7. Others

(1) TRAFFIC SURVEY

The Traffic survey was carried out at 2 locations (Gruvaljin Bridge,peace Bridge). Table 1 shows the traffic volumes, PCU, and the share of large vehicles by each direction.

The survey duration was set to 24 hours. The PCU Coefficient is shown in Table 2.

The following six (6) vehicles were adopted as large vehicles : Small Bus, Large Bus, Middle Rigid Truck(3.5~12ton), Large Rigid Truck(3.5~12ton), Articulated Truck(3.5~12ton), Large Articulated Truck including Trailer(Over 12ton) and the percent of large vehicle was calculated. Table 3 shows the hourly traffic volume at 2 locations by direction.

Table 1 Result of Traffic Survey

	Gurvaljin Bridge			**Peace Bridge (Enkhtaivan)**		
	North→South	**South→North**	**Total**	**North→South**	**South→North**	**Total**
Traffic Volume	13,217	13,727	26,944	25,790	25,734	51,524
PCU	15,613	16,380	31,992	27,508	27,330	54,838
% of Large Vehicle	10.6%	10.6%		3.6%	3.7%	

Table 2 PCU Coefficient

	Cars	Micro bus	Small Bus	Large Bus	Small Rigid Truck (Under 3.5ton)	Middle Rigid Truck (3.5~12ton)	Large Rigid Truck (3.5~12ton)	Articulated Truck /3.5~12ton/	Large Artculated Truck including Trailer/Over 12ton/	Tractor	Motorbike	Bicycle	Animal Cart	Others
PCU Coefficient	1	1.5	2.5	3.5	1.5	1.75	2.5	3	3.5	2	0.7	0.3	0.5	1

Table 3 Traffic Volume by hour

Time (Hrs)	Gurvaljin bridge			Peace bridge "Enkhtaivan"		
	North-South	South-North	Total	North-South	South-North	Total
6:00 - 7:00	105	98	203	190	266	456
7:00 - 8:00	600	379	979	852	811	1663
8:00 - 9:00	1035	616	1651	1659	1623	3282
9:00 - 10:00	**1256**	983	**2239**	1578	**1800**	**3378**
10:00 - 11:00	1012	930	1942	1338	1638	2976
11:00 - 12:00	912	1040	1952	1209	1509	2718
12:0 0 - 13:00	999	973	1972	1336	1556	2892
13:00 - 14:00	1088	957	2045	1578	1611	3189
14:00 - 15:00	940	863	1803	1528	1633	3161
15:00 - 16:00	883	882	1765	**1813**	1508	3321
16:00 - 17:00	895	958	1853	1658	1544	3202
17:00 - 18:00	905	**1193**	2098	1679	1621	3300
18:00 - 19:00	614	1036	1650	1470	1561	3031
19:00 - 20:00	501	863	1364	1670	1529	3199
20:00 - 21:00	361	595	956	1509	1365	2874
21:00 - 22:00	258	377	635	1301	1113	2414
22:00 - 23:00	261	298	559	1148	870	2018
23:00 - 24:00	185	241	426	776	704	1480
24:00 - 01:00	152	189	341	575	590	1165
01:00 - 02:00	89	91	180	380	414	794
02:00 - 03:00	49	52	101	160	157	317
03:00 - 04:00	40	30	70	138	116	254
04:00 - 05:00	39	34	73	113	75	188
05:00 - 06:00	38	49	87	132	120	252
Total	13217	13727	26944	25790	25734	51524
Max	1256	1193	2239	1813	1800	3378

(2) AXLE LOAD SURVEY

The result of the axel load survey is shown in Table 4, additionally the vehicle type and the vehicle count is shown in Table 5. The survey duration was set to 24 hours.

Table 4 Result of axle load survey

	Gurvaljin bridge		Peace bridge	
Axle load(t)	Axle Count	Ratio	Axle Count	Ratio
less than 10	6	5%	10	4%
10 - 11	8	7%	28	11%
11 - 12	12	10%	58	23%
12 - 13	15	13%	61	24%
13 - 14	9	8%	41	16%
14 - 15	9	8%	30	12%
15 - 16	3	3%	12	5%
16 - 17	11	9%	10	4%
17 - 18	1	1%	2	1%
18 - 19	0	0%	3	1%
19 - 20	4	3%	0	0%
20 - 25	13	11%	0	0%
25 - 30	6	5%	0	0%
30 - 35	8	7%	0	0%
35 - 40	9	8%	0	0%
40 - 45	5	4%	0	0%
45 - 50	1	1%	0	0%
over 50	0	0%	0	0%
	120	100%	255	100%

Table 5 Count of load survey by vehicle type

Type of Vehicle		Gurvaljin bridge（Vehicle）	Peace bridge（Vehicle）
1	2 Axle 4 Tire	6	0
2	2 Axle 6 Tire	29	255 (Trolleybus 36)
3	4 Axle 10 Tire	2	0
4	4 Axle 14 Tire	2	0
5	5 Axle 18 Tire	1	0
6	3 Axle Semi	55	0
7	4 Axle Semi	4	0
8	6 Axle Semi	3	0
9	Twin Trailer	17	0
10	Trailers & Bus	1	0
Total		120	255

(3) TRAVEL SPEED SURVEY

For this survey, 2 routes are indentified to cover the major toads in the center of Ulaanbaatar City as shown in Figure 1. Three runs were carried out morning time (0700H to 1000H), afternoon (1000H to 1700H) and evening time (1700H to 2000H) in both directions.

The travel speed and running speed were measured and summarized in Table 6. The detail is shown as Table 7 and Table 8.

Table 6 Description of Travel speed survey

	Travel distance	Average Time Distance(hh:mm:ss) / Average Travel Speed			
		Outward journey		Homeward journey	
Route A（Gurcaljin brd.）	7.6 Km	0:19:45	23.2 km/h	0:19:52	22.7 km/h
Route B（Peace brd.）	4.7 Km	0:15:54	20.1 km/h	0:16:11	23.4 km/h

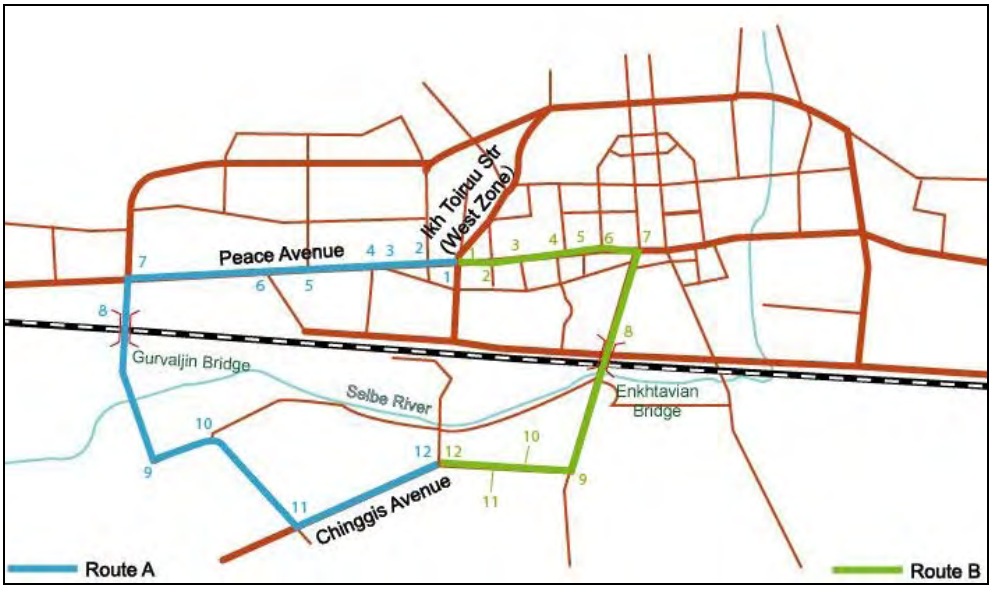


Figure 1 Survey Routes for Travel Speed Survey

Table 7 Result of Travel Speed Survey (Route A)

		Outward jorney			Homeward journey		
Survey Zone		Average Distance [Km]	Travel Time	Travel Speed	Average Distance [Km]	Travel Time	Travel Speed
1	Baruun 4 zam ～ Junction 3 and 4 khoroolol	0.3	0:00:40	24.00	0.23	0:01:31	9.23
2	Junction 3 and 4 khoroolol ～ TBD Anduud	0.3	0:00:55	19.64	0.27	0:00:40	24.00
3	TBD Anduud ～ Railway station junction	0.2	0:00:35	20.57	0.27	0:01:17	12.47
4	Railway station junction ～ Pharmacy No.25	0.5	0:01:42	17.65	0.40	0:01:22	17.56
5	Pharmacy No.25 ～ MT gasoline station	0.4	0:01:02	25.16	0.50	0:01:23	21.69
6	MT gasoline station ～ Sapporo ikh toiruu	1.2	0:03:00	23.33	1.07	0:03:02	21.10
7	Sapporo ikh toiruu ～ Gurvaljin bridge	0.8	0:01:30	33.33	0.83	0:01:12	41.67
8	Gurvaljin bridge ～ Thermal Power station No.3	1.1	0:03:18	19.39	1.07	0:02:55	21.94
9	Thermal Power station No.3 right junction ～ Thermal Power station No.3 left	0.5	0:01:32	19.57	0.57	0:01:32	22.17
10	Thermal Power station No.3 left junction ～ Traffic	1.1	0:02:15	30.22	1.10	0:02:15	29.33
11	Traffic police post ～ White gate	1.2	0:03:17	21.93	1.30	0:02:43	28.71
		7.60	0:19:45	23.16	7.60	0:19:52	22.72

Table 8 Result of Travel Speed Survey (Route B)

		Outward jorney			Homeward journey		
Survey Zone		Average Distance [Km]	Travel Time	Travel Speed	Average Distance [Km]	Travel Time	Travel Speed
1	Baruun 4 zam ～ Hope Denta	0.4	0:01:25	16.94	0.3	0:00:23	46.96
2	Hope Dental ～ Peace & Friendship center	0.3	0:00:57	16.84	0.3	0:01:05	18.46
3	Peace & Friendship center ～ State Department Store	0.3	0:00:34	28.24	0.2	0:00:32	26.25
4	State Department Store ～ Embassy of Russia	0.2	0:00:35	20.57	0.2	0:00:25	28.80
5	Embassy of Russia ～ Flower center	0.2	0:02:12	6.36	0.2	0:01:14	11.35
6	Flower center ～ Postal communication center	0.3	0:00:57	16.84	0.4	0:01:36	13.75
7	Postal communication center ～ Peace bridge	0.9	0:03:53	13.39	0.9	0:05:33	9.73
8	Peace bridge ～ Zaisan /Chinggis Avenue	1.0	0:02:32	24.47	1.0	0:02:32	22.89
9	Zaisan /Chinggis Avenue ～ APU Co., Ltd	0.4	0:01:03	20.95	0.5	0:00:41	40.98
10	APU Co., Ltd ～ "Mongol" University	0.4	0:00:42	34.29	0.4	0:01:08	22.94
11	"Mongol" University ～ White gate	0.4	0:01:06	21.82	0.3	0:01:02	15.48
		4.7	0:15:54	20.1	4.7	0:16:11	23.4

(4) SOIL INVESTIGATION

The exploratory borings with standard penetration tests were carried out at 6 locations and the Test Pit digging survey was carried out at 2 locations (refer to Figure 2).

The items and quantities of the soil investigation are as shown in Table 9.

Figure 2 illustrates the geological profile, as well as the locations of exploratory boring and test pit digging survey.

Table 9 Items and Quantities of Soil Investigation

Item	Location	Elevation L.m)	Depth (m)	Laboratory Soil Test Item
Exploratory Boring	BOR-1	1,284.19	10	Specific gravity, Unit weight, Liquid and plastic limits, Grading analysis, Moisture content
	BOR-2	1,284.28	13	
	BOR-3	1,285.30	11	
	BOR-4	1,285.10	20	
	BOR-5	1,284.52	20	
	BOR-6	1,284.73	10	
Test Pit Digging Survey	RDN-T1	1,284.09	1	Specific gravity, Grading analysis, Moisture content, Compaction test, Soaked CBR test

