	19.00	0.50			19.0	DS											DS Taken
19.00	19.50	0.50			19.5	DS											DS Taken
19.50	20.00	0.50			20.0	UDS											UDS Collected
20.00	20.50	0.50			20.5	DS											DS Taken
20.50	21.00	0.50			21.0	SPT	6	10	10	20							Sample Collected
21.00	21.50	0.50			21.5	DS											DS Taken
21.50	22.00	0.50			22.0	DS											DS Taken
22.00	22.50	0.50			22.5	DS											DS Taken
22.50	23.00	0.50			23.0	UDS											UDS Collected
23.00	23.50	0.50			23.5	DS											DS Taken
23.50	24.00	0.50			24.0	SPT	8	9	14	23							Sample Collected
24.00	24.50	0.50			24.5	DS											DS Taken
24.50	25.00	0.50	Clay		25.0	DS											DS Taken
25.00	25.50	0.50			25.5	DS											DS Taken
25.50	26.00	0.50			26.0	UDS											UDS Collected
26.00	26.50	0.50			26.5	DS											DS Taken
26.50	27.00	0.50			27.0	SPT	8	12	15	27							Sample Collected
27.00	27.50	0.50			27.5	DS											DS Taken
27.50	28.00	0.50			28.0	DS											DS Taken
28.00	28.50	0.50			28.5	DS											DS Taken
28.50	29.00	0.50			29.0	UDS											UDS Collected
29.00	29.50	0.50			29.5	DS											DS Taken
29.50	30.00	0.50			30.0	SPT	7	14	20	34							Sample Collected
30.00	30.50	0.50			30.5	DS											DS Taken
30.50	31.00	0.50			31.0	DS											DS Taken
31.00	31.50	0.50			31.5	DS											DS Taken
31.50	32.00	0.50			32.0	UDS											UDS Collected
32.00	32.50	0.50			32.5	DS											DS Taken
32.50	33.00	0.50			33.0	SPT	9	16	21	37							Sample Collected
33.00	33.50	0.50			33.5	DS											DS Taken

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BORE LOG DETAILS

Client	: DFCC	Existing Ground Lvl. (RL in Mtr)	: 270.593
Project	: G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 3.20
Bore Hole No.	: BH-1(A1)	Date of commencement	: 25.08.12
Location	: Tangri River,Towards Saharanpur, Near Abutment	Date of Completion	: 30.08.12
Type of Boring	: Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	: 150mm in soil		
Type of Sampler used	: UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
33.50	34.00	0.50	Clay		34.0	DS											DS Taken
34.00	34.50	0.50			34.5	DS											DS Taken
34.50	35.00	0.50			35.0	UDS											UDS Collected
35.00	35.50	0.50			35.5	DS											DS Taken
35.50	36.00	0.50	Clay		36.0	SPT	12	19	26	45							Sample Collected
36.00	36.50	0.50			36.5	DS											DS Taken
36.50	37.00	0.50			37.0	DS											DS Taken
37.00	37.50	0.50			37.5	DS											DS Taken
37.50	38.00	0.50			38.0	DS											DS Taken
38.00	38.50	0.50			38.5	DS											DS Taken
38.50	39.00	0.50			39.0	SPT	10	21	22	43							Sample Collected
39.00	39.50	0.50			39.5	DS											DS Taken
39.50	40.00	0.50			40.0	DS											DS Taken
40.00	40.50	0.50			40.5	DS											DS Taken
40.50	41.00	0.50			41.0	DS											DS Taken
41.00	41.50	0.50			41.5	DS											DS Taken
41.50	42.00	0.50	Silty Clay		42.0	SPT	13	15	31	46							Sample Collected
42.00	42.50	0.50			42.5	DS											DS Taken
42.50	43.00	0.50			43.0	DS											DS Taken
43.00	43.50	0.50			43.5	DS											DS Taken
43.50	44.00	0.50			44.0	DS											DS Taken
44.00	44.50	0.50			44.5	DS											DS Taken
44.50	45.00	0.50			45.0	SPT	12	21	24	45							Sample Collected
45.00	45.50	0.50			45.5	DS											DS Taken
45.50	46.00	0.50			46.0	DS											DS Taken
46.00	46.50	0.50			46.5	DS											DS Taken
46.50	47.00	0.50			47.0	DS											DS Taken
47.00	47.50	0.50			47.5	DS											DS Taken
47.50	48.00	0.50			48.0	SPT	13	22	22	44							Sample Collected
48.00	48.50	0.50			48.5	DS											DS Taken
48.50	49.00	0.50			49.0	DS											DS Taken
49.00	49.50	0.50			49.5	DS											DS Taken
49.50	50.00	0.50			50.0	SPT	16	26	30	56							Sample Collected

4199

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	: 267.288
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 1.75
Bore Hole No.	:	BH-2(P1)	Date of commencement	: 05.09.12
Location	: :	Near Pier, Towards Saharanpur, Tangri River	Date of Completion	: 07.09.12
Type of Boring	:	Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	:	150mm in soil		
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth			N value observed	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
0.00	0.50	0.50	Sandy Silt		0.5	DS											DS Taken
0.50	1.00	0.50			1.0	DS											DS Taken
1.00	1.50	0.50			1.5	SPT	5	8	9	17							Sample Collected
1.50	2.00	0.50			2.0	DS											DS Taken
2.00	2.50	0.50			2.5	DS											DS Taken
2.50	3.00	0.50			3.0	SPT	8	11	22	33							Sample Collected
3.00	3.50	0.50	Silty Clay		3.5	SPT	3	5	7	12							Sample Collected
3.50	4.00	0.50			4.0	DS											DS Taken
4.00	4.50	0.50			4.5	SPT	5	6	9	15							Sample Collected
4.50	5.00	0.50			5.0	UDS											UDS Collected
5.00	5.50	0.50			5.5	DS											DS Taken
5.50	6.00	0.50			6.0	SPT	6	8	13	21							Sample Collected
6.00	6.50	0.50			6.5	DS											DS Taken
6.50	7.00	0.50			7.0	DS											DS Taken
7.00	7.50	0.50			7.5	SPT	6	10	10	20							Sample Collected
7.50	8.00	0.50			8.0	UDS											UDS Collected
8.00	8.50	0.50			8.5	DS											DS Taken
8.50	9.00	0.50			9.0	SPT	5	8	10	18							Sample Collected
9.00	9.50	0.50			9.5	DS											DS Taken
9.50	10.00	0.50			10.0	DS											DS Taken
10.00	10.50	0.50			10.5	UDS											UDS Collected
10.50	11.00	0.50			11.0	DS											DS Taken
11.00	11.50	0.50			11.5	DS											DS Taken
11.50	12.00	0.50			12.0	SPT	8	9	13	22							Sample Collected
12.00	12.50	0.50			12.5	DS											DS Taken
12.50	13.00	0.50			13.0	DS											DS Taken
13.00	13.50	0.50			13.5	UDS											UDS Collected
13.50	14.00	0.50			14.0	DS											DS Taken
14.00	14.50	0.50			14.5	DS											DS Taken
14.50	15.00	0.50	Clay		15.0	SPT	7	9	10	19							Sample Collected
15.00	15.50	0.50			15.5	DS											DS Taken
15.50	16.00	0.50			16.0	DS											DS Taken
16.00	16.50	0.50			16.5	UDS											UDS Collected
16.50	17.00	0.50			17.0	DS											DS Taken
17.00	17.50	0.50			17.5	DS											DS Taken

4200

BORE LOG DETAILS

Client	: DFCC	Existing Ground Lvl. (RL in Mtr)	: 267.288
Project	: G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 1.75
Bore Hole No.	: BH-2(P1)	Date of commencement	: 05.09.12
Location	: : Near Pier, Towards Saharanpur, Tangri River	Date of Completion	: 07.09.12
Type of Boring	: Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	: 150mm in soil		
Type of Sampler used	: UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth			N value observed	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
17.50	18.00	0.50			18.0	SPT	8	10	13	23							Sample Collected
18.00	18.50	0.50			18.5	DS											DS Taken
18.50	19.00	0.50			19.0	DS											DS Taken
19.00	19.50	0.50			19.5	UDS											UDS Collected
19.50	20.00	0.50			20.0	DS											DS Taken
20.00	20.50	0.50			20.5	DS											DS Taken
20.50	21.00	0.50			21.0	SPT	7	12	12	24							Sample Collected
21.00	21.50	0.50			21.5	DS											DS Taken
21.50	22.00	0.50			22.0	DS											DS Taken
22.00	22.50	0.50			22.5	UDS											UDS Collected
22.50	23.00	0.50			23.0	DS											DS Taken
23.00	23.50	0.50			23.5	DS											DS Taken
23.50	24.00	0.50			24.0	SPT	9	12	14	26							Sample Collected
24.00	24.50	0.50			24.5	DS											DS Taken
24.50	25.00	0.50			25.0	DS											DS Taken
25.00	25.50	0.50			25.5	UDS											UDS Collected
25.50	26.00	0.50			26.0	DS											DS Taken
26.00	26.50	0.50			26.5	DS											DS Taken
26.50	27.00	0.50	Clay		27.0	SPT	7	11	12	23							Sample Collected
27.00	27.50	0.50			27.5	DS											DS Taken
27.50	28.00	0.50			28.0	DS											DS Taken
28.00	28.50	0.50			28.5	UDS											UDS Collected
28.50	29.00	0.50			29.0	DS											DS Taken
29.00	29.50	0.50			29.5	DS											DS Taken
29.50	30.00	0.50			30.0	SPT	9	13	17	30							Sample Collected
30.00	30.50	0.50			30.5	DS											DS Taken
30.50	31.00	0.50			31.0	DS											DS Taken
31.00	31.50	0.50			31.5	UDS											UDS Collected
31.50	32.00	0.50			32.0	DS											DS Taken
32.00	32.50	0.50			32.5	DS											DS Taken
32.50	33.00	0.50			33.0	SPT	10	18	19	37							Sample Collected
33.00	33.50	0.50			33.5	DS											DS Taken
33.50	34.00	0.50			34.0	DS											DS Taken
34.00	34.50	0.50			34.5	UDS											UDS Collected
34.50	35.00	0.50			35.0	DS											DS Taken
35.00	35.50	0.50			35.5	DS											DS Taken

4201

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	: 267.288
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 1.75
Bore Hole No.	:	BH-2(P1)	Date of commencement	: 05.09.12
Location	: :	Near Pier, Towards Saharanpur, Tangri River	Date of Completion	: 07.09.12
Type of Boring	:	Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	:	150mm in soil		
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth			N value observed	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
35.50	36.00	0.50			36.0	SPT	10	20	25	45							Sample Collected
36.00	36.50	0.50			36.5	DS											DS Taken
36.50	37.00	0.50			37.0	DS											DS Taken
37.00	37.50	0.50			37.5	SPT	9	21	21	42							Sample Collected
37.50	38.00	0.50			38.0	DS											DS Taken
38.00	38.50	0.50			38.5	DS											DS Taken
38.50	39.00	0.50			39.0	SPT	11	21	22	43							Sample Collected
39.00	39.50	0.50			39.5	DS											DS Taken
39.50	40.00	0.50			40.0	DS											DS Taken
40.00	40.50	0.50			40.5	SPT	10	24	25	49							Sample Collected
40.50	41.00	0.50			41.0	DS											DS Taken
41.00	41.50	0.50			41.5	DS											DS Taken
41.50	42.00	0.50			42.0	SPT	13	19	28	47							Sample Collected
42.00	42.50	0.50			42.5	DS											DS Taken
42.50	43.00	0.50	Clay		43.0	DS											DS Taken
43.00	43.50	0.50			43.5	SPT	12	19	26	45							Sample Collected
43.50	44.00	0.50			44.0	DS											DS Taken
44.00	44.50	0.50			44.5	DS											DS Taken
44.50	45.00	0.50			45.0	SPT	13	33	25	58							Sample Collected
45.00	45.50	0.50			45.5	DS											DS Taken
45.50	46.00	0.50			46.0	DS											DS Taken
46.00	46.50	0.50			46.5	SPT	13	22	28	50							Sample Collected
46.50	47.00	0.50			47.0	DS											DS Taken
47.00	47.50	0.50			47.5	DS											DS Taken
47.50	48.00	0.50			48.0	SPT	15	22	29	51							Sample Collected
48.00	48.50	0.50			48.5	DS											DS Taken
48.50	49.00	0.50			49.0	DS											DS Taken
49.00	49.50	0.50			49.5	DS											DS Taken
49.50	50.00	0.50			50.0	SPT	14	24	31	55							Sample Collected

4202

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	:	266.716
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	:	2.10
Bore Hole No.	:	BH-3(P2)	Date of commencement	:	01.09.12
Location	:	Near Pier, Towards Ambala, Tangri River	Date of Completion	:	03.09.12
Type of Boring	:	Rotary Drilling	Conducted By	:	T.K Das
Dia of Bore	:	150mm in soil			
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel			

