

APPENDIX D-4
California Bearing Ratio Testing /CBR/

CALIFORNIA BEARING RATIO TEST/ASTM D-1883/

Client : CTI Engineering Co.,Ltd
 Project : Fly-Over Ajilehin Railway in Ulaanbaatar
 Lab №: SO1305
 Sample № : TP-1
 Depth : 1.8-2.0m
 Date of test : 7/9/2012

BLOWS:10					BLOWS:25					BLOWS:56				
PENETRATION, mm			LOAD		PENETRATION, mm			LOAD		PENETRATION, mm			LOAD	
1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load, kg,c
0.0	0	0	0.0	0.00	0.0	0	0.0	0.0	0.00	0.0	0	0	0.0	0.00
0.5	0.5	0.50	13.2	34.00	0.5	0.5	0.50	30.7	79.00	0.5	0.5	0.50	45.4	117.00
1.0	1.0	1.00	23.7	61.00	1.0	1.0	1.00	49.7	128.00	1.0	1.0	1.00	80.3	207.00
1.5	1.5	1.50	34.5	89.00	1.5	1.5	1.50	76.1	196.00	1.5	1.5	1.50	112.9	291.00
2.0	2.0	2.00	44.2	114.00	2.0	2.0	2.00	103.2	266.00	2.0	2.0	2.00	144.4	372.00
2.5	2.5	2.50	52.4	135.00	2.5	2.5	2.50	126.9	327.00	2.5	2.5	2.50	178.1	459.00
3.0	3.0	3.00	62.1	160.00	3.0	3.0	3.00	152.9	394.00	3.0	3.0	3.00	206.8	533.00
4.0	4.0	4.00	77.2	199.00	4.0	4.0	4.00	195.2	503.00	4.0	4.0	4.00	257.7	664.00
5.0	5.0	5.00	90.8	234.00	5.0	5.0	5.00	222.0	572.00	5.0	5.0	5.00	301.1	776.00
6.0	6.0	6.00	103.2	266.0	6.0	6.0	6.00	243.7	628.0	6.0	6.0	6.00	327.9	845.0
7.5	7.5	7.5	112.5	290.0	7.5	7.5	7.5	265.4	684.0	7.5	7.5	7.5	357.4	921.0
Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking	
CAN No.	011	096	036	067	CAN No.	279	208	256	007	CAN No.	034	061	024	083
ma, g	21.39	21.54	21.34	21.84	ma, g	22.51	22.10	22.26	22.74	ma, g	21.71	21.61	21.64	21.06
mb, g	97.38	85.77	86.54	103.79	mb, g	96.68	93.36	95.23	81.26	mb, g	83.54	67.73	89.36	84.65
mc, g	93.59	82.60	80.92	96.76	mc, g	93.04	89.60	90.13	77.06	mc, g	80.51	65.43	85.40	80.52
W2, g	5.25	5.19	9.43	9.38	W2, g	5.16	5.57	7.51	7.73	W2, g	5.15	5.25	6.21	6.95
	5.22		9.41			5.37		7.62			5.20		6.58	

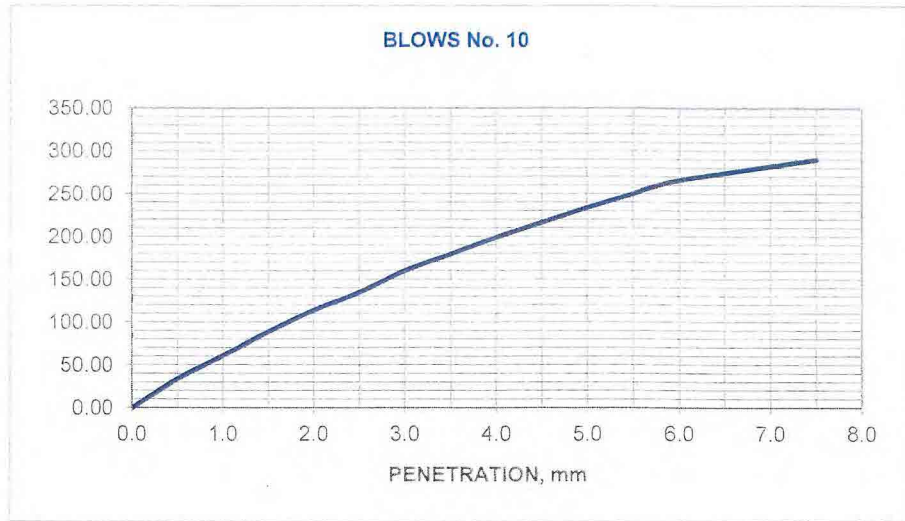
BLOWS: 10			BLOWS: 25			BLOWS: 56		
CBR 2.5	9.09	%	CBR 2.5	23.87	%	CBR 2.5	33.50	%
CBR 5.0	11.53	%	CBR 5.0	28.18	%	CBR 5.0	38.23	%
CBR=	11.53	%	CBR=	28.18	%	CBR=	38.23	%
CBR (at 98% of MDD)= 35.10 %								

CALIFORNIA BEARING RATIO TEST

Name of the sample :				
MDD			2.234	g/cm ³
OMC			5.40	%
Height of mold, mm		116.6	Annular surcharge weight	
			5	kg
Dia. of mold, mm		150	Volume of mold	
			2124	cm ³
No of blows		10	25	56
Preparation of specimen	Wt of Mold+Wet soil, g	10790	10634	11244
	Wt of Mold, g	6161	5940	6364
	Bulk Density, g/cm ³	2.179	2.210	2.298
	Dry Density, g/cm ³	2.071	2.097	2.184
Swelling, mm	Elapsed time	Swelling, mm	Swelling, mm	Swelling, mm
	0	0	0	0
	24	-0.01	-0.01	-0.01
	48	-0.01	-0.01	-0.02
	72	-0.01	-0.01	-0.02
	96	-0.01	-0.01	-0.02
		-0.009	-0.009	-0.017
Dry Density & Moisture content after soaking	Wt of Mold+Wet soil, g	11001	10799	11382
	Bulk Density, g/cm ³	2.279	2.288	2.363
	Dry Density, g/cm ³	2.083	2.126	2.217

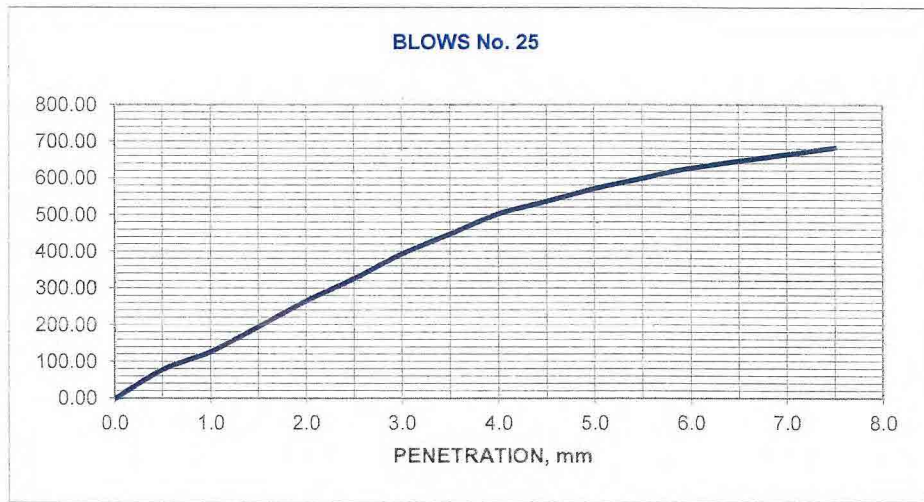
0.0	0.00
0.5	34.00
1.0	61.00
1.5	89.00
2.0	114.00
2.5	135.00
3.0	160.00
3.5	179.50
4.0	199.00
4.5	216.50
5.0	234.00
5.5	250.0
6.0	266.0
7.5	290.0

Load2.5 135.00
Load5.0 234.00



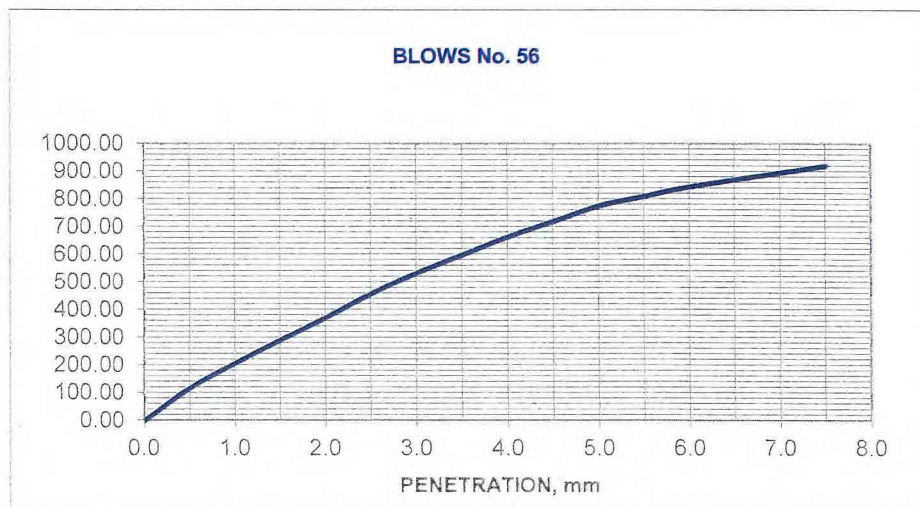
0.0	0.00
0.5	79.00
1.0	128.00
1.5	196.00
2.0	266.00
2.5	327.00
3.0	394.00
3.5	448.50
4.0	503.00
4.5	537.50
5.0	572.00
5.5	600.0
6.0	628.0
7.5	684.0

Load2.5 327.00
Load5.0 572.00



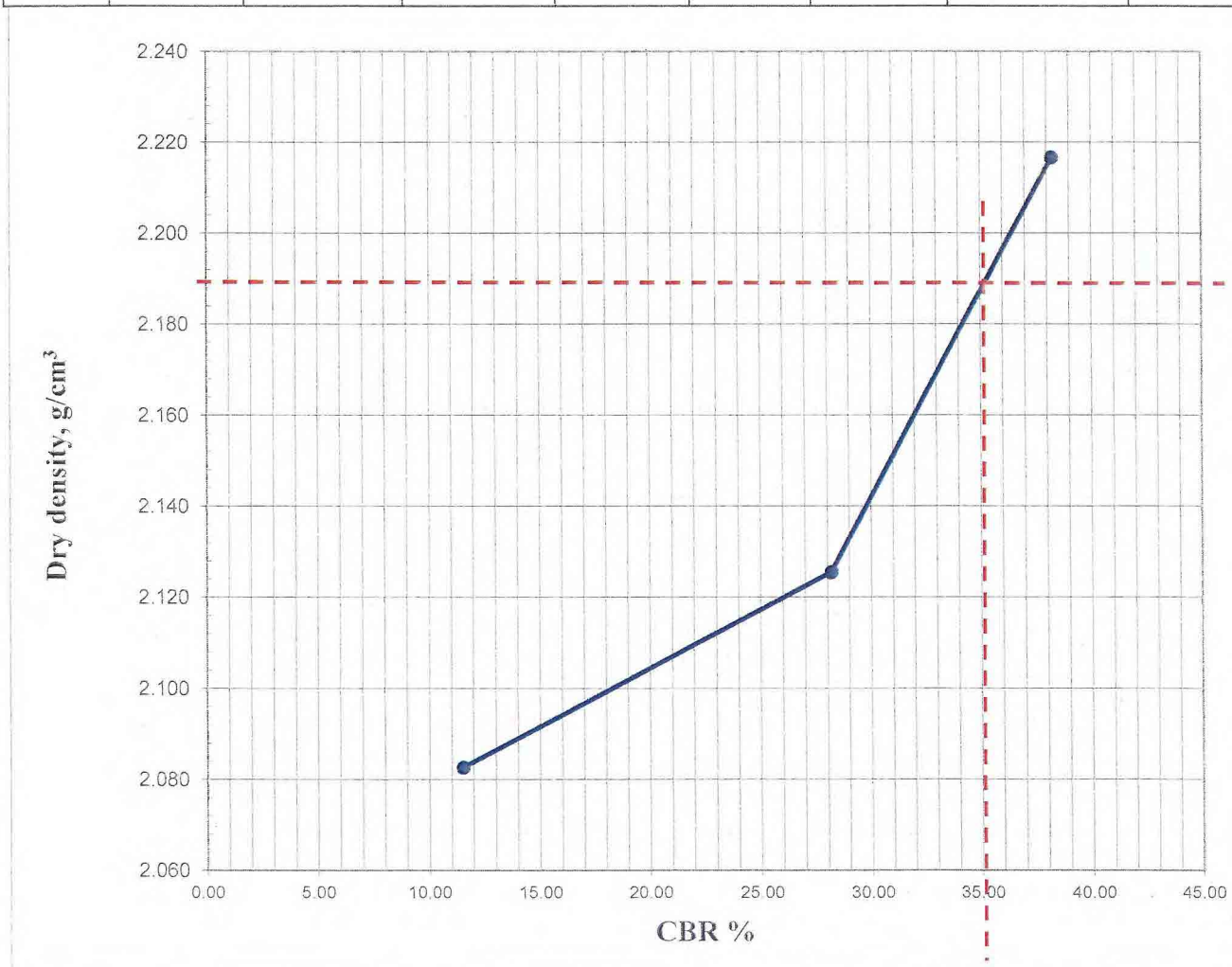
0.0	0.00
0.5	117.00
1.0	207.00
1.5	291.00
2.0	372.00
2.5	459.00
3.0	533.00
3.5	598.50
4.0	664.00
4.5	720.0
5.0	776.0
5.5	810.5
6.0	845.0
7.5	921.0