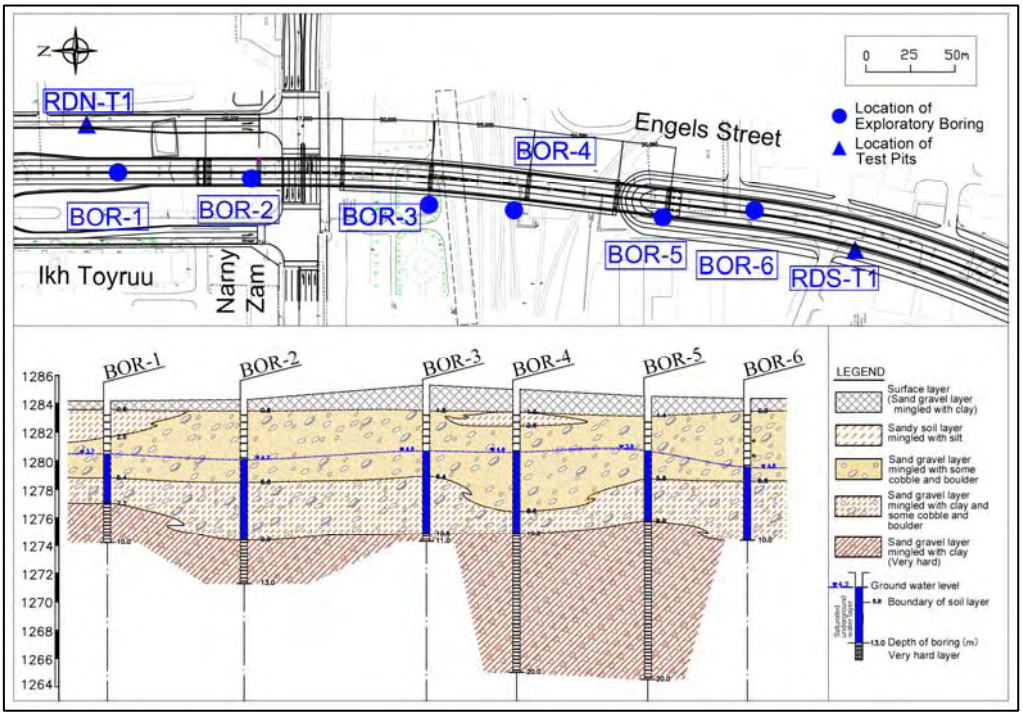


Figure 2 Geological Profile and Locations of Exploratory Boring and Test Pits

Summary of Physical Properties of Soil

1	Sample No	Depth (m)	Particle size															Particle Analysis (%)			Atterberg Limits			Cu	Cc	Soil Type	Soil name	Natural Moisture Content (W), %	Specific gravity G_s, g/cm^3	ρ, g/cm^3	ρ_d, g/cm^3	n,%	e	Sr	J_L
			75	50	37.5	25	19	9.5	4.75	2.00	0.850	0.425	0.300	0.150	0.075	<0.075	%	Gravel	Sand	Silt/ Clay	LL	PL	PI													
0	1	2	3	5	6	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27.00	28.00	29	30	31.0	32.00	33	34	35	36	37	38
1	BR-P3	2.0	0.0	0.0	0.0	8.6	7.5	10.1	12.3	13.6	8.2	11.9	9.0	4.8	5.9	8.1	100.0	38.5	53.4	8.1	20.1	16.7	3.4			SC-SM	Silty SAND with gravel	2.6	2.68	2.19	2.13	20.35	0.256	0.27	<0
2	BR-P3	3.4	0.0	17.7	20.9	16.9	13.2	13.1	8.2	6.4	0.6	0.4	0.3	0.2	0.5	1.7	100.0	90.0	8.3	1.7	nonplastic			7.30	1.80	GP	Poorly graded GRAVEL with sand	0.9	2.67	2.28	2.26	15.37	0.182	0.13	<0
3	BR-P3	4.5	0.0	19.0	17.2	14.3	9.1	15.4	8.3	9.5	1.3	0.8	0.7	0.4	0.9	3.3	100.0	83.3	13.4	3.3	nonplastic			12.60	1.80	GP	Poorly graded GRAVEL with sand	1.8	2.67	2.27	2.23	16.48	0.197	0.24	<0
4	BR-P3	6.4	0.0	0.0	14.5	15.9	16.3	14.6	11.1	8.9	4.8	3.7	3.2	1.2	1.0	4.1	100.0	72.4	23.5	4.1	nonplastic			55.00	4.80	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.26	2.22	16.77	0.202	0.23	<0
5	BR-P3	10.0	0.0	0.0	9.8	14.6	10.1	15.2	12.8	12.0	4.0	4.6	4.4	3.4	1.6	7.5	100.0	62.5	30.0	7.5	20.1	14.0	6.1	6.80	2.30	GP-GC	Poorly graded GRAVEL with sand and clay	0.9	2.67	2.24	2.22	16.85	0.203	0.12	<0
6	BR-P3	14.8	0.0	0.0	0.0	11.5	11.3	6.5	14.2	7.3	4.3	4.6	5.4	5.9	3.6	25.4	100.0	43.5	31.1	25.4	20.9	14.9	6.0			GC	Clayey GRAVEL with sand	7.3	2.71	2.12	1.98	27.09	0.372	0.53	<0
7	BR-P3	17.0	0.0	0.0	13.5	7.9	2.9	8.7	5.8	12.3	5.3	1.2	2.3	4.9	3.8	31.4	100.0	38.8	29.8	31.4	24.4	14.3	10.1			GC	Clayey GRAVEL with sand	6.9	2.72	2.09	1.96	28.12	0.391	0.48	<0
8	BR-P3	15.8	0.0	0.0	18.7	11.8	4.2	1.4	14.6	24.6	2.4	1.4	1.2	1.3	1.3	17.1	100.0	50.7	32.2	17.1	42.0	13.4	28.6			GC	Clayey GRAVEL with sand	5.9	2.71	2.22	2.10	22.65	0.293	0.55	<0
9	BR-P3	18.0	0.0	11.2	17.2	11.8	4.2	1.4	14.6	24.5	0.7	0.4	0.3	0.3	0.8	12.6	100.0	60.4	27.0	12.6	24.5	14.3	10.2			GC	Clayey GRAVEL with sand	6.0	2.72	2.24	2.11	22.31	0.287	0.57	<0
10	BR-A2	2.8	0.0	0.0	16.4	11.7	11.2	16.6	12.9	7.6	1.0	3.9	11.4	3.9	1.1	2.3	100.0	68.8	28.9	2.3	nonplastic			46.40	5.10	GP	Poorly graded GRAVEL with sand	2.3	2.68	2.25	2.20	17.93	0.219	0.28	<0
11	BR-A2	5.5	0.0	0.0	0.0	6.3	12.8	23.6	15.7	15.7	8.4	5.6	4.7	2.8	1.2	3.1	100.0	58.4	38.5	3.1	nonplastic			32.30	2.40	GP	Poorly graded GRAVEL with sand	2.4	2.68	2.19	2.14	20.20	0.253	0.25	<0
12	BR-A2	11.0	0.0	0.0	0.0	0.0	24.2	16.5	11.1	6.3	6.3	5.8	6.4	6.3	4.1	13.0	100.0	51.8	35.2	13.0	20.8	13.9	6.9			GC	Clayey GRAVEL with sand	4.9	2.72	2.23	2.13	21.84	0.279	0.48	<0
13	BR-A2	6.4	0.0	0.0	10.1	12.1	14.7	11.9	15.0	17.2	3.5	2.7	1.4	0.6	1.8	9.1	100.0	63.8	27.1	9.1	21.9	12.7	9.2	202.40	14.20	GP-GC	Poorly graded GRAVEL with sand and clay	2.8	2.69	2.25	2.19	18.64	0.229	0.33	<0
14	BR-A2	7.4	0.0	0.0	13.7	18.8	15.3	11.7	12.7	12.5	2.5	1.8	1.0	1.2	2.1	6.7	100.0	72.2	21.1	6.7	23.0	14.6	8.4	112.50	6.20	GP-GC	Poorly graded GRAVEL with sand and clay	1.9	2.67	2.26	2.22	16.93	0.204	0.25	<0
15	BR-A2	8.4	0.0	13.4	14.7	12.7	11.1	13.7	12.7	6.6	0.7	0.4	0.3	0.7	0.6	12.4	100.0	78.3	9.3	12.4	25.6	12.7	12.9			GC	Clayey GRAVEL with sand	4.6	2.71	2.27	2.17	19.92	0.249	0.50	<0
16	BR-A2	12.0	0.0	0.0	0.0	10.8	22.0	19.1	13.2	11.0	4.4	3.6	3.1	2.4	1.5	8.9	100.0	65.1	26.0	8.9	18.5	14.2	4.3	100.00	5.10	GP-GC	Poorly graded GRAVEL with sand and clay	3.6	2.69	2.24	2.16	19.62	0.244	0.40	<0
17	BR-A2	13.2	0.0	0.0	11.5	14.8	8.0	7.1	15.0	15.0	3.6	1.9	2.4	3.5	3.1	14.0	100.0	56.4	29.6	14.0	22.9	16.0	6.9			GC	Clayey GRAVEL with sand	8.2	2.73	2.21	2.04	25.18	0.337	0.67	<0
18	BR-A2	15.0	0.0	0.0	17.0	10.5	13.7	11.2	13.3	19.5	0.4	0.2	0.6	0.4	0.2	13.0	100.0	65.7	21.3	13.0	28.8	16.0	12.8			GC	Clayey GRAVEL with sand	5.6	2.71	2.25	2.13	21.38	0.272	0.56	<0
19	BR-A2	16.0	0.0	13.4	8.4	8.6	10.4	13.6	10.7	8.3	9.8	1.3	1.0	0.8	1.8	12.1	100.0	65.1	22.8	12.1	24.6	13.9	10.7			GC	Clayey GRAVEL with sand	5.7	2.72	2.24	2.12	22.09	0.284	0.55	<0
20	BR-A2	17.0	0.0	0.0	11.5	16.6	20.7	11.4	14.7	11.0	0.4	0.6	0.4	0.2	0.2	12.2	100.0	74.9	12.9	12.2	25.6	13.4	12.2			GC	Clayey GRAVEL with sand	3.9	2.71	2.25	2.17	20.09	0.251	0.42	<0
21	BR-A2	18.0	0.0	0.0	25.9	11.5	15.5	13.0	11.6	6.1	0.6	0.3	0.7	0.2	0.4	14.1	100.0	77.5	8.4	14.1	26.7	13.4	13.3			GC	Clayey GRAVEL with sand	5.0	2.72	2.26	2.15	20.87	0.264	0.52	<0
22	BR-A2	20.0	0.0	10.0	8.0	7.3	2.4	4.9	12.2	15.8	7.7	4.9	3.4	3.8	2.9	16.7	100.0	44.8	38.5	16.7	25.6	14.4	11.2			GC	Clayey GRAVEL with sand	7.1	2.72	1.97	1.84	32.37	0.479	0.40	<0
23	RDS-1	3.0	0.0	0.0	17.2	15.2	13.1	12.4	15.5	13.3	2.3	2.0	1.7	2.5	1.2	3.6	100.0	73.4	23.0	3.6	nonplastic			44.00	2.80	GP	Poorly graded GRAVEL with sand	1.9	2.67	2.26	2.22	16.93	0.204	0.25	<0
24	RDS-1	4.0	0.0	0.0	12.3	24.6	15.1	12.3	14.1	9.1	1.7	1.4	1.2	2.1	1.4	4.6	100.0	78.4	17.0	4.6	nonplastic			40.00	3.50	GP	Poorly graded GRAVEL with sand	2.7	2.68	2.25	2.19	18.25	0.223	0.32	<0
25	RDS-1	5.0	0.0	0.0	0.0	22.5	19.7	14.9	20.5	13.7	1.6	0.9	0.6	0.8	1.2	3.6	100.0	77.6	18.8	3.6	nonplastic			9.10	0.80	GP	Poorly graded GRAVEL with sand	1.8	2.67	2.26	2.22	16.85	0.203	0.24	<0
26	RDS-1	6.2	0.0	11.8	16.3	14.9	6.9	13.0	12.1	13.6	0.7	0.5	0.4	1.7	1.1	6.9	100.0	75.0	18.1	6.9	23.4	12.4	11.0	67.50	3.70	GP-GC	Poorly graded GRAVEL with sand and clay	2.3	2.69	2.24	2.19	18.60	0.229	0.27	<0
27	RDS-1	7.4	0.0	0.0	11.5	19.6	10.0	18.4	11.2	13.6	1.2	1.7	1.3	0.9	1.1	9.5	100.0	70.7	19.8	9.5	23.0	11.2	11.8	253.20	15.80	GP-GC	Poorly graded GRAVEL with sand and clay	4.1	2.68	2.25	2.16	19.35	0.240	0.46	<0
28	RDS-1	8.2	0.0	0.0	13.7	16.8	12.7	17.1	12.9	16.1	1.2	0.9	0.6	0.7	0.9	6.5	100.0	73.2	20.3	6.5	24.3	16.0	8.3	26.90	1.80	GP-GC	Poorly graded GRAVEL with sand and clay	2.3	2.67	2.26	2.21	17.26	0.209	0.29	<0
29	RDS-1	9.2	0.0	12.5	12.2	14.1	12.2	14.0	10.9	12.4	2.6	0.8	0.5	0.4	0.8	6.4	100.0	75.9	17.7	6.4	23.8	12.0	11.8	16.00	1.40	GP-GC	Poorly graded GRAVEL with sand and clay	3.6	2.68	2.27	2.19	18.24	0.223	0.43	<0
30	BR-A1	1.6	0.0	0.0	6.2	13.9	14.1	15.0	15.6	8.4	11.3	3.4	1.8	3.2	4.7	2.5	100.0	64.8	32.7	2.5	nonplastic			62.50	2.30	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.24	2.20	17.51	0.212	0.21	<0
31	BR-A1	3.0	0.0	0.0	4.9	11.1	11.3	12.0	12.5	6.7	9.0	7.2	6.4	8.8	7.2	2.8	100.0	51.8	45.4	2.8	nonplastic			60.00	0.50	GP	Poorly graded GRAVEL with sand	2.2	2.68	2.22	2.17	18.95	0.234	0.25	<0
32	BR-A1	5.4	0.0	0.0	12.8	14.6	15.0	14.9	11.6	9.3	10.7	3.0	2.6	1.7	1.1	2.4	100.0	68.9	28.7	2.4	nonplastic			28.60	1.30	GP	Poorly graded GRAVEL with sand	1.3	2.67	2.25	2.22	16.81	0.202	0.17	<0
33	BR-A1	6.5	0.0	19.5	13.1	11.1	9.1	11.7	9.0	9.9	4.2	3.2	2.5	1.9	2.9	1.8	100.0	73.5	24.7	1.8	nonplastic			59.40	2.70	GP	Poorly graded GRAVEL with sand	1.6	2.68	2.26	2.22	17.00	0.205	0.21	<0
34	BR-A1	7.4	0.0	15.0	13.5	9.8	9.1	11.7	9.0	9.9	5.6	4.3	3.4	2.5	3.8	2.5	100.0	68.1	29.4	2.5	nonplastic			76.70	2.30	GP	Poorly graded GRAVEL with sand	2.2	2.67	2.23	2.18	18.28	0.224	0.26	<0
35	BR-A1	10.4	0.0	12.5	9.0	12.0	14.6	7.7	12.5	9.5	0.4	0.7	2.2	1.3	3.1	14.4	100.0	68.3	17.3	14.4	24.9	10.2	14.7			GC	Clayey GRAVEL with sand	6.9	2.72	2.24	2.10	22.96	0.298	0.63	<0
36	BR-A1	11.4	0.0	21.3	11.9	9.3	5.6	9.7	13.2	14.2	0.4	0.3	0.8	0.2	0.7	12.4	100.0	71.0	16.6	12.4	25.3	12.0	13.3			GC	Clayey GRAVEL with sand	5.3	2.71	2.26	2.15	20.80	0.263	0.55	<0
37	BR-A1	12.4	0.0	10.9	14.4	9.1	11.2	12.4	10.4	11.1	0.5	1.1	0.6	1.1	2.3	14.9	100.0	68.4	16.7	14.9	23.6	11.7	11.9			GC	Clayey GRAVEL with sand	4.6	2.72	2.24	2.14	21.27	0.270	0.46	<0
38	BR-P2	3.0	0.0	16.1	13.7	12.0	8.6	12.7	16.2	10.0	3.0	1.9	1.1	1.4	1.6	1.8	100.0	79.3	18.9	1.8	nonplastic			14.40	1.10	GP	Poorly graded GRAVEL with sand	1.3	2.68	2.25	2.22	17.12	0.207	0.17	<0
39	BR-P2	5.0	0.0	12.2	13.0	15.2	15.4	16.9	9.8	7.8	1.8	1.4	1.1	0.8	1.2	1.3	100.0	82.5	16.2	1.3	nonplastic			11.90	2.30	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.26	2.22	16.77	0.202	0.23	<0
40	BR-P2	7.4	0.0	23.2	12.0	10.4	9.4	9.9	5.4	3.4	6.5	3.6	1.4	2.1	3.3	9.4	100.0	70.3	20.3	9.4	20.6	13.4	7.2	168.30	7.60	GP-GC	Poorly graded GRAVEL with sand and clay	3.4	2.68	2.26	2.19	18.44	0.226	0.40	<0
41	BR-P2	8.6	0.0	17.6	9.6	17.6	5.9	11.6	8.7	3.8	5.4	2.6	2.2	4.5	1.7	8.8	100.0	71.0	20.2	8.8	21.7	12.6	9.1	104.70	5.63	GP-GC	Poorly graded GRAVEL with sand and clay	2.7	2.69	2.26	2.20	18.19	0.222	0.33	<0
42	RDN-1	2.2	0.0	0.0	0.0	10.2	7.5	11.3	13.5	12.4	10.2	7.5	8.4	5.8	6.4	6.9	100.0	42.5	50.6	6.9	19.2	15.6	3.6			SC-SM	Silty SAND with gravel	3.4	2.69	2.23	2.16	19.83	0.247	0.37	<0
43	RDN-1	4.0	0.0	19.5	16.0	13.5	9.3	14.1	9.8	10.1	2.1	1.3	1.4	1.0	0.7	1.3	100.0	82.2	16.5	1.3	nonplastic			12.50	1.60	GP	Poorly graded GRAVEL with sand	2.1	2.68	2.27	2.22	17.04	0.205	0.27	<0
44	RDN-1	5.2	0.0	17.2	14.5	12.9	10.8	14.3	10.8	12.6	1.7	1.3	0.7	0.9	0.5	1.8	100.0	80.5	17.7	1.8	nonplastic			10.90	1.20	GP	Poorly graded GRAVEL with sand	1.6	2.67	2.27	2.23	16.32	0.195	0.22	<0
45	RDN-1	6.2	0.0	15.2	12.3	13.9	10.2	12.3	9.4	13.3	3.4	2.2	1.3	1.8	1.1	3.6	100.0	73.3	23.1	3.6	nonplastic			29.40	1.50	GP	Poorly graded GRAVEL with sand	1.9	2.67	2.26	2.22	16.93	0.204	0.25	<0
46	RDN-1	8.0	0.0	13.7	11.8	13.7	10.7	11.9	8.0	12.5	1.2	0.2	0.7	0.8	0.1	14.5	100.0	69.8	15.7	14.5	26.9	12.6	14.3			GC	Clayey GRAVEL with sand	4.3	2.71	2.25	2.16	20.40	0.256	0.45	<0

