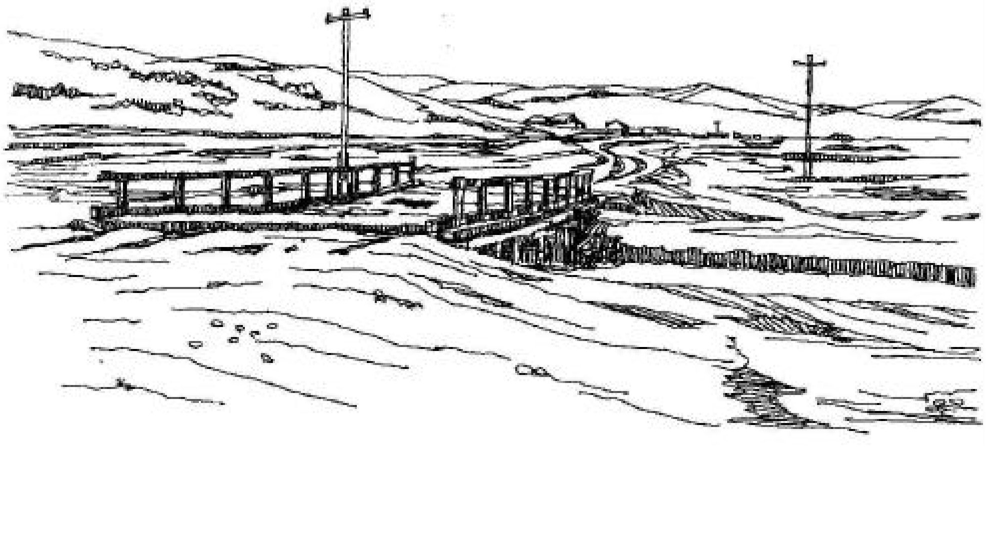
CHAPTER 4 EXISTING ROAD, PAVEMENT AND BRIDGE CONDITIONS AND ITS INVENTORY SURVEY



CHAPTER 4 EXISTING ROAD, PAVEMENT AND BRIDGE CONDITIONS AND ITS INVENTORY SURVEY

4.1 Existing Road Conditions

(1) Existing Road Conditions

The project road between Ulaanbaatar and three east provinces was constructed by the Department of Roads. However, road conditions are far from satisfactory due to shortage of budget. In this chapter, the road conditions and results of road inventory survey is discussed.

1) Route

Study route (National Road A0501) is the major corridor between Ulaanbaatar and the eastern region, which handles the products such as coal, food, medicine, clothing, etc. Because the road conditions are poor, drivers have created alternative dirt paths (known as tracks) parallel to the main road. In this context, drivers tend to lose signposts due to snow in winter, and to be stuck in the mud in summer. It is also difficult for vehicles to be driven comfortably.

2) Structure

The roads in the study area are classified into three types: mountainous, flat and marshy.

In mountainous areas, the slope of the road is steep and the existing road was improved by cutting the side slope in order to protect against roll over of heavy trucks. In addition, rain water and snow thaw cut sections on both sides of the road.

In flat areas, drivers travel freely and easily. Surface conditions are better than mountainous and marshy areas.

Marshy areas are mainly located at the bottom of a valley or beside a river. Vehicles get stuck in the mud, probably caused by the swellings of the frost heave. It is necessary that route selection and road design should consider such surface conditions.

3) Cross Section

The width of gravel roads ranges between 6 and 11 meters. Improved earth road was constructed by leveling with motor grader. As a result, embankments and drainage ditches don't exist, and the grade of the slope embankment is unstable. The design of cross section and other facilities should be standardized.

4) Pavement

The project roads in the study area consists of cement concrete paved, asphalt concrete paved, double bituminous surface treatment, gravel, improved earth, and earth segments.

Many potholes and cracks are observed on the cement concrete paved, asphalt concrete paved and double bituminous surface treatment sections due to old, low quality of construction, poor maintenance and severe climate. The surface pavement is especially damaged by the contraction of serious temperature and frozen sub-grade due to repeated freezing and melting of water inside the road.

Gravel road is barely flat due truck vibration. Therefore, most drivers avoid using the existing gravel road on in order to be more comfortable and drive at higher speeds. Due to the dry climate in Mongolia, gravel scatters as fine particle dust. The design should consider such pavement characteristics.

5) Drainage

Since there are deep tracks on the project road, the road is eroded with many gullies. In addition, the water absorbing capacity of soil is low due to thinness topsoil. In the rainy season, floods occur on the surface of flat and marshy areas. Water level is very different during periods of water shortage and flood season.

Drainage facilities are deformed or settled or broken due to small capacity or weak foundation or general weakness. The design should consider such drainage characteristics.

6) Environment

Vehicles run through freely and arbitrarily on and off roads, and this behavior causes grass to be scraped away and topsoil laid bare. This leads to the destruction of grasslands in livestock areas.

It is, therefore, highly recommended that roads designed effectively to address environment conditions be promoted.

7) Accessibility

At present, non-motorized vehicles such as wagons, horses and camels are popular in the study area. It is undesirable that such slow-moving traffic is mixed with high-speed traffic. It is necessary to provide alternative routes between major cities, for instance, at Undurkhaan which is an important inter-modal connection to three eastern provinces.

8) Road Network Density

In general, the arterial road network should provide high mobility with a degree of access control, while local road networks require higher levels of access. Road Network Density* (hereafter referred to 'RND') is low in the study area from the viewpoint of road transport planning. Especially, RND in Khentii and Dornod provinces are lower than the average for the study area.

Table 4-1-1 shows the Road Network Density in the study area in 2000.

* Road Network Density (RND)
This index, which is computed by province area (ha) and cumulative length (m) of roads and usually expressed in units of m/ha, has implications for the level of mobility. Accordingly, the index is higher in urban area, and lowers in rural area.

Table 4-1-1 Road Network Density (2000)

	Area		National Highway		Regional Road		Total	
Unit	km^2	%	km	m/ha	km	m/ha	km	m/ha
Dornod	123.6	7.9	871.0	70.5	1,748.0	141.4	2,619.0	211.9
Sukhbaatar	82.3	5.3	535.0	65.0	2,477.0	301.0	3,012.0	366.0
Tuv	74.0	4.7	1,010.0	136.5	2,430.0	328.4	3,440.0	464.9
Khentii	80.3	5.1	639.0	79.6	265.0	33.0	904.0	112.6
Total in 4 provinces	360.2	23.0	3,055.0	84.8	6,920.0	192.1	9,975.0	276.9
Total in Mongolia	1,564.1	100.0	11,063.0	70.7	38,187.0	244.1	49,250.0	314.9

(2) Existing Road Network in the Study Area

1) Administrative Classification

Roads in Mongolia are classified by law into four types: International Roads, National Roads, Local Roads, and Internal Roads (of Business Entities and Organizations). While, Local Roads are subdivided functionally into two classes (Regional Roads and Local Roads), National Highways are not statistically discriminated between International Roads and National Roads.

Only National Highways fall under the jurisdiction of the Department of Roads (hereafter referred to 'DOR') of Ministry of Infrastructure. Local governments manage the other roads. However, road design is controlled by DOR due to insufficient number of local engineers.

2) Roads in the Study Area

Total length of roads under DOR is about 49,250 km. Of the total length in Mongolia, National Highways for 22.5% or 11,063 km, and Regional Roads for 77.5% or 38,187 km. Roads in the study area account for 20.3% or 9,975 km, consisting of National Highways of 3,055 (27.6%) and Regional Roads of

6,920 km (18.1%). The share of national highway network is high, and the regional road network is low.

The share of road network in Dornod, Tuv and Khentii provinces have similar tendency. On the other hand, National Highway in Sukhbaatar province is lower, and percentage of Regional Road is higher.

Table 4-1-2 shows the length of DOR Roads in the study area in 2000.

Table 4-1-2 Length of DOR Roads by Province (2000)

	National Highway		Local Road		Total	
Unit	Km	%	Km	%	Km	%
Dornod	871.0	33.3	1,748.0	66.7	2,619.0	100.0
Sukhbaatar	535.0	17.8	2,477.0	82.2	3,012.0	100.0
Tuv	1,010.0	29.4	2,430.0	70.6	3,440.0	100.0
Khentii	639.0	70.7	265.0	29.3	904.0	100.0
Total in 4 provinces	3,055.0	30.6	6,920.0	69.4	9,975.0	100.0
Total in Mongolia	11,063.0	22.5	38,187.0	77.5	49,250.0	100.0

Road length by type and its component are given in Table 4-1-3.

Table 4-1-3 Length of DOR Roads Area by Type (2000)

	National Highway		Regional Road		Total	
Unit	Km	%	Km	%	Km	%
Dornod	871.0	7.9	1,748.0	4.6	2,619.0	5.3
Sukhbaatar	535.0	4.8	2,477.0	6.5	3,012.0	6.1
Tuv	1,010.0	9.1	2,430.0	6.4	3,440.0	7.0
Khentii	639.0	5.8	265.0	0.7	904.0	1.8
Total in 4 provinces	3,055.0	27.6	6,920.0	18.1	9,975.0	20.3
Total in Mongolia	11,063.0	100.0	38,187.0	100.0	49,250.0	100.0

3) Road Length by Type of Road Surface

Table 4-1-4 shows the length of DOR Roads by type of road surface in the study area in 2000. Of total length in Mongolia, paved roads account for only 3.5% or 1,714 km. The majority of roads are still unpaved.

The road length by surface type in the study area is shown as follows: 725.5 km (7.3%) paved, 607.3km (6.1%) gravel road, 310.2 km (3.1 %) improved earth road and 8,332.0 km (83.5%) earth road. More than 90% of roads are unpaved. Paved roads in Sukhbaatar province are less than 1 %.