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth			N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
0.00	0.50	0.50	Sandy Silt		0.5	DS											DS Taken
0.50	1.00	0.50			1.0	DS											DS Taken
1.00	1.50	0.50			1.5	SPT	7	9	11	20							Sample Collected
1.50	2.00	0.50			2.0	DS											DS Taken
2.00	2.50	0.50			2.5	DS											DS Taken
2.50	3.00	0.50			3.0	SPT	9	11	12	23							Sample Collected
3.00	3.50	0.50			3.5	DS											DS Taken
3.50	4.00	0.50			4.0	DS											DS Taken
4.00	4.50	0.50	Silty Clay		4.5	SPT	6	8	9	17							Sample Collected
4.50	5.00	0.50			5.0	DS											DS Taken
5.00	5.50	0.50			5.5	DS											DS Taken
5.50	6.00	0.50			6.0	SPT	7	11	11	22							Sample Collected
6.00	6.50	0.50			6.5	DS											DS Taken
6.50	7.00	0.50			7.0	UDS											UDS Collected
7.00	7.50	0.50			7.5	SPT	8	8	11	19							Sample Collected
7.50	8.00	0.50			8.0	DS											DS Taken
8.00	8.50	0.50			8.5	DS											DS Taken
8.50	9.00	0.50			9.0	SPT	7	11	13	24							Sample Collected
9.00	9.50	0.50			9.5	DS											DS Taken
9.50	10.00	0.50			10.0	UDS											UDS Collected
10.00	10.50	0.50			10.5	DS											DS Taken
10.50	11.00	0.50			11.0	DS											DS Taken
11.00	11.50	0.50			11.5	DS											DS Taken
11.50	12.00	0.50			12.0	SPT	7	8	9	17							Sample Collected
12.00	12.50	0.50			12.5	DS											DS Taken
12.50	13.00	0.50			13.0	UDS											UDS Collected
13.00	13.50	0.50			13.5	DS											DS Taken
13.50	14.00	0.50			14.0	DS											DS Taken
14.00	14.50	0.50			14.5	DS											DS Taken
14.50	15.00	0.50			15.0	SPT	6	6	6	12							Sample Collected
15.00	15.50	0.50			15.5	DS											DS Taken
15.50	16.00	0.50			16.0	UDS											UDS Collected
16.00	16.50	0.50			16.5	DS											DS Taken
16.50	17.00	0.50			17.0	DS											DS Taken
17.00	17.50	0.50			17.5	DS											DS Taken

4203

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	: 266.716
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 2.10
Bore Hole No.	:	BH-3(P2)	Date of commencement	: 01.09.12
Location	:	Near Pier, Towards Ambala, Tangri River	Date of Completion	: 03.09.12
Type of Boring	:	Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	:	150mm in soil		
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth			N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
17.50	18.00	0.50	Silty Clay		18.0	SPT	5	9	11	20							Sample Collected
18.00	18.50	0.50			18.5	DS											DS Taken
18.50	19.00	0.50			19.0	UDS											UDS Collected
19.00	19.50	0.50			19.5	DS											DS Taken
19.50	20.00	0.50			20.0	DS											DS Taken
20.00	20.50	0.50			20.5	DS											DS Taken
20.50	21.00	0.50	Clay		21.0	SPT	8	10	13	23							Sample Collected
21.00	21.50	0.50			21.5	DS											DS Taken
21.50	22.00	0.50			22.0	UDS											UDS Collected
22.00	22.50	0.50			22.5	DS											DS Taken
22.50	23.00	0.50			23.0	DS											DS Taken
23.00	23.50	0.50			23.5	DS											DS Taken
23.50	24.00	0.50			24.0	SPT	7	10	11	21							Sample Collected
24.00	24.50	0.50			24.5	DS											DS Taken
24.50	25.00	0.50			25.0	UDS											UDS Collected
25.00	25.50	0.50			25.5	DS											DS Taken
25.50	26.00	0.50			26.0	DS											DS Taken
26.00	26.50	0.50			26.5	DS											DS Taken
26.50	27.00	0.50			27.0	SPT	9	13	13	26							Sample Collected
27.00	27.50	0.50			27.5	DS											DS Taken
27.50	28.00	0.50			28.0	UDS											UDS Collected
28.00	28.50	0.50			28.5	DS											DS Taken
28.50	29.00	0.50			29.0	DS											DS Taken
29.00	29.50	0.50			29.5	DS											DS Taken
29.50	30.00	0.50			30.0	SPT	8	10	14	24							Sample Collected
30.00	30.50	0.50			30.5	DS											DS Taken
30.50	31.00	0.50			31.0	UDS											UDS Collected
31.00	31.50	0.50			31.5	DS											DS Taken
31.50	32.00	0.50			32.0	DS											DS Taken
32.00	32.50	0.50			32.5	DS											DS Taken
32.50	33.00	0.50			33.0	SPT	11	18	21	39							Sample Collected
33.00	33.50	0.50			33.5	DS											DS Taken
33.50	34.00	0.50			34.0	DS											DS Taken
34.00	34.50	0.50			34.5	DS											DS Taken
34.50	35.00	0.50			35.0	DS											DS Taken
35.00	35.50	0.50			35.5	DS											DS Taken

BORE LOG DETAILS

Client	: DFCC	Existing Ground Lvl. (RL in Mtr)	: 266.716
Project	: G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 2.10
Bore Hole No.	: BH-3(P2)	Date of commencement	: 01.09.12
Location	: Near Pier, Towards Ambala, Tangri River	Date of Completion	: 03.09.12
Type of Boring	: Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	: 150mm in soil		
Type of Sampler used	: UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					
From	To				Depth	Type	Blows Required for Penetration of depth			N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	Remarks
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
35.50	36.00	0.50			36.0	SPT	9	20	22	42							Sample Collected
36.00	36.50	0.50			36.5	DS											DS Taken
36.50	37.00	0.50			37.0	DS											DS Taken
37.00	37.50	0.50			37.5	DS											DS Taken
37.50	38.00	0.50			38.0	DS											DS Taken
38.00	38.50	0.50			38.5	DS											DS Taken
38.50	39.00	0.50			39.0	SPT	12	21	24	45							Sample Collected
39.00	39.50	0.50			39.5	DS											DS Taken
39.50	40.00	0.50			40.0	DS											DS Taken
40.00	40.50	0.50			40.5	DS											DS Taken
40.50	41.00	0.50			41.0	DS											DS Taken
41.00	41.50	0.50			41.5	DS											DS Taken
41.50	42.00	0.50			42.0	SPT	10	22	22	44							Sample Collected
42.00	42.50	0.50			42.5	DS											DS Taken
42.50	43.00	0.50	Clay		43.0	DS											DS Taken
43.00	43.50	0.50			43.5	DS											DS Taken
43.50	44.00	0.50			44.0	DS											DS Taken
44.00	44.50	0.50			44.5	DS											DS Taken
44.50	45.00	0.50			45.0	SPT	13	20	26	46							Sample Collected
45.00	45.50	0.50			45.5	DS											DS Taken
45.50	46.00	0.50			46.0	DS											DS Taken
46.00	46.50	0.50			46.5	DS											DS Taken
46.50	47.00	0.50			47.0	DS											DS Taken
47.00	47.50	0.50			47.5	DS											DS Taken
47.50	48.00	0.50			48.0	SPT	16	25	27	52							Sample Collected
48.00	48.50	0.50			48.5	DS											DS Taken
48.50	49.00	0.50			49.0	DS											DS Taken
49.00	49.50	0.50			49.5	DS											DS Taken
49.50	50.00	0.50			50.0	SPT	18	28	29	57							Sample Collected

4205

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	: 270.288
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 6.75
Bore Hole No.	:	BH-4 (A2)	Date of commencement	: 29.08.12
Location	:	Near Abutment, Towards Ambala, Tangri River	Date of Completion	: 31.08.12
Type of Boring	:	Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	:	150mm in soil		
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
0.00	0.50	0.50	Clayey Silt		0.5	UDS											UDS Collected
0.50	1.00	0.50			1.0	DS											DS Taken
1.00	1.50	0.50			1.5	SPT	4	7	9	16							Sample Collected
1.50	2.00	0.50			2.0	DS											DS Taken
2.00	2.50	0.50			2.5	DS											DS Taken
2.50	3.00	0.50	Sandy Silt		3.0	SPT	7	10	16	26							Sample Collected
3.00	3.50	0.50			3.5	DS											DS Taken
3.50	4.00	0.50			4.0	DS											DS Taken
4.00	4.50	0.50			4.5	SPT	8	11	18	29							Sample Collected
4.50	5.00	0.50			5.0	DS											DS Taken
5.00	5.50	0.50			5.5	DS											DS Taken
5.50	6.00	0.50			6.0	SPT	10	13	21	34							Sample Collected
6.00	6.50	0.50			6.5	DS											DS Taken
6.50	7.00	0.50			7.0	DS											DS Taken
7.00	7.50	0.50	Silty Sand		7.5	SPT	8	12	18	30	24						Sample Collected
7.50	8.00	0.50			8.0	DS											DS Taken
8.00	8.50	0.50			8.5	DS											DS Taken
8.50	9.00	0.50			9.0	SPT	9	16	20	36	27						Sample Collected
9.00	9.50	0.50			9.5	DS											DS Taken
9.50	10.00	0.50			10.0	DS											DS Taken
10.00	10.50	0.50			10.5	DS											DS Taken
10.50	11.00	0.50			11.0	DS											DS Taken
11.00	11.50	0.50			11.5	DS											DS Taken
11.50	12.00	0.50	Silty Clay		12.0	SPT	8	10	15	25							Sample Collected
12.00	12.50	0.50			12.5	DS											DS Taken
12.50	13.00	0.50			13.0	DS											DS Taken
13.00	13.50	0.50			13.5	DS											DS Taken
13.50	14.00	0.50			14.0	DS											DS Taken
14.00	14.50	0.50			14.5	UDS											UDS Collected
14.50	15.00	0.50			15.0	SPT	7	14	14	28							Sample Collected
15.00	15.50	0.50			15.5	DS											DS Taken
15.50	16.00	0.50			16.0	DS											DS Taken
16.00	16.50	0.50			16.5	DS											DS Taken
16.50	17.00	0.50			17.0	DS											DS Taken
17.00	17.50	0.50			17.5	UDS											UDS Collected
17.50	18.00	0.50			18.0	SPT	9	15	16	31							Sample Collected
18.00	18.50	0.50			18.5	DS											DS Taken

4206

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	:	270.288
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	:	6.75
Bore Hole No.	:	BH-4 (A2)	Date of commencement	:	29.08.12
Location	:	Near Abutment, Towards Ambala, Tangri River	Date of Completion	:	31.08.12
Type of Boring	:	Rotary Drilling	Conducted By	:	T.K Das
Dia of Bore	:	150mm in soil			
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel			

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth 0 - 15 cm	15 - 30 cm	30 - 45 cm	N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
18.50	19.00	0.50	Sandy Silt		19.0	SPT	9	13	15	28							Sample Collected
19.00	19.50	0.50			19.5	DS											DS Taken
19.50	20.00	0.50			20.0	DS											DS Taken
20.00	20.50	0.50			20.5	DS											DS Taken
20.50	21.00	0.50			21.0	SPT	7	12	18	30							Sample Collected
21.00	21.50	0.50			21.5	DS											DS Taken
21.50	22.00	0.50			22.0	DS											DS Taken
22.00	22.50	0.50			22.5	DS											DS Taken
22.50	23.00	0.50			23.0	DS											DS Taken
23.00	23.50	0.50			23.5	DS											DS Taken
23.50	24.00	0.50			24.0	SPT	11	13	20	33							Sample Collected
24.00	24.50	0.50			24.5	DS											DS Taken
24.50	25.00	0.50			25.0	DS											DS Taken
25.00	25.50	0.50			25.5	DS											DS Taken
25.50	26.00	0.50			26.0	DS											DS Taken
26.00	26.50	0.50			26.5	DS											DS Taken
26.50	27.00	0.50	Clay		27.0	SPT	9	11	14	25							Sample Collected
27.00	27.50	0.50			27.5	DS											DS Taken
27.50	28.00	0.50			28.0	DS											DS Taken
28.00	28.50	0.50			28.5	DS											DS Taken
28.50	29.00	0.50			29.0	UDS											UDS Collected
29.00	29.50	0.50			29.5	DS											DS Taken
29.50	30.00	0.50			30.0	SPT	8	16	19	35							Sample Collected
30.00	30.50	0.50			30.5	DS											DS Taken
30.50	31.00	0.50			31.0	DS											DS Taken
31.00	31.50	0.50			31.5	DS											DS Taken
31.50	32.00	0.50			32.0	UDS											UDS Collected
32.00	32.50	0.50			32.5	DS											DS Taken
32.50	33.00	0.50			33.0	SPT	10	17	18	35							Sample Collected
33.00	33.50	0.50			33.5	DS											DS Taken
33.50	34.00	0.50	Silty Sand		34.0	SPT	19	30	42	72	33						Sample Collected
34.00	34.50	0.50			34.5	DS											DS Taken
34.50	35.00	0.50			35.0	DS											DS Taken
35.00	35.50	0.50			35.5	DS											DS Taken

4207

BORE LOG DETAILS

Client	:	DFCC	Existing Ground Lvl. (RL in Mtr)	: 270.288
Project	:	G.I. for 3nos Important Bridges	Depth of Ground Water from EGL (in Mtr)	: 6.75
Bore Hole No.	:	BH-4 (A2)	Date of commencement	: 29.08.12
Location	: :	Near Abutment, Towards Ambala, Tangri River	Date of Completion	: 31.08.12
Type of Boring	:	Rotary Drilling	Conducted By	: T.K Das
Dia of Bore	:	150mm in soil		
Type of Sampler used	:	UDS/Split spoon Sampler/Core barrel		