SC-SM-Silty SAND with gravel /EGE-1/

1	Sample No	Depth (m)	Particle size															Particle Analysis (%)			Atterberg Limits			Cu	Cc	Soil Type	Soil name	Natural Moisture Content (W), %	Specific gravity G_s, g/cm^3	p, g/cm^3	p_d, g/cm^3	n,%	e	Sr	J_L
			75	50	37.5	25	19	9.5	4.75	2.00	0.600	0.425	0.300	0.150	0.075	<0.075	%	Gravel	Sand	Silt/ Clay	LL	PL	PI													
0	1	2	3	5	6	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27.00	28.00	29	30	31	32	33	34	35	36	37	38
1	BR-P3	2.0	0.0	0.0	0.0	8.6	7.5	10.1	12.3	13.6	8.2	11.9	9.0	4.8	5.9	8.1	100.0	38.5	53.4	8.1	20.1	16.7	3.4			SC-SM	Silty SAND with gravel	2.6	2.68	2.19	2.13	20.35	0.256	0.27	<0
2	RDN-1	2.2	0.0	0.0	0.0	10.2	7.5	11.3	13.5	12.4	10.2	7.5	8.4	5.8	6.4	6.9	100.0	42.5	50.6	6.9	19.2	15.6	3.6			SC-SM	Silty SAND with gravel	3.4	2.69	2.23	2.16	19.83	0.247	0.37	<0
A max			0.0	0.0	0.0	10.2	7.5	11.3	13.5	13.6	10.2	11.9	9.0	5.8	6.4	8.1		42.5	53.4	8.1	20.1	16.7	3.6					3.4	2.69	2.23	2.16	20.35	0.256	0.37	
A min			0.0	0.0	0.0	8.6	7.5	10.1	12.3	12.4	8.2	7.5	8.4	4.8	5.9	6.9		38.5	50.6	6.9	19.2	15.6	3.4					2.6	2.68	2.19	2.13	19.83	0.247	0.27	
A average			0.0	0.0	0.0	9.4	7.5	10.6	12.9	13.0	9.2	9.7	8.7	5.3	6.2	7.5	100.0	40.5	52.0	7.5	19.7	16.2	3.5					3.0	2.69	2.21	2.15	20.09	0.251	0.32	

GP- Poorly graded GRAVEL with sand /EGE-2/

1	Sample No	Depth (m)	Particle size															Particle Analysis (%)			Atterberg Limits			Cu	Cc	Soil Type	Soil name	Natural Moisture Content (W), %	Specific gravity G_s, g/cm^3	p, g/cm^3	p_d, g/cm^3	n,%	e	Sr	J_L
			75	50	37.5	25	19	9.5	4.75	2.00	0.850	0.425	0.300	0.150	0.075	<0.075	%	Gravel	Sand	Silt/ Clay	LL	PL	PI													
0	1	2	3	5	6	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27.00	28.00	29	30	31.0	32.00	33	34	35	36	37	38
1	BR-A2	2.8	0.0	0.0	16.4	11.7	11.2	16.6	12.9	7.6	1.0	3.9	11.4	3.9	1.1	2.3	100.0	68.8	28.9	2.3	nonplastic			46.40	5.10	GP	Poorly graded GRAVEL with sand	2.3	2.68	2.25	2.20	17.93	0.219	0.28	<0
2	BR-A2	5.5	0.0	0.0	0.0	6.3	12.8	23.6	15.7	15.7	8.4	5.6	4.7	2.8	1.2	3.1	100.0	58.4	38.5	3.1	nonplastic			32.30	2.40	GP	Poorly graded GRAVEL with sand	2.4	2.68	2.19	2.14	20.20	0.253	0.25	<0
3	BR-P3	3.4	0.0	17.7	20.9	16.9	13.2	13.1	8.2	6.4	0.6	0.4	0.3	0.2	0.5	1.7	100.0	90.0	8.3	1.7	nonplastic			7.30	1.80	GP	Poorly graded GRAVEL with sand	0.9	2.67	2.28	2.26	15.37	0.182	0.13	<0
4	BR-P3	4.5	0.0	19.0	17.2	14.3	9.1	15.4	8.3	9.5	1.3	0.8	0.7	0.4	0.9	3.3	100.0	83.3	13.4	3.3	nonplastic			12.60	1.80	GP	Poorly graded GRAVEL with sand	1.8	2.67	2.27	2.23	16.48	0.197	0.24	<0
5	BR-P3	6.4	0.0	0.0	14.5	15.9	16.3	14.6	11.1	8.9	4.8	3.7	3.2	1.2	1.0	4.1	100.0	72.4	23.5	4.1	nonplastic			55.00	4.80	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.26	2.22	16.77	0.202	0.23	<0
6	RDS-1	3.0	0.0	0.0	17.2	15.2	13.1	12.4	15.5	13.3	2.3	2.0	1.7	2.5	1.2	3.6	100.0	73.4	23.0	3.6	nonplastic			44.00	2.80	GP	Poorly graded GRAVEL with sand	1.9	2.67	2.26	2.22	16.93	0.204	0.25	<0
7	RDS-1	4.0	0.0	0.0	12.3	24.6	15.1	12.3	14.1	9.1	1.7	1.4	1.2	2.1	1.4	4.6	100.0	78.4	17.0	4.6	nonplastic			40.00	3.50	GP	Poorly graded GRAVEL with sand	2.7	2.68	2.25	2.19	18.25	0.223	0.32	<0
8	RDS-1	5.0	0.0	0.0	0.0	22.5	19.7	14.9	20.5	13.7	1.6	0.9	0.6	0.8	1.2	3.6	100.0	77.6	18.8	3.6	nonplastic			9.10	0.80	GP	Poorly graded GRAVEL with sand	1.8	2.67	2.26	2.22	16.85	0.203	0.24	<0
9	BR-A1	5.4	0.0	0.0	12.8	14.6	15.0	14.9	11.6	9.3	10.7	3.0	2.6	1.7	1.1	2.4	100.0	68.9	28.7	2.4	nonplastic			28.60	1.30	GP	Poorly graded GRAVEL with sand	1.3	2.67	2.25	2.22	16.81	0.202	0.17	<0
10	BR-A1	6.5	0.0	19.5	13.1	11.1	9.1	11.7	9.0	9.9	4.2	3.2	2.5	1.9	2.9	1.8	100.0	73.5	24.7	1.8	nonplastic			59.40	2.70	GP	Poorly graded GRAVEL with sand	1.6	2.68	2.26	2.22	17.00	0.205	0.21	<0
11	BR-A1	7.4	0.0	15.0	13.5	9.8	9.1	11.7	9.0	9.9	5.6	4.3	3.4	2.5	3.8	2.5	100.0	68.1	29.4	2.5	nonplastic			76.70	2.30	GP	Poorly graded GRAVEL with sand	2.2	2.67	2.23	2.18	18.28	0.224	0.26	<0
12	BR-A1	1.6	0.0	0.0	6.2	13.9	14.1	15.0	15.6	8.4	11.3	3.4	1.8	3.2	4.7	2.5	100.0	64.8	32.7	2.5	nonplastic			62.50	2.30	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.24	2.20	17.51	0.212	0.21	<0
13	BR-A1	3.0	0.0	0.0	4.9	11.1	11.3	12.0	12.5	6.7	9.0	7.2	6.4	8.8	7.2	2.8	100.0	51.8	45.4	2.8	nonplastic			60.00	0.50	GP	Poorly graded GRAVEL with sand	2.2	2.68	2.22	2.17	18.95	0.234	0.25	<0
14	BR-P2	3.0	0.0	16.1	13.7	12.0	8.6	12.7	16.2	10.0	3.0	1.9	1.1	1.4	1.6	1.8	100.0	79.3	18.9	1.8	nonplastic			14.40	1.10	GP	Poorly graded GRAVEL with sand	1.3	2.68	2.25	2.22	17.12	0.207	0.17	<0
15	BR-P2	5.0	0.0	12.2	13.0	15.2	15.4	16.9	9.8	7.8	1.8	1.4	1.1	0.8	1.2	1.3	100.0	82.5	16.2	1.3	nonplastic			11.90	2.30	GP	Poorly graded GRAVEL with sand	1.7	2.67	2.26	2.22	16.77	0.202	0.23	<0
16	RDN-1	4.0	0.0	19.5	16.0	13.5	9.3	14.1	9.8	10.1	2.1	1.3	1.4	1.0	0.7	1.3	100.0	82.2	16.5	1.3	nonplastic			12.50	1.60	GP	Poorly graded GRAVEL with sand	2.1	2.68	2.27	2.22	17.04	0.205	0.27	<0
17	RDN-1	5.2	0.0	17.2	14.5	12.9	10.8	14.3	10.8	12.6	1.7	1.3	0.7	0.9	0.5	1.8	100.0	80.5	17.7	1.8	nonplastic			10.90	1.20	GP	Poorly graded GRAVEL with sand	1.6	2.67	2.27	2.23	16.32	0.195	0.22	<0
18	RDN-1	6.2	0.0	15.2	12.3	13.9	10.2	12.3	9.4	13.3	3.4	2.2	1.3	1.8	1.1	3.6	100.0	73.3	23.1	3.6	nonplastic			29.40	1.50	GP	Poorly graded GRAVEL with sand	1.9	2.67	2.26	2.22	16.93	0.204	0.25	<0
A max			0.0	19.5	20.9	24.6	19.7	23.6	20.5	15.7	11.3	7.2	11.4	8.8	7.2	4.6		90.0	45.4	4.6	nonplastic							2.70	2.68	2.28	2.26	20.20	0.253	0.32	
A min			0.0	0.0	0.0	6.3	8.6	11.7	8.2	6.4	0.6	0.4	0.3	0.2	0.5	1.3		51.8	8.3	1.3	nonplastic							0.90	2.67	2.19	2.14	15.37	0.182	0.13	
A average			0.0	8.4	12.1	14.2	12.4	14.4	12.2	10.1	4.1	2.7	2.6	2.1	1.9	2.7	100.0	73.7	23.6	2.7	nonplastic							1.84	2.67	2.25	2.21	17.31	0.209	0.23	
																		σ			nonplastic							0.49	0.00	0.02	0.03	1.31	0.02	0.05	
																		ν			nonplastic							0.27	0.00	0.01	0.01	0.08	0.09	0.22	
																		ρ0,85			nonplastic							0.07	0.00	0.00	0.00	0.02	0.02	0.06	
																		ρ0,95			nonplastic							0.11	0.00	0.00	0.01	0.03	0.04	0.09	
																		ε0,85			nonplastic							0.12	0.00	0.01	0.01	0.33	0.00	0.01	
																		ε0,95			nonplastic							0.20	0.00	0.01	0.01	0.53	0.01	0.02	
																		γ^{I}			nonplastic							1.64	2.67	2.24	2.20	16.77	0.20	0.21	
																		γ^{II}			nonplastic							1.72	2.67	2.25	2.20	16.98	0.20	0.22	