Load2.5 459.00
Load5.0 776.0



CALIFORNIA BEARING RATIO TEST

OMC			5.40			%		
MDD			2.234			g/cm ³		
98% of MDD			2.189			g/cm ³		
	Before soaking			After soaking				
No. of Blows	Bulk density g/cm ³	Moisture content %	Dry density g/cm ³	Bulk density g/cm ³	Moisture content %	Dry density g/cm ³	2.5mm 1370 kgf	5.0mm 2030 kgf
10	2.179	9.43	2.071	2.279	9.38	2.083	9.09	11.53
25	2.210	7.51	2.097	2.288	7.73	2.126	23.87	28.18
56	2.298	6.21	2.184	2.363	6.95	2.217	33.50	38.23



CALIFORNIA BEARING RATIO TEST/ASTM D-1883/

Client : CTI Engineering Co.,Ltd
 Project : Fly-Over Ajilchin Railway in Ulaanbaatar
 Lab №: SO1302
 Sample № : TP-2
 Depth : 1.7-2.1m
 Date of test : 7/9/2012

BLOWS:10					BLOWS:25					BLOWS:56				
PENETRATION, mm			LOAD		PENETRATION, mm			LOAD		PENETRATION, mm			LOAD	
1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load, kg,c
0.0	0	0	0.0	0.00	0.0	0	0.0	0.0	0.00	0.0	0	0	0.0	0.00
0.5	0.5	0.50	13.2	34.00	0.5	0.5	0.50	19.8	51.00	0.5	0.5	0.50	28.7	74.00
1.0	1.0	1.00	21.3	55.00	1.0	1.0	1.00	34.5	89.00	1.0	1.0	1.00	47.0	121.00
1.5	1.5	1.50	26.0	67.00	1.5	1.5	1.50	48.9	126.00	1.5	1.5	1.50	66.4	171.00
2.0	2.0	2.00	30.7	79.00	2.0	2.0	2.00	62.9	162.00	2.0	2.0	2.00	86.1	222.00
2.5	2.5	2.50	34.9	90.00	2.5	2.5	2.50	75.3	194.00	2.5	2.5	2.50	104.4	269.00
3.0	3.0	3.00	39.2	101.00	3.0	3.0	3.00	89.3	230.00	3.0	3.0	3.00	123.0	317.00
4.0	4.0	4.00	45.4	117.00	4.0	4.0	4.00	107.9	278.00	4.0	4.0	4.00	156.8	404.00
5.0	5.0	5.00	52.0	134.00	5.0	5.0	5.00	124.2	320.00	5.0	5.0	5.00	185.5	478.00
6.0	6.0	6.00	57.0	147.0	6.0	6.0	6.00	138.1	356.0	6.0	6.0	6.00	207.6	535.0
7.5	7.5	7.5	62.9	162.0	7.5	7.5	7.5	153.3	395.0	7.5	7.5	7.5	237.1	611.0
Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking	
CAN No.	202	307	068	138	CAN No.	077	241	200	055	CAN No.	087	231	233	218
ma, g	22.67	22.15	22.45	21.78	ma, g	21.79	22.21	21.74	21.33	ma, g	21.20	22.07	22.18	22.30
mb, g	78.44	77.35	88.81	80.49	mb, g	62.44	66.07	85.96	64.72	mb, g	87.39	79.61	77.84	66.36
mc, g	74.10	73.19	81.39	73.88	mc, g	59.30	62.68	79.68	60.56	mc, g	82.31	75.17	73.10	62.43
W2, g	8.44	8.15	12.59	12.69	W2, g	8.37	8.38	10.84	10.60	W2, g	8.31	8.36	9.31	9.79
	8.29		12.64			8.37		10.72			8.34		9.55	

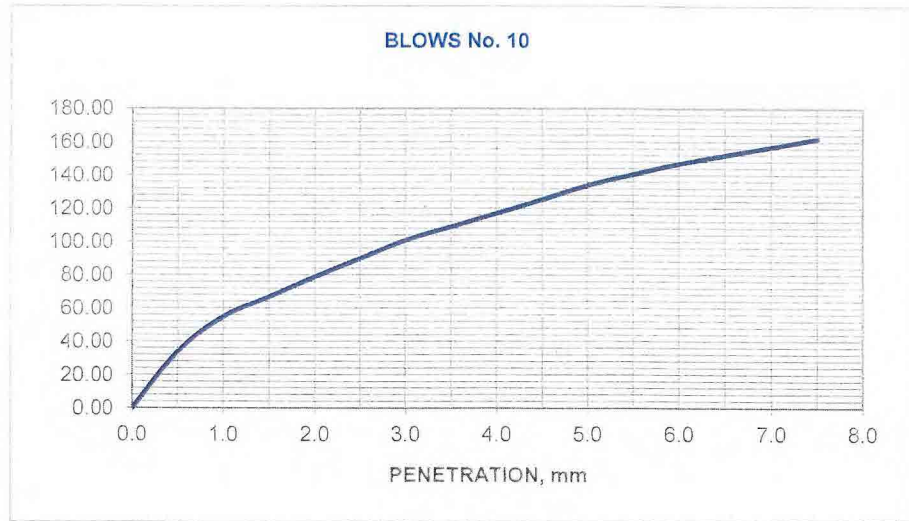
BLOWS: 10			BLOWS: 25			BLOWS: 56		
CBR 2.5	6.17	%	CBR 2.5	14.16	%	CBR 2.5	19.64	%
CBR 5.0	6.60	%	CBR 5.0	15.76	%	CBR 5.0	23.55	%
CBR=	6.60	%	CBR=	15.76	%	CBR=	23.55	%
CBR (at 98% of MDD)= 17.30 %								

CALIFORNIA BEARING RATIO TEST

Name of the sample :					
MDD				2.078	g/cm ³
OMC				8.20	%
Height of mold, mm		116.6	Annular surcharge weight		5 kg
Dia. of mold, mm		150	Volume of mold		2124 cm ³
No of blows		10	25	56	
Preparation of specimen	Wt of Mold+Wet soil, g	10475	10817	11098	
	Wt of Mold, g	5941	6207	6331	
	Bulk Density, g/cm ³	2.135	2.170	2.244	
	Dry Density, g/cm ³	1.971	2.003	2.072	
Swelling,mm	Elapsed time	Swelling, mm		Swelling, mm	
	0	0	0	0	
	24	0.01	-0.05	-0.05	
	48	0.01	-0.06	-0.05	
	72	0.01	-0.06	-0.05	
	96	0.01	-0.07	-0.06	
		0.009	-0.060	-0.051	
Dry Density & Moisture content after soaking	Wt of Mold+Wet soil, g	10690	10967	11186	
	Bulk Density, g/cm ³	2.236	2.241	2.286	
	Dry Density, g/cm ³	1.985	2.024	2.087	

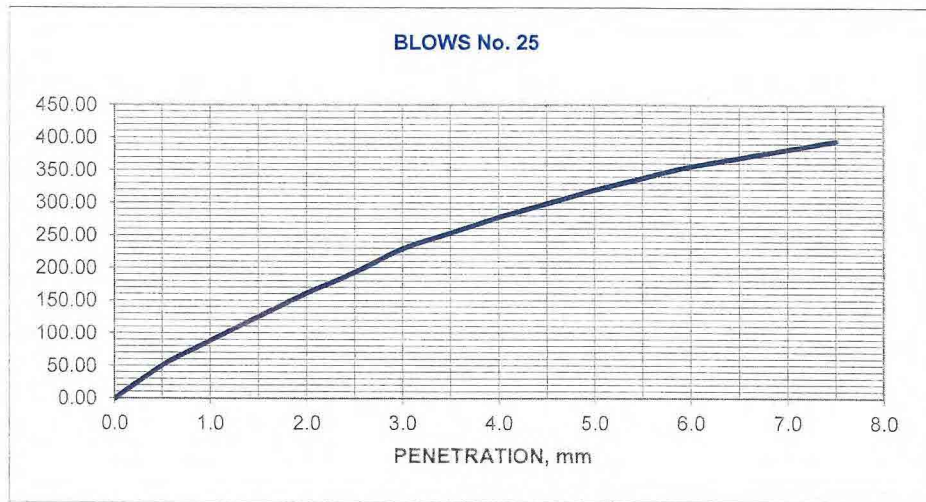
0.0	0.00
0.5	34.00
1.0	55.00
1.5	67.00
2.0	79.00
2.5	90.00
3.0	101.00
3.5	109.00
4.0	117.00
4.5	125.50
5.0	134.00
5.5	140.5
6.0	147.0
7.5	162.0

Load2.5 90.00
Load5.0 134.00



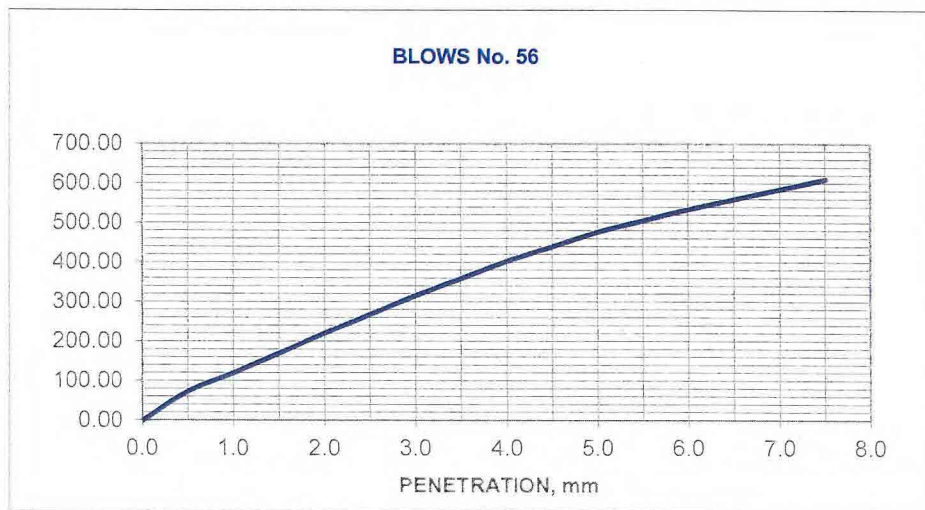
0.0	0.00
0.5	51.00
1.0	89.00
1.5	126.00
2.0	162.00
2.5	194.00
3.0	230.00
3.5	254.00
4.0	278.00
4.5	299.00
5.0	320.00
5.5	338.0
6.0	356.0
7.5	395.0

Load2.5 194.00
Load5.0 320.00



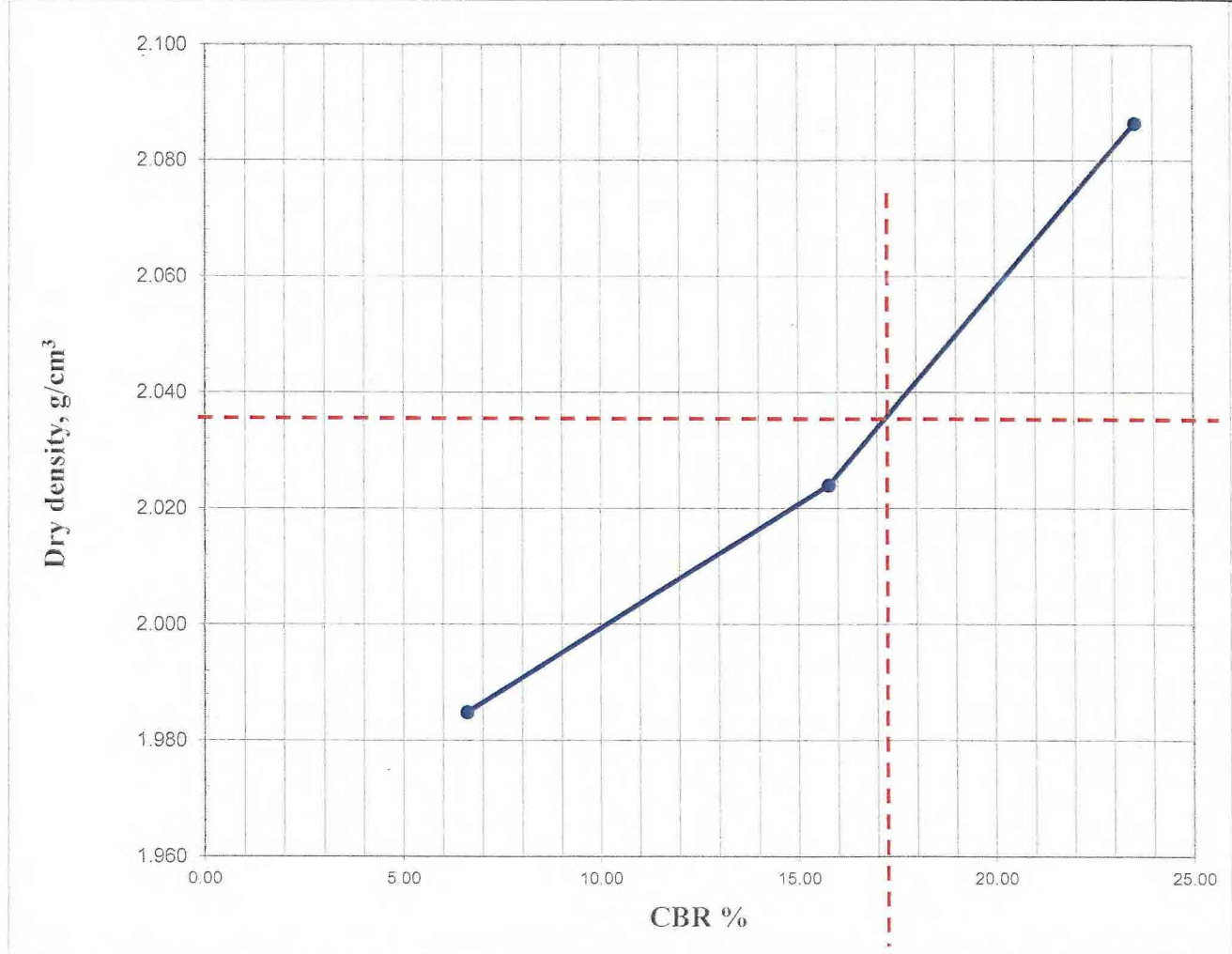
0.0	0.00
0.5	74.00
1.0	121.00
1.5	171.00
2.0	222.00
2.5	269.00
3.0	317.00
3.5	360.50
4.0	404.00
4.5	441.0
5.0	478.0
5.5	506.5
6.0	535.0
7.5	611.0