Depth(m)		Length of Run	Description of Strata	Log of Bore	Sampling		SPT					Details of Rock Core					Remarks
From	To				Depth	Type	Blows Required for Penetration of depth			N value (observed)	N Corrected	Total Length (cm)	No of Pieces	Length of core greater than 10cm	% of Core Recovery	RQD Value (%)	
							0 - 15 cm	15 - 30 cm	30 - 45 cm								
35.50	36.00	0.50	Silty Sand		36.0	SPT	26	43	46	89	33						Sample Collected
36.00	36.50	0.50			36.5	DS											DS Taken
36.50	37.00	0.50			37.0	DS											DS Taken
37.00	37.50	0.50			37.5	DS											DS Taken
37.50	38.00	0.50			38.0	DS											DS Taken
38.00	38.50	0.50			38.5	DS											DS Taken
38.50	39.00	0.50	Clay		39.0	SPT	13	20	20	40							Sample Collected
39.00	39.50	0.50			39.5	DS											DS Taken
39.50	40.00	0.50			40.0	DS											DS Taken
40.00	40.50	0.50			40.5	DS											DS Taken
40.50	41.00	0.50			41.0	DS											DS Taken
41.00	41.50	0.50			41.5	DS											DS Taken
41.50	42.00	0.50			42.0	SPT	11	22	25	47							Sample Collected
42.00	42.50	0.50			42.5	DS											DS Taken
42.50	43.00	0.50			43.0	DS											DS Taken
43.00	43.50	0.50			43.5	DS											DS Taken
43.50	44.00	0.50			44.0	DS											DS Taken
44.00	44.50	0.50			44.5	DS											DS Taken
44.50	45.00	0.50			45.0	SPT	15	21	28	49							Sample Collected
45.00	45.50	0.50			45.5	DS											DS Taken
45.50	46.00	0.50			46.0	DS											DS Taken
46.00	46.50	0.50			46.5	DS											DS Taken
46.50	47.00	0.50			47.0	DS											DS Taken
47.00	47.50	0.50			47.5	DS											DS Taken
47.50	48.00	0.50			48.0	SPT	14	24	30	54							Sample Collected
48.00	48.50	0.50			48.5	DS											DS Taken
48.50	49.00	0.50			49.0	DS											DS Taken
49.00	49.50	0.50			49.5	DS											DS Taken
49.50	50.00	0.50			50.0	SPT	12	29	31	60							Sample Collected

CALCULATIONS FOR CORRECTED SPT (N) VALUES

CHAINAGE NO	DEPTH OF SAMPLE	BULK / SUB DENSITY (t/m3) γ	OVERBURDEN PRESSURE (t/m2)	OVERBURDEN CORRECTION FACTOR (Cn)	OBSERVED SPT 'N' VALUE (N)	CORRECTED SPT (N') VALUE (FOR OVERBURDEN)	FINAL CORRECTED VALUE AFTER DILATANCY CORRECTION (N")
	0.0						
	0.0						
BH-1(Tangri River)	9.0	1.00	9.00	1.06	20	21	18
	12.0	1.00	12.00	0.94	26	24	20
	0.0						
BH-3(Tangri River)	1.5	1.00	1.50	1.72	20	34	25
	3.0	1.00	3.00	1.40	23	32	24
	0.0						
BH-4(Tangri River)	7.5	1.00	7.50	1.10	30	33	24
	9.0	1.00	9.00	1.06	36	38	27
	34.0	1.00	34.00	0.70	72	50	33
	36.0	1.00	36.00	0.58	89	52	33

Appendix -II

(Sample Calculation)

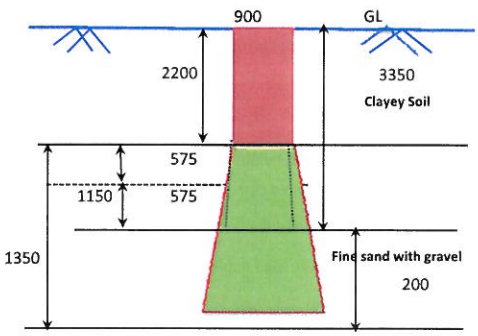
Sample Calculation

Safe Bearing Capacity & Safe Bearing Pressure of Well Foundation

Refer - 6403, 8009(part-I)

Tangri River :- BH-4(A2)

Diameter of Well **(B)**	=	900 cm
Depth of Well **(d_f)**	=	2200 cm
Depth of scour from ground level	=	1032.8 cm
Effective depth of Well	=	1167.2 cm
Founding Strata	=	Clayey Soil
D / B	=	1.297



The Following parameters are utilised in Calculation

(All dimensions are in cm)

N value	=	30		
Cohesion (c)	=	2.00	kg/ cm^2	**(Restricted)**

Angle of Shearing Resistance of Soil **(Φ)** = 0° (Ref : Fig. No-1 ,Pg -11, IS : 6403-1981)

Saturated unit weight of foundation soil **(γ_{sat}) =** 0.002 Kg/Cm^3

Submerged unit weight of foundation soil **(γ') =** 0.001 Kg/Cm^3

(A) Safe Bearing Capacity

Bearing Capacity Factor,

N_c = 5.14 (Ref : Clause no. 5.3.1.1 , IS : 6403-1981)

Shape Factors,

S_c = 1.30 (Ref : Clause no. 5.1.2.1 , IS : 6403-1981)

Depth Factor ,

$\sqrt{N\Phi}$ = $\tan(\pi/4)+\Phi/2$

= 1.00

d_c = $1+0.2(D_f/B) \times \sqrt{N\Phi}$

= 1.26

$d_q = d_\gamma$ = $1+0.1(D_f/B)x\sqrt{N\Phi}$ (Ref : Clause no. 5.1.2.2 , IS : 6403-1981)

= 1.00

Correction factor for water table **(W')** = 0.5 (Assuming water table at the EGL)

Net Ultimate Bearing Capacity **(q_d)** = **cNc Sc dc**

= 16.83 kg/cm^2 (Ref :Clause no. 5.3.1.1,IS : 6403-1981)

Factor of Safety **(FOS)** = 2.50

Safe Bearing Capacity **(q_{safe})** = **q_d /FOS**

= 6.73 kg/cm^2

= 67.32 t/m^2

4211

(B) Safe Bearing Pressure

- Load is dispersed in soil as per 2v : 1h Principle
- The zone of Soil within a depth of 1.5xdia of well is assumed to the involved in setlement

For Clayey Soil Stratum :

Initial Void Ratio at mid-height of layer (e_0) = 0.51

Compression index (C_c) = $0.3(e_0 - 0.27)$ = 0.07 (Ref:Clause no-9.2.2.2 IS: 8009 (Part -1)-1976)

Initial effective Pressure at mid-height of layer (P_0) = 1.742 kg/cm^2

Assuming Structural Load applied (q) = 1 kg/cm^2

Area of the top layer where load applied in cm^2 = 636172.5124

Area of themiddle layer where load applied in cm^2 = 1708731.879

Pressure Increment (Δ_p) at mid-layer of clay layer involved in settlement = 0.37 kg/cm^2

Settlement (S_{oed}) = $\frac{H_t}{1+e_0} C_c \log_{10}\left[\frac{P_0+\Delta_p}{P_0}\right]$ (Ref:Clause no-9.2.2.2 IS: 8009 (Part -1)-1976)

= 4.612 cm

For Sandy Soil Stratum :

N ava of the layer = 25

Assuming Structural Load applied (q) = 1 kg/cm^2

Area of the top layer of foundation = 636172.51

Area of top layer of sandy strata = 3300635.78

Foundation Pressure (p) = 0.19 kg/cm^2

Settlement (S_i) = pB I (1 - μ2) / E

Where, (Ref : Clause no - 9.2.3.2 , IS : 8009 (Part -1) - 1976)

Influence factor (I) = 1.20

Poisson's Ratio (μ) = 0.30 (Ref:Table no-1.16.2,Foundation Design Manual, N. V. Nayak)

Modulus of Elasticity(E) = 1200(N+6)

= 37200 kp_a

= 372 kg/cm^2 (Ref : Bowles, J.E., Foundation Analysis & Design,McGraw-Hill , New York,2002)

Settlement (S_i) = 0.50921303 cm

D / √ LB	=	1.30	(Ref : Fig no - 12 , IS : 8009 (Part -1) - 1976)
√LB / D	=	0.77	
L / B	=	1.00	
Depth Factor	=	0.662	
λ	=	0.70	(Ref : Table no - 1, IS : 8009 (Part -1) - 1976)
Rigidity Factor	=	0.80	

Settlement for 1kg / cm^2 = $((S_{oed} \times \lambda) + S_i) \times$ Depth Factor x Rigidity Factor

= 1.98 cm

19.8 mm Settlement caused due to	=	1.00 kg / cm^2	=	10.00 t / m^2
Hence,				
50 mm Settlement caused due to	=	2.53 kg / cm^2	=	25.26 t / m^2
75 mm Settlement caused due to	=	3.79 kg / cm^2	=	37.89 t / m^2

(C) Allowable Bearing Pressure

Safe Bearing Capacity (q_{safe})	=	67.32 t / m^2
Safe Bearing Pressure for 50mm Settlement	=	25.26 t / m^2
Safe Bearing Pressure for 75mm Settlement	=	37.89 t / m^2
Allowable Bearing Pressure considering shear failure & settlement of 50mm & 75mm	=	**25.26** t / m^2

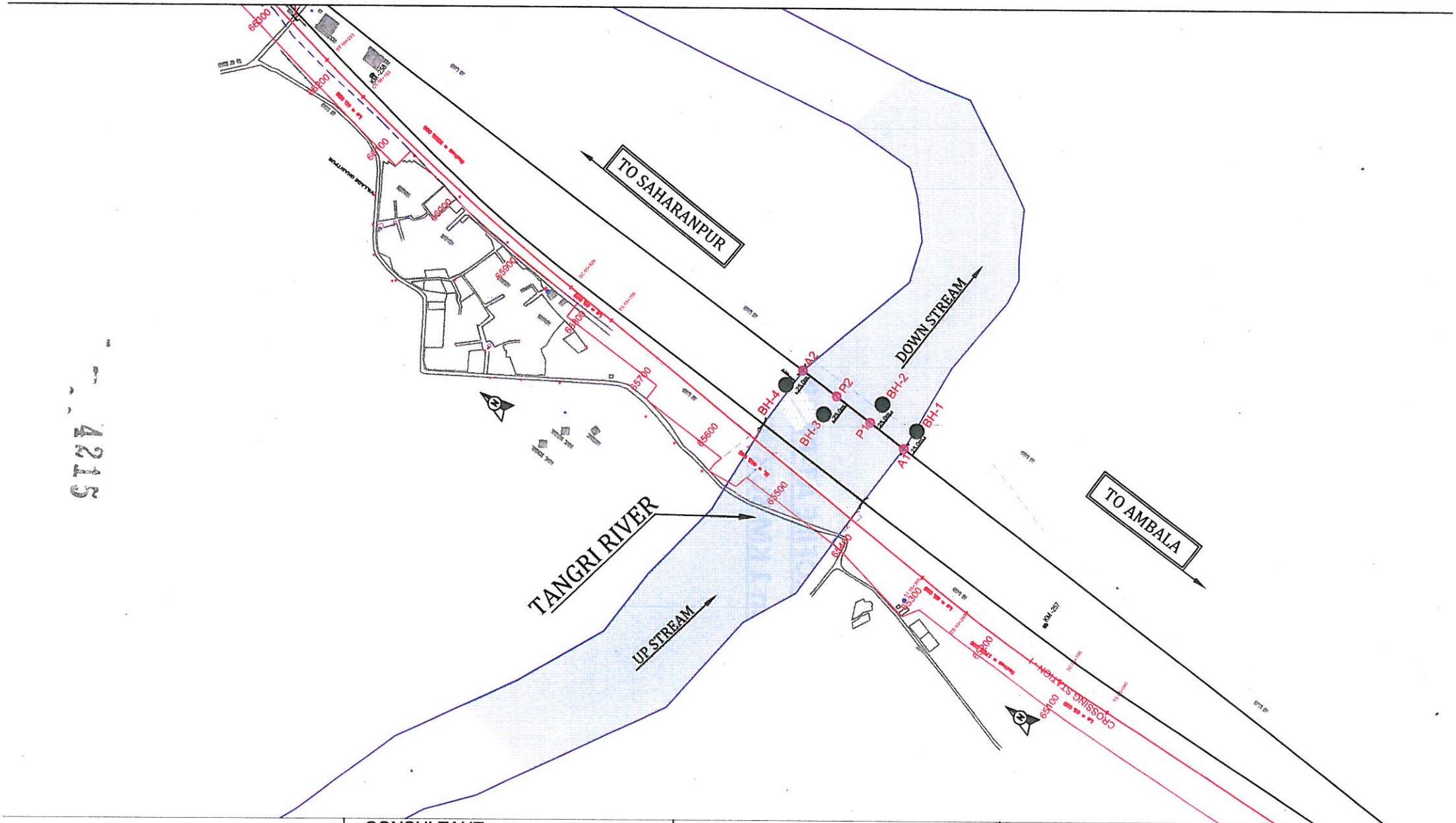
4212

Bridge at Km (10+786)

① Borelocation Plan
② River cross-section 1 km both in U/S and D/S side.
③ Catchment area marking in Toposheet
④ Discharge Calculations
⑤ Silt factor Calculations

BOREHOLE LOCATION PLAN

4214



DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market),
Ambala Cantt-133001
Telefax: 0171-2612412

CONSULTANT:-
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email : business@arkitechno.com,Web : www.arkitechno.com