Table 4-1-4 Length by Type of Road Surface (2000)

	Dornod		Sukhbaatar		Tuv		Khentii		Total in 4 Provinces		Total in Mongolia	
Unit	Km	%	Km	%	Km	%	Km	%	Km	%	Km	%
1. National Highway	**871.0**	**100.0**	**535.0**	**100.0**	**1,010.0**	**100.0**	**639.0**	**100.0**	**3,055.0**	**100.0**	**11,063.0**	**100.0**
a. Paved Road	10.0	1.1	0.0	0.0	523.4	51.8	2.0	0.3	535.4	17.5	1,316.8	11.9
Rigid Cement Pavement	10.0	1.1	0.0	0.0	18.0	1.8	2.0	0.3	30.0	1.0	38.9	0.4
Asphalt Cement Pavement	0.0	0.0	0.0	0.0	338.6	33.5	0.0	0.0	338.6	11.1	759.8	6.9
Surface Treated Pavement	0.0	0.0	0.0	0.0	166.8	16.5	0.0	0.0	166.8	5.5	518.1	4.7
b. Gravel Road	267.0	30.7	4.6	0.9	7.7	0.8	271.0	42.4	550.3	18.0	1,379.2	12.5
c. Improved Earth Road	136.0	15.6	0.0	0.0	95.7	9.5	74.5	11.7	306.2	10.0	1,407.6	12.7
d. Earth Road	458.0	52.6	530.4	99.1	383.2	37.9	291.5	45.6	1,663.1	54.4	6,959.5	62.9
2. Regional Road	**1,748.0**	**100.0**	**2,477.0**	**100.0**	**2,430.0**	**100.0**	**265.0**	**100.0**	**6,920.0**	**100.0**	**38,187.0**	**100.0**
a. Paved Road	7.3	0.4	2.8	0.1	1.4	0.1	178.6	67.4	190.1	2.7	397.3	1.0
Rigid Cement Pavement	0.8	0.0	2.8	0.1	1.4	0.1	26.0	9.8	31.0	0.4	54.8	0.1
Asphalt Cement Pavement	0.0	0.0	0.0	0.0	0.0	0.0	137.4	51.8	137.4	2.0	276.0	0.7
Surface Treated Pavement	6.5	0.4	0.0	0.0	0.0	0.0	15.2	5.7	21.7	0.3	66.5	0.2
b. Gravel Road	10.0	0.6	0.0	0.0	0.0	0.0	47.0	17.7	57.0	0.8	497.9	1.3
c. Improved Earth Road	0.0	0.0	4.0	0.2	0.0	0.0	0.0	0.0	4.0	0.1	516.0	1.4
d. Earth Road	1,730.7	99.0	2,470.2	99.7	2,428.6	99.9	39.4	14.9	6,668.9	96.4	36,775.8	96.3
Total	**2,619.0**	**100.0**	**3,012.0**	**100.0**	**3,440.0**	**100.0**	**904.0**	**100.0**	**9,975.0**	**100.0**	**49,250.0**	**100.0**
a. Paved Road	17.3	0.7	2.8	0.1	524.8	15.3	180.6	20.0	725.5	7.3	1,714.1	3.5
Rigid Cement Pavement	10.8	0.4	2.8	0.1	19.4	0.6	28.0	3.1	61.0	0.6	93.7	0.2
Asphalt Cement Pavement	0.0	0.0	0.0	0.0	338.6	9.8	137.4	15.2	476.0	4.8	1,035.8	2.1
Surface Treated Pavement	6.5	0.2	0.0	0.0	166.8	4.8	15.2	1.7	188.5	1.9	584.6	1.2
b. Gravel Road	277.0	10.6	4.6	0.2	7.7	0.2	318.0	35.2	607.3	6.1	1,877.1	3.8
c. Improved Earth Road	136.0	5.2	4.0	0.1	95.7	2.8	74.5	8.2	310.2	3.1	1,923.6	3.9
d. Earth Road	2,188.7	83.6	3,000.6	99.6	2,811.8	81.7	330.9	36.6	8,332.0	83.5	43,735.3	88.8

Road length by surface type and its component are shown in Table 4-1-5.

Table 4-1-5 Length by Type of Road Surface by Province (2000)

	Unit	Paved Road		Gravel Road		Improved Earth Road		Earth Road		Total
		National Highway	Regional Road	National Highway	Regional Road	National Highway	Regional Road	National Highway	Regional Road	
Dornod	km	10.0	7.3	267.0	10.0	136.0	0.0	458.0	1,730.7	2,619.0
	%	0.4	0.3	10.2	0.4	5.2	0.0	17.5	66.1	100.0
Sukhbaatar	km	0.0	2.8	4.6	0.0	0.0	4.0	530.4	2,470.2	3,012.0
	%	0.0	0.1	0.2	0.0	0.0	0.1	17.6	82.0	100.0
Tuv	km	523.4	1.4	7.7	0.0	95.7	0.0	383.2	2,428.6	3,440.0
	%	15.2	0.0	0.2	0.0	2.8	0.0	11.1	70.6	100.0
Khentii	km	2.0	178.6	271.0	47.0	74.5	0.0	291.5	39.4	904.0
	%	0.2	19.8	30.0	5.2	8.2	0.0	32.2	4.4	100.0
Total in 4 provinces	km	535.4	190.1	550.3	57.0	306.2	4.0	1,663.1	6,668.9	9,975.0
	%	5.4	1.9	5.5	0.6	3.1	0.0	16.7	66.9	100.0
Total in Mongol	km	1,316.8	397.3	1,379.2	497.9	1,407.6	516.0	6,959.5	36,775.8	49,250.0
	%	2.7	0.8	2.8	1.0	2.9	1.0	14.1	74.7	100.0

4) Road Length by Type of Road Surface

Length by section of National Highway is summarized in Table 4-1-6. Study Area is located within No. A0501.

Table 4-1-6 List of National Highway

Code	Section	Length (km)
A01	UB - Nalaikh - Choir - Sainshand - Zamin Uud - Border	686
A02	UB - Mandalgovi - Dalanzadgad - Gashuunsukhait - Border	910
A03	UB - Arvaikheer - Bayankhongor - Altai - Khovd - Ulgii - Tsagaannuur - Border	1,740
A04	UB - Darkhan - Sukhbaatar - Altanbulag - Border	345
A05	UB - Undurkhaan - Choibalsan - Ereentsav - Border	879
A0501	**UB (From A01) - Undurkhaan**	**312**
A0502	Undurkhaan - Choibalsan	327
A0503	Choibalsan - Ereentsav - Border	240
A06	Elsentasarkhay - Kharkhorin - Tsetserleg - Tosontsengel – Numrug - Bayantes - Border	889
A07	Ulgii - Uvs Village in Ulgii Province	210
A08	Kharkorin – Khujirt - Arvaikheer	92
A09	Atar - Bulgan - Murun	581
A10	Darkhan - Erdenet - Bulgan	224
A11	Border - Khankh - Khatgal - Murun - Uliastai - Altai - Burgastai - Border	1,198
A12	Buutsagaan - Tsagaankhairkhan	233
A13	Khutag Undur - Teshig - Border	122
A14	Mankhan (Khovd Province) - Bulgan - Border	326
A15	Ulgii - Dayan - Border	180
A16	Ulaangom - Uureg - Tsagaannuur	199
A17	Khovd - Ulaangom - Border	354
A18	Ompuu - Baruunturuun - Ulaangom	578
A19	Undurkhaan - Bayan-Uul - Onon - Border	314
A20	Undurkhaan - Baruun-Urt - Bichigt - Border	517
A21	Choibalsan - Bayan-Uul	180
A22	Choibalsan - Baruun-Urt	181
A23	Khavirga - Border	90
A24	Nalaikh - Terelj	31
A25	Turgen - Zuunmod	4
Total		11,063

4.2 Road Inventory Survey

The road inventory survey was conducted by the local consultants under the supervision of the study team. The Study Team carried out the supplementary road survey for other existing roads as exception to the Scope of Work.

(1) Scope of Work

The objective of this survey is to grasp the current status of the existing road in the study area. Basic data are collected for analysis of alternative and the preliminary design.

a) Survey Location

The survey was carried out along the existing National Highway A0501 between Erdene and Undurkhaan as shown in Figure 4-2-1.

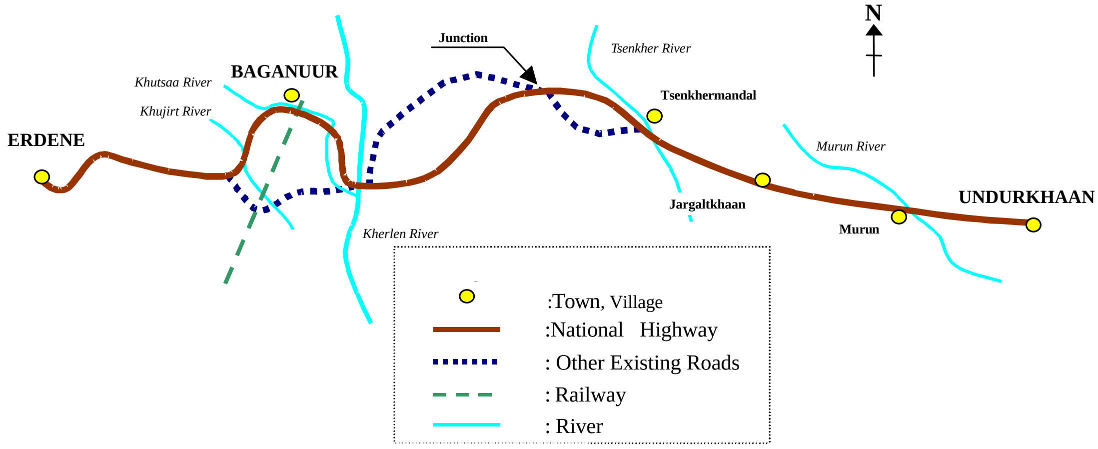


Figure 4-2-1 Location Map of Road Inventory Survey

b) Survey Items

The survey was divided into paved road and unpaved road. The survey items of paved road are identification items, horizontal curve radius, vertical gradient of alignment, type of pavement and thickness of pavement. Survey items are listed below.

- Road Inventory: Road name, kilometer post, road length, cross section, existence of shoulder, type of slope protection, culvert and retaining wall and other facilities.
- Road Condition Survey: Condition of pavement, culvert, slope protection, retaining wall and other facilities.

c) Survey Method

The surveyors recorded and measured the survey items at one kilometer intervals, and filled out the survey sheets including photographs.

(2) Result of Inventory Survey

a) General

Table 4-2-1 shows road length and number of culverts. Section B was used until 1978 when Baganuur Coal mine started to operate.

Table 4-2-1 Road Length and Number of Culverts

Section	Location	Road Length (km)	Number of Culverts	Remark
A	Erdene - Undurkhaan	264.0	35	
B	Baganuur	22.3	8	
C	Jargalant Valley	33.5	0	
D	Bor Khujirt Pass	18.9	0	

b) Roads

- Proportion of Road Surface

The results of road inventory between Section A and D are shown in Tables 4-2-2 and 4-2-3.

The road lengths by surface type in Section A are as follows: 1.0 km (0.4%) cement concrete paved, 17.7 km (6.7%) asphalt concrete paved, 1.2 km (0.5%) bituminous surface treatment, 32.0 km (12.1%) gravel, 77.5 km (29.4%) improved earth, and 129.6 km (49.1%) earth road. Approximately half of total roads in the study area had improved condition. However, more than 90% of roads are unpaved.

The road lengths of surface types in Section B are as follows: 5.8 km (26.0%) gravel and 16.5 km (74.0%) earth road. Most of roads in Section B are quite unpaved. Similarly, roads in Section C and D are 33.5 km and 18.9 km earth road respectively, and quite unpaved.