Load2.5 269.00
Load5.0 478.0



CALIFORNIA BEARING RATIO TEST

OMC				8.20		%		
MDD				2.078		g/cm ³		
98% of MDD				2.036		g/cm ³		
	Before soaking			After soaking				
No. of Blows	Bulk density g/cm ³	Moisture content %	Dry density, g/cm ³	Bulk density, g/cm ³	Moisture content . %	Dry density, g/cm ³	2.5mm 1370 kgf	5.0mm 2030 kgf
10	2.135	12.59	1.971	2.236	12.69	1.985	6.17	6.60
25	2.170	10.84	2.003	2.241	10.60	2.024	14.16	15.76
56	2.244	9.31	2.072	2.286	9.79	2.087	19.64	23.55



CALIFORNIA BEARING RATIO TEST/ASTM D-1883/

Client : CTI Engineering Co.,Ltd
 Project : Fly-Over Ajilchin Railway in Ulaanbaatar
 Lab №: SO1301
 Sample № : TP-3
 Depth : 1.8-2.0m
 Date of test : 7/9/2012

BLOWS:10					BLOWS 25					BLOWS.56				
PENETRATION, mm			LOAD		PENETRATION, mm			LOAD		PENETRATION, mm			LOAD	
1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load,kg,c	1	2	AVE	PROVING RING READING	Load, kg,c
0.0	0	0	0.0	0.00	0.0	0	0.0	0.0	0.00	0.0	0	0	0.0	0.00
0.5	0.5	0.50	15.5	40.00	0.5	0.5	0.50	26.4	68.00	0.5	0.5	0.50	45.4	117.00
1.0	1.0	1.00	25.2	65.00	1.0	1.0	1.00	41.1	106.00	1.0	1.0	1.00	74.5	192.00
1.5	1.5	1.50	34.5	89.00	1.5	1.5	1.50	55.1	142.00	1.5	1.5	1.50	97.4	251.00
2.0	2.0	2.00	40.4	104.00	2.0	2.0	2.00	73.0	188.00	2.0	2.0	2.00	123.8	319.00
2.5	2.5	2.50	46.2	119.00	2.5	2.5	2.50	92.0	237.00	2.5	2.5	2.50	146.7	378.00
3.0	3.0	3.00	53.6	138.00	3.0	3.0	3.00	108.7	280.00	3.0	3.0	3.00	166.5	429.00
4.0	4.0	4.00	63.3	163.00	4.0	4.0	4.00	135.0	348.00	4.0	4.0	4.00	197.1	508.00
5.0	5.0	5.00	72.6	187.00	5.0	5.0	5.00	161.0	415.00	5.0	5.0	5.00	221.2	570.00
6.0	6.0	6.00	78.0	201.0	6.0	6.0	6.00	184.7	476.0	6.0	6.0	6.00	241.8	623.0
7.5	7.5	7.5	82.7	213.0	7.5	7.5	7.5	202.2	521.0	7.5	7.5	7.5	262.7	677.0
Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking	
CAN No.	189	080	231	240	CAN No.	021	002	120	017	CAN No.	210	033	279	087
ma, g	22.27	22.29	22.07	22.15	ma, g	21.51	21.26	21.68	21.49	ma, g	22.38	21.32	22.51	21.20
mb, g	92.05	82.97	102.04	79.04	mb, g	87.77	86.45	81.73	86.86	mb, g	93.48	86.48	84.09	72.60
mc, g	87.32	78.60	93.80	73.24	mc, g	83.22	82.03	76.32	81.20	mc, g	88.69	82.06	79.46	68.57
W2, g	7.27	7.76	11.49	11.35	W2, g	7.37	7.27	9.90	9.48	W2, g	7.22	7.28	8.13	8.51
	7.52		11.42			7.32		9.69			7.25		8.32	

BLOWS: 10

BLOWS: 25

BLOWS: 56

CBR 2.5 8.14 % CBR 2.5 17.30 % CBR 2.5 27.59 %

CBR 5.0 9.21 % CBR 5.0 20.44 % CBR 5.0 28.08 %

CBR= 9.21 % CBR= 20.44 % CBR= 28.08 %

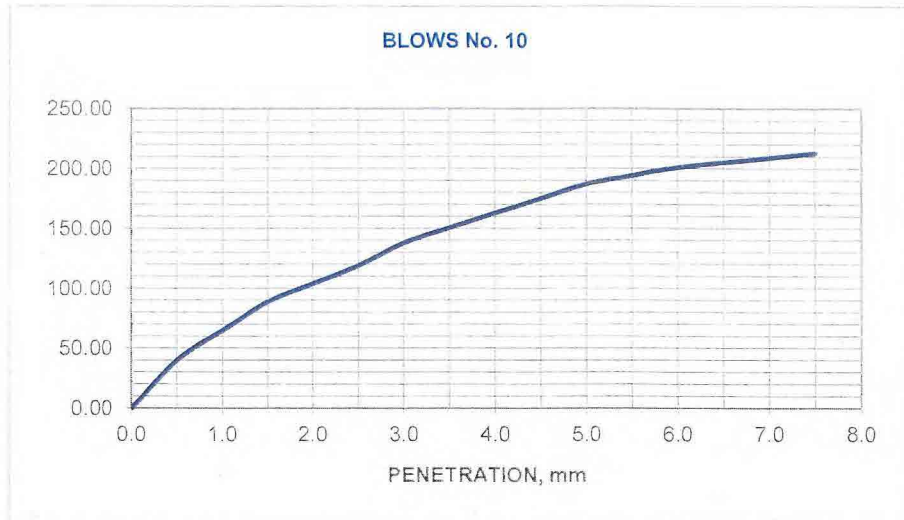
CBR (at 98% of MDD)= 21.50 %

CALIFORNIA BEARING RATIO TEST

Name of the sample :				
MDD			2.110	g/cm ³
OMC			7.40	%
Height of mold, mm		116.6	Annular surcharge weight	
			5	kg
Dia. of mold, mm		150	Volume of mold	
			2124	cm ³
No of blows		10	25	56
Preparation of specimen	Wt of Mold+Wet soil, g	10427	11132	11517
	Wt of Mold, g	5900	6492	6710
	Bulk Density, g/cm ³	2.131	2.185	2.263
	Dry Density, g/cm ³	1.982	2.035	2.110
Swelling, mm	Elapsed time	Swelling, mm	Swelling, mm	Swelling, mm
	0	0	0	0
	24	-0.01	-0.03	0.00
	48	-0.01	-0.06	0.00
	72	-0.02	-0.07	0.00
	96	-0.02	-0.08	-0.01
		-0.014	-0.064	-0.004
Dry Density & Moisture content after soaking	Wt of Mold+Wet soil, g	10624	11285	11634
	Bulk Density, g/cm ³	2.224	2.257	2.318
	Dry Density, g/cm ³	1.996	2.057	2.140

0.0	0.00
0.5	40.00
1.0	65.00
1.5	89.00
2.0	104.00
2.5	119.00
3.0	138.00
3.5	150.50
4.0	163.00
4.5	175.00
5.0	187.00
5.5	194.0
6.0	201.0
7.5	213.0

Load2.5 119.00
Load5.0 187.00



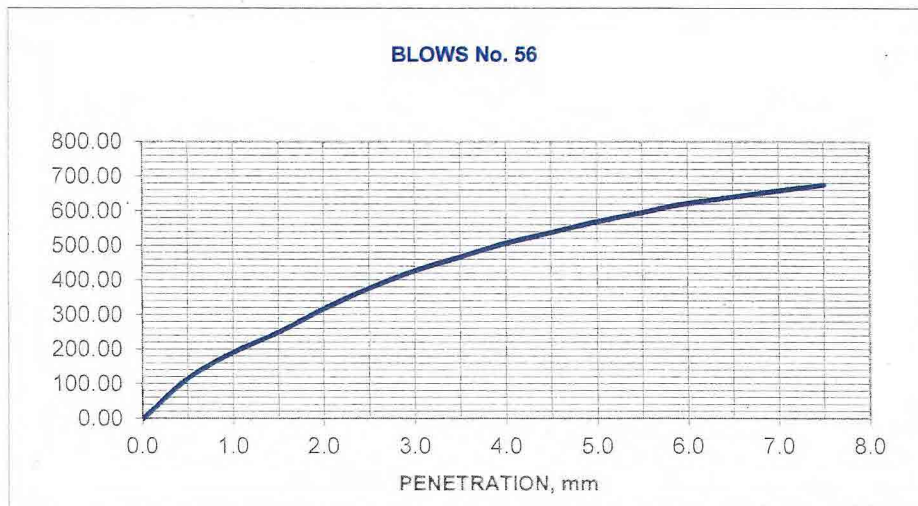
0.0	0.00
0.5	68.00
1.0	106.00
1.5	142.00
2.0	188.00
2.5	237.00
3.0	280.00
3.5	314.00
4.0	348.00
4.5	381.50
5.0	415.00
5.5	445.5
6.0	476.0
7.5	521.0

Load2.5 237.00
Load5.0 415.00



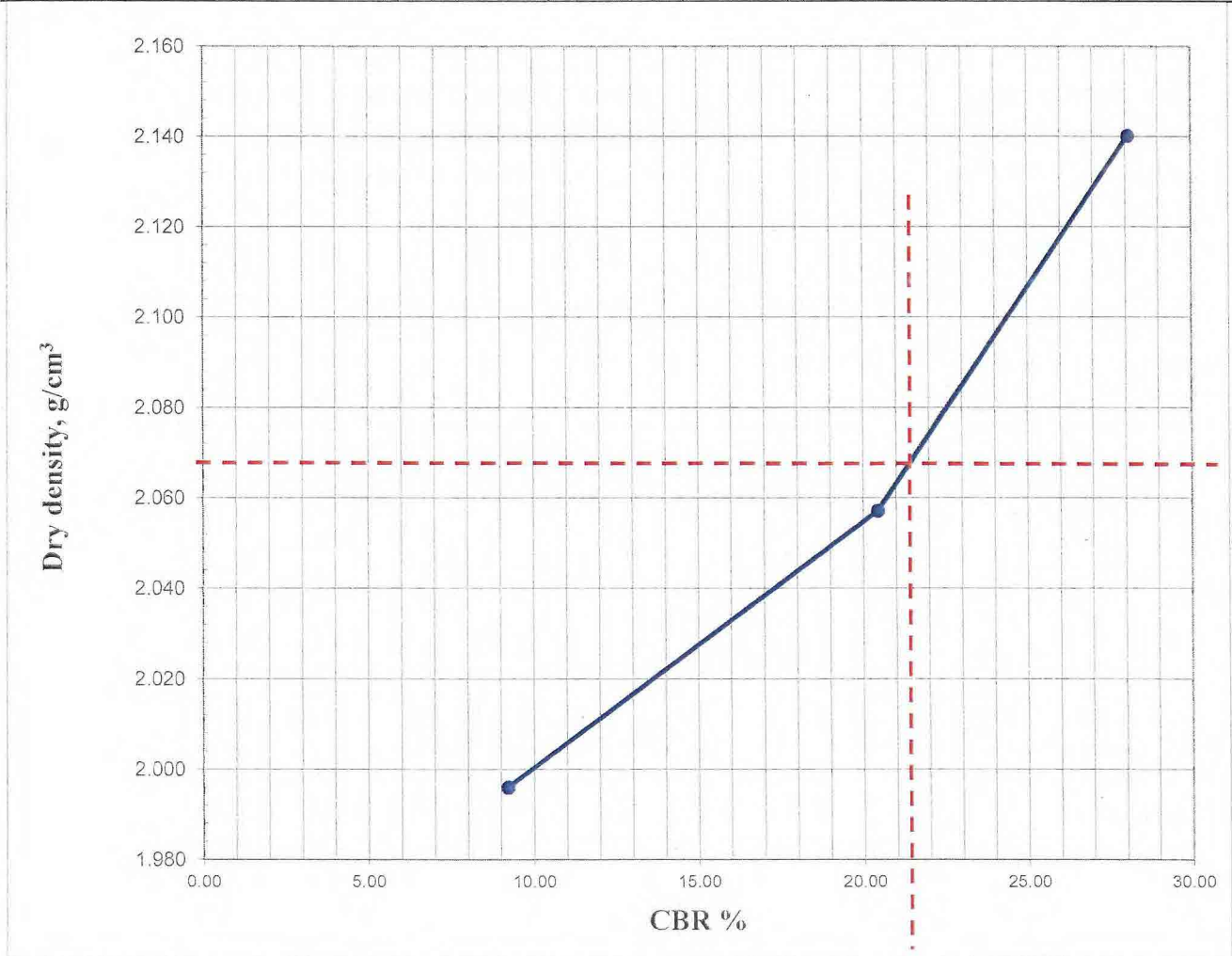
0.0	0.00
0.5	117.00
1.0	192.00
1.5	251.00
2.0	319.00
2.5	378.00
3.0	429.00
3.5	468.50
4.0	508.00
4.5	539.0
5.0	570.0
5.5	596.5
6.0	623.0
7.5	677.0

Load2.5 378.00
Load5.0 570.0



CALIFORNIA BEARING RATIO TEST

OMC				7.40			%	
MDD				2.110			g/cm ³	
98% of MDD				2.068			g/cm ³	
	Before soaking			After soaking				
No. of Blows	Bulk density g/cm ³	Moisture content %	Dry density, g/cm ³	Bulk density, g/cm ³	Moisture content . %	Dry density, g/cm ³	2.5mm 1370 kgf	5.0mm 2030 kgf
10	2.131	11.49	1.982	2.224	11.35	1.996	8.14	9.21
25	2.185	9.90	2.035	2.257	9.48	2.057	17.30	20.44
56	2.263	8.13	2.110	2.318	8.51	2.140	27.59	28.08



CALIFORNIA BEARING RATIO TEST/ASTM D-1883/

Client : CTI Engineering Co.,Ltd
 Project : Fly-Over Ajilchin Railway in Ulaanbaatar
 Lab №: SO1326
 Sample № : TP-4
 Depth : 1.8-2.0m
 Date of test : 7/9/2012