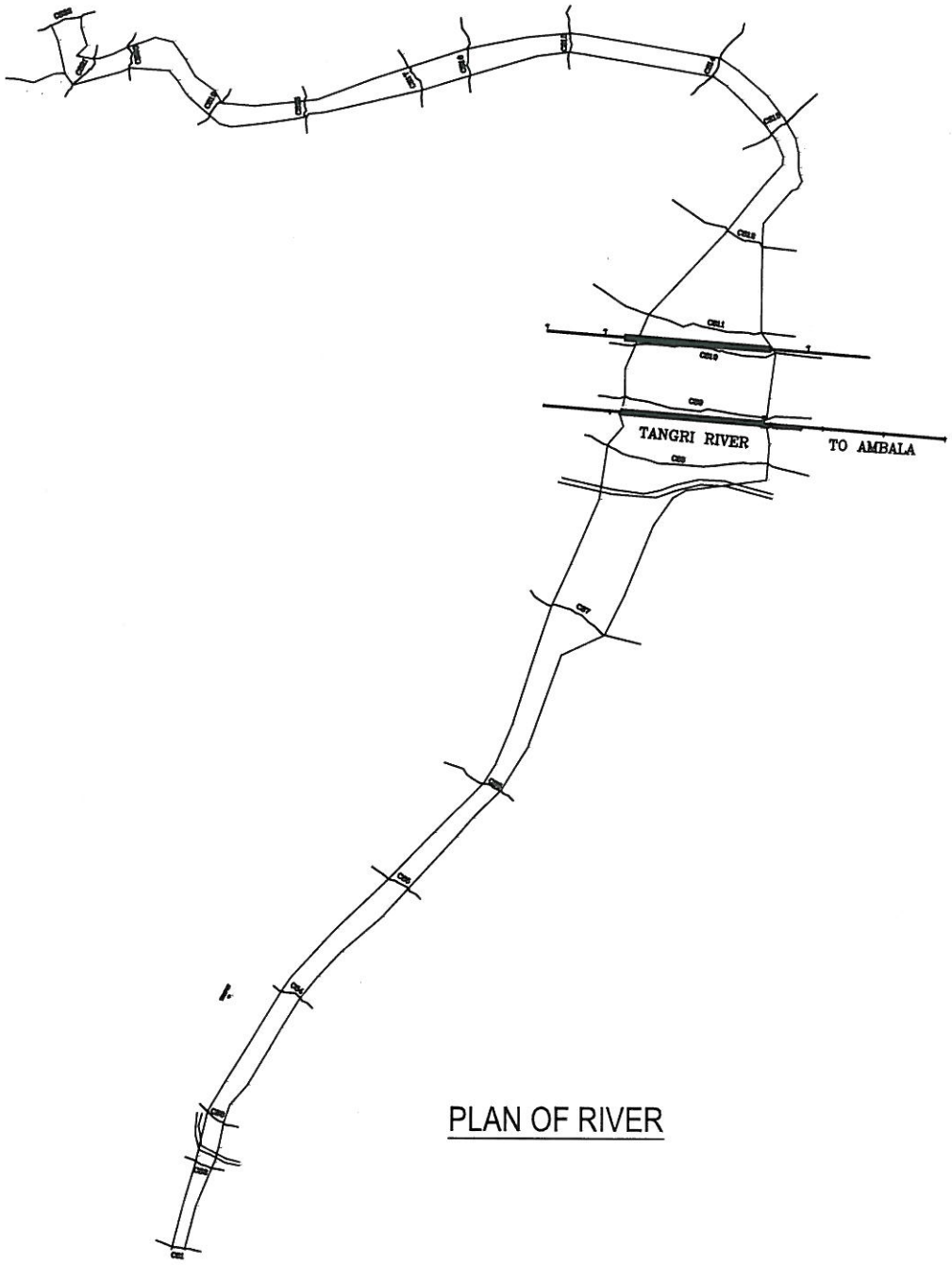
PROJECT:-
GEOTECHNICAL INVESTIGATION FOR 3 NOS IMPORTANT BRIDGES

LOACTION PLAN ALONG TANGRI RIVER

DRG NO.	ATCPL/DFCC/TR/LP-02	DRN BY:-I.B	CHKD BY:-JKR
DATE	JUNE-2013	SCALE	AS SHOWN

TANGRI RIVER PROFILE AT-PROP:-65+481 SPAN SIZE :-
3 X 45.7M on 1 KM SURVEY BOTH IN U/S & D/S

4216



PLAN OF RIVER

DATE	DESCRIPTION	CHKD.	APPRD.
	REVISIONS		

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cantt-133001
Telefax: 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER AT PROP.CH:-65+481
SPAN SIZE:-
3 x 45.7m OPEN WEB GIRDER

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD. BY	NMA	
Apprvd By:		

ARKITECHNO Consultants (India) Pvt.Ltd
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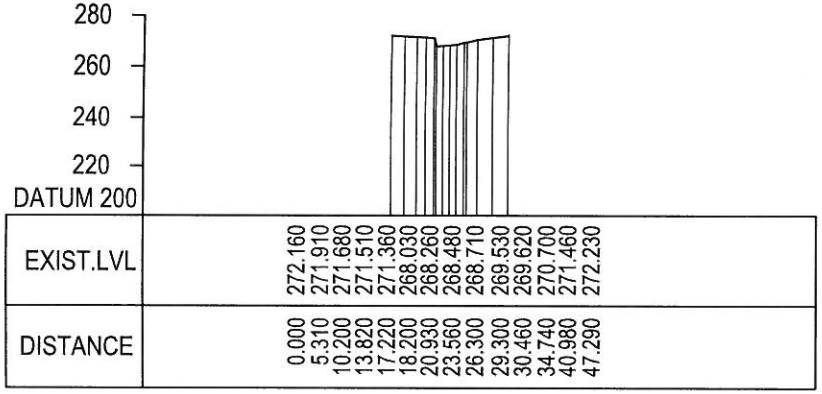
DRAWING NO.
ATCPL/DFCC/2013/BR/65/CS

REV.

4217



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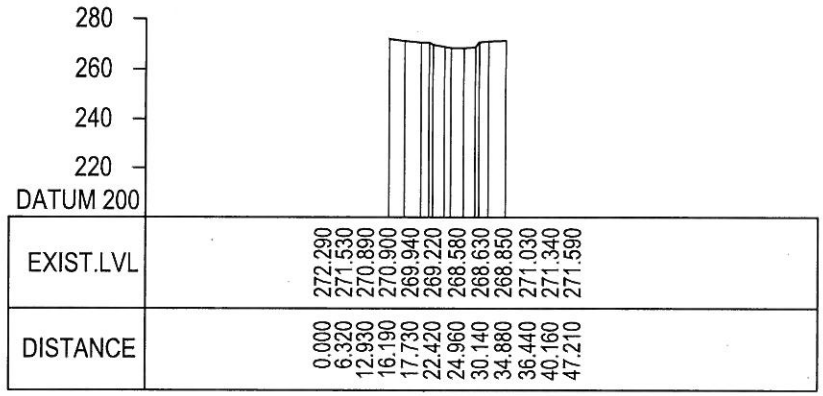

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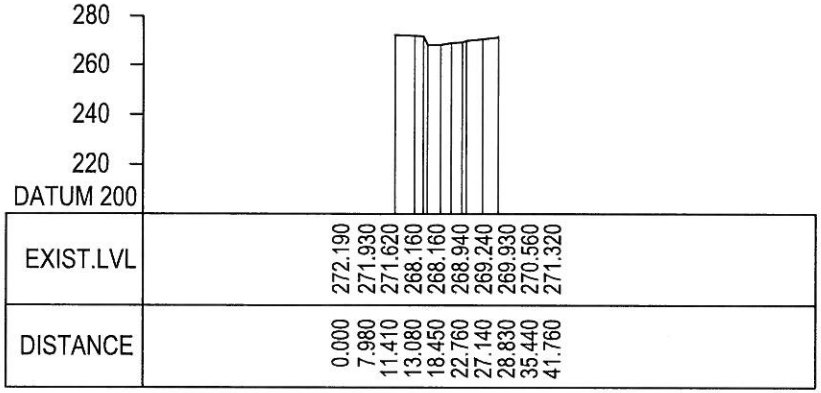

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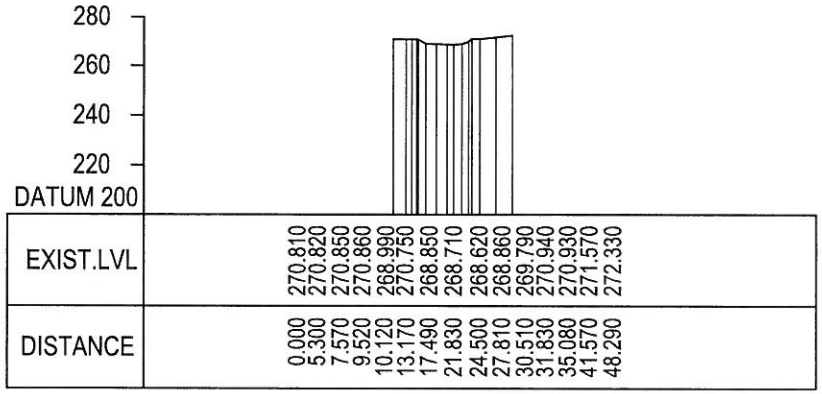

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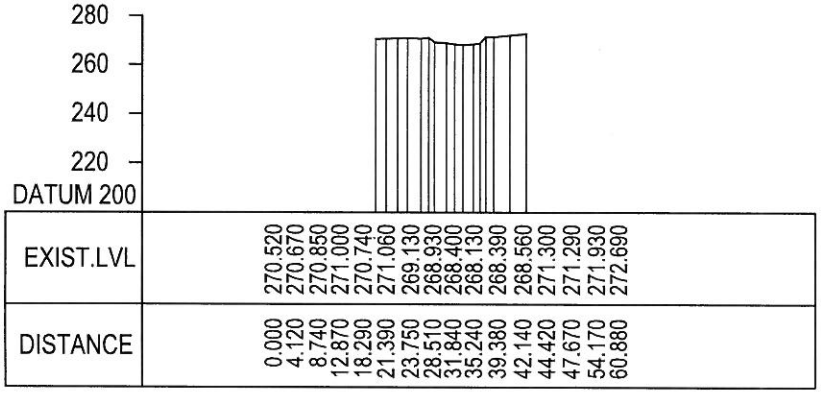

CROSS SECTION - 5

DATE	DESCRIPTION	CHKD.	APPRD.

REVISIONS

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cantt-133001
Telefax: 0171-2612712

TITLE:-
CROSS SECTION OF TANGRI RIVER
AT PROP.CH:-65+481
SPAN SIZE:-
x m EN EB DE

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD. BY	NM	
Appd. By.		

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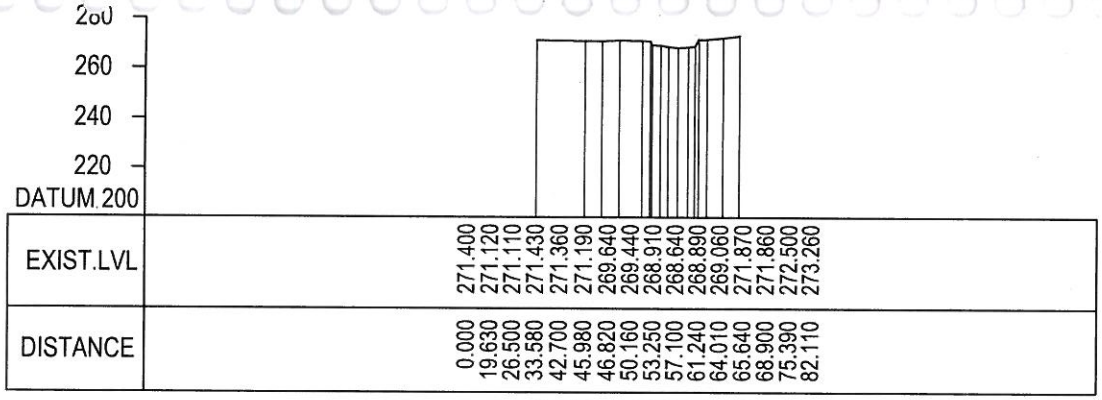
REV-44

SHEET -1

4218



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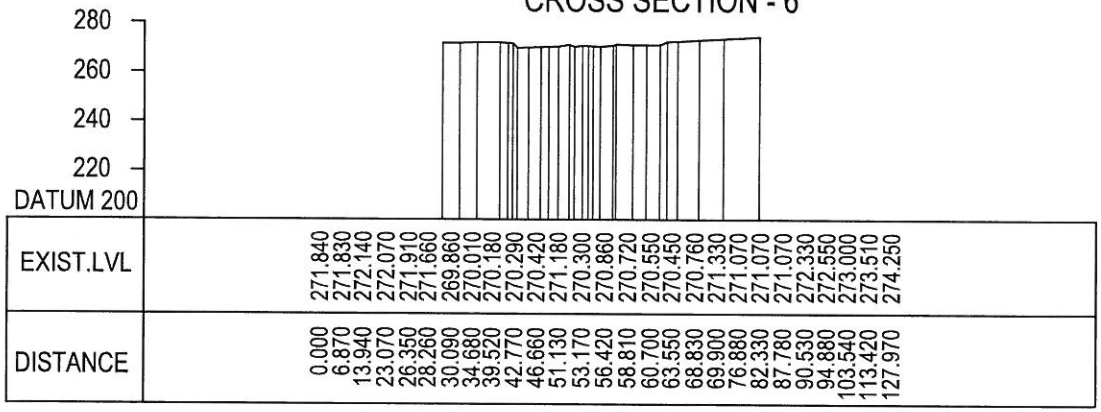

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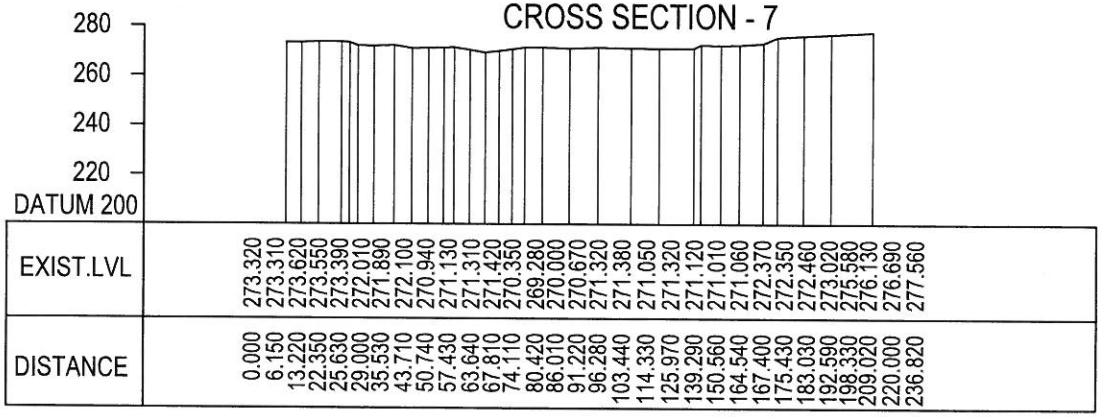