Table 4-2-2 Road Length by Type in Section A

Surface Type	Section	Location	Length km	Length %	Construction Year	Remark
Cement Concrete Pavement			**1.00**	**0.4**		
	Murun - Undurkhaan	Undurkhaan City	1.00		1979	
Asphalt Concrete Pavement			**17.70**	**6.7**		
	Erdene - Baganuur	Baganuur District	17.70		1984	
Bituminous Surface Treatment			**1.20**	**0.5**		
	Baganuur - Tsenkhermandal	Baganuur District	1.20		1981	
Gravel			**32.0**	**12.1**		
	Erdene - Baganuur	2 sections at Dutluur Pass	4.0		1983	
	Baganuur - Tsenkhermandal	Before and behind of Kherlen Bridge	1.0		1974	
	Murun - Undurkhaan	Murun Sum	27.0		1978	
Improved Earth			**77.5**	**29.4**		
	Baganuur - Tsenkhermandal	Crossing point at west side with Khutsaa River	3.0		1976	
	Baganuur - Tsenkhermandal	In front of Kherlen Hotel	1.0		1975	
	Baganuur - Tsenkhermandal	From Khukh chuluut to Tsenkher Bridge	28.0		1982	
	Tsenkhermandal - Jargaltkhaan	In front of Jargaltkhaan Sum	2.5		1980	
	Jargaltkhaan - Murun	Before and behind of Khamar Pass	5.0		1970	
	Jargaltkhaan - Murun	Before and behind of Duut Pass	6.0		1950	
	Jargaltkhaan - Murun	Zulegtei - Chandgana in Murun	32.0		1975	
Earth Road			**129.6**	**49.1**		
Under Construction			**5.0**	**2.0**		Erdene 5km
Total			**264.0**	**100.0**		

Table 4-2-3 Road Length by Type in Section B, C and D

Section	Surface Type	Location	Length km	Length %	Remark
B	Gravel		**5.80**	**26.0**	
		6+300 - 8+300	2.00		
		9+300 - 9+900	0.60		
		12+200 - 15+100	2.90		
		21+500 - 21+800	0.30		
	Earth		**16.50**	**74.0**	
		0+000 - 6+300	6.30		
		8+300 - 9+300	1.00		
		9+900 - 12+200	2.30		
		15+100 - 21+500	6.40		
		21+800 - 22+300	0.50		
	Total		**22.3**	**100.0**	
C	Earth		**33.50**	**100.0**	
		0+000 - 33+500	33.50		
D	Earth		**18.90**	**100.0**	
		0+000 - 18+900	18.90		

- Cross Sections and Thickness of Pavement

  The cement concrete pavement roads: the width of road and width of carriageway are 7.0 m and 7.0 m respectively. The shoulder is not clear. The slope is 1 to 6 grade, flat and no protection. Cement concrete pavement structure consists of cement concrete surface (20 cm thickness), gravel sand base and gravel sand sub-base.

  The asphalt concrete pavement roads: width of road, carriageway and shoulder are 6.5-13.2 m, 6.5-7.7 m and 2-3 m respectively. The cross section is not stable. The slope is almost 1 to 3 grade without protection. The asphalt concrete pavement structure consists of double bituminous treated surface (7 cm thickness), gravel base (20 cm thickness) and gravel sand sub-base.

  The double bituminous treatment roads: width of road, carriageway and shoulder are 10-13 m, 6 m 1.8-3.6 m respectively. The cross section is not stable even on asphalt concrete pavement. The slope is almost 1 to 3 grade without protection.

  The gravel and improved earth roads: width of road varies widely between 6-11 m. The slope is also between 1-1 and 1-4 m grade without protection.

b) Culverts

- Number of Culverts

  The results of culvert inventory in Section A and B are shown in Tables 4-2-4 and 4-2-5. There are no culverts in Section C and D because they lack both construction and maintenance.

  The culverts in Section A total 35 as follows: 21 reinforced concrete pipes, 6 steel pipes, 4 jointed RC and steel pipes, 3 RC boxes and 1 wooden box. However, most culverts are nonfunctional due to clogging or being broken or settled or deformed, etc.

  The culverts in Section B total 8 as follows: 7 reinforced concrete pipes and 1 RC box. However, all culverts are nonfunctional due to being clogged or broken, etc.

Table 4-2-4 Culverts in Section A

No.	Station	Type	Size (m)	Depth of Soil (m)	Remark
1	83+600	RC Pipe	D1.00	0.7	
2	83+800	RC Pipe	D1.00	0.8	
3	85+100	RC Pipe	D1.00	1.0	
4	86+200	RC Pipe	D1.00	0.8	
5	87+100	RC Pipe	D1.00	1.4	
6	88+100	RC Pipe	D0.75	0.4	
7	89+100	RC Pipe	D1.00	2.1	
8	89+500	RC Pipe	D0.80	5.5	
9	109+900	RC Pipe	D0.75	1.5	Rashaant River
10	118+100	RC Pipe	D1.50	1.2	
11	119+000	RC Pipe	D1.50	0.5	
12	121+100	RC Pipe	2xD1.50	2.2	
13	121+700	RC Pipe	D1.50	1.3	
14	122+800	RC pipe	2xD1.50	0.7	
15	124+500	RC Pipe	D1.50	0.7	
16	125+000	RC Pipe	2xD1.50	1.0	
17	137+350	Steel Pipe	D0.70	0.4	
18	143+800	RC Pipe	D1.00	1.5	
19	144+000	RC Pipe	D1.00	1.1	
20	180+200	Steel Pipe	5xD0.30	0.8	
21	183+400	RC Box	0.9x0.60	0.1	
22	188+800	RC Box	0.9x0.60	0.4	
23	189+900	RC Pipe	D1.00	0.2	
24	190+200	Steel Pipe	4xD0.30	0.15	
25	194+000	Steel Pipe	3xD0.30	0.4	
26	195+100	Steel Pipe	3x0.28	0.80	
27	197+100	RC Pipe	3xD0.30	0.8	
28	198+600	RC Pipe	3xD0.30	0.5	
29	202+400	Steel/RC Pipe	2xD0.30	0.5	
30	202+600	Steel/RC Pipe	2xD0.3	0.1	
31	203+500	Steel Pipe	3xD0.3	0.7	
32	205+900	Steel/RC Pipe	2xD0.3	0.2	
33	206+600	Steel/RC Pipe	2xD0.3	0.2	
34	229+500	RC Box	0.9x0.5	0.2	
35	279+000	Wooden Box	2.0x0.24	0.8	

Table 4-2-5 Culverts in Section B

No.	Station	Type	Size (m)	Depth of Soil (m)	Remark
1	0+050	RC Box	0.8x1.2	0.7	
2	6+300	RC Pipe	D1.00	0.1	
3	9+500	RC Pipe	D1.00	0.3	
4	9+700	RC Pipe	D1.00	0.1	
5	9+800	RC Pipe	D0.94	0.2	
6	12+200	RC Pipe	D1.00	0.1	
7	12+700	RC Pipe	D1.00	0.6	
8	13+300	RC Pipe	D1.00	0.5	

4.3 Recent Road Project

(1) Schedule of Construction

Much of the construction of new roads and bridges has been delayed due to lack of finance, lack of the construction machinery and material, and influence of severe climate and vast territory of the county. Table 4-3-1 shows recent road development in Mongolia.

(2) Development Directions

After the change to capitalistic economy, a road development plan was put forward on the basis of the ADB Road Master Plan. In accordance with the Road Master Plan, the government of Mongolia came up with the Millennium Road Project for the purpose to promote international trade and to strengthen east and west axis. In the future, road projects will be parts of the Millennium Road.

In the study area, DOR is developing roads totaling 36.8 km between Erdene and Baganuur. However, the development is low priority, compared with loan projects. As a result, five kilometers from Erdene were only budgeted in this year.

Table 4-3-1 Current Status of Recent Road Development in Mongolia

Project Name	Location	Length (km)	Donor	Fund Type	Year	Components	Current Status
Projects for Road Construction Utilizing Rock Asphalt in Mongolia	Nalaikh - Erdene	31.1	JICA	Grant Aid	October 1997	Detailed Design, Road Construction and Equipment Procurement. New construction was 13.3 km. Rehabilitation was 17.8 km	Constructed
Road Development Projects	Ulaanbaatar - Darkhan - Altanbulag	326.3	ADB	Loan	July 2000	Detailed Design, Rehabilitation and Equipment Procurement	Constructed
Darkhan - Erdenet Road Project	Darkhan - Erdenet	180.0	Kuwait Fund	Loan	June 1997	Detailed Design and Preparation of the Tender Documents	Under Construction
Secondary Roads Development Project	Nalaikh - Choir	200.0	ADB	Loan	December 2000	Engineering Design and Road Construction	Contractor Selection
Feasibility Study for Erdenet - Bulgan - Murun Road Project	Erdenet - Bulgan - Murun	397.0	Kuwait Fund	Loan	February 2001	Feasibility Study	-
Transport Development Subproject	Kharkhorin - Tsetserleg	35.4	WB	Loan and Road Fund of Mongolia	July 2000	Improvement	Constructed
Transport Development Subproject	Tsetserleg - Undur-Ulaan - Tosontsengel	53.1	WB	Loan and Road Fund of Mongolia	July 2001	Improvement	Constructed
Transport Development Subproject	Erdenesant - Arvaikheer	413.0	WB	Loan	March 2000	Rehabilitation	Contractor Selection
Construction between Erdene and Baganuur	Erdene - Baganuur	36.8	Mongolia	Road Fund of Mongolia	July 2001	Construction	Under Construction

4.4 Condition of Existing Bridges

The length of existing road for the Project between Erdene and Undurkhaan is approximately 250 km. There are five bridges (Br.No.1 to 5) on the Project Road as shown in Figure 4-4-1 below.

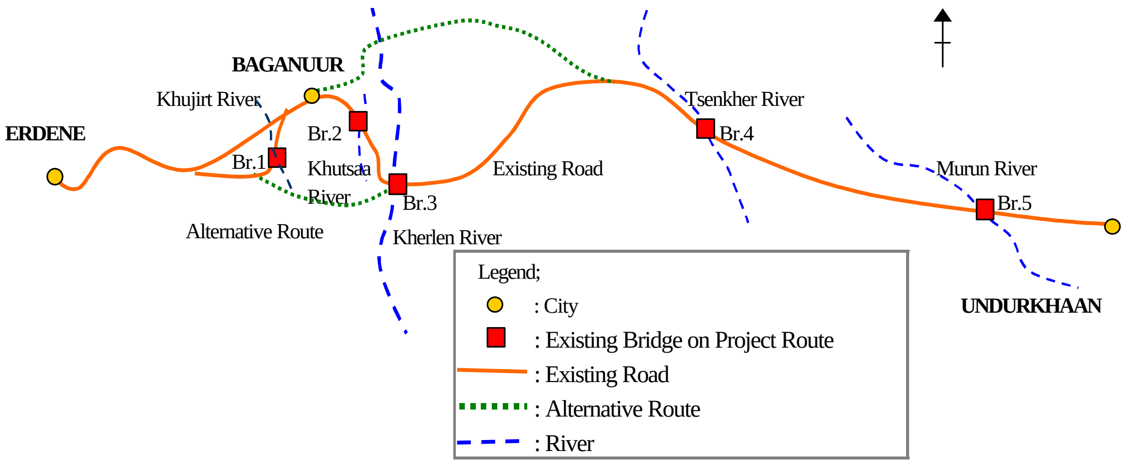


Figure 4-4-1 Existing Bridges on the Project Route

In Mongolia, the types of bridges are almost all reinforced concrete (hereafter RC) slab for short length span, RC-T shape girder for long length span, and wooden type for temporary bridge from the viewpoint of ease of supply of materials and construction method.

The existing bridges on the Project Road are classified into three types as follows: one RC slab, three wooden bridges and one RC- T shape girder. These bridges were constructed by Russian and/or Mongolian Contractors in the 1960s- 1970s.

The scale and dimension of the Project bridges are shown in Table 4-4-1 below.