1	Sample No	Depth (m)	Particle size 75	50	37.5	25	19	9.5	4.75	2.00	0.600	0.425	0.300	0.150	0.075	<0,075	%	Particle Analysis (%) Gravel	Sand	Silt/ Clay	Atterberg Limits LL	PL	PI	Cu	Cc	Soil Type	Soil name
0	1	2	3	5	6	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27.00	28.00	29	30
1	BR-P2	3.0	0.0	16.1	13.7	12.0	8.6	12.7	16.2	10.0	3.0	1.9	1.1	1.4	1.6	1.8	100.0	79.3	18.9	1.8	nonplastic			14.40	1.10	GP	Poorly graded GRAVEL with sand
2	BR-P2	5.0	0.0	12.2	13.0	15.2	15.4	16.9	9.8	7.8	1.8	1.4	1.1	0.8	1.2	1.3	100.0	82.5	16.2	1.3	nonplastic			11.90	2.30	GP	Poorly graded GRAVEL with sand
3	BR-P3	10.0	0.0	0.0	9.8	14.6	10.1	15.2	12.8	12.0	4.0	4.6	4.4	3.4	1.6	7.5	100.0	62.5	30.0	7.5	20.1	14.0	6.1	6.80	2.30	GP-GC	Poorly graded GRAVEL with sand and clay
4	BR-A2	6.4	0.0	0.0	10.1	12.1	14.7	11.9	15.0	17.2	3.5	2.7	1.4	0.6	1.8	9.1	100.0	63.8	27.1	9.1	21.9	12.7	9.2	202.40	14.20	GP-GC	Poorly graded GRAVEL with sand and clay
5	BR-A2	7.4	0.0	0.0	13.7	18.8	15.3	11.7	12.7	12.5	2.5	1.8	1.0	1.2	2.1	6.7	100.0	72.2	21.1	6.7	23.0	14.6	8.4	112.50	6.20	GP-GC	Poorly graded GRAVEL with sand and clay
6	BR-A2	12.0	0.0	0.0	0.0	10.8	22.0	19.1	13.2	11.0	4.4	3.6	3.1	2.4	1.5	8.9	100.0	65.1	26.0	8.9	18.5	14.2	4.3	100.00	5.10	GP-GC	Poorly graded GRAVEL with sand and clay
7	RDS-1	6.2	0.0	11.8	16.3	14.9	6.9	13.0	12.1	13.6	0.7	0.5	0.4	1.7	1.1	6.9	100.0	75.0	18.1	6.9	23.4	12.4	11.0	67.50	3.70	GP-GC	Poorly graded GRAVEL with sand and clay
8	RDS-1	7.4	0.0	0.0	11.5	19.6	10.0	18.4	11.2	13.6	1.2	1.7	1.3	0.9	1.1	9.5	100.0	70.7	19.8	9.5	23.0	11.2	11.8	253.20	15.80	GP-GC	Poorly graded GRAVEL with sand and clay
9	RDS-1	8.2	0.0	0.0	13.7	16.8	12.7	17.1	12.9	16.1	1.2	0.9	0.6	0.7	0.9	6.5	100.0	73.2	20.3	6.5	24.3	16.0	8.3	26.90	1.80	GP-GC	Poorly graded GRAVEL with sand and clay
10	RDS-1	9.2	0.0	12.5	12.2	14.1	12.2	14.0	10.9	12.4	2.6	0.8	0.5	0.4	0.8	6.4	100.0	75.9	17.7	6.4	23.8	12.0	11.8	16.00	1.40	GP-GC	Poorly graded GRAVEL with sand and clay
A max			0.0	12.5	16.3	19.6	22.0	19.1	15.0	17.2	4.4	4.6	4.4	3.4	2.1	9.5		75.9	30.0	9.5	24.3	16.0	11.8	253.20	15.80		
A min			0.0	0.0	0.0	10.8	6.9	11.7	10.9	11.0	0.7	0.5	0.4	0.4	0.8	6.4		62.5	17.7	6.4	18.5	11.2	4.3	6.80	1.40		
A average			0.0	3.0	10.9	15.2	13.0	15.1	12.6	13.6	2.5	2.1	1.6	1.4	1.4	7.7	100.0	69.8	22.5	7.7	22.3	13.4	8.9	98.16	6.31		
																		8			1.89	1.56	2.44	80.08	4.68		
																		8–			0.085	0.117	0.275	0.816	0.741		
																		8–э|ν			0.029	0.041	0.096	0.284	0.258		
																		8–э|6			0.048	0.067	0.157	0.467	0.424		
																		8э|6┐			0.656	0.543	0.848	27.856	1.628		
																		8э|6┐			1.079	0.893	1.395	45.836	2.679		
																		8–8			21.2	12.5	7.5	52.3	3.6		
																		8–8–			21.6	12.8	8.0	70.3	4.7		

GC-Clayey GRAVEL with sand /EGE-4/

1	Sample No	Depth (m)	Particle size 75	50	37.5	25	19	9.5	4.75	2.00	0.850	0.425	0.300	0.150	0.075	<0,075	%	Particle Analysis (%) Gravel	Sand	Silt/ Clay	Atterberg Limits LL	PL	PI	Cu	Cc	Soil Type	Soil name
0	1	2	3	5	6	7	8	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27.00	28.00	29	30
1	BR-P3	14.8	0.0	0.0	0.0	11.5	11.3	6.5	14.2	7.3	4.3	4.6	5.4	5.9	3.6	25.4	100.0	43.5	31.1	25.4	20.9	14.9	6.0			GC	Clayey GRAVEL with sand
2	BR-P3	17.0	0.0	0.0	13.5	7.9	2.9	8.7	5.8	12.3	5.3	1.2	2.3	4.9	3.8	31.4	100.0	38.8	29.8	31.4	24.4	14.3	10.1			GC	Clayey GRAVEL with sand
3	BR-P3	15.8	0.0	0.0	18.7	11.8	4.2	1.4	14.6	24.6	2.4	1.4	1.2	1.3	1.3	17.1	100.0	50.7	32.2	17.1	42.0	13.4	28.6			GC	Clayey GRAVEL with sand
4	BR-P3	18.0	0.0	11.2	17.2	11.8	4.2	1.4	14.6	24.5	0.7	0.4	0.3	0.3	0.8	12.6	100.0	60.4	27.0	12.6	24.5	14.3	10.2			GC	Clayey GRAVEL with sand
5	BR-A2	11.0	0.0	0.0	0.0	0.0	24.2	16.5	11.1	6.3	6.3	5.8	6.4	6.3	4.1	13.0	100.0	51.8	35.2	13.0	20.8	13.9	6.9			GC	Clayey GRAVEL with sand
6	BR-A2	13.2	0.0	0.0	11.5	14.8	8.0	7.1	15.0	15.0	3.6	1.9	2.4	3.5	3.1	14.0	100.0	56.4	29.6	14.0	22.9	16.0	6.9			GC	Clayey GRAVEL with sand
7	BR-A2	20.0	0.0	10.0	8.0	7.3	2.4	4.9	12.2	15.8	7.7	4.9	3.4	3.8	2.9	16.7	100.0	44.8	38.5	16.7	25.6	14.4	11.2			GC	Clayey GRAVEL with sand
8	BR-A2	15.0	0.0	0.0	17.0	10.5	13.7	11.2	13.3	19.5	0.4	0.2	0.6	0.4	0.2	13.0	100.0	65.7	21.3	13.0	28.8	16.0	12.8			GC	Clayey GRAVEL with sand
9	BR-A1	10.4	0.0	12.5	9.0	12.0	14.6	7.7	12.5	9.5	0.4	0.7	2.2	1.3	3.1	14.4	100.0	68.3	17.3	14.4	24.9	10.2	14.7			GC	Clayey GRAVEL with sand
10	BR-A1	11.4	0.0	21.3	11.9	9.3	5.6	9.7	13.2	14.2	0.4	0.3	0.8	0.2	0.7	12.4	100.0	71.0	16.6	12.4	25.3	12.0	13.3			GC	Clayey GRAVEL with sand
11	BR-A1	12.4	0.0	10.9	14.4	9.1	11.2	12.4	10.4	11.1	0.5	1.1	0.6	1.1	2.3	14.9	100.0	68.4	16.7	14.9	23.6	11.7	11.9			GC	Clayey GRAVEL with sand
12	BR-A2	8.4	0.0	13.4	14.7	12.7	11.1	13.7	12.7	6.6	0.7	0.4	0.3	0.7	0.6	12.4	100.0	78.3	9.3	12.4	25.6	12.7	12.9			GC	Clayey GRAVEL with sand
13	BR-A2	16.0	0.0	13.4	8.4	8.6	10.4	13.6	10.7	8.3	9.8	1.3	1.0	0.8	1.8	12.1	100.0	65.1	22.8	12.1	24.6	13.9	10.7			GC	Clayey GRAVEL with sand
14	BR-A2	17.0	0.0	0.0	11.5	16.6	20.7	11.4	14.7	11.0	0.4	0.6	0.4	0.2	0.2	12.2	100.0	74.9	12.9	12.2	25.6	13.4	12.2			GC	Clayey GRAVEL with sand
15	BR-A2	18.0	0.0	0.0	25.9	11.5	15.5	13.0	11.6	6.1	0.6	0.3	0.7	0.2	0.4	14.1	100.0	77.5	8.4	14.1	26.7	13.4	13.3			GC	Clayey GRAVEL with sand
16	RDN-1	8.0	0.0	13.7	11.8	13.7	10.7	11.9	8.0	12.5	1.2	0.2	0.7	0.8	0.1	14.5	100.0	69.8	15.7	14.5	26.9	12.6	14.3			GC	Clayey GRAVEL with sand
A max			0.0	21.3	25.9	16.6	24.2	16.5	15.0	24.6	9.8	5.8	6.4	6.3	4.1	31.4		78.3	38.5	31.4	42.0	16.0	28.6				
A min			0.0	0.0	0.0	0.0	2.4	1.4	5.8	6.1	0.4	0.2	0.3	0.2	0.1	12.1		38.8	8.4	12.1	20.8	10.2	6.0				
A average			0.0	6.7	12.0	10.6	10.7	9.4	12.2	12.8	2.8	1.6	1.8	2.0	1.8	15.6	100.0	61.6	22.8	15.6	25.8	13.6	12.3				
																		8			6.00	1.64	6.40				
																		8–			0.232	0.121	0.522				
																		8–э|ν			0.062	0.032	0.140				
																		8–э|ν			0.102	0.053	0.228				
																		8э|ν┐			1.605	0.439	1.711				
																		8э|ν┐			2.625	0.718	2.798				
																		8–8			23.2	12.9	9.5				
																		8–8–			24.2	13.1	10.5				

Statistical calculations made by: **T.Renchindorj**

Soil Trade LLC

REPORT OF BOREHOLE: BH-(BR-A1)

and Standard Penetration Test (SPT)

CLIENT:	JICA	SURVACE RL:	1284.28 m	DRILLER:	Soil Trade LLC
PROJECT:	Basic Desing Study for Construction of Railway Flyover	HOLE DEPTH:	13.0 m	DRILL RIG:	UGB-50 m
LOCATION:	Ulaanbaatar City	GROUND WATER LEVEL:	Detected 4.9 m	HOLE DIA:	168 mm
			Stabilized 4.2 m	DATE:	04/20/2008
				LOGGED:	T.Renchindorj

Scale	Started depth, m	Ended depth, m	Thickness of stratum, m	Soil: Graphic log	Soil: Symbol	Soil: Description of soil	Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm	0 10 20 30 40 50	Ground water	Sampling: Depth, m	Sampling: Symbol of samples
1	0.0	0.8	0.8		SW-SC	Embankment soil: Well graded SAND with gravel and sand - dark brown	1.0	33/30	14	18	15				
2							2.0	49/30	13	17	32			1.6	•
3					GP	Poorly graded GRAVEL with sand, cobbles and boulders - yellowish brown, well rounded, moist to wet, medium dense to dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ m-iv)	3.0	41/30	7	21	20		3.0	•
4							4.0	39/30	16	18	21				
5							5.0	20/30	7	10	10		▼		
6	0.8	5.8	5.0				6.0	46/30	4	22	24			5.4	•
7							7.0	50/14	50/14					6.5	•
8					GC	Clayey Gravel with sand - yellowish brown, well rounded at 9.9-13.0 m depth, medium plasticity, dense to very dense, moist. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ m-iv)	8.0	50/12	50/12					7.4	•
9							9.0	50/11	50/11						
10	5.8	9.9	4.1				10.0	82/20	7	32	50/5				
11							11.0	50/7	29	50/7				10.4	•
12					GC	Clayey Gravel with sand - yellowish brown, well rounded, subangular at 15.2-20.0 m depth, medium plasticity, medium to very dense, moist. Upper & Modern Quaternary age's Proluvium deposit (pQ m-iv)	12.0	50/60	50/60					11.0	•
13	9.9	13.0	3.1				13.0	50/9	50/9					12.4	•
14							14.0								
15							15.0								
16							16.0								
17							17.0								
18							18.0								
19							19.0								
20							20.0								