CROSS SECTION - 8

DATE	DESCRIPTION	CHKD.	APPRD.
	REVISIONS		

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cantt-133001
Telefax: 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER AT PROP.CH:-65+481
SPAN SIZE:-
3 x 45.7m OPEN WEB GIRDER

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD. BY	NNA	
Appvd By:		

ARKITECHNO
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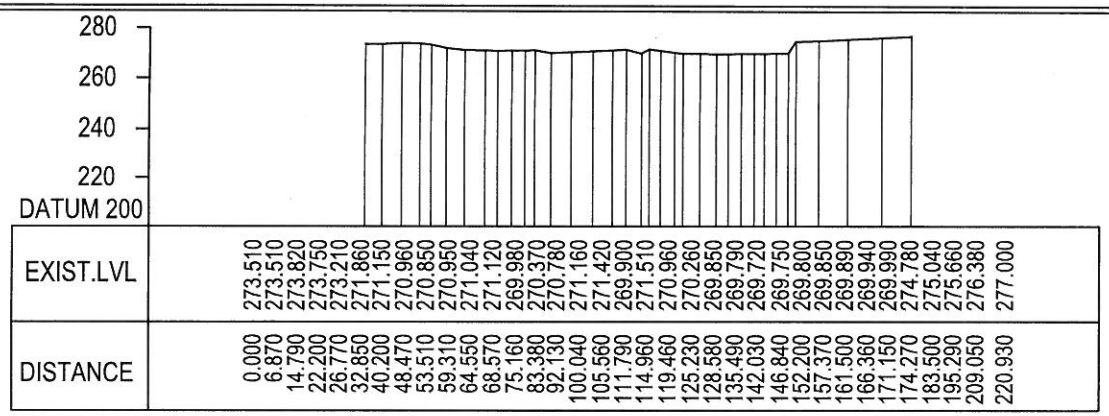
DRAWING NO.
ATCPL/DFCC/2013/BR/68/CS

REV. 45

SHEET NO-2



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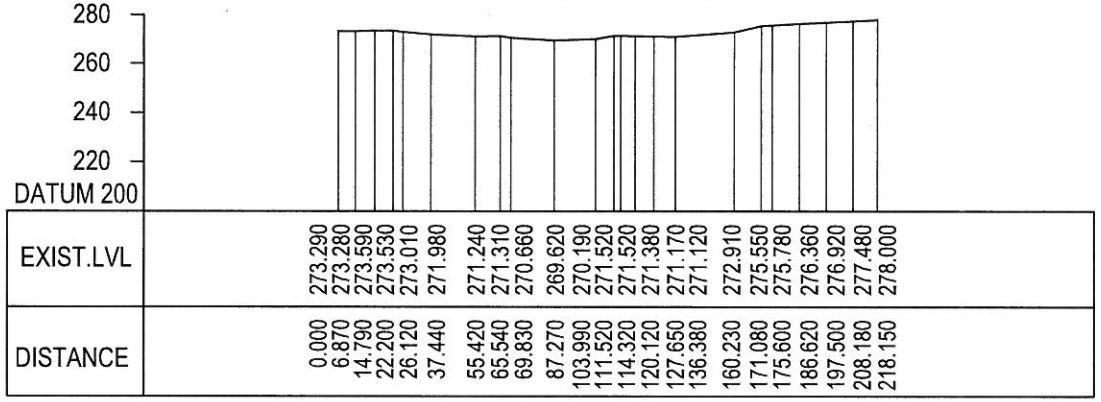

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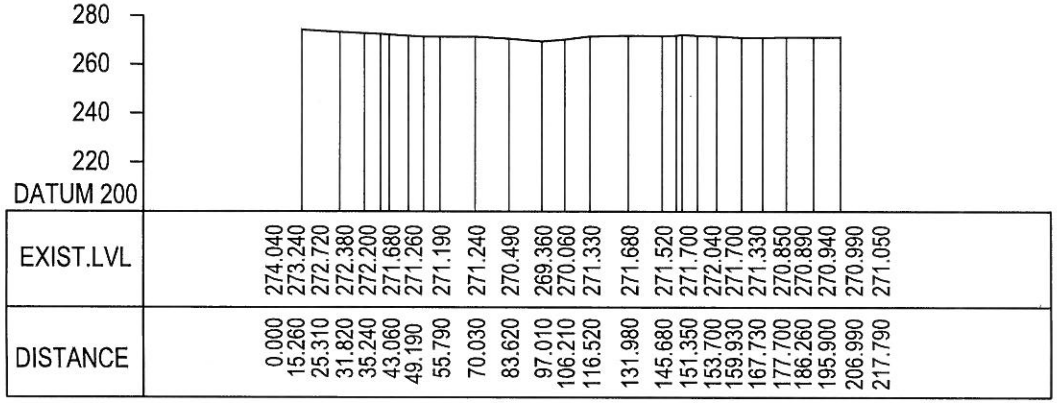

CROSS SECTION - 11

DATE	DESCRIPTION	CHKD.	APPRD.
	REVISIONS		

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cant. 133001
Telefax. 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER AT PROP.CH:-65+481
SPAN SIZE:-
x m EN B DE

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CH BY	NI	
Appvd By:		

ARKITECHNO
ARKITECHNO Consultants (India) Pvt.Ltd
ISO 9001-2008 Certified Company
Plot No# N3/91,IRC Village,Nayapalli
Bhubaneswar-751015,Odisha
Ph:+ 97 54 5,T ax 53
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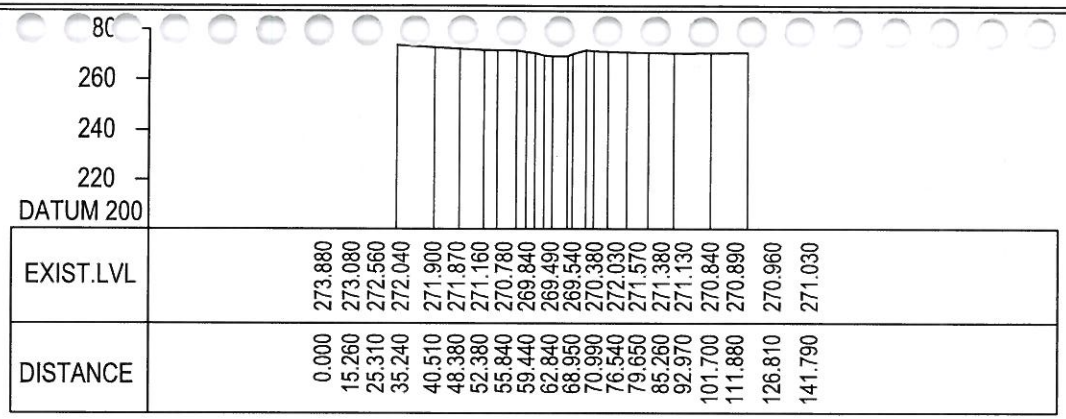
DRAWING NO.
ATCPL/DFCC/2013/BR/68/CS

REV. 46 | SHEET -3



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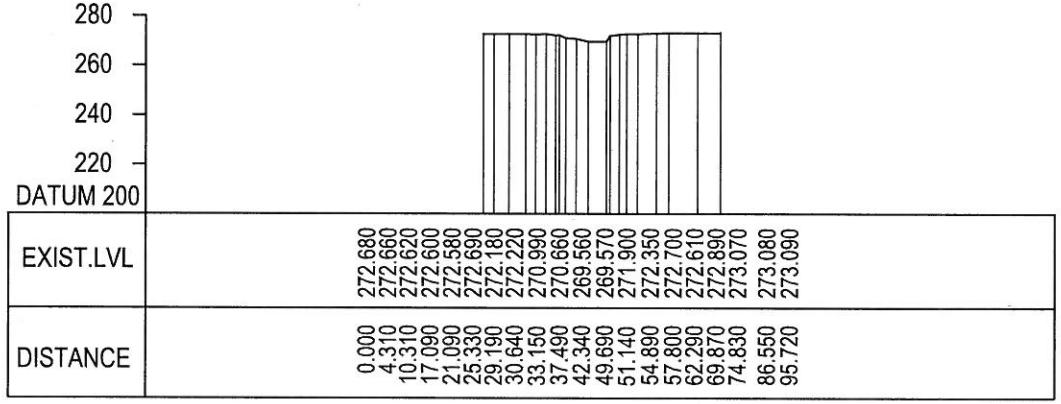

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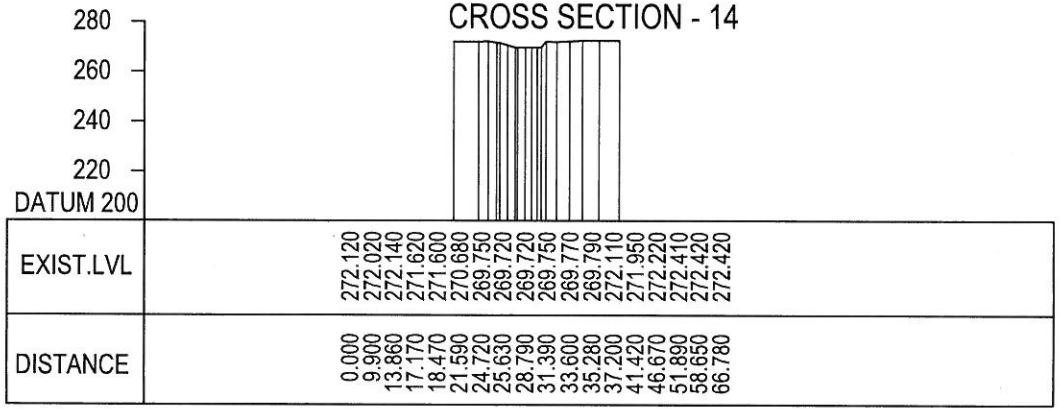

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DATE	DESCRIPTION	CHKD.	APPRD.
REVISIONS			

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cantt-133001
Telefax: 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER AT PROP.CH:-65+481
SPAN SIZE:-
3 x 45.7m OPEN WEB GIRDER

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD. BY	NNA	
Appvd By:		

ARKITECHNO
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ISO 9001-2008 Certified Company
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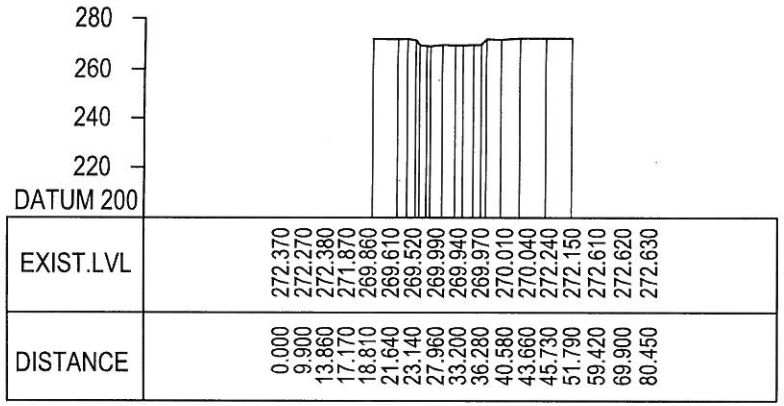
DRAWING NO.
ATCPL/DFCC/2013/BR/68/CS

REV: 47

SHEE NO-4



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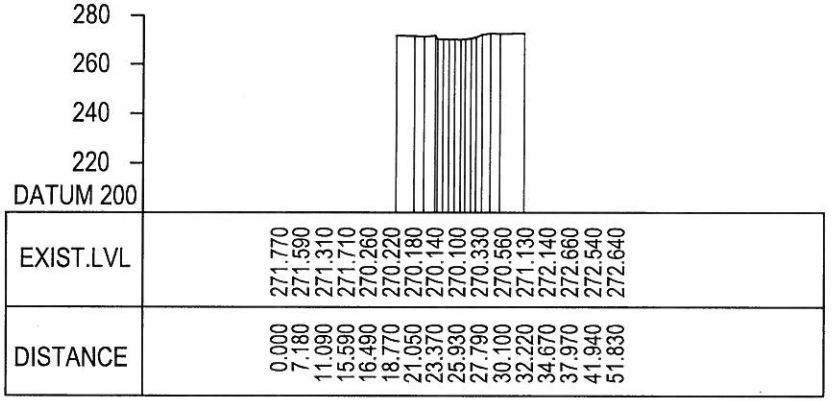

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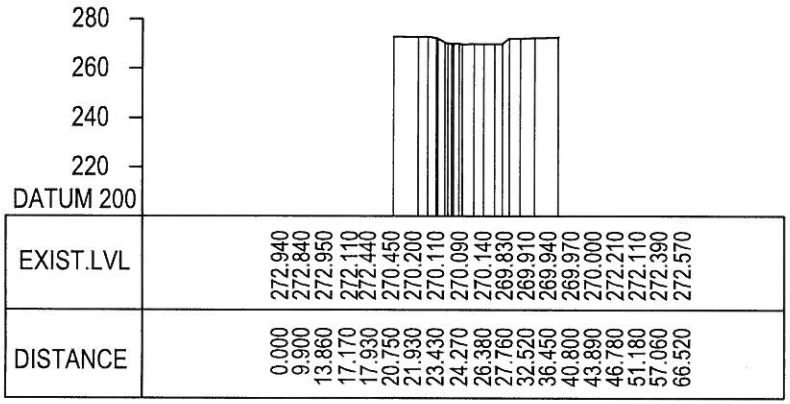