Table 4-4-1 Scale and Dimension of the Project Bridges

Name		Br.No1 Khujirt River	Br.No.2 Khutsaa River	Br.No.3 Kherlen River	Br.No.4 Tsenkher River	Br.No.5 Murun River
Station No.		117.0km	137.2km	145.6km	211.1km	315.1km
Dimension	Bridge length	9.2m 2@ 4.6m	14.7m 8.8+3.8m	268.8m 16@16.8m	30.7m 6@5.0m	19.6m 5@ 3.92m
	Width	15.6m (Carriage: 6.7m)	6.1m (Carriage: 5.6m)	9.8m (Carriage: 7.0m)	5.9m (Carriage: 5.6m)	5.9m (Carriage: 5.6m)
Type	Super Str.	RC slab panel	Wooden slab, Beam	RC-T girder	Wooden slab, Beam	Wooden slab, Beam
	Sub Str.	RC wall	Wooden piles	RC Reversed T	Wooden piles	Wooden piles
	Foundation	Spread	-do-	Caisson, Spread	-do-	-do-
Construction year		1970s	1995	1974	1962	1962
River Conditions		W=8m, H=2.7m	W=15m, H=2.8m	W=270m, H=4.2m	W=30m H=1.2m	W=20m H=1.3m

There are as-built drawings for Br.No.3 (RC T - shape girder), but none for Br.No1 (RC slab by Russian contractor) or Br. Nos. 2, 4, and 5 (wooden temporary bridges).

Br.No.1 on the Khujirt River may not be stable because of deterioration of concrete due to its age and heavy traffic.

The wooden 3 bridges (Nos. 2, 4 and 5) are inadequate in terms of load capacity and rigidity for heavy vehicle transportation.

Br.No.3 on the Kherlen River was constructed in 1974. However, the fifth pier from Undurkhaan side was not stable because of eccentricity of the pier over the caisson foundation. Consequently, the pier was reinforced with an additional footing around the top of the caisson in 1993. Moreover, several defective parts of girders and shoe beds were repaired at that time. (See Appendix)

This RC T- shape girder type of Mongolian Standard has no cross beam between girders, and insufficient height and thickness of girder to support heavy live loads.

On the other hand, the bearing layers under substructures are hard gravel (N-value over 30) for the Project bridges.

The revetments and approach embankments at the bridge sides are scoured, deteriorated or destroyed due to floods and other reasons, such as poor construction quality.

4.5 Bridge Inventory Survey

4.5.1 Scope of Work

The scope of the bridge inventory survey are as follows:

(1) Survey Contents

- Bridge Inventory: Bridge name, kilometer post, type of bridge, bridge length, span length and cross section.
- Bridge Condition Survey: Condition of superstructure, substructure and pavement.

(2) Survey Method

The surveyors recorded and measured the survey items at the sites under the JICA Study Team, and filled in Tables A, B, and C including photographs for conditions of bridges provided in the inventory survey form.

4.5.2 Results of Inventory Survey

The results of the condition survey for the 5 bridges are given in Table 4-5-1.

Table 4-5-1 Present Conditions of Project Bridges

No. Bridge Name	Present Conditions	Requirement of Repair or Replacement
No.1	The bridge is functional although both RC slab panels of superstructure and RC abutment/pier walls of substructures show efflorescence and a carbonated concrete surface due to age. The retaining walls at the abutments are broken due to flood damage.	Early repair of the retaining walls is required. Broken pavement and settled embankment should be replaced.
No.2	A temporary wooden bridge has been constructed. Approach between embankment and wooden retaining wall was damaged by flooding and by heavy vehicles. One side of the riverbed was scoured due to flooding.	Early replacement with permanent material such as RC type is required.
No.3 Refer to Figure-	The RC T girders are deteriorated by reason of cracks on all surfaces and end parts, poor quality of concrete, exposed reinforcing bars and no-cross beam between girders. Some girders were set off-vertical at the time of construction. Several joint parts on the surface were broken, and obstruct traffic flow. Also, there is a gap between approach embankment and bridge caused by washout/erosion. The piers and abutments are sound except fifth and sixth piers from Undurkhaan side. The fifth pier has insufficient stability because of eccentricity of the column over the caisson at the time of construction, even though reinforced with a concrete footing. The under part of sixth pier is deteriorated due to wear and honeycombs from poor concreting. The revetment at the approach area is fairly sound. There is no sign of scouring in the main river flow.	Early reinforcement with adequate materials or replacement of bridge is required for normal traffic flow and heavy traffic capacity.
No.4	Heavy vehicles such as trucks and trailers cannot pass on this wooden bridge due to settlement, broken slab, and inclined pier piles and approach gap.	Early replacement with permanent material such as RC type is required.
No.5	As with Br.No4, this wooden bridge is also heavily damaged including slab, pier piles and approach.	ditto

The inventory sheets are shown in attached Appendix C-2.

- Table-A: Bridge Inventory Sheet (Dimensions, defects/damage, other conditions)
- Table-B: Bridge Sketch Sheet (Drawing of bridge dimensions for profile,)
- Table-C: Photograph Sheet (General view, defects/damage, river/revetment conditions, etc)

The character of deterioration cracks of RC structures are classified into three types by cause: due to external forces, due to concreting works deficiencies and due to carbonation and lack of cover to reinforcing bar.

4.6 Stability of Existing Bridges

The stability of the existing bridges was examined by the following two methods for evaluation using factors A and B below as shown in Figure 4-6-1.

A. Soundness evaluation by site inspection/observation and data collection

B. Check of structural stability/strength from calculation results

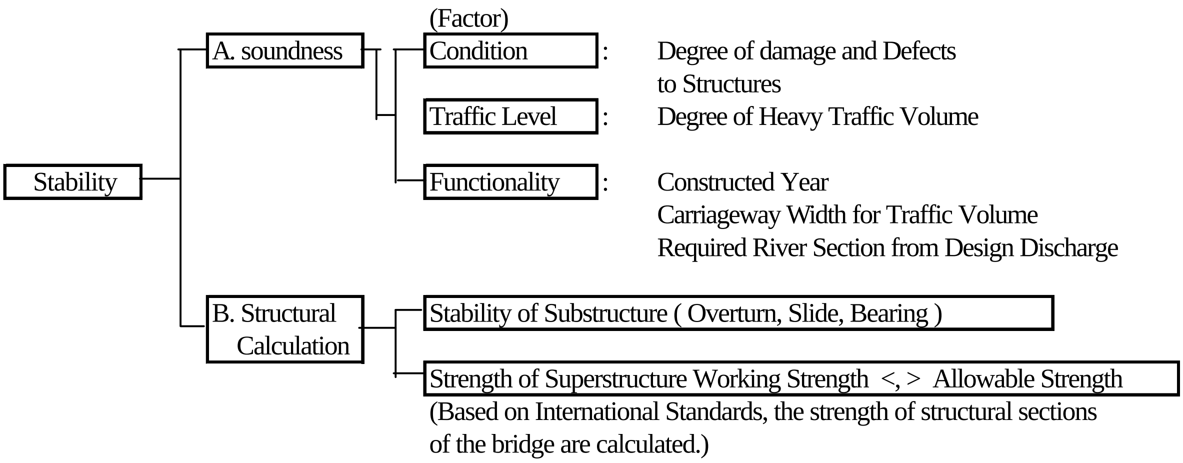


Figure 4-6-1 Overall Evaluation Factors

4.6.1 Soundness Evaluation

As listed in Table 4-6-1 below, the evaluation of damage and defects of bridges is rated in 4 classes by visual and technical observations.

Table 4-6-1 Rating for Bridges

Bridge Conditions	Rating	Evaluation
Survey results showed no damages and defects. Bridge has functional stability.	**1**	**D**
Damage has been detected and a follow-up survey is required. Bridge has functional stability at present.	**2**	**C**
There is significant damage / defects. Therefore, a detailed survey is needed and the necessity of repair work including functionality of the bridge should be considered.	**3**	**B**
There is significant damage / defects, and the bridge is not functional. Urgent repair is required. The bridge has to be closed to traffic or restrictions on vehicle weight imposed. (or re-construction of bridge)	**4**	**A**

To determine the above rating, soundness of the bridges is examined in terms of three elements: condition, traffic level and functionality using weighted numerical factors.

Condition is evaluated according to the inventory survey (damage and defects) as listed in Tables A, B and C. (Refer to Appendix)

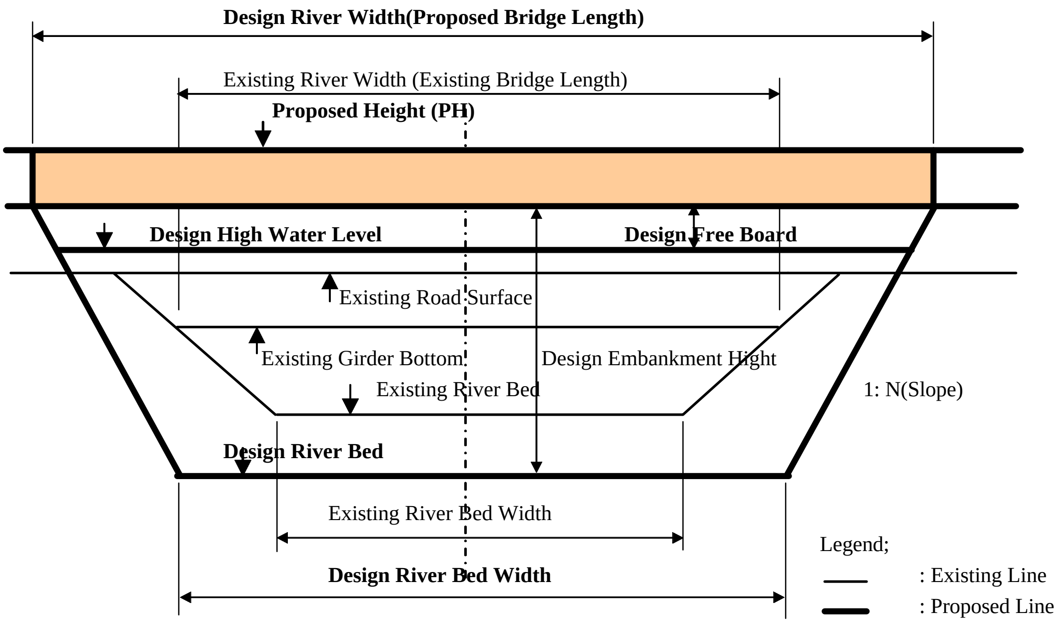
Traffic level is evaluated according to the proportion and axle loads of heavy vehicles using the bridge.

Functionality refers to adequacy of the carriageway width for the traffic volume, and adequacy of the river section for design flood flows.

In this basic evaluation, the overall rating is based on the condition rating, but also takes into account the highest rating of any individual factor.