Soil Trade LLC

REPORT OF BOREHOLE: BH-(BR-P2)

and Standard Penetration Test (SPT)

CLIENT:	JICA	SURVACE RL:	1285.30 m	DRILLER:	Soil Trade LLC
PROJECT:	Basic Desing Study for Construction of Railway Fly-over	HOLE DEPTH:	11.0m	DRILL RIG:	UGB1VS
LOCATION:	Ulaanbaatar City	GROUND WATER LEVEL:	Detected 4.6 m	HOLE DIA:	168 mm
			Stabilized 4.6 m	DATE:	04/25/2008
				LOGGED:	T.Renchindorj

Scale	Started depth, m	Ended depth, m	Thickness of stratum, m	Soil: Graphic log	Soil: Symbol	Soil: Description of soil	Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm	Ground water	Sampling: Depth, m	Sampling: Symbol of sampling
1	0.0	1.8	1.8		GC	Embankment soil - Clayey gravel with sand (tQ IV): low plasticity, black brown, in frozen condition, with lense of Clayey Sand at the depth of 0.2 m	1.0	59/30	10	17	42			
2							2.0	28/30	7	13	15			
3							3.0	37/30	13	12	25		3.0	•
4					GP	Poorly graded GRAVEL with sand, cobbles and boulders - yellowish brown, well rounded, subangular, moist to wet, dense to very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ III-IV)	4.0	50/10	50/10					
5							5.0	33/30	10	13	20	▼	5.0	•
6	1.8	6.4	4.6				6.0	50/13	16	50/13				
7							7.0	54/30	21	23	31			
8							8.0	50/11	11	50/11			7.4	•
9					GP-GC	Poorly graded GRAVEL with Sand, Clay and boulders - yellowish brown, well rounded, subangular, low plasticity, very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ III-IV)	9.0	77/21	8	27	50/6		8.6	•
10							10.0	55/30	10	19	36			
11	6.4	10.5	4.1				11.0	50/13	20	50/13				
12	10.5	11.0	0.5		GC	Clayey GRAVEL with sand - yellowish brown	12.0							
13							13.0							
14							14.0							
15							15.0							
16							16.0							
17							17.0							
18							18.0							
19							19.0							
20							20.0							

Soil Trade LLC

REPORT OF BOREHOLE: BH-(BR-P3)

and Standard Penetration Test (SPT)

CLIENT:	JICA	SURVACE RL:	1285.01 m	DRILLER:	Soil Trade LLC
PROJECT:	Basic Desing Study for Construction of Railway Fly-over	HOLE DEPTH:	20.0m	DRILL RIG:	Power4000
LOCATION:	Ulaanbaatar City	GROUND WATER LEVEL:	Detected 4.9 m	HOLE DIA:	168 mm
			Stabilized 4.4 m	DATE:	04/15-16/2008
				LOGGED:	T.Renchindorj

Scale	Started depth, m	Ended depth, m	Tickness of stratum, m	Soil: Graphic log	Soil: Symbol	Soil: Description of soil	Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm	Ground water	Sampling: Depth, m	Sampling: Symbol of sampling
1	0.0	1.6	1.6		GP-GC	Embankment soil - Poorly graded gravel with sand and clay: low plasticity, at frozen condition, partially melted, moist, dark brown	1.0	63/30	11	29	34			
2	1.6	2.6	1.0		SM	Silty Sand - loose density, moist, brown, low plasticity. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})	2.0	8/30	3	4	4		2.0	•
3							3.0	31/30	5	14	17		3.4	•
4							4.0	9/30	10	6	3			
5					GP	Poorly graded GRAVEL with sand, cobbles and boulders - yellowish brown, well rounded, subangular, loose to dense, moist to wet. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})	5.0	32/30	9	14	18	▼	4.5	•
6							6.0	36/30	9	17	19			
7							7.0	40/30	10	18	22		6.4	•
8	2.6	8.6	6.0				8.0	43/30	14	20	23			
9					GP-GC	Poorly graded GRAVEL with Sand, Clay and boulders - yellowish brown, well rounded, subangular, low plasticity, very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})	9.0	56/30	18	25	31			
10	8.6	10.2	1.6				10.0	57/30	20	25	32		10.0	•
11							11.0	56/30	19	26	30			
12							12.0	26/30	8	11	15			
13					GC	Clayey Gravel with sand - yellowish brown, well rounded, subangular at 14.6-20.0 m depth, medium plasticity, very dense, moist. Upper & Modern Quaternary age's Proluvium deposit (pQ_{III-IV})	13.0	31/30	10	13	18			
14							14.0	50/10	50/10					
15							15.0	59/10	6	59/10			14.8	•
16							16.0	60/10	3	60/10			15.8	•
17							17.0	50/10	5	50/10			17.0	•
18							18.0	50/10	6	50/10			18.0	•
19							19.0	50/10	7	50/10				
20	14.6	20.0	5.4					50/7	50/7					

Soil Trade LLC

REPORT OF BOREHOLE: BH-(BR-A2)

AND Standard Penetration Test (SPT)

CLIENT: JICA
PROJECT: Basic Desing Study for Construction of Railway Fly-over
LOCATION: Ulaanbaatar City

SURVACE RL: 1284.52 m
HOLE DEPTH: 20.0m
GROUND WATER LEVEL: Detected 4.9 m
Stabilized 3.8 m

DRILLER: Soil Trade LLC
DRILL RIG: UGB-50 m
HOLE DIA: 168 mm
DATE: 04/20/2008
LOGGED: T.Renchindorj

Scale	Started depthl, m	Ended depth, m	Tickness of stratum, m	Soil: Graphic log	Soil: Symbol	Soil: Description of soil	Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm	Ground water	Sampling: Depth, m	Sampling: Symbol of sampling
1	0.0	1.4	1.4		GP-GC	Embankment soil - Clayey gravel with sand (tQ_{IV}): low plasticity, loose, dark brown to yellowish brown	1.0	12/30	7	6	6			
2							2.0	18/30	7	10	8			
3							3.0	39/30	15	19	20		2.8	•
4					GP	Poorly graded GRAVEL with Sand - yellowish brown, well rounded, subangular, moist to wet, medium to very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})	4.0	50/4	50/4			▼		
5							5.0	18/30	6	9	9			
6	1.4	5.8	4.4				6.0	50/7.5	50/7.5				5.5	•
7					GP-GC	Poorly graded GRAVEL with Sand, Clay and boulders - yellowish brown, well rounded, subangular, low plasticity, very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})	7.0	50/14	50/14				6.4	•
8							8.0	50/10	50/10				7.4	•
9	5.8	8.8	3.0				9.0	75/30	6	25	50		8.4	•
10							10.0	44/30	5	25	50			
11					GC	Clayey Gravel with sand - yellowish brown, well rounded, subangular at 15.2-20.0 m depth, medium plasticity, medium to very dense, moist. Upper & Modern Quaternary age's Proluvium deposit (pQ_{III-IV})	11.0	69/30	4	35	34		11.0	•
12							12.0	26/30	4	8	18		12.0	•
13							13.0	50/10	19	50/10			13.2	•
14							14.0	50/13	15	50/13				
15							15.0	50/12	18	50/12			15.0	•
16							16.0	50/14	14	50/14			16.0	•
17							17.0	50/13	19	50/13			17.0	•
18							18.0	50/13	50/13				18.0	•
19							19.0	50/7	10	50/7				
20	8.8	20.0	11.2										20.0	•

Soil Trade LLC

REPORT OF BOREHOLE: BH-(RDN-1)

and Standard Penetration Test (SPT)

CLIENT: JICA
PROJECT: Basic Desing Study for Construction of Railway Fly-over
LOCATION: Ulaanbaatar City

SURVACE RL: 1284.19 m
HOLE DEPTH: 10.0 m
GROUND WATER LEVEL: Detected 4.9 m
Stabilized 3.7 m

DRILLER: Soil Trade LLC
DRILL RIG: UGB-1
HOLE DIA: 168 mm
DATE: 04/20/2008
LOGGED: T.Renchindorj

Scale	Started depth, m	Ended depth, m	Tickness of stratum, m	Soil: Symbol	Soil: Description of soil
	0.0	0.6	0.6	GC	Empakment Soil - Clayey GRAVEL, dark gray
1–2	0.6	2.6	2.0	SP-SM	Poorly graded Sand with Silt - yellowish brown, moist, at frozen condition, without plasticity, well rounded. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})
3–5	2.6	5.4	2.8	GP	Poorly Graded Gravel with sand, cobbles and boulders - yellowish brown, with cobbles at 3.5 m depth, well rounded at 4.8-5.0 m depth, moist to wet, medium to very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})
6–7	5.4	7.2	1.8	GP-GC	Poorly graded Gravel with Sand, Clay and boulders - yellowish brown, very dense, well rounded, wet. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ_{III-IV})
8–10	7.2	10.0	2.8	GC	Clayey GRAVEL with sand - yellowish brown, well rounded, very dense. Upper & Modern Quaternary age's Proluvium deposit (pQ_{III-IV})

Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm
1.0	39/30	16	18	21
2.0	27/30	20	12	15
3.0	30/30	8	14	16
4.0	36/30	10	17	19
5.0	63/30	27	29	34
6.0	56/30	24	27	29
7.0	50/30	20	21	29
8.0	58/30	18	27	31
9.0	63/30	25	30	33
10.0	50/10	50/10		

Standard Penetration Test: 0 10 20 30 40 50 60

Ground water

Sampling: Depth, m / Symbol of sampling

Depth, m	Symbol of sampling
2.2	•
4.0	•
5.2	•
6.2	•
8.0	•

Soil Trade LLC

REPORT OF BOREHOLE: BH-(RDS-1)

and Standard Penetration Test (SPT)

CLIENT:	JICA	SURVACE RL:	1284.73 m	DRILLER:	Soil Trade LLC
PROJECT:	Basic Desing Study for Construction of Railway Fly-over	HOLE DEPTH:	10.0m	DRILL RIG:	UGB1VS
LOCATION:	Ulaanbaatar City	GROUND WATER LEVEL:	Detected 5.2 m	HOLE DIA:	168 mm
			Stabilized 4.8 m	DATE:	04/22/2008
				LOGGED:	T.Ranshindorj

Scale	Started depth, m	Ended depth, m	Thickness of stratum, m	Soil: Graphic log	Soil: Symbol	Soil: Description of soil	Standard Penetration Test: Depth, m	Number of blows / Penetration depth, cm	Number of blows every 15 cm: 15cm	30cm	45cm	Ground water	Sampling: Depth, m	Sampling: Symbol of sampling
1	0.0	0.9	0.9		GP	Embankment soil: Poorly graded gravel with sand - dense, dark brown to yellowish brown	1.0	32/30	15	18	14			
2							2.0	42/30	7	16	26			
3					GP	Poorly graded GRAVEL with sand, cobbles and boulders - yellowish brown, well rounded, moist to wet, loose to medium dense. Upper & Modern Quaternary aged, Alluvium-Proluvium deposit (apQ III-IV)	3.0	39/30	12	19	20		3.0	▪
4							4.0	38/30	16	17	21		4.0	▪
5	0.9	5.8	4.3				5.0	66/30	18	31	35	▼	5.0	▪
6							6.0	64/30	22	30	34		6.2	▪
7							7.0	77/30	33	38	34		7.4	▪
8					GP-GC	Poorly graded GRAVEL with Sand, Clay and boulders - yellowish brown, well rounded, subangular, low plasticity, very dense. Upper & Modern Quaternary age's Alluvium-Proluvium deposit (apQ III-IV)	8.0	61/30	21	30	31		8.2	▪
9							9.0	62/30	29	30	32		9.2	▪
10	5.8	10.0	4.2				10.0	67/30	5	17	50			
11							11.0							
12							12.0							
13							13.0							
14							14.0							
15							15.0							
16							16.0							
17							17.0							
18							18.0							
19							19.0							
20							20.0							

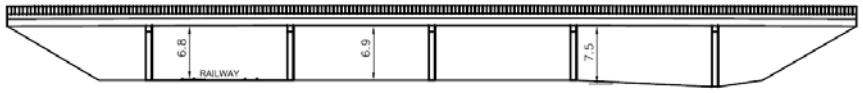
(5) SOUNDNESS SURVEY OF EXISTING BRIDGE

(a) Gurvaljin Bridge

Bridge Name	Gurvaljin Bridge
Location	Songinokhairkhan District, Gurvaljin area Yarmag-1st khoroolol Gurvaljin Road, Ulaanbaatar City
Bridge Length	108.3m (6 @ 18.05m)
Width	W=28.01m Carriage Way: 2@11m Median Strip: 2.41m Side Walk: 2@1.5m Curb: 2@0.3m
Year of Construction	1985～1987
Record of Rehabilitation	None
Traffic Control	None
Super Structure	Pre-casting RC-T type（6-span simple beam）
Sub Structure	Pre-casting RC Rigid Frame Type
Other Information	Surround Condition: Storage for Cargo, Stock Yard Traffic Condition: Many Large Truck and Trailers

Result of Soundness Survey
General Exfoliations at covered concrete and isolated lime are appeared at the Super Structure. It is highly possible that the soundness of the bridge would be severely degraded due to increasing of heavy traffic and frost damage. Piers that has been assembled with pre-cast block is at high risk of collapse by earthquake. **Deck Slab** Isolated Lime has bee appeared at deck slab spreading throughout particularly at interfiling concrete. Repeating of freeze and thawing are causing developing of cracks and isolated limes. **Main Girders** Concrete of bottom part of the main girders has been exfoliated and reinforcing bars have been exposed due to shoddy work at the construction period and/or frost damage. It is highly possible that the girder would be severely degraded due to increasing of heavy traffic and frost damage. **Substructure** Significant deformation has not been appeared at Piers and Abutments. A part of pier concrete have been damaged and reinforcing bars have been exposed. It seems to be caused by shoddy work at the construction period.