BLOWS:10					BLOWS:25					BLOWS:56				
PENETRATION, mm			LOAD		PENETRATION, mm			LOAD		PENETRATION, mm			LOAD	
1	2	AVE	PROVING RING READING	Load,kg.e	1	2	AVE	PROVING RING READING	Load,kg.e	1	2	AVE	PROVING RING READING	Load, kg.e
0.0	0	0	0.0	0.00	0.0	0	0.0	0.0	0.00	0.0	0	0	0.0	0.00
0.5	0.5	0.50	28.3	73.00	0.5	0.5	0.50	52.0	134.00	0.5	0.5	0.50	55.1	142.00
1.0	1.0	1.00	42.3	109.00	1.0	1.0	1.00	80.7	208.00	1.0	1.0	1.00	106.7	275.00
1.5	1.5	1.50	54.7	141.00	1.5	1.5	1.50	111.8	288.00	1.5	1.5	1.50	149.0	384.00
2.0	2.0	2.00	68.7	177.00	2.0	2.0	2.00	141.2	364.00	2.0	2.0	2.00	198.7	512.00
2.5	2.5	2.50	80.7	208.00	2.5	2.5	2.50	170.0	438.00	2.5	2.5	2.50	247.2	637.00
3.0	3.0	3.00	97.4	251.00	3.0	3.0	3.00	201.8	520.00	3.0	3.0	3.00	288.3	743.00
4.0	4.0	4.00	126.9	327.00	4.0	4.0	4.00	259.2	668.00	4.0	4.0	4.00	354.7	914.00
5.0	5.0	5.00	157.5	406.00	5.0	5.0	5.00	294.5	759.00	5.0	5.0	5.00	404.7	1043.00
6.0	6.0	6.00	183.9	474.0	6.0	6.0	6.00	324.4	836.0	6.0	6.0	6.00	440.4	1135.0
7.5	7.5	7.5	208.0	536.0	7.5	7.5	7.5	355.1	915.0	7.5	7.5	7.5	489.3	1261.0
Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking	
CAN No.	197	114	161	027	CAN No.	036	283	072	204	CAN No.	136	240	096	033
ma, g	21.17	21.23	21.48	21.79	ma, g	21.34	22.27	21.78	22.79	ma, g	21.06	22.15	21.54	21.32
mb, g	77.32	72.07	70.92	82.29	mb, g	79.43	67.49	83.71	73.84	mb, g	73.05	72.67	65.73	81.70
mc, g	74.53	69.41	67.10	77.44	mc, g	76.51	65.28	79.31	70.11	mc, g	70.42	70.15	62.95	78.04
W2, g	5.23	5.52	8.37	8.72	W2, g	5.29	5.14	7.65	7.88	W2, g	5.33	5.25	6.71	6.45
	5.37		8.54			5.22		7.77			5.29		6.58	

BLOWS: 10

BLOWS: 25

BLOWS: 56

CBR 2.5	14.05	%	CBR 2.5	31.97	%	CBR 2.5	46.50	%
CBR 5.0	20.00	%	CBR 5.0	37.39	%	CBR 5.0	51.38	%
CBR=	20.00	%	CBR=	37.39	%	CBR=	51.38	%

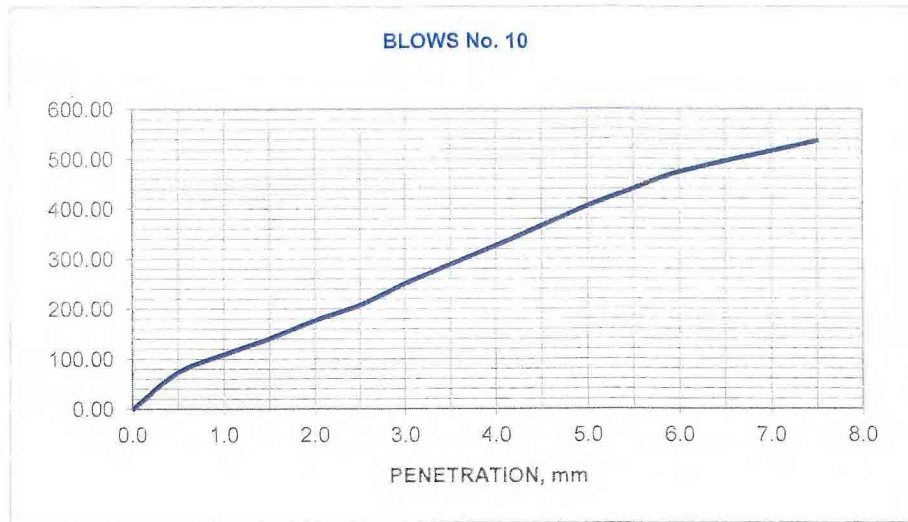
CBR (at 98% of MDD)= 44.60 %

CALIFORNIA BEARING RATIO TEST

Name of the sample :				
MDD			2.260	g/cm ³
OMC			5.30	%
Height of mold, mm		116.6	Annular surcharge weight	
			5	kg
Dia. of mold, mm		150	Volume of mold	
			2124	cm ³
No of blows		10	25	56
Preparation of specimen	Wt of Mold+Wet soil, g	12776	13010	13260
	Wt of Mold, g	8229	8231	8233
	Bulk Density, g/cm ³	2.141	2.250	2.367
	Dry Density, g/cm ³	2.032	2.138	2.248
Swelling,mm	Elapsed time	Swelling, mm	Swelling, mm	Swelling, mm
	0	0	0	0
	24	-0.03	-0.01	0.00
	48	-0.05	-0.02	0.00
	72	-0.06	-0.04	0.00
	96	-0.06	-0.04	0.00
		-0.051	-0.034	0.001
Dry Density & Moisture content after soaking	Wt of Mold+Wet soil, g	12987	13167	13338
	Bulk Density, g/cm ³	2.240	2.324	2.403
	Dry Density, g/cm ³	2.064	2.156	2.255

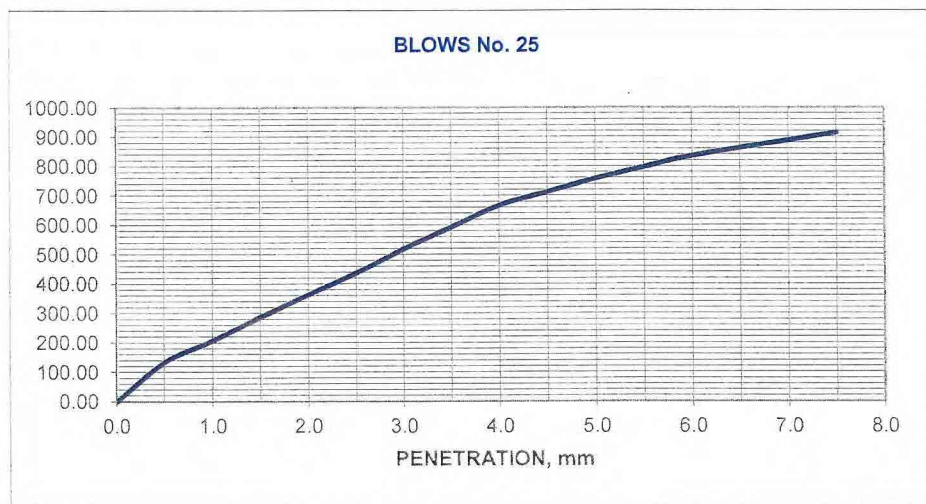
0.0	0.00
0.5	73.00
1.0	109.00
1.5	141.00
2.0	177.00
2.5	208.00
3.0	251.00
3.5	289.00
4.0	327.00
4.5	366.50
5.0	406.00
5.5	440.0
6.0	474.0
7.5	536.0

Load2.5 208.00
Load5.0 406.00



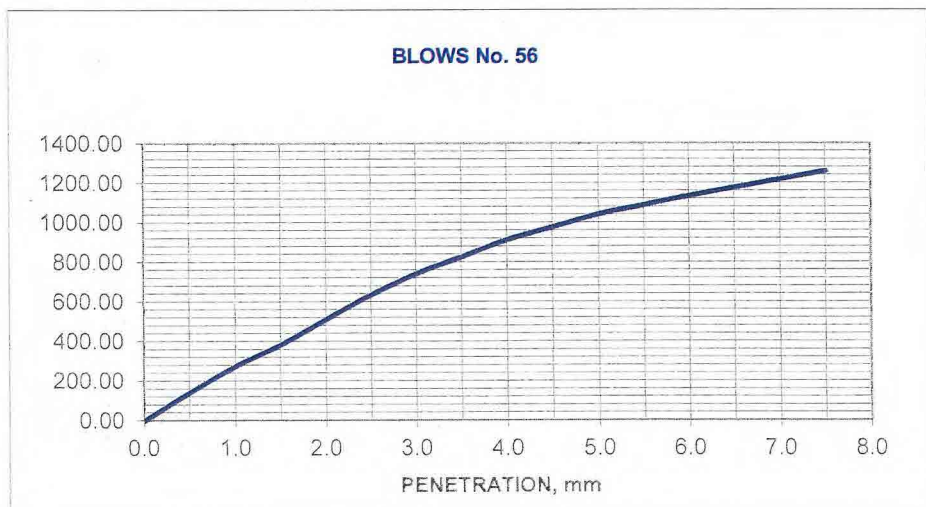
0.0	0.00
0.5	134.00
1.0	208.00
1.5	288.00
2.0	364.00
2.5	438.00
3.0	520.00
3.5	594.00
4.0	668.00
4.5	713.50
5.0	759.00
5.5	797.5
6.0	836.0
7.5	915.0

Load2.5 438.00
Load5.0 759.00



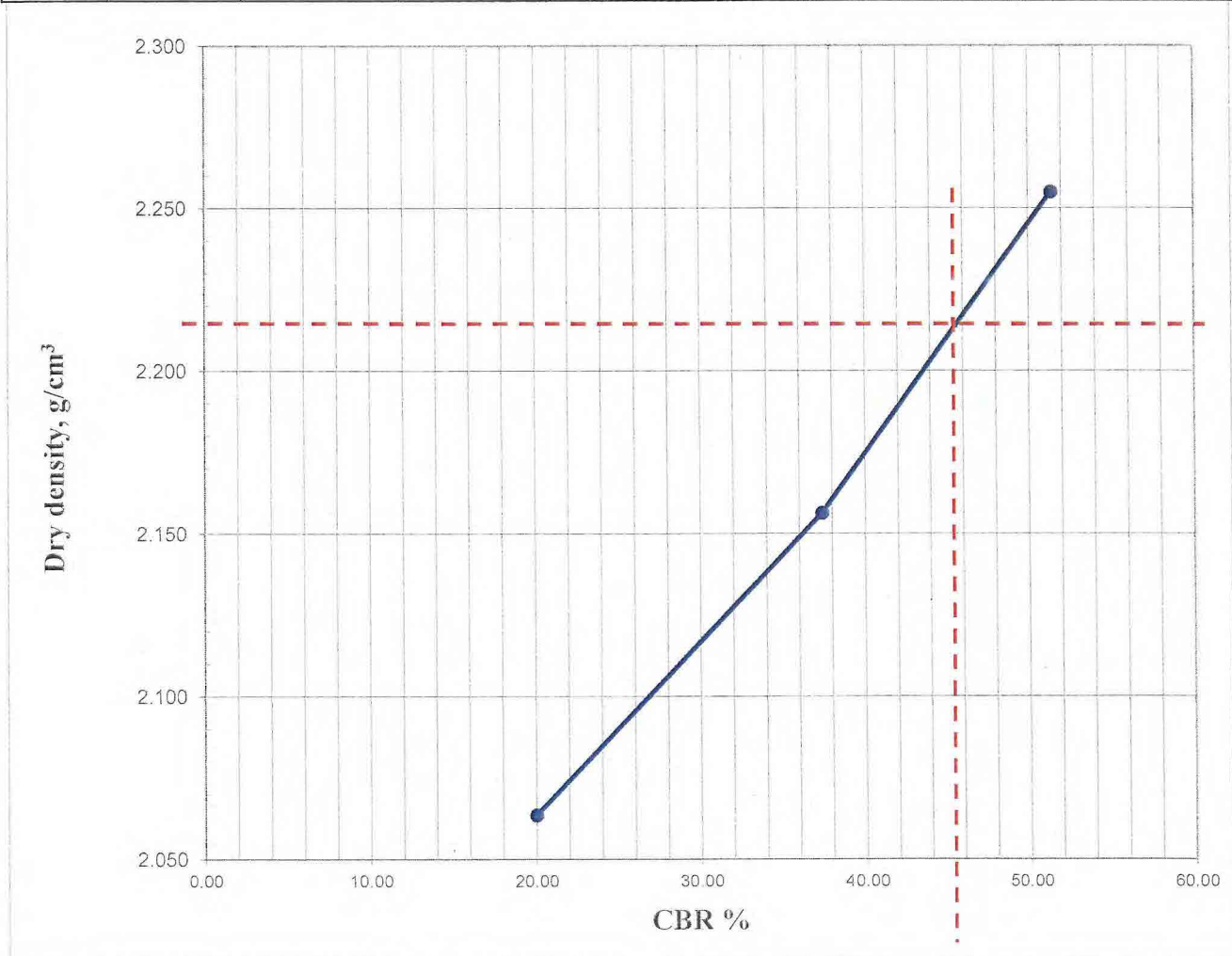
0.0	0.00
0.5	142.00
1.0	275.00
1.5	384.00
2.0	512.00
2.5	637.00
3.0	743.00
3.5	828.50
4.0	914.00
4.5	978.5
5.0	1043.0
5.5	1089.0
6.0	1135.0
7.5	1261.0

Load2.5 637.00
Load5.0 1043.0



CALIFORNIA BEARING RATIO TEST

OMC				5.30		%		
MDD				2.260		g/cm ³		
98% of MDD				2.215		g/cm ³		
	Before soaking			After soaking				
No. of Blows	Bulk density g/cm ³	Moisture content %	Dry density g/cm ³	Bulk density g/cm ³	Moisture content %	Dry density g/cm ³	2.5mm 1370 kgf	5.0mm 2030 kgf
10	2.141	8.37	2.032	2.240	8.72	2.064	14.05	20.00
25	2.250	7.65	2.138	2.324	7.88	2.156	31.97	37.39
56	2.367	6.71	2.248	2.403	6.45	2.255	46.50	51.38