Existing and Design River Sections:

Table 4-6-2 Existing and Design River Sections



	Name of Bridge		BrNo1(Khujirt)	BrNo.2(Khutsaa	BrNo.3(Kherlen	BrNo.4(Tsenkhe	BrNo.5(Murun)
Item			Existing	Existing	Existing	Existing	Existing
Existing Conditions	River Width		8m(9m)	15m(14.7m)	270m(268.8m)	30m(30.7m)	20m(19.6m)
	Road Surface Level	EL	1360.0m	1330.6m	1303.1m	1370.9m	1057.0m
	Girder Bottom Level	EL	1358.2m	1329.6m	1301.8m	1370.2m	1056.3m
	Lowest River Bed Level	EL	1356.5m	1326.8m	1297.6m	1369.0m	1055.0m
	River Bed Width		4.6m	5m	67.2m	25.0m	15.6m
	Girder Bottom-River Bed		1356.5m	1326.8m	1297.6m	1369.0m	1055.0m
	HighWater level	EL					
	Water Level (April, May)		0.2m	0.2m	0.9m	0.3m	0.3m
			Design	Design	Design	Design	Design
Proposed Dimension	Discharge (Q m3/s)		111	128	1100	300	350
	River Width(Bridge Length)		15.0m	17.5m	268.8m	52.5m	52.5m
	HighWater level		2.0m	1.8m	2.0m	1.8m	1.9m
	River Bed Width		9.0m	11.5m	260.8m	46.5m	46.5m
	River Bed Level	EL	1352.0m	1327.5m	1297.6m	1366.3m	1090.3m
	Embankment Hight		2.6m	2.6m	3.0m	2.6m	2.6m
	Free Board		0.6m	0.6m	1.0m	0.6m	0.6m
	Hight of Girder + Pavement	EL	1.1m	1.3m	1.9m	1.3m	1.3m
	Road Surface Level(Min)		1355.7m	1331.7m	1303.0m	1370.5m	1094.6m
	Slope of Protection (1:N)		1:1.5	1:1.5	1:2.0	1:1.5	1:1.5

From the results of hydrological analysis, the river sections at the 5 bridges are deemed to be inadequate for the required discharge (Q m3/s) as shown in above Table 4-6-2. This is evidenced by frequent flood marks, damage and broken approach embankments seen at the bridges.

The overall soundness results of the 5 bridges are shown in Table 4-6-3.

Table 4-6-3 Soundness Evaluation Rating for Project Bridges

Evaluation Item			Rating Point 1 2 3 4 good to bad	Br.No1	Br.No2	Br.No3	Br.No.4	Br.No.5
1.Condition	Degree of superstructure damage and defect		1 2 3 4	3	4	3	4	4
	Degree of substructure damage and defect		1 2 3 4	2	4	2(3)	4	4
2.Traffic Level	Low traffic, Heavy vehicle axle load less than 10 tons /less than 10% HGV's		1	1	1	1	1	1
	High traffic, Heavy vehicle axle load greater than 10 tons/ more than 10% HGV's		3					
3.Functionality	Age (years)	Less than 25 years	1		1			
		More than 25 years	3	3		3	3	3
	Road width & Flood flow width	Sufficient width for traffic	1	1				
		Sufficient width for flood flow	3	3	3	3	3	3
Evaluation of Soundness		D: Sound	1					
		C: Farly Sound	2					
		B: Unsound/Low FOS	3	3		3		
		A: Dangerous	4		4		4	4

According to this preliminary evaluation 3 bridges require urgent improvement or replacement, and 2 bridges should be considered for improvement and/or replacement.

4.6.2 Evaluation of Structural Calculation of Existing Bridges

Structural calculations for RC bridges No.1 and No.3 were made taking into account the damage and defects. Stability checks were made for the live-loading systems of both the Mongolian, Japanese and AASHTO standards, as shown in Appendix-c-3 details.

(1) Bridge No.1 (Khujirt River)

The strength of existing RC deck slab and substructure piers/abutments for No.1 bridge gave results as shown in Tables 4-6-4 and 4-6-5. Note that the reinforced concrete sections are assumed because of the lack of as-built drawings.

Table 4-6-4 Results of Strength Check for RC Slab of Superstructure Br. No.1

Application of Live Load	Slab (Length 4.68m) (Thickness 50cm, Reinforcing Bar Dia.19-6.667 no./m)
Mongolia Live Load	M=13.36 tfm Concrete strength σc= 49 kg/cm^2 < Allowable strength σca= 70kg/cm^2 (σck= 210 kg/cm^2) Steel bar strength σs= 1744 kg/cm^2 > Allowable strength σsa= 1400 kg/cm^2 (**Over Strength**) (Yield strength 2400 kg/cm^2)
Japan A, B -Live Load (Axle Load: 10 tf)	M=15.46 tfm Concrete strength σc= 57 kg/cm^2 < Allowable strength σca= 70 kg/cm^2 (σck= 210 kg/cm^2) Steel bar strength σs= 2017 kg/cm^2 > Allowable strength σsa= 1400 kg/cm^2 (**Over Strength**) (Yield strength 2400 kg/cm^2)

Note: Number and Diameter of reinforcing bars: assumption from standard drawing and survey.

Table 4-6-5 Results of Strength Check for Substructure Walls Br. No.1

* Analysis: Calculation for Box type (U- shape @2)

Code	Wall of Abutment Thickness of wall 60cm Reinforcing Bar Dia. 19-5 no./m	Wall of Pier Thickness of wall 66cm Reinforcing Bar Dia. 19-5 no./m
Mongolia Live Load	M=9.69 tfm, N=9.89 tf Concrete stress σc=34 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs= 1126 kgf/cm^2 < Allowable stress σsa= 1600 kgf/cm^2 (Yield stress 3000 kgf/cm^2)	M=3.99 tfm, N=16.00 tf Concrete stress σc=10 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs= 90 kgf/cm^2 < Allowable stress σsa= 1600 kgf/cm^2 (Yield stress 3000 kgf/cm2)
Japan A-Live Load And/or American AASHTO	M=14.33 tfm, N=11.38 tf Concrete stress σc=50 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs= 1777 kgf/cm^2 > Allowable stress σsa= 1600 kgf/cm^2 (Yield stress 3000 kgf/cm^2)	M=7.92 tfm, N=16.51 tf Concrete stress σc=22 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm2) Steel bar stress σs= 525 kgf/cm^2 < Allowable stress σsa= 1600 kgf/cm^2 (Yield stress 3000 kgf/cm^2)

Note: Number and Diameter of reinforcing bars: assumption from standard drawing and survey

The results from the above table show the existing RC slab and walls of Br.No.1 do not have the required factor of safety against the Japanese code in a number of cases, and against the Mongolian code in one case. It is noted, however, that the number of reinforcing bars for super/sub-structure and the shape of buried foundation are assumed because of the lack of as-built drawings.

(2) Bridge No.3 (Kherlen River)

The strength of RC slab and RC T girder of superstructure, and pier of substructure for Br.No.3 (Kherlen river) was calculated as shown in Tables 4-6-6 and 4-6-7. Mongolian Standard of T girder section for 18 m length is shown in Figure 4-6-2.

Table 4-6-6 Results of Strength Check for RC T Girder (Slab) Br. No.3

Code	Slab (length 1.68m) (Thickness 15cm, Reinforcing Bar Dia.13-10 no./m)	Girder (Length 16.8m) (Girder height 1.05m, width 16cm. Reinforcing Bar Dia.29-10 no.)
Mongolia Live Load	M=2.51 tfm Concrete stress σc=110 kgf/cm^2 > Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs=2108 kgf/cm^2> Allowable stress σsa= 1400 kgf/cm^2 (Yield strength 2400 kgf/cm^2)	M=88.44 tfm Concrete stress σc= 54 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs=1817kgf/cm^2 = Allowable stress σsa= 1800 kgf/cm^2 (Yield strength 3000 kgf/cm^2)
Japan A-Live Load And/or AASHTO	M=2.62 tfm Concrete stress σc=115 kgf/cm^2 > Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/c^{m2}) Steel bar stress σs=2200 kgf/cm^2> Allowable stress σsa= 1400 kgf/cm^2 (Yield strength 2400 kgf/cm^2)	M= 102.8 tfm Concrete stress σc= 62 kgf/cm^2 < Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs=2111kgf/cm^2 > Allowable stress σsa= 1800 kgf/cm^2 (Yield strength 3000 kgf/cm^2)

Note: Number and Diameter of reinforcing bars: assumption from standard drawing and survey.

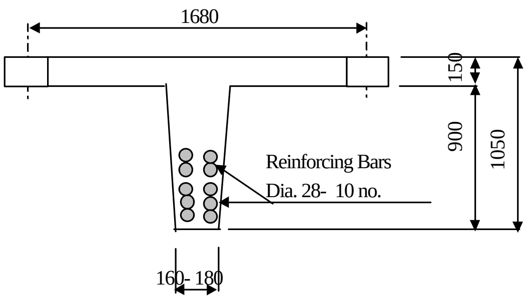


Figure 4-6-2 Mongolian Standard T- Girder Section

Table 4-6-7 Results of Strength Check for Substructure Piers Br. No.3

Code	Pier beam Length 3.0m, Section 1.07*1.20m (Reinforcing bar Dia. 29- 15 no.)	Shoe bed (reinforcing bar area 1070cm2) And Stability of Caisson
Mongolia Live Load	M=152 tfm Concrete stress σc=73 kgf/cm^2 > Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs=1770 kgf/cm^2 < Allowable stress σsa= 1800 kgf/cm^2 (Yield strength 3000 kgf/cm^2)	Pier shoe bed Shearing force 3.7 ton Working stress τ = 3.4 kgf/cm^2 < Allowable stress τa= 8.5 kgf/cm^2 Caisson stability : Stabled
Japan A-Live Load And/or AASHTO	M=179 tfm Concrete stress σc=86 kgf/cm^2 > Allowable stress σca= 70 kgf/cm^2 (σck= 210 kgf/cm^2) Steel bar stress σs=2078 kgf/cm^2> Allowable stress σsa= 1800 kgf/cm^2 (Yield strength 3000 kgf/cm^2)	Pier shoe bed Shearing force 4.4 ton Working stress τ = 4.1 kgf/cm^2 < Allowable stress τa= 8.5 kgf/cm^2 Caisson stability : Stabled

Note: Number and Diameter of reinforcing bars: assumption from standard drawing and survey.

These results show the girders of Br.No.3 meet the Mongolian code, however, stresses in the slab, girder and pier beam exceed allowable working stresses. When checked against the Japanese code, the structure is highly under-strength.

As can be also seen in the results of the survey, the existing girders are damaged with shearing and bending cracks caused by the excessive vertical loads.

(3) Wooden Bridge (Br.No.2 Khutsaa River, Br.No.4 Tsenkher River, Br.No.5 Murun River)

The three wooden bridges are temporary. The wooden deck slabs and piling supports are broken and settled. Moreover, the approach parts between wooden wall and embankment are broken/inclined due to heavy traffic loads, impact and flood flow. The heavy trucks and trailers cannot pass over Br.No.4, and Br.No.5 at present.

4.6.3 Results of Overall Evaluation

The results of overall evaluation for the Project bridges are summarized in Table 4-6-8.

It is recommended that Br.No.1 (Khujirt River) be replaced by reasons of inadequate river section for the design discharge, below strength according to the Japanese live loading standards, and deterioration due to its advanced age. The bridge should not be used in the long term for the future Millennium International Road.

Three timber bridges Br.No2 (Khutsaa River), Br.No.4 (Tsenkher River) and Br.No.5 (Murun River) should be replaced with permanent type reinforced concrete structures.

Br.No.3 (Kherlen River) is also recommended for replacement and/or reinforcement due to poor evaluation result on most points.