PLAN



PROFILE

N

GURVALJIN BRIDGE

0 25 50m

East Side View

Depression at the Expansion Joint.
Steel Chanel of the Joint seems to be forfeited at construction of overlay for surface course.

Exfoliation of concrete and rusty exposed reinforcing bar at the bottom of Main Girder

Expansion Joint at North Side
Overlay was finished.

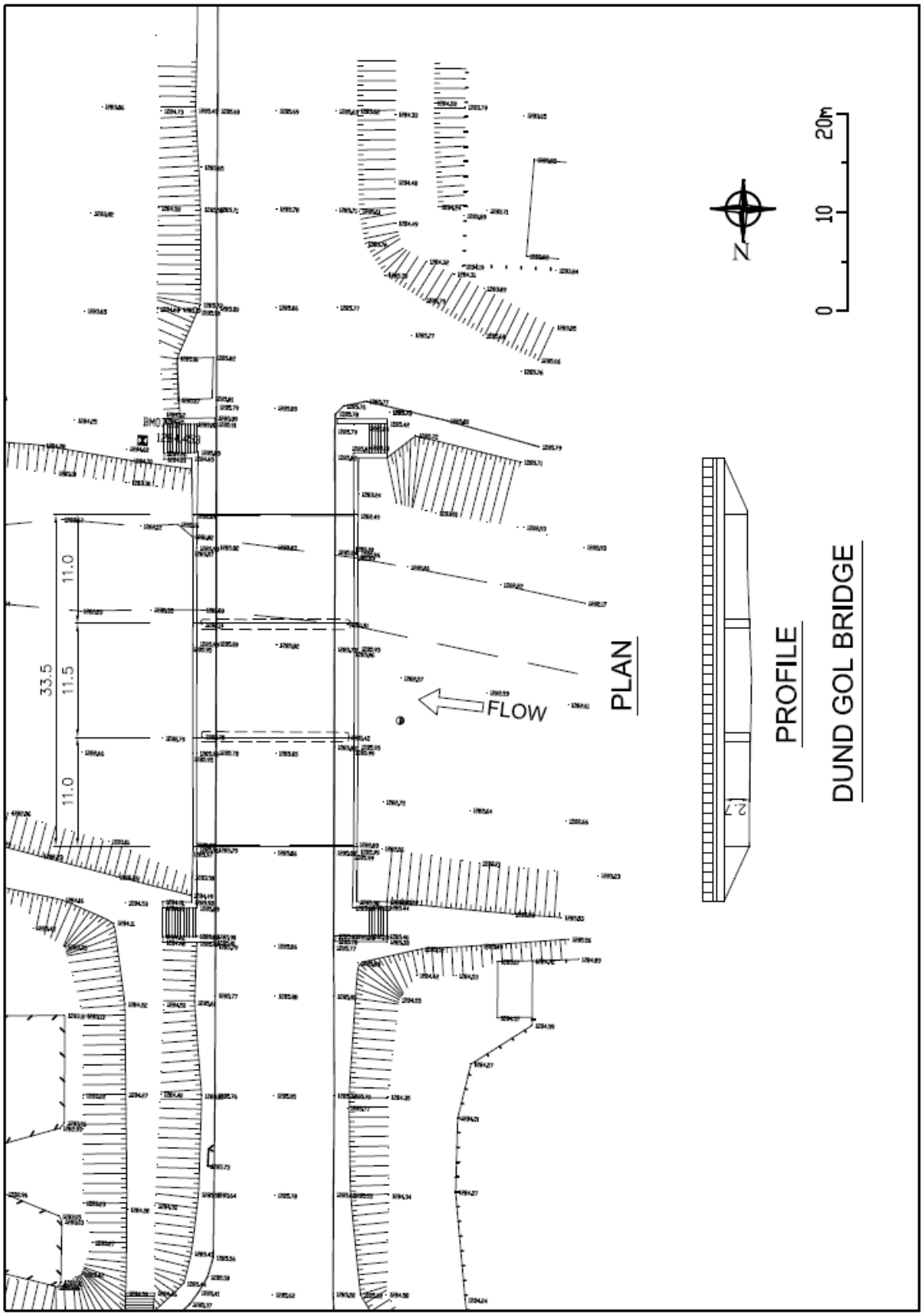
Isolated lime at Inter filling concrete (South side)

Piers have been constructed with Cumulated Pre-casting concrete block.

(b) Dund Gol Dund Bridge

Bridge Name	Dund Gol Dund Bridge
Location	On the Engels street crossing Dund Gol river, Near Transport College, Ulaanbaatar City
Bridge Length	L=33.5m (11m + 11.5m + 11m)
Width	W=16.00m Carriage Way: 2@5.75m Median Strip: 2.41m Side Walk: 2@2.0m Wheel Gurd: 2@0.25m
Year of Construction	1961-1962
Record of Rehabilitation	None
Traffic Control	None
Super Structure	3-span continues Pre Casting RC T-type
Sub Structure	Pile Bent Type Pier
Other Information	Less Traffic Volume but Trailers and Heavy track are passing.

Result of Soundness Survey
Deck Slab： Isolated lime has been appeared at joint and edge of deck slab due to small cracks arisen by repeated traffic load. There are some part exfoliated. It seems to be due to shoddy work at the construction and frees and thaws. Rust of reinforcing bar has not been developed at the moment, it will become the condition that reinforcing bar is easily rust after neutralization of the concrete due to effluence of lime in concrete by the isolated lime. Additionally increasing of heavy vehicle will induce development of the isolated lime. **Main Girders：** There are crossing beams distributing load of deck slab. Huge damage has not been appeared. 46-year passed has been passed since it was constructed, so that deterioration can be appeared according to increasing of heavy vehicle. **Substructure** No damage and deformation can be seen at main column and blest wall but connecting part of main girder and crossing beam of pier has been damaged. Temperature variation is inducing the stress concentration at the beam since there are not bearings and the girders are directly set on the beam.


DUND GOL BRIDGE
PROFILE
PLAN
FLOW
N
0
10
20m
33.5
11.5
11.0
11.0
2.7

Expansion Joint (North Side) / Steel Channel has been loosed

Damage on main girder (East Side) because of shoddy work and frost damage

Islated Lime defuluented to the beam from deck slab and girders

Damage at Crossing Beam /

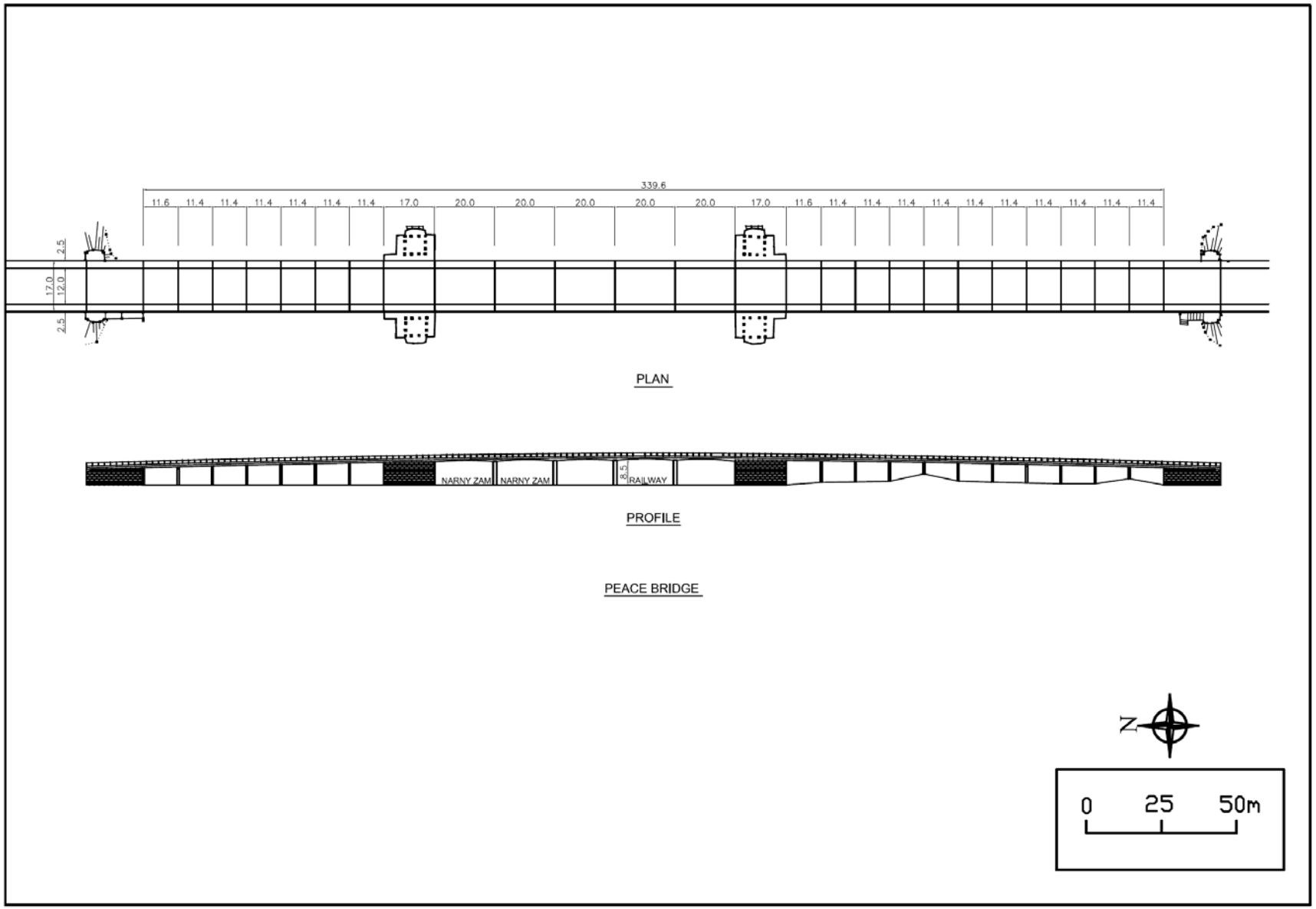
There are not bearing on the beam. The damage seems to be induced by stress concentration because of temperature variation.

Damage at bearing sheet of girder at the Abutment

(c) Peace Bridge

Bridge Name	Piece Bridge
Location	Chingis Avenue, Near UB City Center, Ulaanbaatar City
Bridge Length	L=340m (span; 11m～20m) 8-span simple RC T-girder 5-span continues RC slab with Gelber Hinge 12-span simple RC-T girder
Width	W=17m Side Walk; 2@2.5 m Carriage Way; 4@3 m
Year of Construction	1959 ~ 1961
Record of Rehabilitation	Crack filling and painting have been carried out in 2006.
Traffic Control	Less than 15 ton can be passed.
Super Structure	Pre-casting RC Simple T-girder and Continues Girder
Sub Structure	RC Wall type and Rigid Frame type piers
Other Information	Commercial Area

Result of Soundness Survey
Large damage is not appeared since it is not long after rehabilitation work by China carried out in 2006 and traffic control is has been implemented. On the other hand following small damage is recognized. • 3-location of girder seat has been damaged due to stress concentration by temperature variation without bearings. • Crack has been appeared at the surface of slab due to connecting of slabs on the simple beam with out enough reinforcement. • Many catchments of drainage on surface of the bridge are clogged. Drainage pipes have been dropped at 2 locations. • Since the thickness of girder at the location of hinge is not enough, there is a worry that durability becomes low if heavy traffic is increased. • A part of girder has been damaged due to transportation or erection probably. • Less large damage has been appeared since crossing beams are effectively working for distribution of live load on deck slab.

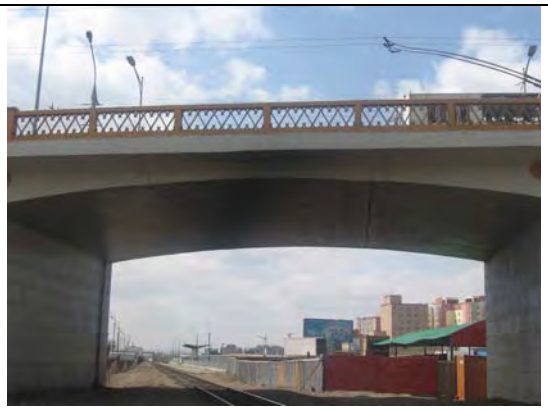

339.6
11.6 11.4 11.4 11.4 11.4 11.4 11.4 17.0 20.0 20.0 20.0 20.0 20.0 17.0 11.6 11.4 11.4 11.4 11.4 11.4 11.4 11.4 11.4 11.4 11.4
2.5
17.0
12.0
2.5
PLAN
NARNY ZAM
NARNY ZAM
8.5
RAILWAY
PROFILE
PEACE BRIDGE
N
0 25 50m

Traffic control has been implemented. Bus is able to pass.

Catch basin of drainage has been clogged.

Deck slab has been coupled on the simple beam.

Damaged at main girder



Hinge connection which can be weak point against heavy and repeated traffic load has been adopted.

Crossing beam; there are some traces of rehabilitation. Huge deterioration has not been appeared.