CALIFORNIA BEARING RATIO TEST/ASTM D-1883/

Client : CTI Engineering Co.,Ltd
 Project : Fly-Over Ajilchin Railway in Ulaanbaatar
 Lab №: SO1327
 Sample № : TP-5
 Depth : 1.8-2.0m
 Date of test : 7/9/2012

BLOWS:10					BLOWS:25					BLOWS:56				
PENETRATION, mm			LOAD		PENETRATION, mm			LOAD		PENETRATION, mm			LOAD	
1	2	AVE	PROVING RING READING	Load,kg.c	1	2	AVE	PROVING RING READING	Load,kg.c	1	2	AVE	PROVING RING READING	Load, kg.c
0.0	0	0	0.0	0.00	0.0	0	0.0	0.0	0.00	0.0	0	0	0.0	0.00
0.5	0.5	0.50	21.0	54.00	0.5	0.5	0.50	41.5	107.00	0.5	0.5	0.50	45.0	116.00
1.0	1.0	1.00	36.9	95.00	1.0	1.0	1.00	71.4	184.00	1.0	1.0	1.00	78.0	201.00
1.5	1.5	1.50	48.9	126.00	1.5	1.5	1.50	99.3	256.00	1.5	1.5	1.50	114.1	294.00
2.0	2.0	2.00	60.1	155.00	2.0	2.0	2.00	125.0	322.00	2.0	2.0	2.00	159.9	412.00
2.5	2.5	2.50	69.8	180.00	2.5	2.5	2.50	154.8	399.00	2.5	2.5	2.50	201.4	519.00
3.0	3.0	3.00	81.9	211.00	3.0	3.0	3.00	182.4	470.00	3.0	3.0	3.00	239.4	617.00
4.0	4.0	4.00	99.7	257.00	4.0	4.0	4.00	232.1	598.00	4.0	4.0	4.00	300.3	774.00
5.0	5.0	5.00	118.0	304.00	5.0	5.0	5.00	269.3	694.00	5.0	5.0	5.00	345.4	890.00
6.0	6.0	6.00	137.4	354.0	6.0	6.0	6.00	293.4	756.0	6.0	6.0	6.00	382.2	985.0
7.5	7.5	7.5	156.0	402.0	7.5	7.5	7.5	327.9	845.0	7.5	7.5	7.5	419.5	1081.0
Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking		Moisture Content	Before soaking		After soaking	
CAN No.	100	241	084	021	CAN No.	091	262	107	090	CAN No.	111	068	242	049
ma, g	21.38	22.21	22.42	21.51	ma, g	21.41	22.16	21.47	21.29	ma, g	21.22	22.45	22.11	21.35
mb, g	82.26	81.00	79.49	91.89	mb, g	83.21	83.41	90.31	82.00	mb, g	72.14	72.39	75.71	94.13
mc, g	78.66	77.59	74.22	85.18	mc, g	79.60	79.84	84.99	77.06	mc, g	69.16	69.44	72.11	89.19
W2, g	6.28	6.16	10.17	10.54	W2, g	6.20	6.19	8.38	8.86	W2, g	6.22	6.28	7.20	7.28
	6.22		10.36			6.20		8.62			6.25		7.24	

BLOWS: 10

BLOWS: 25

BLOWS: 56

CBR 2.5	12.23	%	CBR 2.5	29.12	%	CBR 2.5	37.88	%
CBR 5.0	14.98	%	CBR 5.0	34.19	%	CBR 5.0	43.84	%
CBR=	14.98	%	CBR=	34.19	%	CBR=	43.84	%

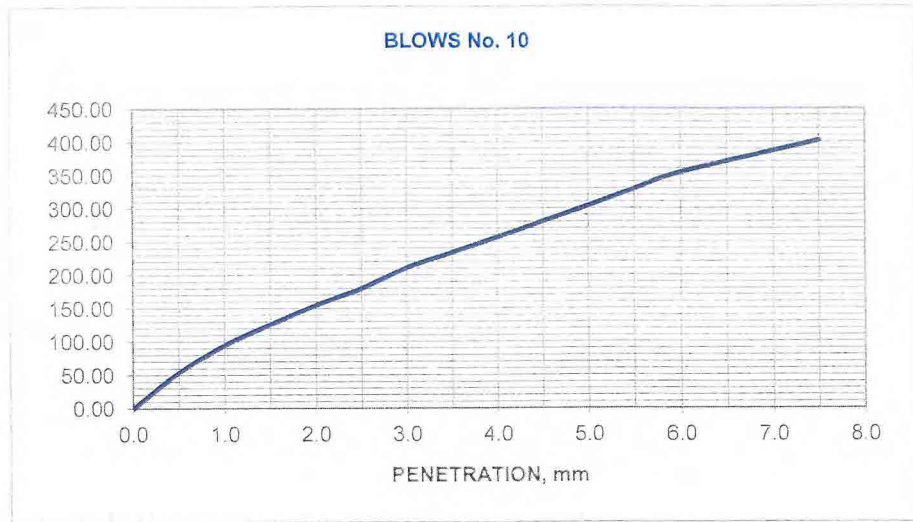
CBR (at 98% of MDD)= 35.50 %

CALIFORNIA BEARING RATIO TEST

Name of the sample :				
MDD			2.221	g/cm ³
OMC			6.20	%
Height of mold, mm	116.6	Annular surcharge weight		5 kg
Dia. of mold, mm	150	Volume of mold		2124 cm ³
No of blows	10	25	56	
Preparation of specimen	Wt of Mold+Wet soil, g	10830	11639	11212
	Wt of Mold, g	6252	6838	6196
	Bulk Density, g/cm ³	2.155	2.260	2.362
	Dry Density, g/cm ³	2.029	2.128	2.223
Swelling, mm	Elapsed time	Swelling, mm	Swelling, mm	Swelling, mm
	0	0	0	0
	24	0.00	0.00	0.00
	48	0.00	0.00	0.00
	72	0.00	0.00	0.00
	96	0.00	0.00	0.00
	0.003	0.000	0.000	
Dry Density & Moisture content after soaking	Wt of Mold+Wet soil, g	11035	11777	11314
	Bulk Density, g/cm ³	2.252	2.325	2.410
	Dry Density, g/cm ³	2.041	2.141	2.247

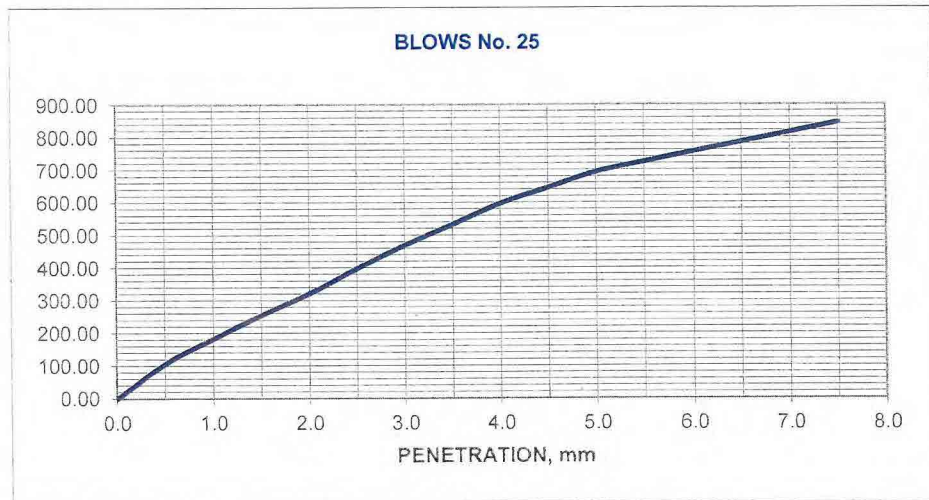
0.0	0.00
0.5	54.00
1.0	95.00
1.5	126.00
2.0	155.00
2.5	180.00
3.0	211.00
3.5	234.00
4.0	257.00
4.5	280.50
5.0	304.00
5.5	329.0
6.0	354.0
7.5	402.0

Load2.5 180.00
Load5.0 304.00



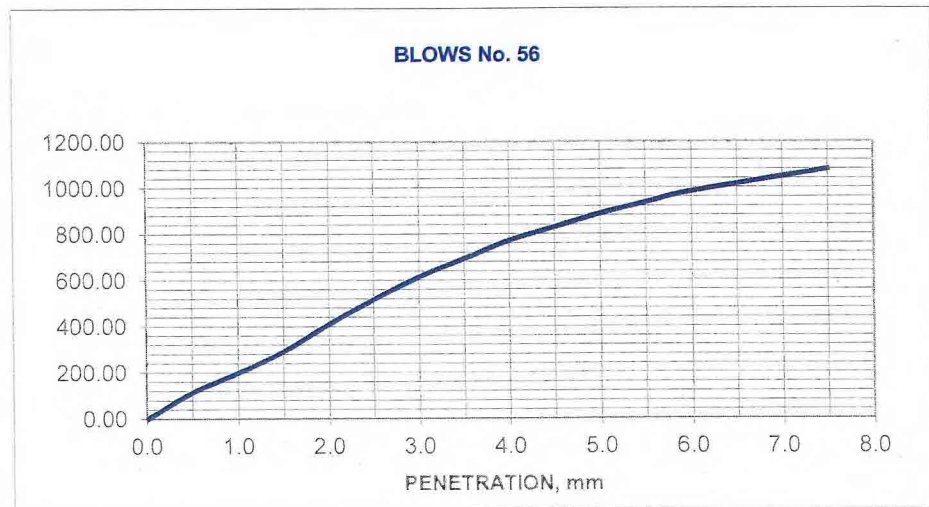
0.0	0.00
0.5	107.00
1.0	184.00
1.5	256.00
2.0	322.00
2.5	399.00
3.0	470.00
3.5	534.00
4.0	598.00
4.5	646.00
5.0	694.00
5.5	725.0
6.0	756.0
7.5	845.0

Load2.5 399.00
Load5.0 694.00



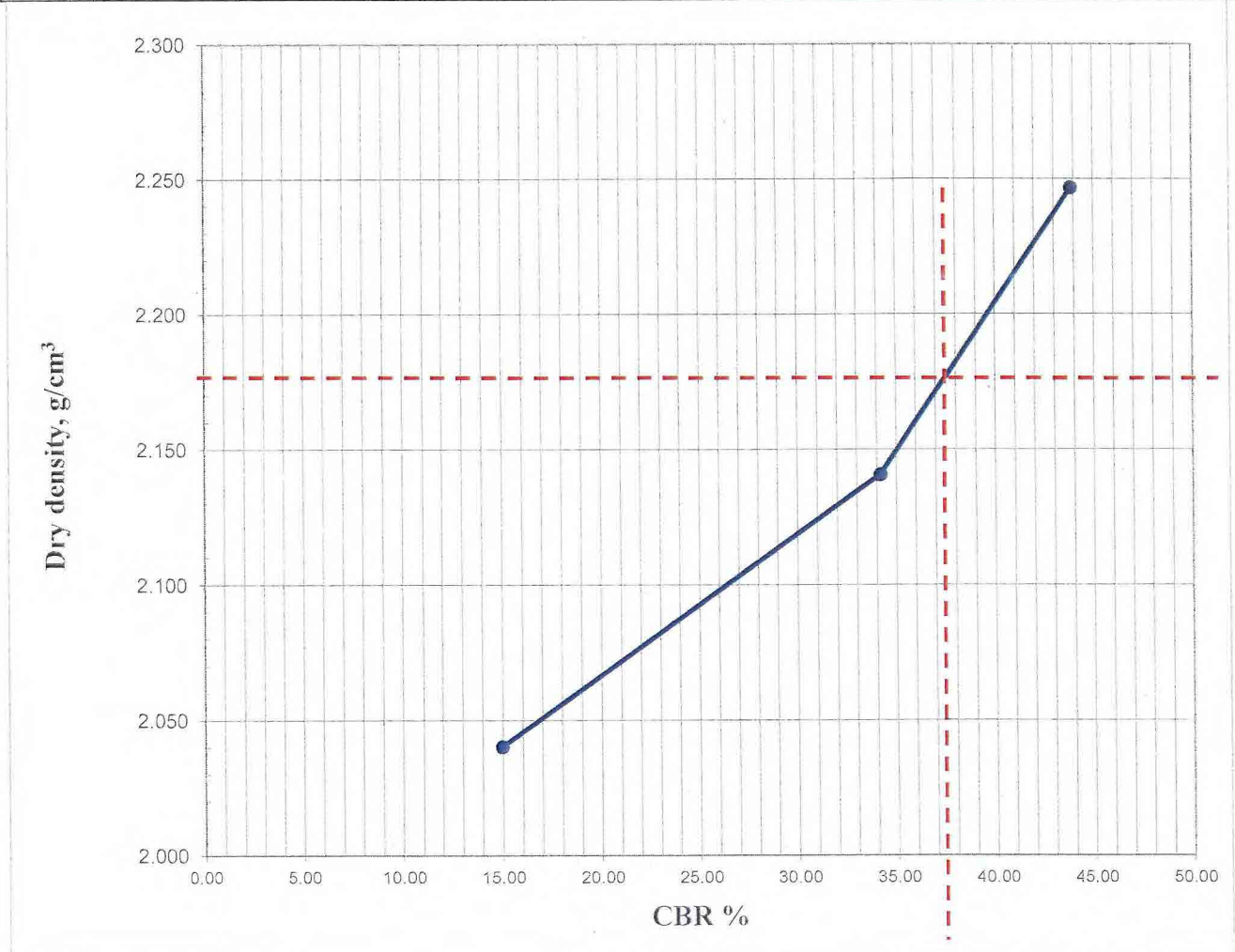
0.0	0.00
0.5	116.00
1.0	201.00
1.5	294.00
2.0	412.00
2.5	519.00
3.0	617.00
3.5	695.50
4.0	774.00
4.5	832.0
5.0	890.0
5.5	937.5
6.0	985.0
7.5	1081.0