Table 4-6-8 Overall Evaluation Results for Project Bridges

	Exising Bridge Category	Br.No1 Khujirt River	Br.No.2 Khtsaa River	Br.No.3 Kherlen River	Br.No.4 Tsenkher River	Br.No.5 Murun River	Remark
Scale of Bridge	Bridge Length	9.2m	14.7m	268.8m	30.7m	19.6m	Total length
	Width	6.7m	5.6m	7.0m	5.6m	5.6m	Carriageway width
	Type:Superstr. Type:Substr.	RC slab RC wall	Wooden slab Wooden pile	RC T girder RC wall	Wooden slab Wooden pile	Wooden slab Wooden pile	Super structure Sub structure
	River	W:8m, H:2.7m	W:15m, H:2.8m	W:270m, H:4.2m	W:30m, H:1.2m	W:20m, H:1.3m	W:width, H:clearance
Method for Evaluating Stability of Existing Bridge	Stability A. soundness — (Factor) Durability : Degree of damages and Defects of Structures Load Capacity : Degree of Heavy Traffic Volume Functional : Constructed Year; Carriageway Widh from Traffic Volume; Required River Section from Design Discharge B. Structural Calculation Stability for Substructure (Overturn, Slide, Bearing) Strength for Superstructure Working Strength <, > Allowable Strength (Based on the International Standard, the strengths of structural section for the bridge shall be calculated.)						
Conditions (A:Soundness)	Durability (super) (sub)	**3**: Leaked **2**: Carbonated	**4**: Damaged **4**: Broken	**3**: Cracks, Gaps **2**: Deteriorated	**4**: Broken **4**: Settled	**4**: Damaged **4**: Inclined	Degree of Damage, defect good:1- bad:4
	Load Capacity (Vehicle 12 ton base)	**1**: 8.4%	**1**: 4.8%	**1**: 4.8%	**1**: 4.8%	**1**: 7.8%	Ratio of Heavy Vehicle 10%: less:1- more:3
	Function: Constructed year Carriage width River section	 **3**: 1970s **1**:6.7m(improve) **3**: 15m required	 **1**(3): 1995y **3**: 5.6m **3**: 17.5m required	 **3**: 1974y **3**: 7.0m **3**: 350m required	 **3**: 1962y **3**: 5.6m **3**: 52.5m required	 **3**: 1962y **3**: 5.6m **3**: 52.5m required	 25year:less:1- more:3 8m:enough:1- short:3 section:enough:1- short:3
Conditions (B:Structural Study)	Applied Mongolian Live Load	Slab:Over Stress Wall:Allowable (for Abutment & Pier) **Not Stabled**		Girder:Allowable Slab:Over Stress Pier:Allowable **Not Stabled**			
	Applied International Live Load	Slab:Over Stress Wall:Over Stress (for Abutment) **Not Stabled**	Temporary Wooden Type **Danger**	Girder:OverStress Slab:Over Stress Pier:Over Stress **Not Stabled**	Temporary Wooden Type **Danger**	Temporary Wooden Type **Danger**	
Overall Evaluation	Soundness Survey	**3**	**4**	**3**	**4**	**4**	Rank of Evaluation **D**:Sound, Stabled (**1**) **C**:Fairy Sound & Fairy Stabled (**2**)
	Structural Calculation (capacity)	**3**	**4**	**3**	**4**	**4**	**B**:Unsound & Not Stabled, Repair or Replace(**3**)
	Overall Rank	**B**	**A**	**B**	**A**	**A**	**A**:Danger, Replace(**4**)

- Concrete Culverts

  Evaluation for Crossing Culvert Structures

  There are many crossing culvert structures along the Project Road. The type of culverts are: pre-cast concrete pipe, pre-cast concrete square type, and steel pipe.

  The pre-cast concrete pipes embedded in concrete mortar in Baganuur city are sound. These culverts show no defects or damage, and are covered by solid asphalt pavement on the embankment.

  However, the other culverts crossing along the Project road are in poor condition and most are broken and defective. They are not suitable for the Project.

- Other Reference for the existing structures

  (1) Report: [Explanation of Reinforcement for Kherlen Bridge Br.No.3]
  (December, 1993 Ulaanbaatar City Government)

  1) Results of Inspection and Reasons for Reinforcement / Repair

  Kherlen Bridge has been inspected by a working group of Autozam Company cooperating with Moscow University in 1990. It has also been investigated by Khan Khentii Contractor and MONAZ Company in 1992/1993, who advised to reinforce and/or repair the bridge urgently.

  In summary, the findings were:

  - The foundation of the fifth pier from Undurkhaan side was constructed eccentrically, leading to cracking in the pier due to lack of stability.
  - Traffic flow was hindered due to deteriorated and uneven surface of the concrete pavement.
  - Concrete strength of the girders was 70 to 80% of designed 28-day strength. (Poor mixing materials, quality)
  - The girders were damaged / defective due to poor casting, erection and setting.
  - The revetment and approach were scoured by floods.

  2) Reinforcement/ Repair

  The damaged areas were reinforced / repaired:

  - Revetment and approach embankment
  - Expansion joints
  - Approach slab behind abutments
  - Pedestrian ways and carriage surface
  - Reinforcement with foundation on caisson at fifth pier
  - Girder surface and end parts with concrete mortar

4.7 Review of Recent Bridge Construction Project

Bridges have been constructed by Russian / Chinese Contractors in Mongolia since 1960s in accordance with Russian Standard. Recent bridges by Mongolian contractors since the 1990s apply the Mongolian Standard which is based on the Russian Standard.

Recent Trunk Roads projects in Mongolia funded by the Asian Development Bank, the Kuwait Fund and Japanese Grant Aid apply various Design Standards such as American and Japan standards, etc.

Recent and ongoing bridge projects in Mongolia are shown in Table 4-7-1. New bridges on recent ODA projects were of reinforcing concrete and prestressed concrete types.

Table 4-7-1 List of Recent Constructed Bridges Project in Mongolia

Location	Type	Constructed	Conditions
Gurvaljin Bridge in Ulaanbaatar	RC T Girder	1989	Defects exposed re-bar, cracks in girders
Dambadarjaa Bridge in Ulaanbaatar	RC T Girder	1990	Exposed re-bar due to lack of cover
Ikh Tenger Bridge in Ulaanbaatar	RC T Girder	1994	Broken girders near shoes, exposed re-bar, cracks
Dambadarjaa Bridge in Ulaanbaatar	RC T Girder	1995	Exposed re-bar on bottom of girders, efflorescence on slab
Bor nuur Bridge at UB- Darkhan	RC T Girder	1999	Exposed re-bar due to debris during floods, cracks in girder
Orkhon Bridge at Darkhan-Altanbulag(ADB)	PC Box Girder	1999	Good condition
Hangal Bridge at Darkhan-Erdenet(Kuwait)	PC Box Girder	2000	--
Khuurain Khundii Bridge (Kuwait)	PC Hollow Slab	2000	--
Nalaikh- Maanti Bridges(ADB)	RC Slab	---	Starting Construction
Dood Selbe bridge on Teeverchid (Japan)	RC T Girder	---	Starting Construction

4.8 Review of Pavement Structures on Recent Road Construction Projects

The review of existing pavement structures on recent road construction projects in Mongolia was carried out to examine a suitable pavement structure for the Study. The field investigations aimed to find a pavement structure that is deemed suitable from an economical viewpoint as well as for ease of maintenance: namely low initial investment cost and better performance through the project life cycle. Projects by JICA, ADB, Kuwait Fund, the World Bank and the DOR are described in this chapter, and preliminary recommendations made on pavement type.

4.8.1 JICA Road Construction Project

(1) Background of the project

In 1993, Mongolia requested to Japan to provide grant aid for the procurement of equipment needed to accomplish the country's road construction and equipment development plan. In response, the Japanese government sent a project survey team , which led to a pilot construction program using domestically produced rock asphalt as a possible means of reducing dependence on imported bitumen as pavement material.

(2) Outline of the Project

The first road construction project by JICA was called “The Project for Road Construction utilizing Rock Asphalt in Mongolia”. It was conducted by Pacific Consultants International in association with Japan Overseas Consultants Co., Ltd between 1996 and 1998.

1) Rehabilitation Section

It is approximately 17.8 km long section from Terelj Fork to Aguit pass. It was split into three types of rehabilitation as follows.

- Reconstruction of 600 m section, which was totally damaged by insufficient material used for base course, underground water and poor drainage system.
- Repair of small-scale damage such as potholes and cracks.
- Overlaying widely damaged area

From observation at site, the following problems were found.

- Thickness of base course was not sufficient.
- Grading of mechanically stabilized aggregates was not smooth and pebbles were used in the mixture.
- Thickness of the asphalt mixture was not uniform.
- No prime coat is applied on the base course.

2) Pilot Construction Section

Approximately 13.3 km long section was constructed from entrance to Bayan pass to Erdene sum. New pavement design was based on the Japanese Manual for Asphalt Pavement and the following values were obtained.

Traffic: L - Class traffic volume based in Japanese Manual for Asphalt Pavement
ESAL is based on 5-ton wheel load
ESAL for 10-year period was approximately 365,000

Pavement structure selected was as follows.

Surface Course (Rock Asphalt Mixture)		:	6 cm
Base Course	(CBR = 80 %)	:	18 cm
Subbase	(CBR = 30 %)	:	20 - 25 cm

After completion of the pavement, the following result was obtained.

- After passing a winter season, a large amount of cracking was found due to low capacity of relaxation of stress at low temperatures.
- However, it was in a stable condition due to the rigid base, proper asphalt mixing, and proper drainage.

4.8.2 ADB First Road Development Project

(1) Background of the project

The project road was originally constructed between 10 and 25 years ago and had largely outlived its reasonably expected life.

The original pavement structure was marginally constructed, composed of a bituminous surfacing layer of 80 mm thickness resting directly on a gravelly subbase of variable quality, with no base layer present and road pavement damage like cracking, heaving and disintegration that are largely associated with extremely low temperature.

Intercontinental Consultants and Technocrats Pvt. Ltd., (ICT) and Scott Wilson Kirkpatrick (SWK) were selected for Detailed Engineering Design and Preparation of Tender Documents.

(2) Outline of the project

The project road is from Ulaanbaatar, Capital of Mongolia to Altanbulag, border to Russia and covered approximately 310 km (from km 18.8 to km 345.1).

Followings are major items of the project.

- The project consisted of four types of work such as “periodic maintenance”, “rehabilitation”, “partial reconstruction” and “full reconstruction”.
- Periodic maintenance is Seal Coat or Patching or Crack Sealing on existing surface and the length was approximately 139 km.
- Rehabilitation is AC (asphalt concrete) Surfacing (50mm) and Crushed Base (100-300 mm) on scarified existing surface and the length was approximately 73 km.
- Partial Reconstruction is AC Surfacing (50mm), Crushed Base (200 mm) and Granular Subbase (100-300 mm) and the length was approximately 80 km.
- Full Reconstruction is AC Surfacing (25 mm), Binder Course (50 mm), Crushed Base (250 mm), Granular Subbase (200 mm) and Non-frost Subgrade (300-600 mm) and the length was approximately 20 km.

(3) Pavement Design

The structural design of pavement was performed by using Transport and Road Research laboratory (TRRL) Road Note 31.

1) Evaluation of traffic

For the purposes of estimating design traffic, the following Road Note 31 Method was used.