(6) UNDERGROUND UTILITIES

Table 10 List of Utilities Affected by the Construction Works

Section	Station	Underground						On and Above Ground									Overhead	
		Sewer Pipe	Drainage Pipe	Water Supply Pipe	Electric Cable	Hot Water Distribution Pipe	Telecommunication Cable	Electric Pole	Advertising Pillar	Tree	Street Lighting and Foundation	Fence	Entrance with staircase	Kiosk	Traffic Signal	Traffic Sign Board	Power Supply Catenaries of Trolleybus	Electlic/Telecommunication Cable
Ikh Toyruu	No.18 - No.19		RD	RD	RD	RD	RD			RD				RD			RD	RD
	No.19 - No.20		RD	RD	RD	RD	RD			RD	RD		RD	RD			RD	RD
	No.20 - No.21		RD	RD	RD	RD	RD			RD			RD	RD			RD	RD
	No.21 - No.22		RD	RD	RD	RD	RD			RD							RD	RD
	No.22 - No.23		RD	RD	RD	RD	RD		RD	RD		RD		RD			RD	RD
	No.23 - No.24		RD	RD	RD	RD	RD			RD	RD		RD			RD	RD	RD
	No.24 - No.25		RD	RD	RD	RD	RD			RD	RD		RD				RD	RD
	No.25 - No.26	RD				RD		RD		RD	RD		RD				RD	RD
	No.26 - No.27	RD	RD	RD	RD	RD	RD	RD		RD	RD						RD	RD
	No.27 - No.28	RD				RD				RD							RD	RD
	No.28 - No.29	RD				RD				RD							RD	RD
	No.29 - No.30	RD			RD			RD		RD	RD						RD	RD
	No.30 - No.31	BP			BP					RD	RD	RD					RD	RD
	No.31 - No.32	BP		BP	BP					RD	RD	RD					RD	RD
	No.32 - No.33	BP		BP	BP	BP					RD						RD	RD
	No.33 - No.34	BP		BP	BP	BP		RD			RD						RD	RD
	No.34 - No.35	BP		BP	BP			RD	RD		RD	RD			RD	RD	RD	RD
	No.35 - No.36				BP		BP				BR	BR						
	No.36 - No.37				BP		BP					BR						
Railway Station	No.37 - No.38									BR								
	No.38 - No.39			BP						BR								
	No.39 - No.40											BR						
	No.40 - No.41																	
	No.41 - No.42				BP						BR	BR						BR
	No.42 - No.43											BR						
	No.43 - No.44				BP							BR						BR
Engels Street	No.44 - No.45							BR										BR
	No.45 - No.46			BP	BP													
	No.46 - No.47			RD	RD													
	No.47 - No.48			RD	RD													
	No.48 - No.49			RD	RD													
	No.49 - No.50			RD	RD			RD										RD
	No.50 - No.51			RD	RD						RD							
	No.51 - No.52				RD													RD
	No.52 - No.53				RD						RD							RD
	No.53 - No.54				RD													RD
	No.54 - No.55				RD						RD							RD
	No.55 - No.56				RD													RD
	No.56 - No.57				RD						RD							RD
	No.57 - No.58				RD													RD
	No.58 - No.59				RD						RD							RD
	No.59 - No.60				RD													RD
	No.60 - No.61				RD			RD			RD							RD
	No.61 - No.62				RD			RD										RD
	No.62 - No.63				RD			RD										RD

Notes: RD: Affected by Road Construction
BP: Affected by Bridge Pier Construction
BR: Affected by Bridge Construction

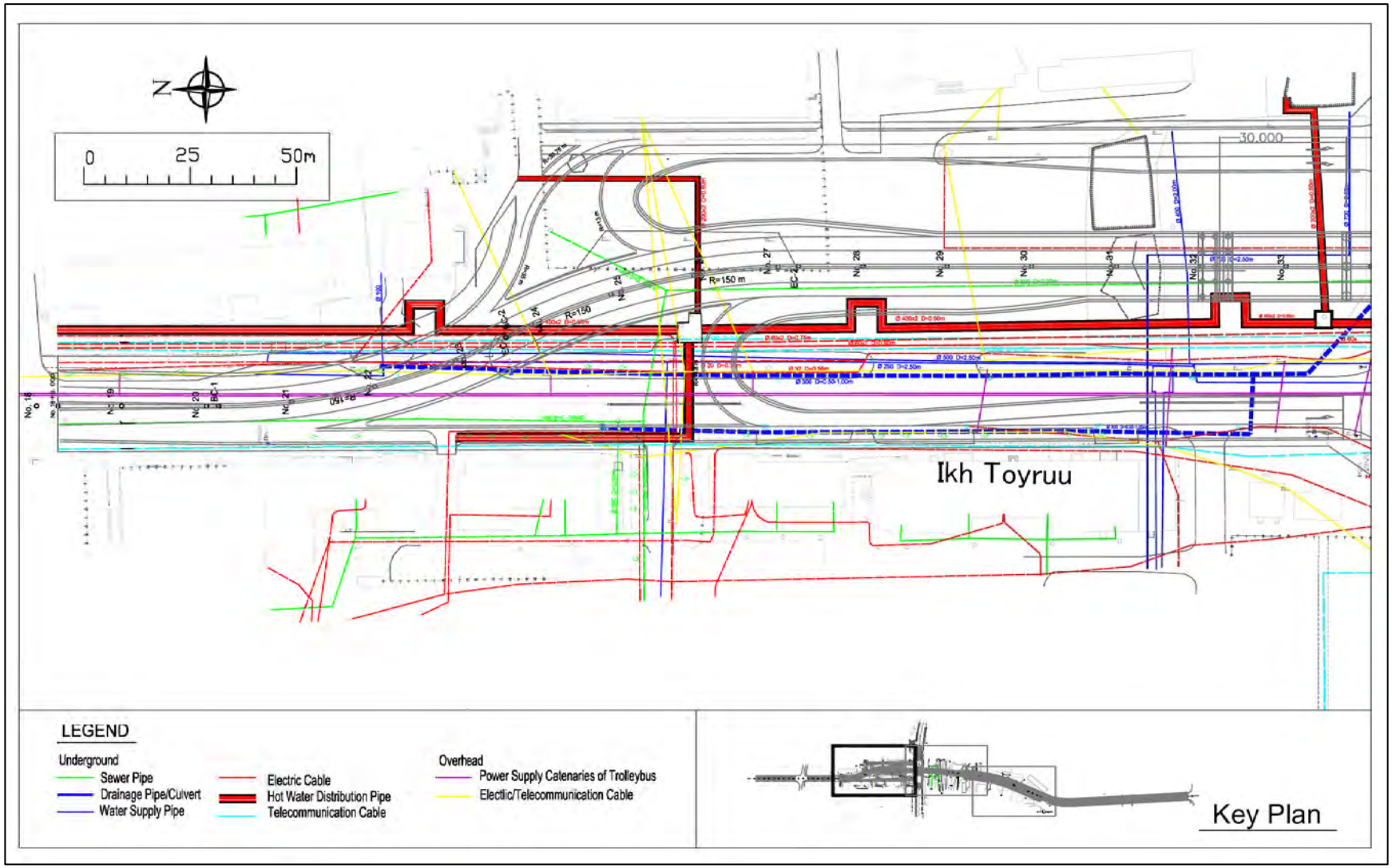


Figure 3 Location of Utilities (1/3)

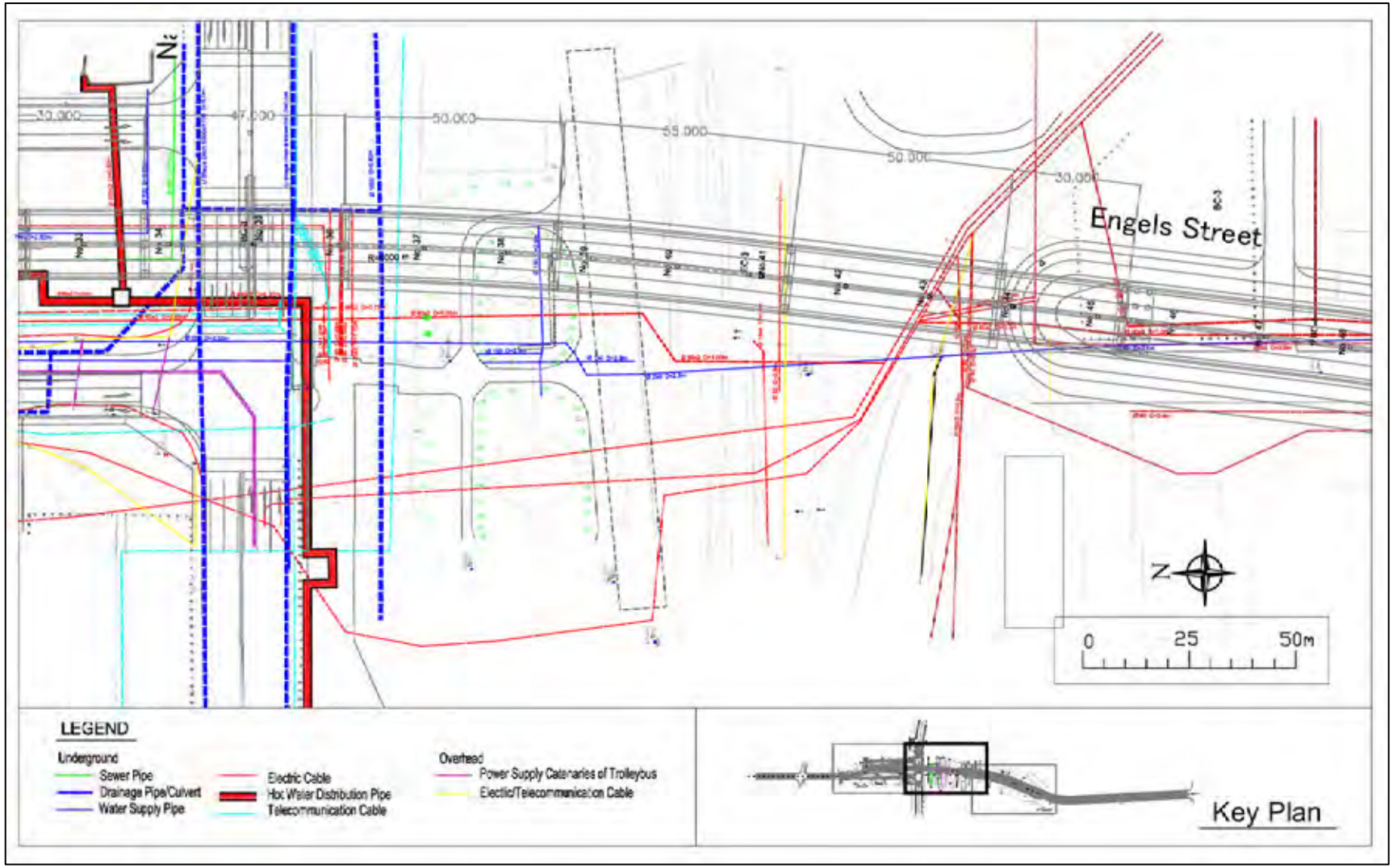


Figure 4 Location of Utilities (2/3)

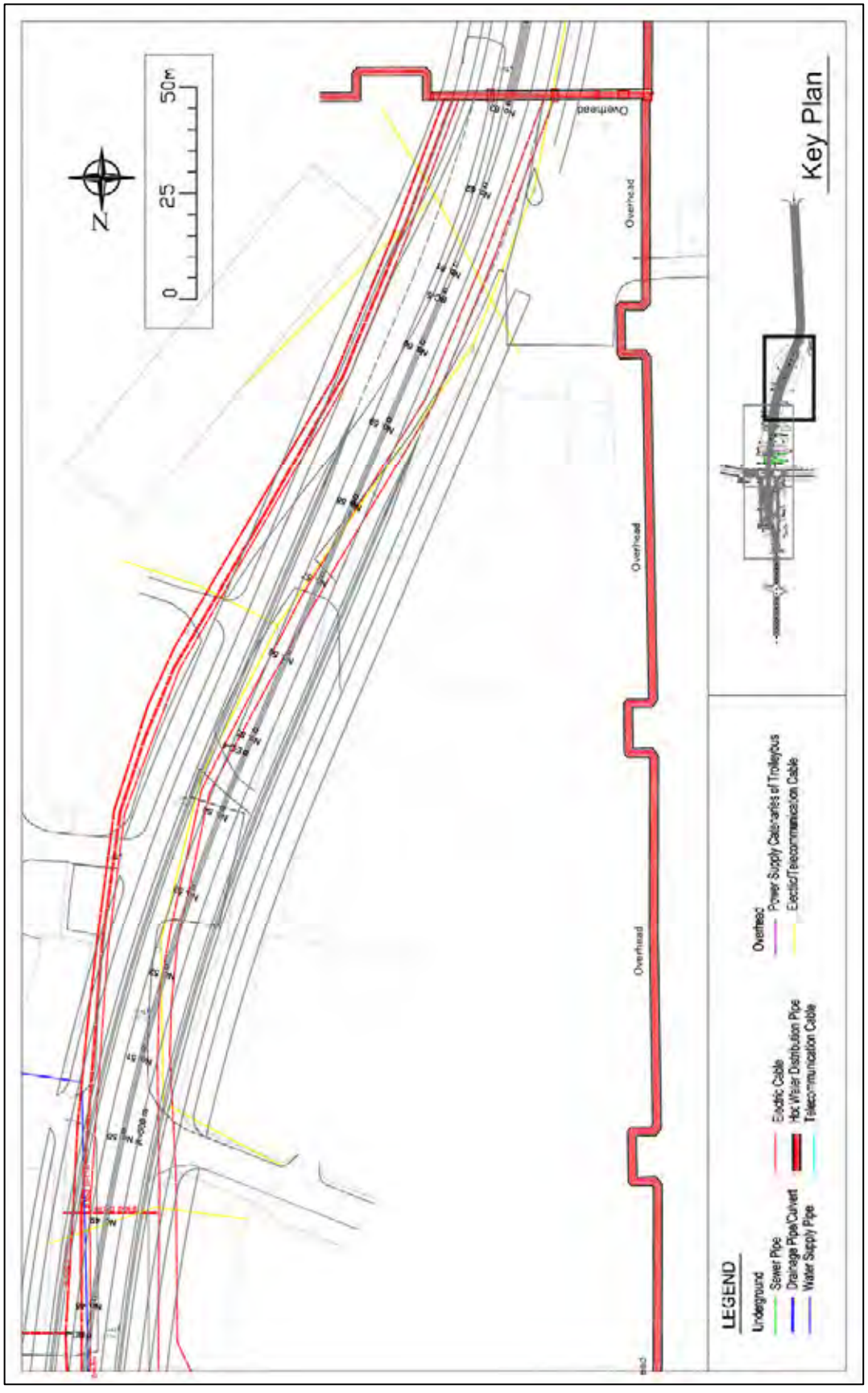


Figure 5 Location of Utilities (3/3)

(7) THE ECONOMIC ANALYSIS ON ESCALATION RISKS OF PROJECT COSTS

1. Objectives

It is obvious that the recent price escalation for construction costs of public investment projects is extremely high due to the massive demand for the construction investment in the Ulaanbaatar city. Especially, prices for steel materials which are important components for the flyover project have been recently skyrocketing due to the price hikes of steel materials in the international market. Observing these circumstances, the price escalation of major project cost items might have risks of affecting the total project cost. In this connection, the economic analysis on the price escalation risks of major project cost items have been carried out for forecasting the annual price escalation risks during the year 2010 - 2013.