Load2.5 519.00
Load5.0 890.0



CALIFORNIA BEARING RATIO TEST

OMC				6.20		%		
MDD				2.221		g/cm ³		
98% of MDD				2.177		g/cm ³		
	Before soaking			After soaking				
No. of Blows	Bulk density g/cm ³	Moisture content %	Dry density, g/cm ³	Bulk density, g/cm ³	Moisture content %	Dry density, g/cm ³	2.5mm 1370 kgf	5.0mm 2030 kgf
10	2.155	10.17	2.029	2.252	10.54	2.041	12.23	14.98
25	2.260	8.38	2.128	2.325	8.86	2.141	29.12	34.19
56	2.362	7.20	2.223	2.410	7.28	2.247	37.88	43.84



APPENDIX D
Chemical Analysis of Groundwater

CHEMICAL ANALYSES OF GROUNDWATER

PROJECT NAME: CONSTRUCTION OF FLY-OVER AJILCHIN RAILWAY FLYOVER
 LOCATION OF SAMPLE: 4th khoroo, Bayangol District, Fly-over Railway, Ulaanbaatar city
 NUMBER AND TYPE OF WATER SOURCE: BH-04
 SAMPLED DEPTH: 3.2 m
 SAMPLED DATE: 29 JUNE 2012
 TESTED DATE: 19 JULY 2012

Anion	Measurement per 1 dm ³			Cation	Measurement per 1 dm ³		
	Mg	mg-eq/l	equ%		mg	mg-eq/l	equ%
Cl ⁻	39.1	1.10	18.05	Na ⁺ +K ⁺	51.9	2.26	37.01
SO ₄ ²⁻	3.0	0.06	1.03	Ca ²⁺	54.1	2.70	44.30
NO ₂ ⁻	0.00	0.00	0.00	Mg ²⁺	13.4	1.10	18.05
NO ₃ ⁻	2.0	0.03	0.53	NH ₄ ⁺	0.7	0.04	0.64
CO ₃ ²⁻	0.0	0.00	0.00	Fe ²⁺	0.0	0.00	0.00
HCO ₃ ⁻	298.9	4.90	80.40	Fe ³⁺	0.0	0.00	0.00
Total	343.0	6.09	100.00	Total	120.1	6.09	100.00
∑ half of HCO ₃ ⁻ Anion+Cation		313.6 mg/dm ³		Total Dissolved Solids (TDS)		309 ppm	
∑ Total Anion+Cation		463.0 mg/dm ³		Free Co ₂ #		11 mg /l	
Dry Residual		305.7 mg/dm ³		EC		572 µS/sm	
pH		7.31		Corrosion		-mg/dm ³	
General Hardness		3.80 mg-equ/dm ³		Oxygen Dissolved		-	
Causticity		12.80 mg-equ/dm ³		Oxygen Reduction potential		-	
Dissolved Hardness		mg-equ/dm ³		Electrical Conductivity (EC)		-	
Alkalinity		107.8 mg/l		Oxygen		mg/dm ³	
Carbonate Hardness		4.9 mg-eq/l		Permanganate Oxidize		mg-O/l	
Silica Acidize SiO ₂				Caustic CO ₂		0.0 mg/l	
<i>Physical Properties</i>							
Color	grey			Turbidity	10 cm		
Odor	5 points			Sediments	Greyish mud		
Taste	0			Temperatur	-°C		
				Clarity	unclear		

Formula of chemical composition is given by following equation:

$$M_{0.5} \frac{HCO_3^{2-} 80xSO_4^{2-} 18}{Ca^{2+} 44xNa^+ + K^+ 37Mg^{2+} 18}$$

Chemical laboratory analysis indicates as soft and clear water of hydrocarbon type of calcium and sodium group, 1st type. Based on test result carbonate hardness ranges high but doesn't any caustic reaction on concrete, cement and metal. The water sample meets to the requirement of norm and standard "Specifications of Water Usage for Concrete Mixture" CNR 3821-85.

Water sample was analyzed by chemist B.Oyu-Erdene.

Checked by Dr.Ph.D director M.Enkhtuya



ШИНЖЛЭХ УХААНЫ АКАДЕМИ
ГЕОЭКОЛОГИЙН ХҮРЭЭЛЭН УСНЫ
ШИНЖИЛГЭЭНИЙ ЛАБОРАТОРИ

Усны химийн шинжилгээний тодорхойлолт

Сорьц авсан: 2012 оны 06 сарын 29 өдөр

Шинжилгээ хийсэн: 2012 оны 07 сарын 19 өдөр

Сорьц авсан газрын нэр: Баянгол дүүрэг, 4-р хороо
Төмөр зам, ВН04

Сорьц шинжлүүлсэн байгууллага, хувь хүн: "Сойл Трейд" ХХК

Солбицлол X= Гүн : 3.2 м

Y= Ундарга: л/с

Уст цэгийн төрөл ба дугаар: хөрсний ус

Тодорхойлсон нь:

Анион	1 дм ³ -д байгаа			Катион	1 дм ³ -д байгаа		
	мг	мг-экв	мг-экв%		мг	мг-экв	мг-экв%
Cl ⁻	39.1	1.10	18.05	Na ⁺ +K ⁺	51.9	2.26	37.01
SO ₄ ²⁻	3.0	0.06	1.03	Ca ²⁺	54.1	2.70	44.30
NO ₂ ⁻	0.00	0.00	0.00	Mg ²⁺	13.4	1.10	18.05
NO ₃ ⁻	2.0	0.03	0.53	NH ₄ ⁺	0.7	0.04	0.64
CO ₃ ²⁻	0.0	0.00	0.00	Fe ²⁺	0.0	0.00	0.00
HCO ₃ ⁻	298.9	4.90	80.40	Fe ³⁺	0.0	0.00	0.00
Дүн	343.0	6.09	100.00	Дүн	120.1	6.09	100.00

HCO₃⁻ ийн хагасыг хассан анион катионуудын

Анион катионуудын

нийлбэр: 313.6 мг/ дм³

нийлбэр: 463.0 мг/ дм³

Хуурай үлдэгдэл: 305.7 мг/ дм³

Ус агуулагч чулуулгийн нэр:

Ерөнхий хатуулаг: 3.80 мг-экв/ дм³ Онцлог тодорхойлолт

pH: 7.31 EC: 572 µS/cm

Исэлдэх чанар: 12.80 мг/ дм³ TDS: 309 ppm

Физик чанар:	Чөлөөт CO ₂	11 мг/л
	Карбонатын хатуулаг	4.9 мг/л
Тунгалаг: 10 см	Ерөнхий шүлтлэг	107.8 мг/л
	Идэмхий CO ₂	0 мг/л

Өнгө: саарал

Үнэр: 5 балл

Амт: - балл

Тунадас: саарал лаг

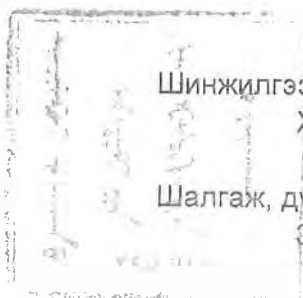
HCO₃⁻80 Cl⁻18

Усны найрлагын томъёо: M_{0.5}

Ca²⁺44 Na⁺+K⁺37 Mg²⁺18

Дүгнэлт

Химийн бүрэлдэхүүнээрээ гидрокарбонатын ангийн, кальци, натрийн бүлгийн, 1-р төрлийн, цэнгэг, зөөлөвтөр ус байна. Шинжилгээний дүнгээс харахад карбонатын хатуулаг их байгаа нь карбонат кальцийг уусган эвдрэлд оруулах нөлөөлөл их байгаа боловч идэмхий CO₂ хэмжээ бага байна. Манай улсад мөрдөгдөж байгаа "Бетон болон барилгын зуурмагт хэрэглэх ус" УСТ 3821-85 стандартад карбонатын хатуулаг болон идэмхий CO₂-н хэмжээг заагаагүй ба энэ стандартад заасан бусад үзүүлэлтүүд нь чанарын шаардлагыг хангаж байна.



Шинжилгээ хийсэн:
Химич

/Б.Оюун-Эрдэнэ/

Шалгаж, дүгнэсэн:

Эрхлэгч: Доктор, Ph.D

/М.Энхтуяа/

APPENDIX E
Groundwater Measuring

**Report of field testing of groundwater level measurement provided by
Senior chief engineer Ogawa Tsutomu of CTI**

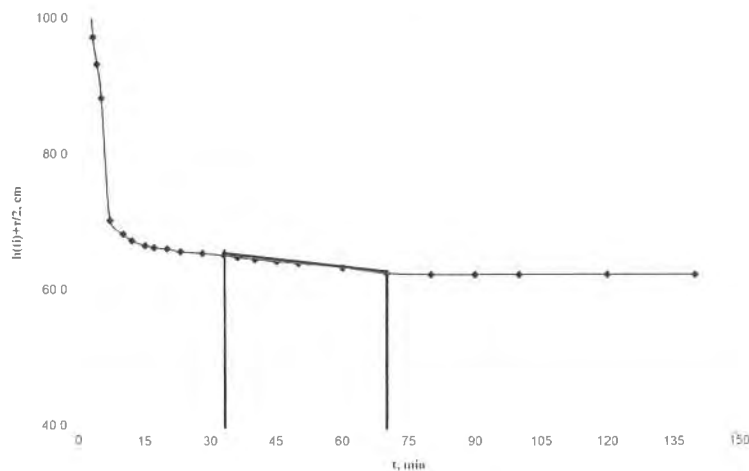
Borehole number	JUNE						JULY					
	25	26	27	28	29	30	1	2	3	4	5	6
BH-1	4.2	4.5	3.8	4.2	3.9	4.3	4.3	4.3	4.2	4.2	4.3	4.6
BH-2	-	4.2	4.2	4.2	4.4	4.2	4.5	4.5	4.5	4.6	4.5	4.3
BH-6		-							3.9	-	3.7	3.9
BH-7									4.5	-	4.2	4.5

APPENDIX F
Determination of Coefficient of Permeability

Ajilchin Railway Fly-Over					
No. of Borehole	BH-1	Tested by		Engineer Nyamdori, Ch	
Borehole Depth (D)	100 (cm)	Date		30 June 2010	
Bore Radius (r)	50mm	r/2	0,250	Soil name	GP
Ht of Water	h(ti) (cm)	15			
Д/Д	Time t (min)	Depth Of Water hi(ti) (cm)	Ht of Water h(ti) (cm)	h(ti)+r/2 (cm)	Note
1	2	3	4	5	6
1	0.5	38	162	162.3	
2	1	60	140	140.3	
3	1.5	70	130	130.3	
4	2	90	110	110.3	
5	3	103	97	97.3	
6	4	107	93	93.3	
7	5	112.0	88	88.3	
8	7	130.0	70	70.3	
9	10	132.0	68	68.3	
10	12	133.0	67	67.3	
11	15	133.7	66.3	66.6	
12	17	134.0	66	66.3	
13	20	134.2	65.8	66.1	
14	23	134.6	65.4	65.7	
15	28	134.9	65.1	65.4	
16	33	135.2	64.8	65.1	
17	36	135.5	64.5	64.8	
18	40	135.8	64.2	64.5	
19	45	136.1	63.9	64.2	
20	50	136.4	63.6	63.9	
21	60	137.0	63	63.3	
22	70	137.8	62.2	62.5	
23	80	138.0	62	62.3	
24	90	138.0	62	62.3	
25	100	138.0	62	62.3	
26	120	138.0	62	62.3	
27	140	138.0	62	62.3	

$$K = 1.15 * r * \frac{\log(h(t1) + 2r) - \log(h(th) + 2r)}{th - t1}$$

Permeability Test
Borehole 1 (depth 100cm)



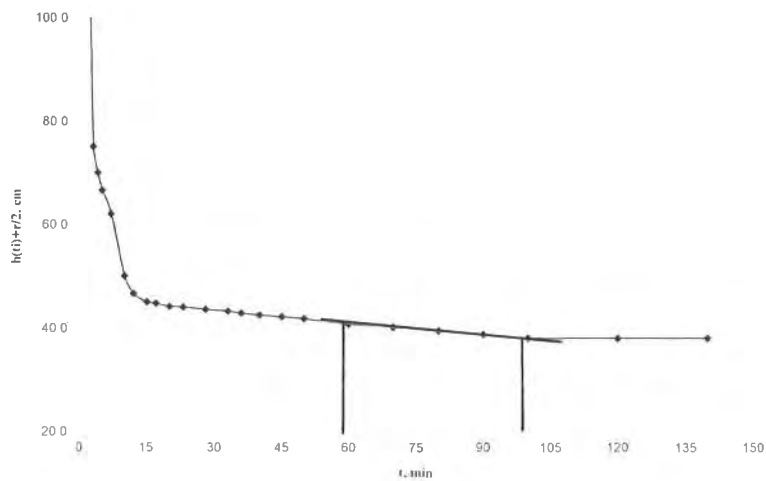
X(t1) = 33
X(tm) = 70

Y(h1+r/2) = 64.8
Y(hm+r/2) = 62.2

tg(A) = 5.4E+00
Kφ = 1.15 * 50 * tg(A)
Kφ = 3.1E+02
K = 310m/day

Ajilehin Railway Fly-Over					
No. of Borehole	BH-2	Tested by		Engineer Nyamdoi, Ch	
Borehole Depth (D)	100 (cm)	Date		30 June 2010	
Bore Radius (r)	50mm	r/2	0.250	Soil name	GP
Ht of Water	h(ti) (cm)	15			
D/d	Time t (min)	Depth Of Water hi(ti) (cm)	Ht of Water h(ti) (cm)	h(ti)+r/2 (cm)	Note
1	2	3	4	5	6
1	0.5	58.0	142.0	142.3	<p style="text-align: center;">$K = 1.15 * r * \frac{\log(h(tl) + 2r) - \log(h(th) + 2r)}{th - tl}$</p>
2	1	60.0	140.0	140.3	
3	1.5	70.0	130.0	130.3	
4	2	90.0	110.0	110.3	
5	3	125.0	75.0	75.3	
6	4	130.0	70.0	70.3	
7	5	133.4	66.6	66.9	
8	7	138.0	62.0	62.3	
9	10	150.0	50.0	50.3	
10	12	153.4	46.6	46.9	
11	15	155.0	45.0	45.3	
12	17	155.3	44.7	45.0	
13	20	155.9	44.1	44.4	
14	23	156.0	44.0	44.3	
15	28	156.5	43.6	43.8	
16	33	156.8	43.2	43.4	
17	36	157.2	42.8	43.1	
18	40	157.5	42.5	42.7	
19	45	157.9	42.1	42.4	
20	50	158.3	41.8	42.0	
21	60	159.3	40.7	41.0	
22	70	159.9	40.1	40.4	
23	80	160.6	39.4	39.7	
24	90	161.3	38.7	39.0	
25	100	162.0	38.0	38.2	
26	120	162.0	38.0	38.3	
27	140	162.0	38.0	38.3	