- standard axle load is 8.16 tons
- ESAL (Equivalent Standard Axle Load) for W tons is
  ESAL w = (W / 8.16) 4.5

- the proportion of traffic that comprises heavy vehicles is 20%
- over a 10-year period between 2000 and 2009, the cumulative ESAL is approximately 400,000 and 20-year period between 2000 and 2019 is approximately 1,100,000.
- The 10-year cumulative ESAL corresponds to traffic class T2 (0.3-0.7 million ESAL) and 20-year cumulative ESAL corresponds to T3 (0.7-1.5 million ESAL).

2) Surface Type

For choosing the pavement surface type, it is adequate to consider traffic volume up to the 10th year, since the life of the initial surfacing will be coming to an end and a new surfacing will have to be provided around the 10th year.

Traffic in terms of ADT at the end of the 10th year will be in the range 540-774 vehicles/day for different road sections. For this range of traffic, double bituminous surface treatment (DBST) will be an adequate surfacing.

3) Pavement structural design

Pavement structural design has to take into following considerations.

- Subgrade design CBR
- Pavement materials
- Cumulative axle loading (ESAL) and design life in years
- Climate particularly precipitation, temperature and hydro-geological regime

From the result of soil investigation, selected soil subgrade (having minimum design CBR 7 which is achievable) was concluded. With DBST surfacing and CBR 7 subgrade, the rest of the pavement structure consisting of 2 layers as follows.

- Graded aggregate base course
- Graded aggregate subbase using riverbed or pit gravels or sand gravels.

As a warm climate design criteria based on TRRL Road Note 31 a typical pavement structure for T3 traffic and S3 subgrade (5-7 CBR) might consist of:

- DBST surfacing
- 200 mm crushed aggregate base course
- 225 mm granular subbase

As a measure of frost protection, it was recommended that the thickness of the crushed aggregate base course should be increased to 250 mm.

4.8.3 ADB Second Road Development Project

(1) Background of the project

The project road was selected in the Road Master Plan and a Feasibility Study conducted by ADB in 1995; it was part of the Asian Highway and connected between Ulaanbaatar and Zamin-Uud. The existing project road was a natural pass and many routes existed.

The original route between Nalaikh and Maanti, 70 km section was detail designed by ICT and was reviewed in 1999.

Japan Overseas Consultants Co., Ltd. in association with SERGELT were selected for Detailed Engineering Design and preparation of tender documents in 2000.

(2) Outline of the project

The project road is from Nalaikh, satellite city of Ulaanbaatar to Choir, capital of Dornogovi Province and covered approximately 200 km.

The following are major items of the project.

- Detailed design between Maanti and Choir, which is 130 km section.
- Review for the Nalaikh and Maanti section, which is 70 km section.

(3) Pavement Design

The structural design of pavement was performed by using "Thickness Design - Asphalt Pavement for Highways and Streets" by the Asphalt Institute of the United State of America.

The design procedure is as follows:

- To determine required thickness based on subgrade resilient modulus and designed traffic volume for full-depth asphalt concrete (AC).
- To calculate required structural number for the full-depth AC based on layer coefficient of AC.
- To determine thickness of each layer of pavement such as surface course, base course and subbase based on layer coefficient of each component of pavement.

1) Subgrade Resilient Modulus

The subgrade resilient modulus is estimated from CBR-value of the subgrade using a following empirical equation:

$$Mr = 10.3\ CBR$$

Where,

Mr (Mpa) : resilient modulus
CBR (%) : CBR - value of subgrade

2) Design Traffic Volume

The design traffic volume is expressed as cumulative expected 80 kN equivalent single axle loads (ESALs) during the analysis period. The analysis period is 20 years assumed between 2004 and 2024.

The design traffic volume in ESALs is as follows:

Nalaikh - Maanti	:	805,000
Maanti - Choir	:	660,000

3) Pavement Structure

In consideration of initial cost, performance period (durability of surface), maintenance cost for the 20 years analysis period, and availability of material, an option of asphalt pavement covering the full stretch of the road was selected in the Draft Bidding. However, reducing the initial cost was discussed with DOR, and a combination of AC surface and double bituminous surface treatment was finally adopted.

Adopted pavement structure was as follows.

- Type 1: AC surface (50mm), Base Course (150 mm) and Subbase (250 mm)
- Type 2: DBST surface, Base Course (150 mm) and Subbase (400 mm)
- Type 3: DBST surface, Base Course (150 mm) and Subbase (500 mm)

4.8.4 Kuwait Fund Road Project

(1) Background of the project

The project road is situated in the province of Selenge and Bulgan, connecting two major cities Darkhan and Erdenet. The existing road between Darkhan and Erdenet was constructed during the period of 1973 to 1976 when the copper mines and city of Erdenet were developed. The extremely severe climate in Mongolia and insufficient periodic maintenance have caused deterioration in many sections.

To improve the road section, Intercontinental Consultants and Technocrats Pvt. Ltd. (ICT) and Scott Wilson Kirkpatrick (SWK) was selected for Detailed Engineering Design and preparation of tender documents.

(2) Outline of the project

The 183 km road section runs from Darkhan to Erdenet. Depending on terrain and existing road condition, it was divided into several sections.

However, only four types of pavement structure were used as follows.

- Type 1 is the existing asphaltic concrete surfaced pavement cracked but with no sign of load associated damage requiring an asphaltic concrete overlay.

- Type 2 is badly cracked, raveled or disintegrated asphalt in poor condition or regravelled pavement requiring scarification, reshaping and recompacting existing surface, the provision of subbase and base pavement layers and surfacing.
- Type 3 is an existing concrete pavement requiring a crack relief layer of grade crushed gravel and surfacing.
- Type 4 is requiring construction of embankment and pavement.

Despite the low traffic volume, light weight of traffic and with most industrial products being transported by rail, the pavement has not performed well for the following reasons.

- Inadequate initial design
- Poor construction control measures, particularly in respect of compaction
- The extreme severe climate
- Insufficient road maintenance
- Poor road drainage exacerbating any potential for frost heave or freeze-thaw action in the subgrade.

(3) Pavement Design

The structural design of pavement was performed by using an Analytical-Empirical design Methodology, which assumes the use of standard pavement materials and allows varying subgrade conditions.

1) Evaluation of traffic

For the purposes of estimating design traffic, the following conservative assumptions were made:

- one heavy goods vehicle is equivalent to two standard axles of 10 tons
- the average daily traffic is 350 vehicles per day
- the proportion of traffic that comprises heavy vehicles is 20%
- over a 10-year period the traffic in each direction is 250,000 standard axles
- this traffic volume will double as a result of a predicted improvement of the Mongolian economy and generated traffic

The design traffic adopted for the project road was 500,000 standard axles.

2) Evaluation of elastic parameters of individual pavement layers.

The following values were adopted for designing the pavement structure.

a) Asphaltic concrete surface : 3,500 Mpa
b) Surface dressing : 1,000 Mpa
c) Crushed gravel base courses : 300 Mpa

d) Subbase material : $E_{subbase} = 0.21 \times (h_{subbase}^{0.45}) \times E_{subgrade}$
h is in mm, E is in MPa

e) Subgrade : $E_{subgrade} = 17.6 \times (CBR)\ 0.64$
CBR is in percentage, E is in Mpa

(4) Calculation of pavement layer thickness

ICT suggested using double seal surface dressing rather than a thin layer of asphaltic concrete by following reasons.

- In order to minimize thermally induced cracking (bituminous sealing layer should be flexible)
- The low volume traffic anticipated on the project road

However the DOR technical committee later ruled that the Project Road be surfaced with a 50 mm layer of asphaltic concrete.

Concerning this matter, ICT has commented that this will lead to early cracking.

The design thickness of subbase layers as a function of subgrade CBR values are given in Table 4-8-1.

Table 4-8-1 Design Subbase Thickness as a Function of Subgrade CBR

Subgrade CBR	Thickness of subbase
2 - 3 %	520 mm
3 - 5 %	420 mm
5 - 8 %	320 mm
8 - 15 %	230 mm
15 - 30 %	150 mm
> 30 %	100 mm

After computing subbase thickness, the following pavement types were selected.

- Type 1: 50 mm overlay of asphaltic concrete with a bituminous leveling course and cold milling of existing pavement.
- Type 2: scarifying existing surface, reshaping and compacting and providing subbase of minimum thickness 100 mm, base course of 150 mm and 50 mm thick asphaltic concrete surface.
- Type 3: same as Type 2 except 150 mm thick subbase.
- Type 4: same as Type 2 except 230 mm thick subbase.
- Type 5: same as Type 2 except 320 - 520 mm thick subbase.

4.8.5 World Bank Transport Rehabilitation Project

(1) Background of the project

The road is situated in the provinces of Uvurkhangai, Arkhangai and Zavkhan and connecting between Kharkhorin - Tsetserleg - Tosontsengel. It is one of the major routes towards the west and average daily traffic was between 100 - 200 vehicles. The area is suitable for tourism. The existing road was severely damaged and heavily rutted especially in winter season. In March 1997 a feasibility study including various survey such us road inventory, traffic counting, material survey etc. was carried out.

(2) Outline of the project

The 454 km road section is from Kharkhorin to Tosontsengel. Pavement design was carried out by DOR itself and it was 6m width asphaltic concrete pavement and 2 m shoulders. However, SWK has reviewed it and proposed a gravel road as feasible, and a partially constructed 200 mm thick gravel road would serve as part of staged construction for a future asphaltic concrete pavement.

(3) Existing Condition

A site visit was carried out on May 22, 2001 and photographs shown below taken. Photographs already show potholes and rutting on the surface after one year since construction. In addition, there is loss of fine aggregates on the top of the gravel road and large angular stones were exposed.

These kinds of defects may cause reduced riding comfort and without frequent maintenance, it is very difficult to keep good riding comfort on this kind of gravel road.

Photograph 4-8-1 Large amount of potholes on Gravel Road

Photograph 4-8-2 Rutting on Gravel Road

Photograph 4-8-3 Exposed large stones

4.8.6 DOR Road Construction Projects

Current road construction projects carried out by DOR are as follows.

(1) Nalaikh - Bayan Pass Road Construction Project

The road connects Ulaanbaatar and Erdene sum. The 28 km section was designed by local consultant (MONAZ) in 1990. Subsequently, the sections before Aguit pass and after Bayan pass were deleted and become part of JICA's project section. A 10.5 km section was constructed by local contractor (Tuv Zam Company).

According to the design, the pavement structure was 4 cm Rock Asphalt concrete surface, 5 cm Rock Asphalt concrete binder course and 27 cm base course. However, it was changed by the Technical Committee at the time of construction and 7 cm Asphaltic Concrete surface and 15 to 20 cm base course were adopted.

(2) Elsentasarkhai - Kharkhorin Road Construction Project

The road connects Ulaanbaatar and Kharkhorin is 86.6 km long. It was split into 5 sections as shown in Figure 4-8-1.