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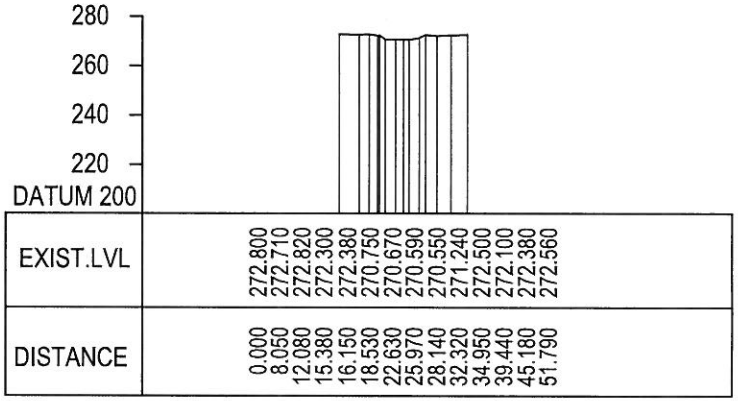

CROSS SECTION - 19

DATE	DESCRIPTION	CHKD.	APPRD.
	REVISIONS		

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cant. 133001
Telefax. 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER
AT PROP.CH:-65+481
SPAN SIZE:- x 4 m [illegible]

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD BY	NM	
Appvd By:		

ARKITECHNO
ARKITECHNO Consultants (India) Pvt.Ltd
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Plot No# N3/91,IRC Village,Nayapalli
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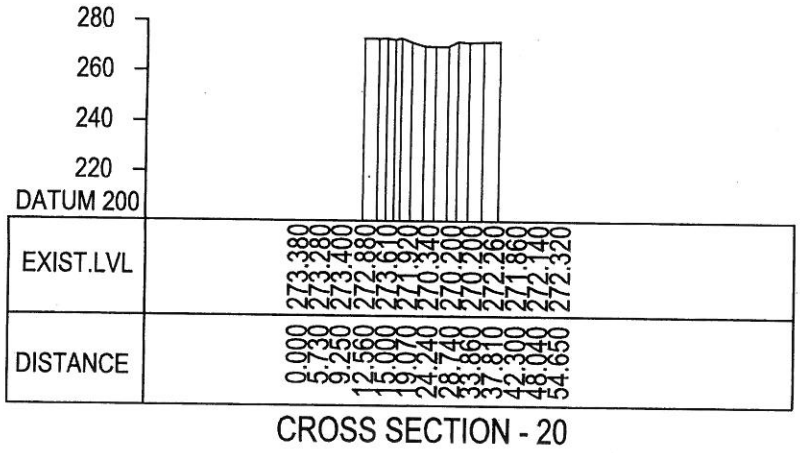
DRAWING NO.
ATCPL/DFCC/2013/BR/68/CS

REV | SHEET



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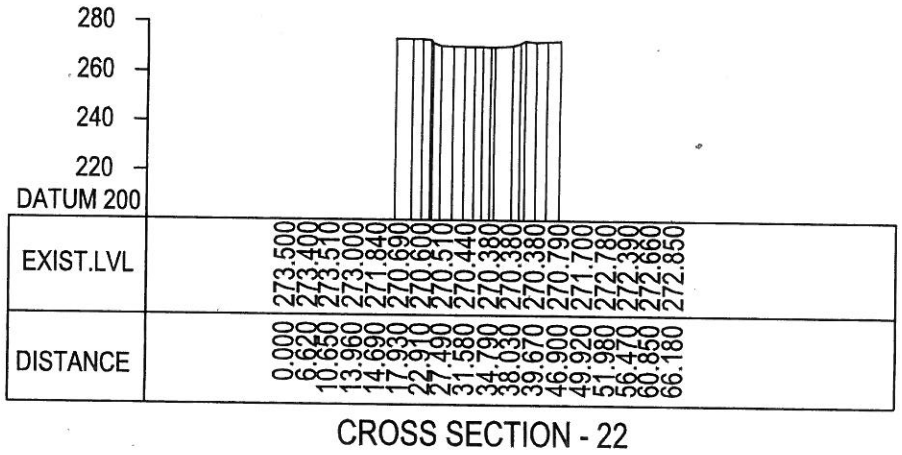

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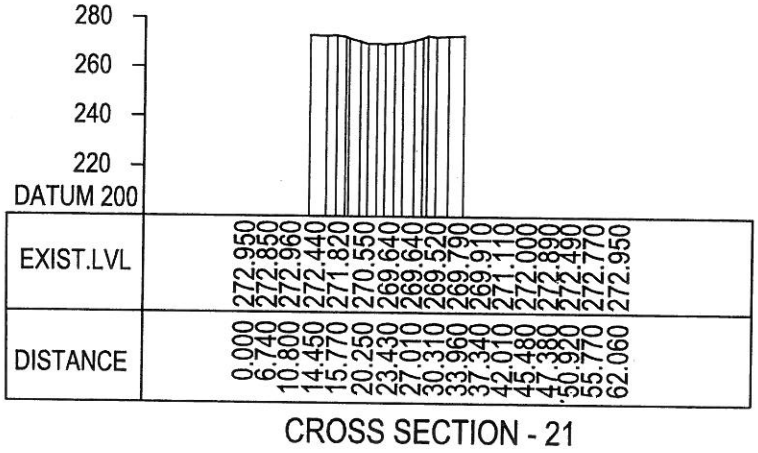

CROSS SECTION - 21

4223

DATE	DESCRIPTION	CHKD.	APPRD.
REVISIONS			

CLIENT:- DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)
Old Railway colony (Near Anand Market)
Ambala Cantt-133001
Telefax: 0171-2612412

TITLE:-
CROSS SECTION OF TANGRI RIVER AT PROP.CH:-65+481
SPAN SIZE:-
3 x 45.7m OPEN WEB GIRDER

SCALE :	AS SHOWN	SIGNATURE
DATE :	APRIL-2013	
PREP.BY	GM	
DESG.BY		
CHKD. BY	NNA	
Appvd By:		

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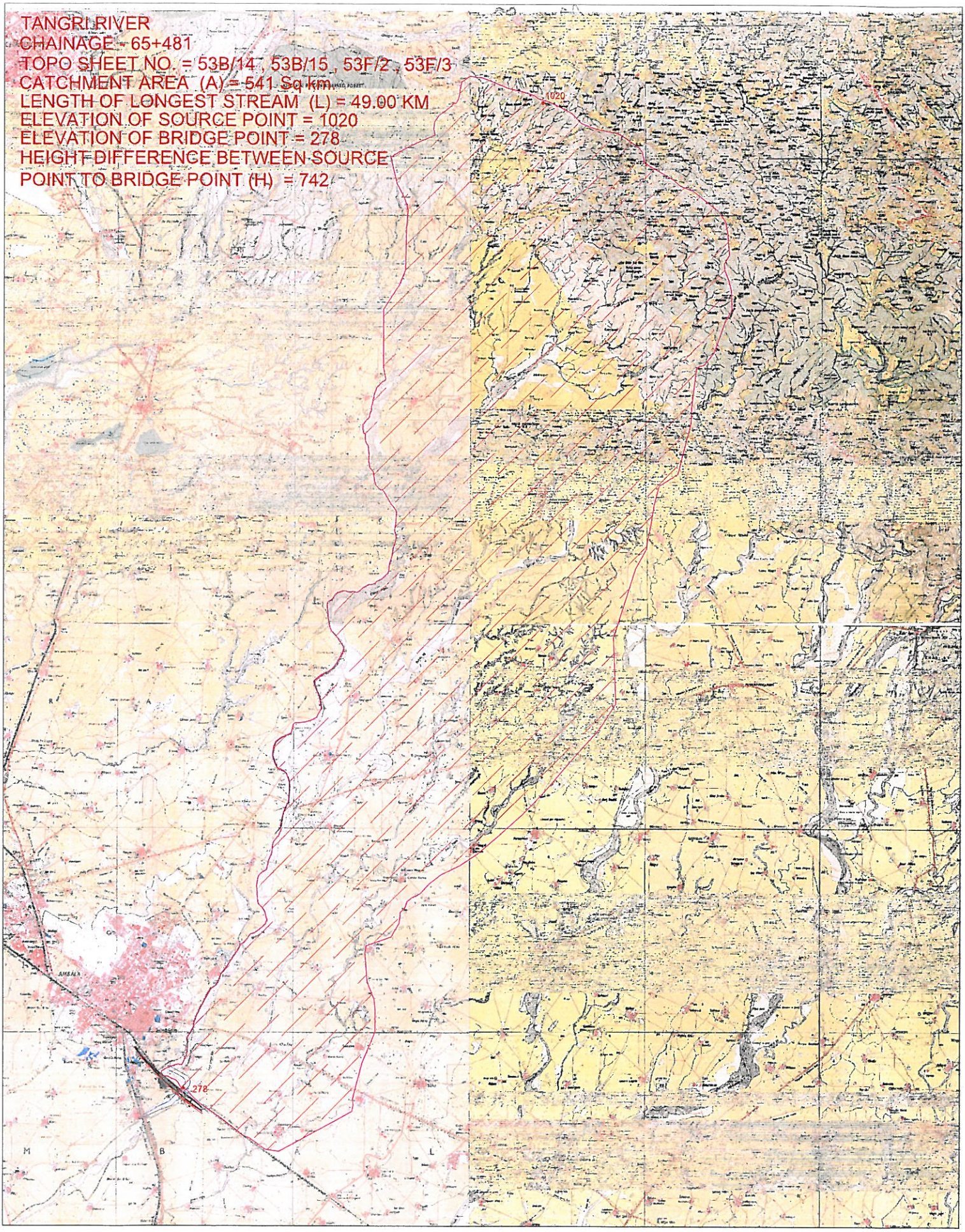
DRAWING NO.
ATCPL/DFCC/2013/BR/68/CS

REV.

SHEET NO-5

CATCHMENT AREA MARKING IN TOPOSHEET


TANGRI RIVER
CHAINAGE - 65+481
TOPO SHEET NO. = 53B/14 , 53B/15 , 53F/2 , 53F/3
CATCHMENT AREA (A) = 541 Sq. Km.
LENGTH OF LONGEST STREAM (L) = 49.00 KM
ELEVATION OF SOURCE POINT = 1020
ELEVATION OF BRIDGE POINT = 278
HEIGHT DIFFERENCE BETWEEN SOURCE POINT TO BRIDGE POINT (H) = 742
1020
278
AMBALA

4225

DISCHARGE CALCULATIONS

Discharge Calculations :-
Hydrology & Hydraullic calculations @ 65+841

1.0 Discharge Calculations as per Empirical Formula (Dickens) :

Details of the Bridge :

Chainage = 65+841 km

Preparation of Catchment Area Plan:

A catchment plan showing the river/stream , contours and spot levels was prepared for determining the physiographic parameters as follow:

Physiographic Parameters:

Catchment Area (M) = 541.000 sq km (From Topo Sheet)

Discharge Calculations :

Discharge $Q = CM^{3/4}$, As per Dickens Formula

Where
Q = The Peak run-off in cum/sec
C = 14
M = 541.0 Sq.km

$\therefore Q = 14 \times 541.0^{3/4}$
$= 1570.457$ **cu.m/sec**

2.0 Discharge Calculations as per Rational Formula :

$Q = 0.028\ P.f.A.Ic$

Where Q = Maximum run-off in cu.m / sec

A = Area of catchment in hectares = 54100.0 From Topo Sheet

P = Percentage coefficient of runoff for the catchment characteristics (From Code) = 0.6

f = fraction depending on the catchment area from f curve(From Code) = 0.62

Ic = Critical Intensity of rainfall in cm per hour

$= Io \left(\frac{2}{tc + 1} \right)$ Io = one hour rainfall

Where $Io = \frac{F}{2} \left(1 + \frac{1}{T} \right)$ = 7.30 cm/hr

F = Precipitation of the storm in cm = 7.3 cm

T = Duration in hours = 1 hrs

tc = Concentration time of Catchment in hours

$= 0.870 \left(\frac{L^3}{H} \right)^{0.385}$ = 6.118 hrs

From Topo Sheet
L = The distance from the critical point to the culvert in km. = 49.000

H = The fall in level from the critical point to the bridge in metre. = 742.0

$\therefore Q = A.Io\lambda$

$I = \frac{0.056\ f.P}{tc + 1} = \frac{0.056 \times 0.62 \times 0.6}{6.118 + 1} = 0.002926776$

$Q = 54100 \times 7.3 \times 0.003 =$ **1155.872 cu.m/sec**

Discharge calculation by Unitgraph Method

1 Design data

Catchment Area	(A)	=	541	sqkm
Length of Longest Stream	(L)	=	49	km
Length of Longest Stream from cg to site	(L_c)	=	24.5	km
Unit Duration of Unitgraph	(t)	=	1.0	hr