Permeability Test
Borehole 1 (depth 100cm)

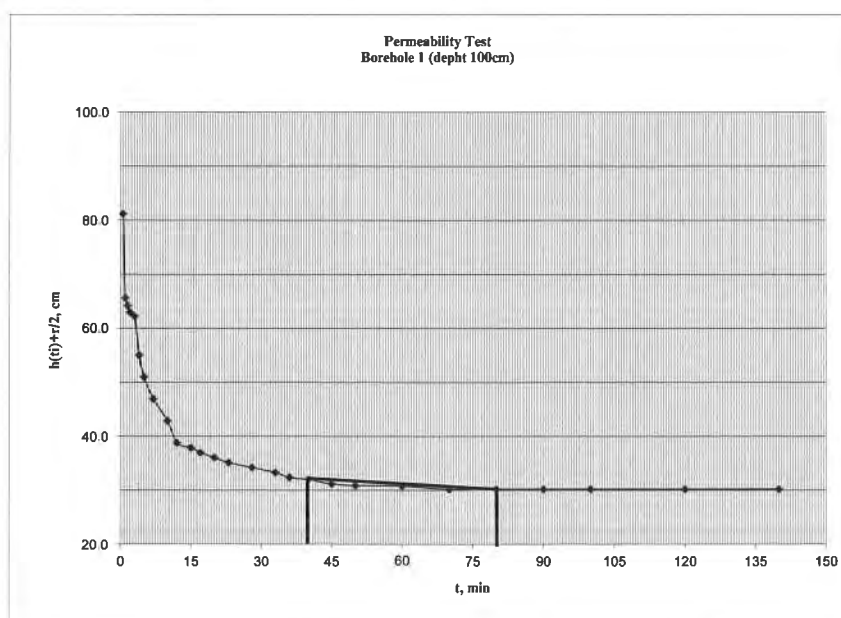


X(t1) = 60
X(tn) = 100

Y(h1+r/2) = 40.7
Y(hn+r/2) = 38.0

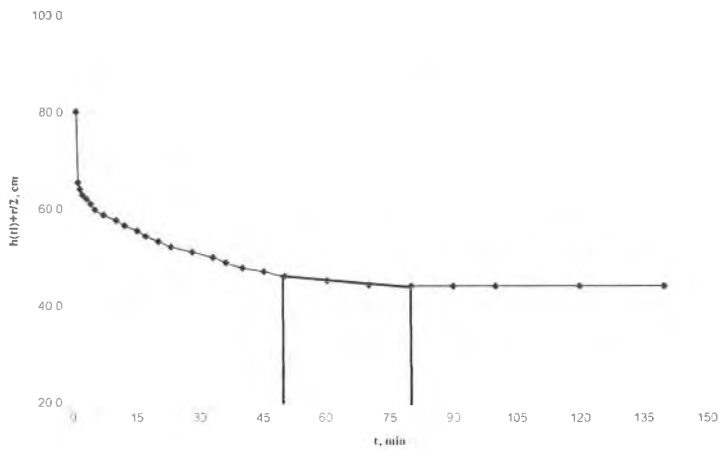
lg(A) = 5.0E+00
Kφ = 1.15 * 50 * lg(A)
Kφ = 2.9E+02
K = 290m/day

Ajlchin Railway Fly-Over					
No. of Borehole	BH-6	Tested by		Engineer Nyamdorj.Ch	
Borehole Depth (D)	100 (cm)	Date		30.June.2010	
Bore Radius (r)	50mm	r/2	0.250	Soil name	GP
Ht of Water	h(ti) (cm)	15			
No	Time t (min)	Depth Of Water hi(ti) (cm)	Ht of Water h(ti) (cm)	h(ti)+r/2 (cm)	Note
1	0.5	119.0	81.0	81.3	<p style="text-align: center;"> $K = 1.15 * r * \frac{\log(h(tl) + 2r) - \log(h(th) + 2r)}{th - t1}$ </p>
2	1	134.6	65.4	65.7	
3	1.5	136.0	64.0	64.3	
4	2	137.2	62.8	63.1	
5	3	138.0	62.0	62.3	
6	4	145.1	54.9	55.1	
7	5	149.2	50.8	51.1	
8	7	153.3	46.7	47.0	
9	10	157.3	42.7	42.9	
10	12	161.4	38.6	38.9	
11	15	162.3	37.7	38.0	
12	17	163.2	36.8	37.0	
13	20	164.1	35.9	36.1	
14	23	165.1	34.9	35.2	
15	28	166.0	34.0	34.3	
16	33	166.9	33.1	33.4	
17	36	167.8	32.2	32.4	
18	40	168.2	31.8	32.1	
19	45	169.0	31.0	31.3	
20	50	169.3	30.7	31.0	
21	60	169.4	30.6	30.9	
22	70	170.0	30.0	30.3	
23	80	170.0	30.0	30.3	
24	90	170.0	30.0	30.3	
25	100	170.0	30.0	30.3	
26	120	170.0	30.0	30.3	
27	140	170.0	30.0	30.3	



Aijichin Railway Fly-Over					
No. of Borehole	BH-7	Tested by		Engineer Nyamdorj Ch	
Borehole Depth (D)	100 (cm)	Date		30 June 2010	
Bore Radius (r)	50mm	r/2	0.250	Soil name	GP
Ht of Water	h(ti) (cm)	15			
No	Time t (min)	Depth Of Water hi(ti) (cm)	Ht of Water h(ti) (cm)	h(ti)+r/2 (cm)	Note
1	2	3	4	5	6
1	0.5	120.0	80.0	80.3	<p style="text-align: center;"> $K = 1.15 * r * \frac{\log(h(t1) + 2r) - \log(h(th) + 2r)}{th - t1}$ </p>
2	1	134.6	65.4	65.7	
3	1.5	136.0	64.0	64.3	
4	2	137.2	62.8	63.1	
5	3	138.0	62.0	62.3	
6	4	139.1	60.9	61.2	
7	5	140.3	59.7	60.0	
8	7	141.3	58.7	58.9	
9	10	142.4	57.6	57.8	
10	12	143.5	56.5	56.7	
11	15	144.6	55.4	55.6	
12	17	145.7	54.3	54.5	
13	20	146.8	53.2	53.4	
14	23	147.9	52.1	52.3	
15	28	149.0	51.0	51.2	
16	33	150.1	49.9	50.2	
17	36	151.2	48.8	49.1	
18	40	152.3	47.7	48.0	
19	45	153.0	47.0	47.3	
20	50	154.0	46.0	46.3	
21	60	154.9	45.1	45.4	
22	70	155.8	44.2	44.5	
23	80	156.0	44.0	44.3	
24	90	156.0	44.0	44.3	
25	100	156.0	44.0	44.3	
26	120	156.0	44.0	44.3	
27	140	156.0	44.0	44.3	

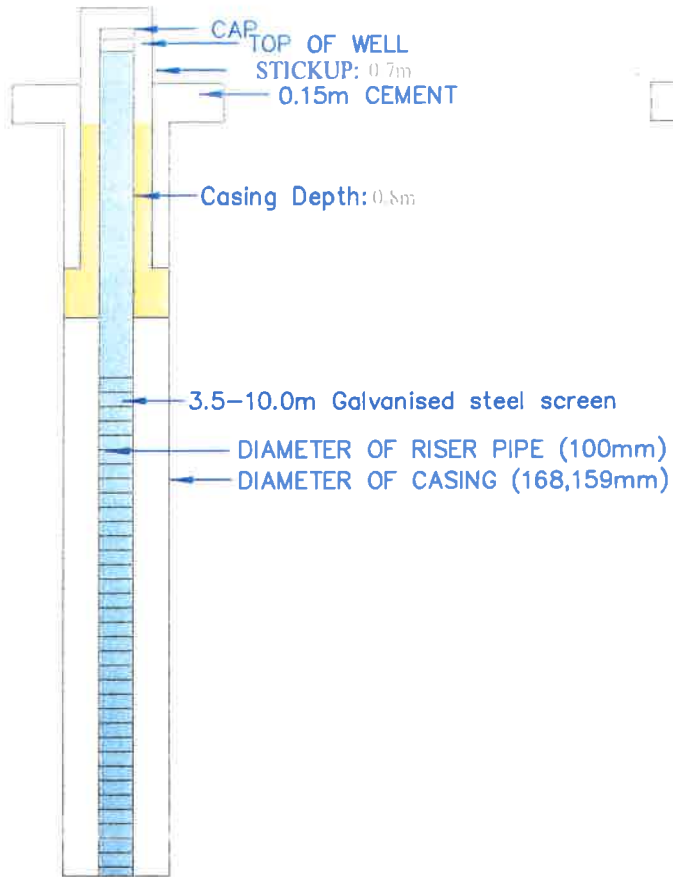
Permeability Test
Borehole 1 (depth 100cm)



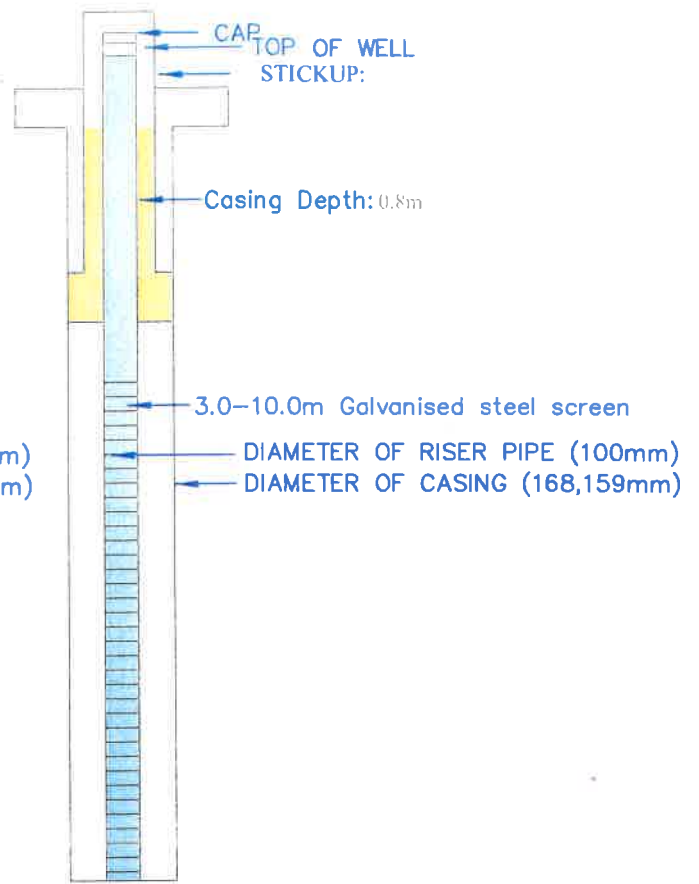
$X(t1) = 50$
 $X(tn) = 80$
 $Y(h(t1+r/2)) = 46.0$
 $Y(h(tn+r/2)) = 44.0$
 $tg(A) = 6.7E+00$
 $K\phi = 1.15 * 50 * tg(A)$
 $K\phi = 3.8E+02$
 $K = 380m/day$

APPENDIX G
Scheme of Monitoring Borehole Installation

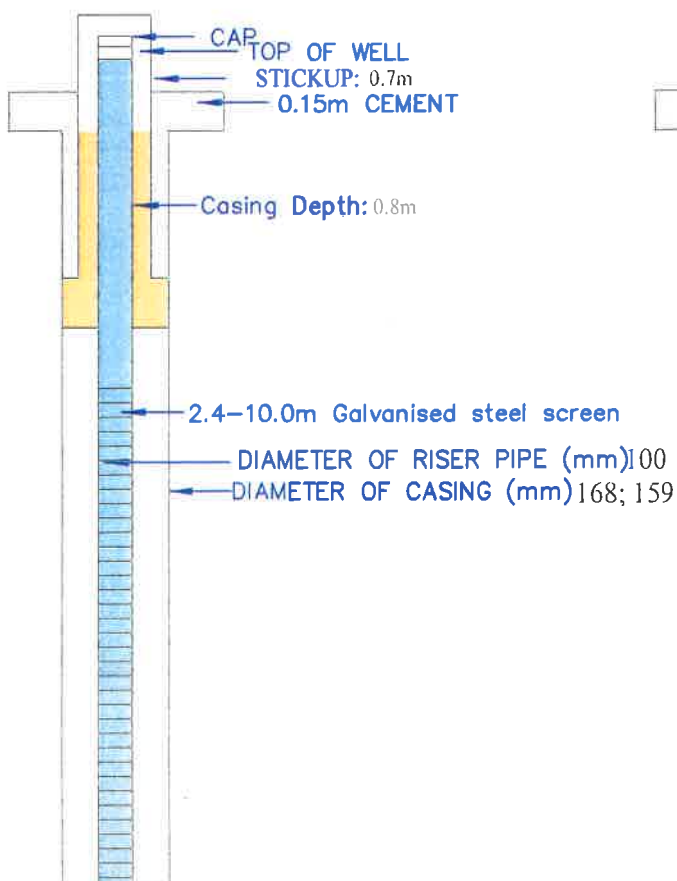
LOG OF PIZOMETER
INSTABLIZED BOREHOLE:
BH-01