2. Basic Approaches

In general, the price escalation risks for project costs include exchange rate risks, inflation risks of each unit price (price contingency), and unexpected cost increase due to physical reasons (physical contingency). In the economic analysis, the inflation risks of each unit price (price contingency) are mainly studied. When a trend of inflation is forecasted, it is widely accepted to focus on a unit labor cost (ULC), a demand-supply gap and an expected inflation rate. This approach is a basic approach to forecast an inflation rate in accordance with a so-called Phillips curve based on a new Keynesian model. More concretely, the typical and standard macro-economic model for forecasting a trend of inflation is a new Keynesian model based on the assumption of price rigidity which is called NKPC Calvo-pricing model. The inflation forecasting model employed by the Bank of Mongolia is NKPC-VAR（Vector Autoregressive）which is one of the variations of NKPC Calvo-pricing model. However, the said model includes the forecasting of the consumer price index (CPI) based on the IMF method since 1991, and Laspeyres Standard Index (LSI) is being employed as the basic index to streamline the CPI. Since the CPI includes general prices of consumer goods and services, there is a limitation to apply the said macro-economic model for methodologies to directly forecast the trend of prices of construction materials.

In this connection, it is obvious that the current macro-economic model based on the CPI is not suitable to forecast the trend of the inflation of construction costs. Therefore, in this specific analysis, the inflation rate of each project cost item is estimated based on the item-wise price escalation risks which are forecasted by the regression analysis by using a couple of independent variables.

3. Methodologies

In general, the price escalation risks for project costs include i) exchange rate risks, ii) inflation risks of each unit price (price contingency), and iii) unexpected cost increase due to physical reasons (physical contingency). In the economic analysis, the inflation risks of each unit price (price contingency) are mainly studied. In this specific analysis, the inflation rate of each project cost item is estimated based on the item-wise price escalation risks which are forecasted by the regression analysis by using a couple of independent variables.

In general, construction costs are composed of direct construction costs, site management costs, overhead and general administration costs, and etc. Direct construction costs are also composed of construction material costs, transportation costs and wages for workers, and etc. In case that construction materials are required to import from overseas countries, construction material costs can be divided into imported construction materials and domestically procured construction materials. Table 11 shows the basic components of the construction costs for the flyover construction project.

Table 11 Basic Components of Construction Costs

Cost Item	Component	
	Overseas Procurement	Domestic Procurement
Construction Material Costs	Major Imported Construction Materials	Major Domestically Procured Construction Materials
Transportation Costs	Ocean and In-land Transportation	In-land Transportation
Wages and Salaries	Wages and Salaries for Foreign Staff and Workers	Wages for Local Workers
Overhead, Administration and Site Management Costs	Overhead and Administration Costs	Site Management Costs

The major construction materials for the bridge of the flyover project are steel materials, and those materials will be procured by importing them from overseas countries. There are two ways for the procurement of those steel materials. The first way is to procure from an overseas country which produces appropriate steel materials and fabricate them in the said country, while the second way is to procure from an overseas country and fabricate them in the third country. In this flyover construction project, the forecasting of prices of steel materials is based on the assumption that the major steel materials will be procured by importing from and fabricating in Japan.

More concretely, the following steps are employed in order to forecast the annual inflation rate of each project cost item during the year 2010 to 2013.

a) The major independent factors for the multiple regression analysis are selected.

b) A couple of independent variables to determine the price of each project cost item are estimated by using the results of the multiple regression analysis, thereby forecasting the annual inflation risk of each project cost item.

c) If the multiple regression analysis is not valid, one independent variable to determine the price of each project cost item is estimated by using the results of the single regression analysis, thereby forecasting the annual inflation risk of each project cost item.

d) If both the multiple regression equation and the single regression equation are statistically invalid, the trend analysis by using the time-series data for the last 5 years is employed, thereby forecasting the annual inflation risk of each project cost item.

e) In case that the trend analysis by using the time-series data for the last 5 years is also not possible, the forecast results of cost items of similar projects are employed.

Table 12 shows the major data sources for the independent variables to determine the price of each project cost item for forecasting the annual inflation risk of the said project cost item.

Table 12 Major Data Sources for Independent Variables

No.	Variables	Data Source	URL
1	International Steel Prices	The International Steel Trade Association	http://www.steeltrade.co.uk/linksf.htm
2	International Crude Oil Prices	Energy Information Administration	http://www.tonto.eia.doe.gov/dnav/pet/_pri_wco_k_w/html
3	Real GDP of Asia Region	Asian Development Outlook	http://www.adb.org/Documents/Books/ADO/default.asp
4	Real GDP of Mongolia	Annual Statistics of Mongolia	
5	Construction Price Index	Annual Statistics of Mongolia	
6	Consumer Price Index	IMF	http://www.thedti.gov.za/econdb/IMFConMONGOLIACPICHA.html

4. Results of Economic Analysis

In order to carry out the multiple regression for major project cost items, 2 independent variables for each cost item are employed by using time-series data for the last 5 years (2003-2007). As a result, the annual price escalation risks of major project cost items during the year 2010 to 2013 are forecasted based on the major factors as per Table 13.

Table 13 Major Factors Affecting Price Escalation

Major Project Cost Items	Selected Independent Variable for the Multiple Regression Analysis	
	Independent Variable X1	Independent Variable X2
Overseas Procurement		
Materials		
Steel Materials	Worldwide Demand of Steel Materials	International Crude Oil Price
Steel Rods	Worldwide Demand of Steel Materials	International Crude Oil Price
Other Materials	Worldwide Demand of Steel Materials	International Crude Oil Price
Transportation Cost	Real GDP of Asia Region	International Crude Oil Price
Domestic Procurement		
Materials		
Concrete	Real GDP of Mongolia	Construction Investment Amount in Ulaanbaatar City
Aggregates	Real GDP of Mongolia	Construction Investment Amount in Ulaanbaatar City
Asphalt	Real GDP of Mongolia	Construction Investment Amount in Ulaanbaatar City
Wages for Civil Works	Consumer Price Index（CPI）	Construction Investment Amount in Ulaanbaatar City
Wages for Bridge Fabrication	Consumer Price Index（CPI）	Construction Investment Amount in Ulaanbaatar City

Source: JICA Study Team

The results of the economic analysis are as per Table 14.

a) Steel Materials

The multiple regression equation based on 2 independent variables (worldwide demand of steel materials and international crude oil prices) is estimated as Y (prices of steel materials) = -732.43+145.62X1(worldwide demand for steel materials) -8.61X2 (worldwide process of crude oil). Since the determination variable is estimated at 0.908, this multiple regression equation can explain 90.8 percent of prices of steel materials. As a result of the application of this multiple regression analysis, the inflation rate for steel materials is estimated at 22.59 percent per annum.

b) Steel Rods

It has been revealed that the multiple regression equation for forecasting prices of steel rods based on 2 independent variables (worldwide steel demand and international crude oil prices) is not valid. At the same time, the single regression equation based on each independent variable is also statistically not valid. Therefore, the inflation rate for prices of steel rods has been forecasted at 16.02 percent per annum by using the time series data for prices of steel rods for the last 5 years.

c) Supplementary Parts

Due to the insufficient regression data for supplementary parts, the average fluctuation rate of

prices of steel rods for the last 5 years is employed to forecast the inflation rate of supplementary parts at 16.02 percent per annum.

d) Other Materials

Due to the insufficient regression data for other materials, the average fluctuation rate of prices of steel rods for the last 5 years is employed to forecast the inflation rate of other materials at 16.02 percent per annum

e) Bridge Fabrication Cost

Due to the insufficient regression data for bridge fabrication cost, the average fluctuation rate of prices of steel rods for the last 5 years is employed to forecast the inflation rate of the bridge fabrication cost at 16.02 percent per annum.

f) Transportation Costs

Due to the difficulties in obtaining time-series transportation costs for forecasting the future transportation cost, the worldwide inflation rate forecasted by IMF has been employed. As a result, the inflation rate for the transportation cost is estimated at 3.90 percent per annum.

g) Mechanical Costs

Due to the difficulties in obtaining time-series transportation costs for forecasting the future mechanical cost, the worldwide inflation rate forecasted by IMF has been employed. As a result, the inflation rate for the mechanical cost is estimated at 3.90 percent per annum.

h) Concrete

It has been revealed that the multiple regression equation for forecasting concrete prices based on 2 independent variables (real GDP of Mongolia and construction investment amount of Ulaanbaatar City) is not valid. At the same time, the single regression equation based on each independent variable is also statistically not valid. Therefore, the inflation rate for cement prices has been forecasted at 9.48 percent per annum by using the time series data for concrete prices for the last 5 years.

i) Aggregates

Due to the insufficient time-series data of prices of aggregates, the forecasted inflation rate of prices of aggregates is estimated at 9.48 percent per annum by using the forecast result for concrete.

j) Asphalt

The multiple regression equation based on 2 independent variables (real GDP of Mongolia and construction investment amount of Ulaanbaatar City) is estimated as “Y(Asphalt Price) = 224.81-0.0902X1 (Real GDP of Mongolia) + 0.0133X2 (construction investment amount of

Ulaanbaatar City). Since the determination variable is estimated at 0.995, this multiple regression equation can explain 99.5 percent of asphalt prices. As a result of the application of this multiple regression analysis, the inflation rate for asphalt is estimated at 25.29 percent per annum.

k) Other Materials

Due to the insufficient time-series data of other materials, the forecasted inflation rate of other materials is estimated at 9.48 percent per annum by using the forecast results for concrete and aggregates.

l) Wages for Civil Works

It has been revealed that the multiple regression equation for forecasting wages for civil works based on 2 independent variables (consumer price index of Mongolia and construction investment amount of Ulaanbaatar City) is not valid. However, the single regression equation which explains wages for civil works based on one variable (construction investment amount of Ulaanbaatar City) is estimated as Y (wages for civil works) = -109.31+0.02X2(construction investment amount of Ulaanbaatar City). Since the determination variable is estimated at 0.829, this single regression equation can explain 82.9 percent of wages for civil works. As a result of the application of this single regression analysis, the inflation rate for wages for civil works is estimated at 15.85 percent per annum.

m) Wages for Bridge Fabrication

Due to the insufficient time-series data of wages for bridge fabrication, the forecasted inflation rate of wages for bridge fabrication is estimated at 15.85 percent per annum by using the forecast results for wages for civil works.

n) Mechanical Costs（Domestic Procurement）

Due to the insufficient time-series data of mechanical costs, the forecasted inflation rate of the mechanical cost is estimated at 9.48 percent per annum by using the forecast results for other materials.

o) Other Costs（Domestic Procurement）

Due to the insufficient time-series data of prices of other costs (domestic procurement), the forecasted inflation rate of other costs (domestic procurement) is estimated at 15.85 percent per annum by using the forecast results for wages for civil works.

p) Site Management Costs and Overhead Costs

Due to the insufficient time-series data of site management costs and overhead costs, the forecasted inflation rate of site management costs and overhead costs is estimated at 15.85

percent per annum by using the forecast result for wages for civil works.

Table 14 Results of Economic Analysis

Major Project Cost Items	R2 and Forecast Annual Inflation Rate		Regression Equation and Results of Analysis
	R2	Forecasted Annual Inflation Rate	
Overseas Procurement			
Material			
Steel Materials	0.908	22.59%	Y=-732.43+145.62X1-8.61X2
Steel Rods	0.872	16.02%	Due to the invalid statistical regression equation, the average fluctuation rate for the last 5 years is employed
Supplementary Materials	-	16.02%	Ditto
Other Materials	-	16.02%	Ditto
Bridge Fabrication Cost	-	16.02%	Ditto
Transportation Cost	-	3.90%	The latest worldwide inflation forecast by IMF is applied.
Mechanical Cost	-	3.90%	Ditto
Domestic Procurement			
Materials			
Concrete	0.874	9.48%	Due to unavailability of data for the regression analysis, the fluctuation rate of concrete for the last 5 years is employed.
Aggregates	0.874	9.48%	Ditto
Asphalt	0.995	25.29%	Y=-224.81-0.0902X1+0.0133X2
Other Materials	-	9.48%	Due to unavailability of data for the regression analysis, the fluctuation rate of concrete for the last 5 years is employed.
Wages for Civil Works	0.829	15.85%	Due to the invalid statistical multiple regression equation, the regression equation based on the independent variable X2 is employed. Y=-109.31+0.002X2
Wages for Bridge Fabrications	0.829	15.85%	Due to the invalid statistical multiple regression equation, the regression equation based on the independent variable X2 is employed. Y=-109.31+0.002X2
Mechanical Costs	-	9.48%	Due to unavailability of data for the regression analysis, the fluctuation rate of other materials for the last 5 years is employed.
Other Costs	-	15.85%	Due to the insufficient time-series data, the forecast results of wages for civil works are employed.
Supervision（Except for Consulting Fee for Supervision）			
Site Management Costs	-	15.85%	Due to the insufficient time-series data, the forecast results of wages for civil works are employed.
Overhead Costs	-	15.85%	Due to the insufficient time-series data, the forecast results of wages for civil works are employed.
General Administration Costs	-	0.00%	The price escalation risk is not considered
Consulting Fee for Supervision	-	0.00%	The price escalation risk is not considered.

Source: JICA Study Team