2 Computation of Equivalent Stream Slope (S)

Sl. No.	Reduced distance	Reduced levels	L_i	D_i	$D_{i-1} + D_i$	$L_i(D_{i-1}+ D_i)$
	(kms)	(m)	(kms)	(m)	(m)	(mxkm)
1	2	3	4	5	6	7
1	0.000	270.674	0		-	-
2	0.120	270.663	0.120	-0.011	-	0.00
3	0.320	270.638	0.200	-0.036	-0.047	-0.01
4	0.330	270.607	0.010	-0.067	-0.103	0.00
5	0.410	270.586	0.080	-0.088	-0.155	-0.01
6	0.460	270.575	0.050	-0.099	-0.187	-0.01
7	0.510	270.307	0.050	-0.367	-0.466	-0.02
8	0.704	270.295	0.194	-0.3791	-0.7461	-0.14
9	0.712	270.293	0.008	-0.3814	-0.7605	-0.01
10	0.800	270.281	0.088	-0.3926	-0.774	-0.07
11	0.910	270.277	0.110	-0.3974	-0.79	-0.09
12	1.000	270.257	0.090	-0.4169	-0.8143	-0.07
13	1.100	270.253	0.100	-0.4214	-0.8383	-0.08
14	1.150	270.238	0.050	-0.4358	-0.8572	-0.04
15	1.200	270.237	0.050	-0.4369	-0.8727	-0.04
			1.200			**-0.6049**

Slope (S) = $\Sigma \frac{L_i(D_{i-1}+D_i)}{L^2}$ = **0.4201** m/km

3 Determination of Synthetic Unitgraph Parameters:-

Time fromcenter of unit rain fall to Unit hydrograph in hr.	tp	=	$0.433[L/\sqrt{s}]^{0.704}$
		=	28.79 hr
Peak discharge of unit hydrograph in cumecs / Sq. Km	q_p	=	$1.161 \times (tp)^{-0.635}$
		=	0.137 cumecs / Sq. Km
Width of unit hydrograph at 50% of Max discharge ordinate	W_{50}	=	$2.284(q_p)^{-1.0}$
		=	16.61 hr
Width of unit hydrograph at 75% of Max discharge ordinate	W_{75}	=	$1.331(q_p)^{-0.991}$
		=	9.511 hr
Width of rising side of unit hydrograph at 50% of Max discharge ordinate		=	$0.827 \times (qp)^{-1.023}$
	W_{R50}	=	6.297 hr
Width of rising side of unit hydrograph at 75% of Max discharge ordinate		=	$0.561 \times (qp)^{-1.037}$
	W_{R50}	=	4.392 hr
Base width of Unit hydrograph	T_B	=	$8.375 \times (tp)^{0.512}$
		=	46.79 hr
Time from the start of rise to the peak of unit hydrograph	T_M	=	$t_p + t_r / 2$
		=	29.29 hr
Peak discharge of unit hydrograph	Qp	=	q_p X A
		=	74.37 cumecs

Slope of River bed calculations :-

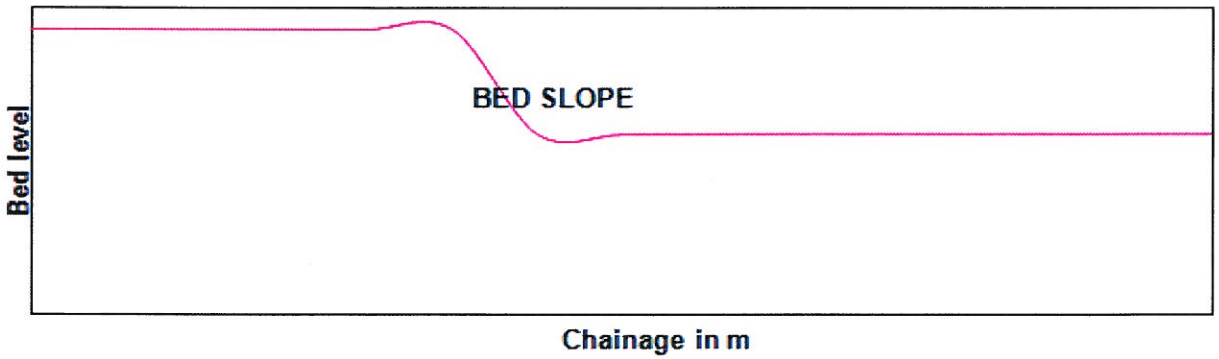
Bed Slope / Longitudinal Slope of River Bed :

Details of the Bridge :

Chainage = 65+841 KM

S. No.	length	LBL
1	0	270.674
2	120	270.674
3	320	270.674
4	330	270.674
5	410	270.674
6	460	270.674
7	510	270.307
8	704	270.307
9	712	270.307
10	800	270.307
11	910	270.307
12	1000	270.307
13	1100	270.307
14	1150	270.307
15	1200	270.307

Bed slope = 0.00191 - ve sign indicate Down Ward Slope



Discharge Calculations as per Area-velocity Method :-

At Upstream Site(500 m from Bridge center)

Q = A x V

Where A = Cross Sectional Area

V = Velocity, calculated from Manning's formula

$= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

R = Hydraulic Mean depth = A / P

P = Wetted Perimeter

S = Bed Slope, measured over a long reach

n = Coefficient of rugosity (from code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.911 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	276.50	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	270.49	2.577	1.289	30.000	38.655	30.110
3	273.062	70.00	267.80	5.259	3.918	40.000	156.720	40.090
4	273.062	110.00	266.91	6.151	5.705	40.000	228.200	40.010
5	273.062	150.00	268.83	4.232	5.192	40.000	207.660	40.046
6	273.062	190.00	272.98	0.081	2.157	40.000	86.260	40.215
7	273.062	220.00	274.54	0.000	0.041	30.000	1.215	30.000
		AVG. B.L =	271.150					

Total (Cross sectional Area, A) = **718.710** sq. m

Wetted Perimeter, P in m = **220.471**

Hydraulic Radius, R = A / P = = **3.260 m**

Velocity, V = $1/n * R^{2/3} . S^{1/2}$ = **1.924 m/sec**

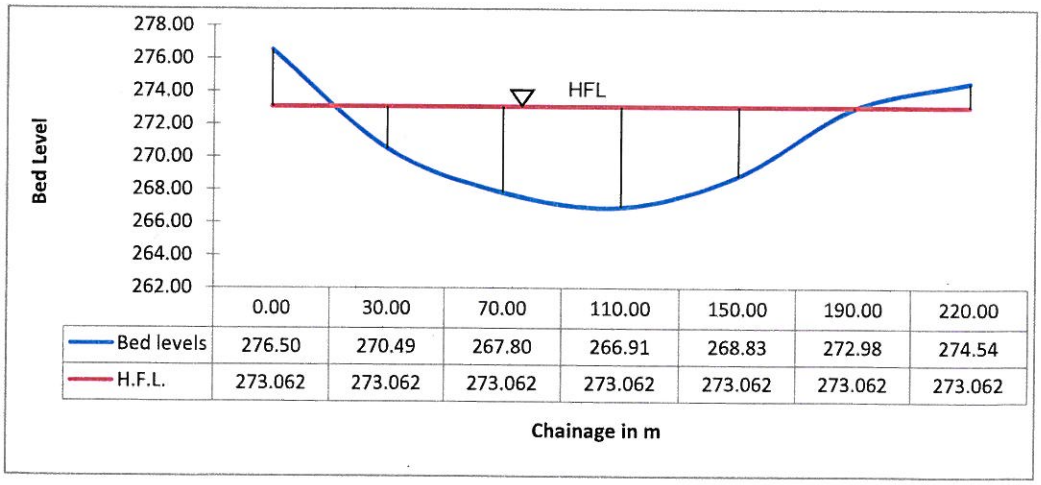
Discharge, Q = A*V = 1382.577 cumecs

Say **1383.00** cumecs

Linear water way = **220.000** m

Abbreviations

H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



Discharge Calculations as per Area-velocity Method :-

At Upstream Site(500 m from Bridge center)

Q = A x V

Where A = Cross Sectional Area

V = Velocity, calculated from Manning's formula

$= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

R = Hydraulic Mean depth = A / P

P = Wetted Perimeter

S = Bed Slope, measured over a long reach

n = Coefficient of rugosity (from code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.911 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	276.50	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	270.49	2.577	1.289	30.000	38.655	30.110
3	273.062	70.00	267.80	5.259	3.918	40.000	156.720	40.090
4	273.062	110.00	266.91	6.151	5.705	40.000	228.200	40.010
5	273.062	150.00	268.83	4.232	5.192	40.000	207.660	40.046
6	273.062	190.00	272.98	0.081	2.157	40.000	86.260	40.215
7	273.062	220.00	274.54	0.000	0.041	30.000	1.215	30.000
		AVG. B.L =	271.150					

Total (Cross sectional Area, A) = **718.710** sq. m

Wetted Perimeter, P in m = **220.471**

Hydraulic Radius, R = A / P = = **3.260 m**

Velocity, V = $1/n * R^{2/3}. S^{1/2}$ = **1.924 m/sec**

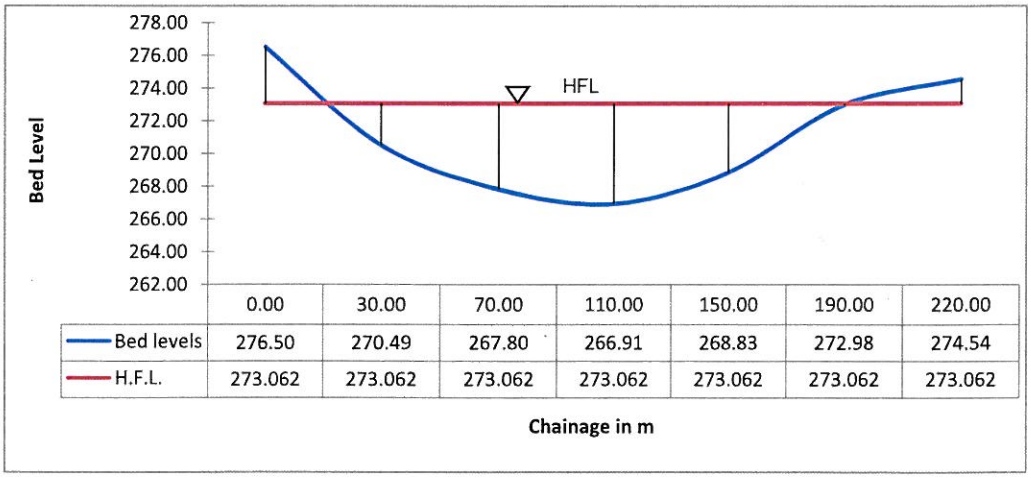
Discharge, Q = A*V = 1382.577 cumecs

Say **1383.00** cumecs

Linear water way = **220.000** m

Abbreviations

H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



4232

Discharge Calculations as per Area-velocity Method :-

At Upstream Site(100 m from Bridge center)

Q = A x V

Where

A = Cross Sectional Area

V = Velocity, calculated from Manning's formula

$= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

R = Hydraulic Mean depth = A / P

P = Wetted Perimeter

S = Bed Slope, measured over a long reach

n = Coefficient of rugosity (From code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.601 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	276.220	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	270.375	2.687	1.344	30.000	40.305	30.120
3	273.062	70.00	267.563	5.499	4.093	40.000	163.720	40.099
4	273.062	110.00	266.601	6.461	5.980	40.000	239.200	40.012
5	273.062	150.00	268.620	4.442	5.452	40.000	218.060	40.051
6	273.062	190.00	272.861	0.201	2.322	40.000	92.860	40.224
7	273.062	220.00	274.360	0.000	0.101	30.000	3.015	30.001
		AVG. B.L =	270.943					

Total (Cross sectional Area, A) = **757.160** sq. m

Wetted Perimeter, P in m = **220.506**

Hydraulic Radius, R = A / P = = **3.434 m**

Velocity, V = $1/n * R^{2/3} . S^{1/2}$ = **1.991 m/sec**

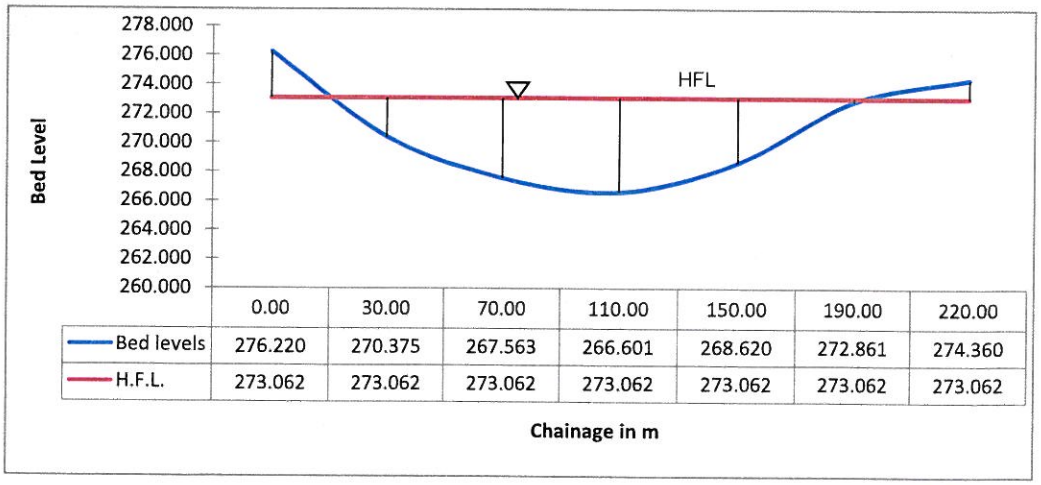
Discharge, Q = A*V = 1507.879 cumecs

Say **1508.00** cumecs

Linear water way = **220.000** m

Abbreviations

H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



Discharge Calculations as per Area-velocity Method :- *At Bridge Site*

Q = A x V

Where A = Cross Sectional Area

V = Velocity, calculated from Manning's formula

$= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

R = Hydraulic Mean depth = A / P

P = Wetted Perimeter

S = Bed Slope, measured over a long reach

n = Coefficient of rugosity (From code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.486 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	275.895	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	270.060	3.002	1.501	30.000	45.030	30.150
3	273.062	70.00	267.378	5.684	4.343	40.000	173.720	40.090
4	273.062	110.00	266.486	6.576	6.130	40.000	245.200	40.010
5	273.062	150.00	268.405	4.657	5.616	40.000	224.660	40.046
6	273.062	190.00	272.556	0.506	2.581	40.000	103.260	40.215
7	273.062	220.00	273.935	0.000	0.253	30.000	7.590	30.004
		AVG. B.L =	270.674					