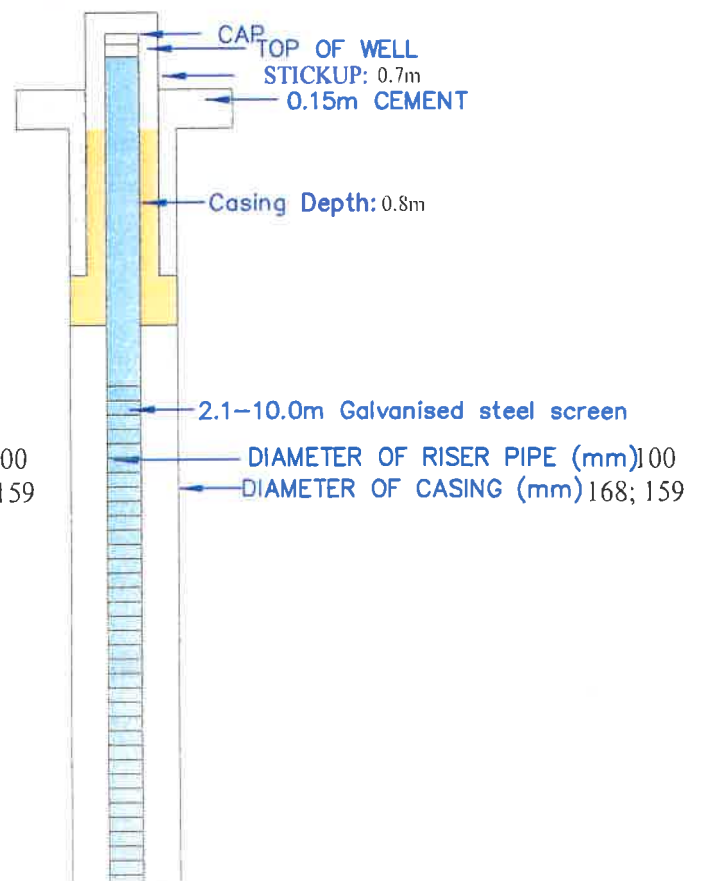
LOG OF PIZOMETER
INSTABLIZED BOREHOLE:
BH-02



LOG OF PIZOMETER
INSTABLIZED BOREHOLE:
BH-06



LOG OF PIZOMETER
INSTABLIZED BOREHOLE:
BH-07



APPENDIX H
Scope of Work Received from the Client

**THE PREPARATORY STUDY ON THE PROJECT FOR CONSTRUCTION OF FLY-OVER
AJILCHIN RAILWAY FLYOVER IN ULAANBAATAR CITY IN MONGOLIA**

**Scope of Work and Technical Specification
for
Soil Investigation and CBR Test**

1. Introduction

The Specification is to be applied to the work conducted by the Local Consultant under the supervision by the Study Team. The results of the survey will be used by the Study Team for the Preliminary Design Study on the Project for Construction of Ajilchin Railway Fly-over in Ulaanbaatar City in Mongolia.

2. Location of the Investigation

The soil investigation shall be carried out at:

- eleven (11) locations of exploratory boring at Ajilchin Railway Fly-over,
- five (5) locations of test pit sampling for CBR test

The locations of above investigation are conceptually shown in Fig.1. The exact location of each borehole and test pit shall be designated by the Study Team.

3. Summary of Scope of Work and the responsibility for the local consultant

The work consists of the Soil Investigation, Laboratory Test and Report Preparation.

The local consultant shall compensate of the repair cost of utility facilities if damaged by boring test.

3.1 Soil Investigation

The Soil Investigation shall consist of following works:

- (1) Exploratory borings with Standard Penetration Tests
- (2) Undisturbed Sampling (in case soft cohesive layer is encountered)
- (3) Test Pit Digging for Bulk sampling for CBR test
- (4) Permeability test (4 boreholes)
- (5) Setting of polyethylen pipes(ϕ 100mm) into 4 bore holes for inspection wells

* The above four holes shall be as shown in Figure1.

3.2 Laboratory Test

The Laboratory Test shall consist of following works:

- (1) Sand and gravel (disturbed sample): grain size distribution, unit weight, moisture content, Permeability test
- (2) Cohesive soil (undisturbed sample): unit weight, moisture content, Atterberg (LL/PL), consolidation test, one-axial compression

- (3) Soaked CBR test

3.3 Report Preparation

The Report Preparation shall consist of following works:

- (1) Preliminary Drilling Log at completion of each borehole
- (2) Factual Report on Soil Investigation and Laboratory Test

4. Time Frame

The field work and laboratory tests shall be completed within ten(10) days after Notice to Proceed is given, and the final factual report shall be submitted within three(3) weeks after Notice to Proceed is given as shown in Table 1.

5. Standard and Unit

The fieldwork and laboratory tests shall be carried out in accordance with the latest edition of ASTM, AASHTO or equivalent, unless otherwise specified. SI unit shall be used. Method statements to be used by the Local Consultant for the field work and laboratory tests shall be submitted prior to commencement of the work for approval by the Study Team.

6. Laboratory and Laboratory Test Formats

The Local Consultant shall submit name and address of a testing laboratory to be used for this project. The Study Team has a right to visit the laboratory for inspection, and has also a right to change the laboratory in such a case that he is not satisfied on quality and workmanship of the laboratory. The Local Consultant cannot claim any extra costs for changing the laboratory.

Formats of the laboratory tests shall be submitted to the Study Team for approval.

The Local Consultant shall submit test results immediately after completion of individual tests.

7. Soil Investigation

7.1 Exploratory Borings with Standard Penetration Tests

7.1.1 Drilling

The Local Consultant shall drill eight (11) boreholes at the proposed locations of abutment, pier of Ajilchin Railway Fly-over and road nearby river. The Study Team shall instruct the exact borehole locations. The Local Consultant shall carry out a positioning survey including measurement of elevation and prepare a location map of each drilling point.

The Local Consultant shall propose his drilling method to the Study Team for approval. Rotary boring machines shall be used. Percussion drilling and any other methods, which may loosen or soften at the test depth, shall not be allowed without permission of the Study Team. The drilling machines shall be capable for drilling through boulder layers and relatively hard rock layer.

Sufficient number of well-maintained drilling machines should be mobilized to follow the

schedule. Sufficient number of experienced supervising engineers who can communicate with the Study Team shall station at the site always.

All findings during the drilling shall be recorded in the field drilling logs. Field drilling logs shall be prepared at the site and submit daily to the Study Team. Preliminary Drilling Log shall be submitted to the Study Team within two (2) days after completion of drilling at each borehole. Handwriting is acceptable for this submission. Prior to commencement of field work, the Local Consultant shall submit a format of drilling log for approval of the Study Team.

Drilling at fly-over and bridge locations shall be terminated after confirming a ten (10) meter thick competent bearing stratum with N-value of fifty (50) or more in Standard Penetration Test (SPT). The Local Consultant shall not shift the drilling machine to the next borehole location without approval of the Study Team.

Water level in the borehole shall be measured in every morning before commencement of the boring work. The borehole shall be backfilled when the field work is completed.

Drilling depth for the cost estimation purpose is estimated twenty (20) m at fly-over and bridge locations and ten (10) m at road sections.

Drilling depth at site should be decided by the location of the bearing stratum. (Thickness of bearing stratum (N-value >50) is more than 10m.)

7.1.2 Standard Penetration Test

Standard penetration test (SPT) shall be carried out at every one (1) m and whenever type of soil is changed during drilling in accordance with ASTM D 1586.

Mass of the SPT hammer to be used shall be measured and reported to the Study Team for approval prior to commencement of the work. Free-fall of the hammer shall be secured during the test. Usage of automatic trigger is recommended to ensure the free-fall of the hammer.

Samples obtained by SPT shall be observed their color and structure, size and shape of sand and gravel particles, type of soil and condition of moisture at the site. The observation records shall be summarized in the drilling logs.

The disturbed samples taken by SPT shall be kept in plastic bags to avoid desiccation. Borehole number, test depth and N-value shall be indicated on the plastic bag. When more than two types of soil are recovered by a SPT, the samples shall be kept in separate transparent double plastic bags, which shall be tightly sealed with strings. All the samples shall not be exposed under strong sunlight and/or high temperature.

7.1.3 Confirmation of Depths of Boreholes

The depth of borehole shall be measured accurately every time when drilling is stopped. Then,

when boring starts again or when SPT is to perform, all slime which may deposit at the bottom of bore hole shall be removed till the depth recorded, then boring and tests shall be performed.

7.2 Laboratory Tests

7.2.1 Soil Tests on Disturbed/Undisturbed Samples Collected from Boreholes

Laboratory soil tests shall be carried out on selected soil samples. For cost estimation purpose, total number of samples to be tested is twenty (20) for sand and gravel (disturbed samples) and five (5) for cohesive soil (undisturbed samples). The tests shall be carried out in accordance with the methods specified in ASTM. Item of the tests are:

- Unit weight (ASTM C29)
- Specific gravity (ASTM D854)
- Liquid and plastic limits (ASTM D4318)
- Grading analysis (sieving + Hydrometer test, ASTM D422)
- Moisture content (ASTM D2216)
- Consolidation test (ASTM D2435)
- Permeability test (ASTM D2434)
- Compressive test (ASTM D695)

7.2.2 CBR Tests on Bulk Samples collected from Test Pits

Following laboratory tests shall be carried out on bulk samples collected from test pits. Total number of samples to be tested is five (5) for the cost estimation purpose.

- Specific gravity (ASTM D854)
- Grading analysis (sieving + Hydrometer test, ASTM D422)
- Moisture content (ASTM D2216)
- Soaked CBR test (AASHTO T99)

Test specimens for soaked CBR test shall be prepared with natural moisture content .

7.3 Preparation of the Factual Report

The Local Consultant shall prepare and submit the following reports. All the submission shall be prepared in English.

Before commencement of the work, the Local Consultant shall submit followings:

- Name and resume of personal in charge,
- Execution plan including work schedule organization of staff,
- Type and capacity of equipment and apparatus, and
- Forms of drilling log and laboratory tests, and detail of the laboratory to be used.

During and after the work, the Local Consultant shall submit followings:

- Field drilling logs (daily),
- Preliminary drilling logs in hand writing,

- Preliminary laboratory test results, and
- Final reports.

The final report, one (1) original with digital data and three (3) copies, shall contain following items:

- Location map of boreholes,
- Brief statement for method of the work,
- Items and quantities of the work performed,
- Duration of the drilling work,
- Brief statement of geological feature around the site,
- Daily record of water level in the borehole and casing depth,
- Drilling logs,
- Laboratory test results, and photograph of the field activities.
- Laboratory test results, and photograph of the field activities,
- Profile view and sectional views of soil layers, N-value drawings.

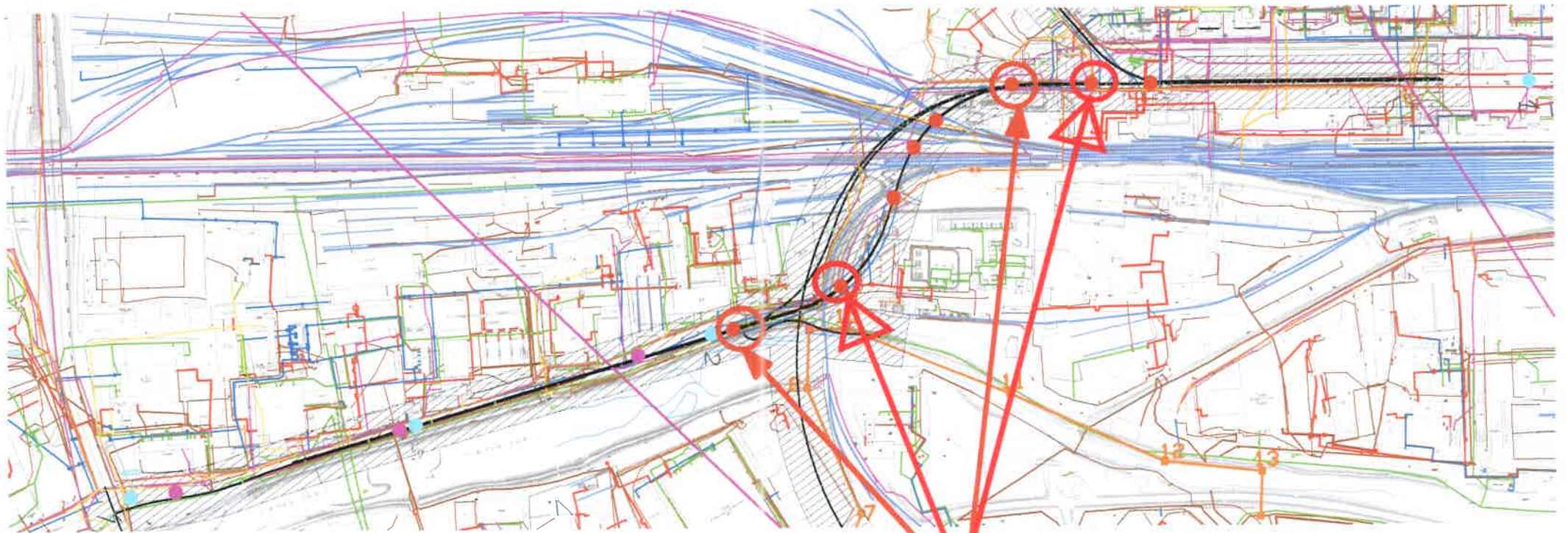
Soil samples kept in box (separate for the borehole locations) shall be stored by the Local Consultant.

Table 1 Schedule

Work Items	June 2012			July 2012		
	10	20	30	10	20	31
Preparatory Work		15				
Soil Investigation			1 25			
Laboratory Test incl. CBR Test			25			
Reporting						

Figure1. Plan of Soil Investigation Points

- Boring Tests (8points L \approx 20m)
- Boring Tests (3points L \approx 10m)
- CBR Tests (5points)



Location of polyethylene pipes(ϕ 100mmwith cap)
(Inspection Wells for permeability tests
and water hygiene tests(at environmental section))