Total (Cross sectional Area, A) = **799.460** sq. m

Wetted Perimeter, P in m = **220.515**

Hydraulic Radius, R = A / P = = **3.625 m**

Velocity, V = $1/n * R^{2/3} . S^{1/2}$ = **2.065 m/sec**

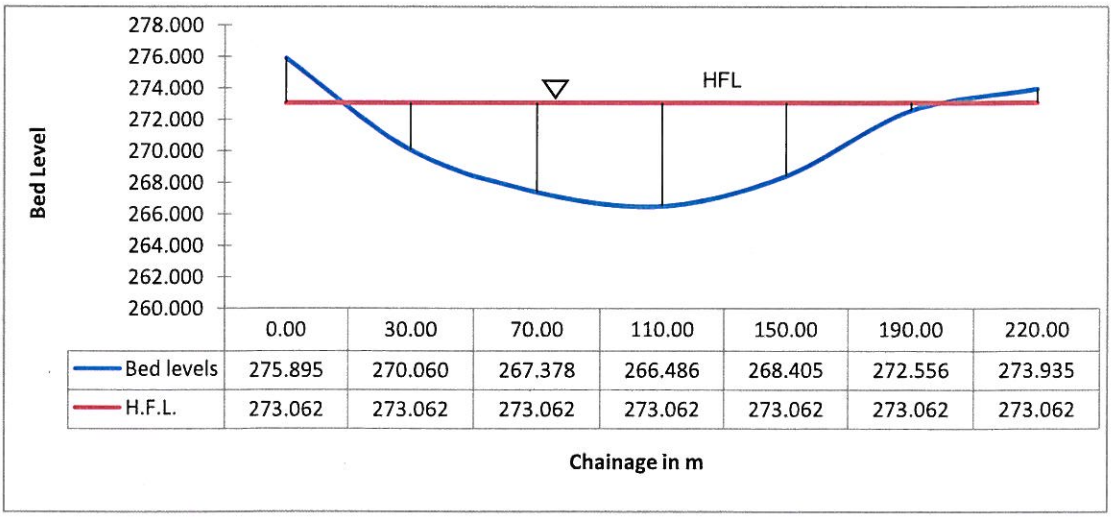
Discharge, Q = A*V = 1650.836 cumecs

Say **1651.00** cumecs

Linear water way = **220.000** m

Abbreviations

H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



Discharge Calculations as per Area-velocity Method :-

At Down stream Site
(100 m from Bridge center)

Q = A x V

Where
A = Cross Sectional Area
V = Velocity, calculated from Manning's formula
= $\frac{1}{n} \times R^{2/3} \times S^{1/2}$
R = Hydraulic Mean depth = A / P
P = Wetted Perimeter
S = Bed Slope, measured over a long reach
n = Coefficient of rugosity (from code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.239 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	275.648	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	269.813	3.249	1.624	30.000	48.735	30.175
3	273.062	70.00	267.131	5.931	4.590	40.000	183.600	40.090
4	273.062	110.00	266.239	6.823	6.377	40.000	255.080	40.010
5	273.062	150.00	268.158	4.904	5.863	40.000	234.540	40.046
6	273.062	190.00	272.309	0.753	2.828	40.000	113.140	40.215
7	273.062	220.00	275.688	0.000	0.376	30.000	11.295	30.009
		AVG. B.L =	270.712					

Total (Cross sectional Area, A) = **846.390** sq. m
Wetted Perimeter, P in m = **220.545**

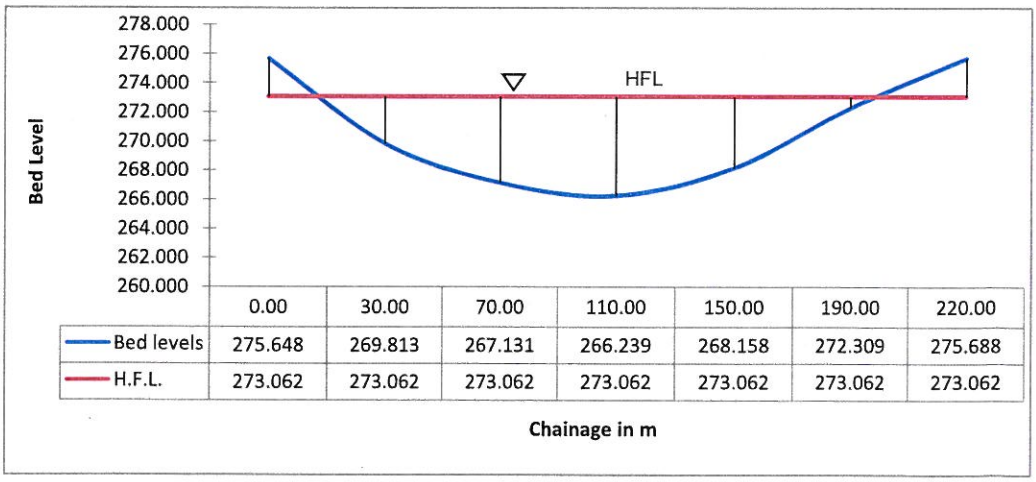
Hydraulic Radius, R = A / P = = **3.838 m**

Velocity, V = $1/n * R^{2/3} . S^{1/2}$ = **2.145 m/sec**

Discharge, Q = A*V = 1815.320 cumecs
Say **1816.00** cumecs

Linear water way = **220.000** m

Abbreviations
H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



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Discharge Calculations as per Area-velocity Method :-

At Down stream Site (500 m from Bridge center)

Q = A x V

Where A = Cross Sectional Area

V = Velocity, calculated from Manning's formula

$= \frac{1}{n} \times R^{2/3} \times S^{1/2}$

R = Hydraulic Mean depth = A / P

P = Wetted Perimeter

S = Bed Slope, measured over a long reach

n = Coefficient of rugosity (from code)

Chainage 65+841 :

H.F.L = 273.062 m L.B.L = 266.119 m

Bed slope S = 0.00191 Spread length = 220.000 m

Rugosity coefficient, n = 0.050

S.No.	H.F.L	offset (M)	Bed Level	D.O.F	A.D.O.F	Distance	Area	W.P
1	2	3	4	5	6	7	8	9
							(6 x 7)	sqrt{7*7+ (h1-h2)^2}
1	273.062	0.00	275.528	0.000	0.000	0.000	0.000	0.000
2	273.062	30.00	269.693	3.369	1.684	30.000	50.535	30.189
3	273.062	70.00	267.011	6.051	4.710	40.000	188.400	40.090
4	273.062	110.00	266.119	6.943	6.497	40.000	259.880	40.010
5	273.062	150.00	268.038	5.024	5.983	40.000	239.340	40.046
6	273.062	190.00	272.189	0.873	2.949	40.000	117.940	40.215
7	273.062	220.00	275.568	0.000	0.436	30.000	13.095	30.013
		AVG. B.L =	270.592					

Total (Cross sectional Area, A) = **869.190** sq. m

Wetted Perimeter, P in m = **220.562**

Hydraulic Radius, R = A / P = = **3.941 m**

Velocity, V = $1/n * R^{2/3} . S^{1/2}$ = **2.183 m/sec**

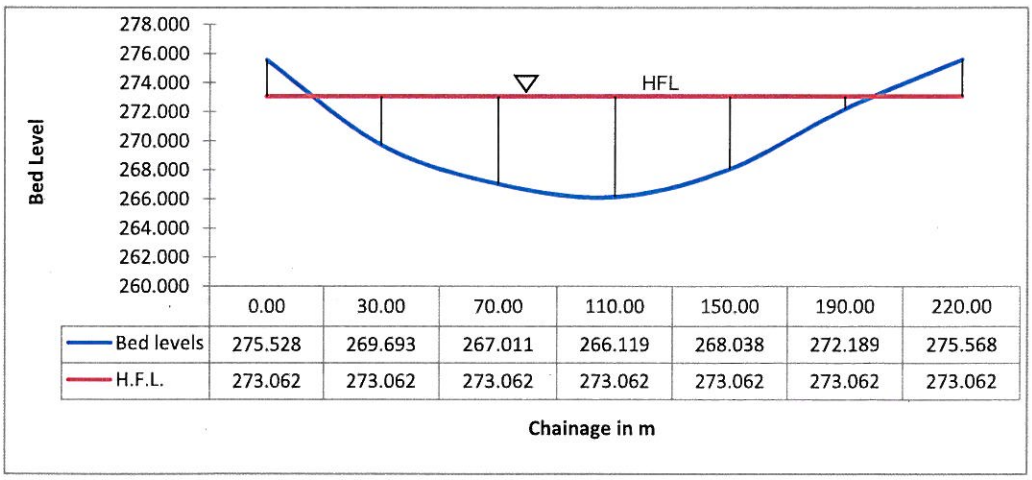
Discharge, Q = A*V = 1897.457 cumecs

Say **1898.00** cumecs

Linear water way = **220.000** m

Abbreviations

H.F.L. - High Flood Level
D.O.F. - Depth Of Flow
A.D.O.F. - Average Depth Of Flow
W.P. - Wetted Perimeter
L.B.L. - Lowest Bed Level



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Linear water way & Afflux :-

1 **Linear Water Way:**

Design discharge	=	1898.00 m^3/s	(As calculated)
Velocity of river	=	2.18 m/s	
HFL	=	273.062 m	
Bed level	=	266.486 m	
Depth of water	=	6.58 m	
Assumed Afflux	=	0.05 m	
Velocity of approach	=	2.163 m/s	
Head due to velocity of approach (V^2 / 2g)	=	0.239 m	
Total head	=	0.290 m	
Velocity through vent (2gh)	=	2.38 m/s	
Velocity allowable	=	2.38 m/s	
Linear water way required	=	121.10 m	
Proposed vent way 03 x 45.7	=	137.10 m	O.K

2 **Check for Afflux**

As per Cl. 2.2.7 of Pocket Book for Bridge Engineers published by Indian Road Congress, New Delhi

By Molesworth formula

Afflux = $\left[\frac{V^2}{17.89}+0.015\right]\times\left[\left(\frac{Au}{Ae}\right)^2-1\right]$

Velocity, V	=	2.18 m/sec		
Unobstructed area, Au	=	799.460 m^2		
Effective vent area, Ae	=	901.57 m^2		
Afflux	=	0.000 m	<	Assumed afflux
		Hence OK		

3 **Design of Formation Level**

Vertical clearance (V_c) required = 0.90 m

Bottom of deck level to be provided = 274.013 m

4 **Scour Depth Calculations :**

$d_{sm} = 1.34\ (D_b^2 / K_{sf})^{1/3}$ As per cl.703.2 of IRC 78 - 2000

where, D_b = the discharge in cumecs per metre width.
K_{sf} = silt factor

$D_b = \frac{2468.0}{137.1} = 18.00$ cumecs/m

K_{sf} = 0.71 (From Dr. Ghuman and Gupta Geotech Consultants, Chandigarh)

d_{sm} = 1.34 x (18.001^2 / 0.71)^(1/3) = **10.317** m below HFL

Max. depth of scour for Piers = $2 \times d_{sm}$ = 20.63 m below HFL

Max. depth of scour for Abutment = $1.27 \times d_{sm}$ = 13.10 m below HFL

Scour level for Abutments = 259.96 m

Scour level for Piers = 252.43 m

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SILT FACTOR CALCULATION

TANGRI RIVER			
Bore Hole No	**Depth (m)**	**Sub-Starta**	**Silt Factor**
BH-1	1.5	Clayey Silt	0.64
BH-2	3.0	Sandy Silt	1.85
BH-3	1.5	Sandy Silt	2.04
BH-4	1.5	Clayey Silt	0.97

Appendix -III

(Laboratory Test Results)

Arki Techno Consultants (India) Pvt. Ltd

ARKITECHNO

N 3/91, IRC Village, Bhubaneswar

GRAIN SIZE ANALYSIS OF SOIL WITH SILT FACTOR

(AS PER IS 2720, P- 4 & IRC 5)

Client:	DFCC		
Project Name	G.I For 3nos Important Bridges		
Type of Sample	SPT	Date of Testing :	12.09.12
Location	BH-1(Tangri River-Aharanpur)	Sampled by :	T. K. Das
Depth	1.5m	Tested by :	K.C Sahoo

Weight of oven dried sample before washing (gm) :- 100

Weight of oven dried sample after washing (gm) :- 6.39

Sieve Size mm	Individual Weight Retained in gm.	Individual Wt. Retained In %	Cummulative Wt Retained In %	Cummulative Wt Passing In %	Average size of Particle in mm	Column 3 X Column 6
1	2	3	4	5	6	7
4.75	0.00	0.00	0.00	100.00	2.38	0.00
2.00	2.13	2.13	2.13	97.87	3.38	7.19
0.425	1.53	1.53	3.66	96.34	1.21	1.86
0.075	2.01	2.01	5.67	94.33	0.25	0.50
Pan	0.72	94.33	100.00	0.00	0.0375	3.54
Wash Loss	93.609					
Total	100					

Gravel Content (%)= 0.00 **Sand Content (%) 5.67** **Silt and clay % 94.33**

Weighted mean dia of Particle (d_{sm}) = 0.13 **Silt Factor 1.76 X sqrt (d_{sm}) = 0.64**

Remarks :-

Lab Manager

Checked By

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