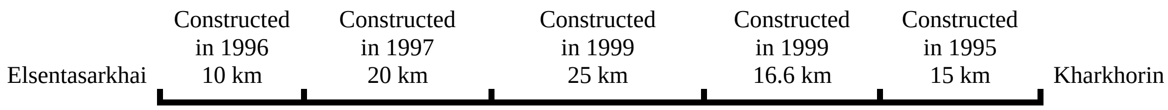


Figure 4-8-1 Project Sections in Elsentasarkhai-Kharkhorin Road

The pavement structure was designed by DOR and Bridge Design Laboratory using SNIP, the Russian Design Standard in 1990. It was originally designed as 3 cm fine grade asphaltic concrete surface, 6 cm bituminous treated base course and 20 cm gravel base with 40 to 70 mm crushed aggregate.

However, it was changed by the Technical Committee to two layers of asphaltic concrete courses consisting of 7 cm surface course in hot-mixed asphaltic concrete, and 8 cm of asphalt treated base course using cutback asphalt and 20 cm aggregate base course.

All sections have the same cross-section, which is 3 m paved road and 2 m shoulders.

4.8.7 Comparison of Pavement Structures

As described in Chapter 4.8.1 to 4.8.6, several projects have adopted different methods for designing pavement structures.

A summary is shown in Table 4-8-2.

Table 4-8-2 Comparison of Pavement Structures in Each Project

	JICA Road Construction Project	ADB First Road Development Project	ADB Second Road Development Project	Kuwait Fund Road Projects
Consultants	Pacific Consultants in association with Japan Overseas Consultants Co., Ltd.	Intercontinental Consultants and Technocrats Pvt. Ltd. (ICT) and Scott Wilson Kirkpatrick (SWK)	Japan Overseas Consultants Co., Ltd. in association with SERGELT	Intercontinental Consultants and Technocrats Pvt. Ltd. (ICT) and Scott Wilson Kirkpatrick (SWK)
Design Method	Japanese Manual for Asphalt Pavement	Transport and Road Research laboratory (TRRL) Road Note 31	"Thickness Design - Asphalt Pavement for Highways and Streets" by Asphalt Institute in the United State of America	The Analytical-Empirical design Methodology (Theory of elasticity)
ESAL's	**365,000** for **10** year period (Assuming maximum of L class traffic)	**400,000** for **10** year period	-	**500,000** for **10** year period
	-	**1,100,000** for **20** year period	**805,000** in Nalaikh-Maanti **660,000** in Maanti-Choir for **20** year period	-
Convert to ESAL	$ESAL=(w/5)^{4}$ * w: wheel Load	$ESAL=(w/8.16)^{4.5}$ * w: Axle Load	$ESAL=(w/8.16)^{4.5}$ * w: Axle Load	One heavy goods vehicle is equivalent to 2 x 10 tons axle *ignore small vehicles
Subgrade **CBR**	**12**	**7**	**10**	**2 - 30**
	Pavement Structure			
Surface course	6cm Rock Asphalt mixture	2.5cm A/C mixture	5cm A/C mixture or 2.5cm DBST	5cm A/C mixture
Binder Course	-	5cm A/C mixture	-	-
Base Course	18cm Crushed Aggregate	25cm Crushed Aggregate	15cm Crushed Aggregate	15cm Crushed Aggregate
Subbase	20 - 25cm Granular base	25cm Granular base	25 - 40 cm Granular base	10 - 52cm Granular base
Total Thickness	44 - 49 cm	57.5 cm	45 - 60 cm	30 - 72 cm

Note: Pavement structures in table is shown in new construction / full reconstruction only.

4.9 Review of Detailed Design by Department of Roads

The Department of Roads (DOR) has completed the detailed design between Erdene and Undurkhaan from 1992 to 1998 as shown in Figure 4-9-1. The detailed design covers 206 km long road in total. After the completion of detailed design, the implementation of project is limited to two sections. One is 3 km long stretch at Murun in Khentii province that the DOR had started the earthwork but it was suspended in 1998 due to shortage of fund, and another is 5 km long stretch at Erdene in Tuv province that the DOR starts the earthwork recently and it is planned to complete in 2001as a part of Millennium Road Plan.

4.9.1 Design of Road

(1) General

An approval letter of DOR Director is required to start any detailed design work using DOR budget, and such letter should contain name of owner, name of consultant, period of design, budget and design criteria/specifications such as road class, width of major cross section element, major construction materials, minimum height of embankment, necessity of geological investigation and so forth.

The detailed design between Erdene and Murun was carried out in accordance with the approval letter, but the letter and a part of the drawings between Murun and Undurkhaan were missing.

The detailed design except the existing paved road in Baganuur was divided into seven sections, and the design of each section was made based on its own topographic maps at a variety of scales.

Table 4-9-1 shows the summary of detailed design by each section.

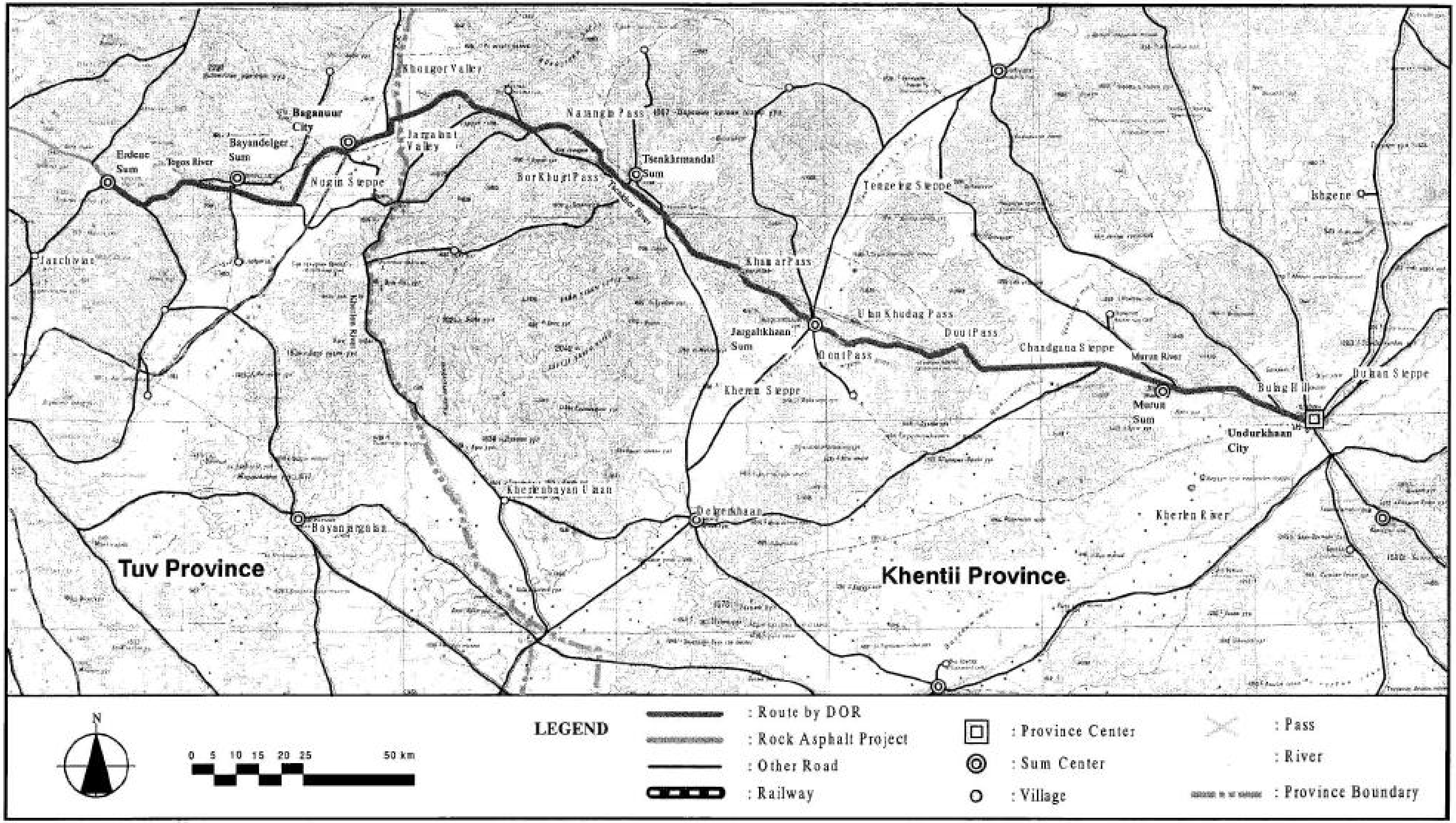


Figure 4-9-1 Designed Route by Department of Roads

Table 4-9-1 Summary of Detailed Design

No.	Volume	Section	Design Year	Length (km)	Scale			Design Company	Custody Agency
					Plan	Profile	Cross Section		
1	-	Erdene - Bayandelger	1992	20.0	1:500	1:1,000 1:5,000	1:200	State Road and Bridge Design Research	DOR
2	-	Bayandelger - Baganuur	1992	16.8	1:5,000	1:500 1:5,000	1:200	Erdeneburen Company	DOR
3	A	Baganuur - Tsenkhermandal	1998	1.8	1:5,000	1:200 1:2,000	1:200	Monaz Company	DOR
	B	Baganuur - Tsenkhermandal	1998	9.0	1:5,000	1:500 1:5,000	1:200	Monaz Company	DOR
	C	Baganuur - Tsenkhermandal	1998	21.0	1:5,000	1:500 1:5,000	-	Monaz Company	DOR
	D	Baganuur - Tsenkhermandal	1998	20.1	1:5,000	1:500 1:5,000	1:200	Monaz Company	DOR
4	-	Tsenkhermandal - Tsenkher Bridge	1998	13.7	1:5,000	1:500 1:5,000	1:200	Avto Zam Science and Industry Public Corporation	DOR
5	A	Tsenkher Bridge - Duut Pass	1998	21.0	1:2,500	1:250 1:2,500	1:250 1:500	Sergelt Company	DOR
	B	Tsenkher Bridge - Duut Pass	1998	22.5	1:2,500	1:500 1:2,500	1:250 1:500	Sergelt Company	DOR
	C	Tsenkher Bridge - Duut Pass	1998	20.1	1:2,500	1:500 1:2,500	1:250 1:500	Sergelt Company	DOR
6	-	Duut Pass - Chandgana Steppe	1998	20.0	1:1,000	1:500 1:5,000	1:200	Intersection Company	DOR
7	-	Chandgana Steppe - Murun	1996	20.0	1:5,000	1:500 1:5,000	-	Monaz Company	Khentii Branch, DOR
Total				206					

(2) Route Description of Existing Routes

The DOR design follows the existing route in principle although multiple shifting tracks are found. However, the DOR proposed route is different from the existing route in the section between 3-leg intersection in Baganuur and Jargalant crossroads.

There are two existing routes: namely, the northern and the southern routes as shown in Figure 4-9-2. The northern route runs northward from a 3-leg intersection, passes the existing paved road in Baganuur urbanized area, bypasses the facilities of Baganuur coal mine in the north, crosses wooden bridge over the Khutsaa river and runs southward in the Nuga steppe up to Kherlen Bridge.

The southern route runs eastward to avoid the Ikh Gun lake, bypasses the south end of Baganuur coal mine, underpasses railway bridge, crosses floodplain of the Khutsaa river and runs to Kherlen bridge. This route is not available during summer because no bridge crossing the Khutsaa River exists.

Both routes pass Kherlen Bridge and divert their route to pass either Jargalant valley or Ust valley to get to Jargalant crossroads.

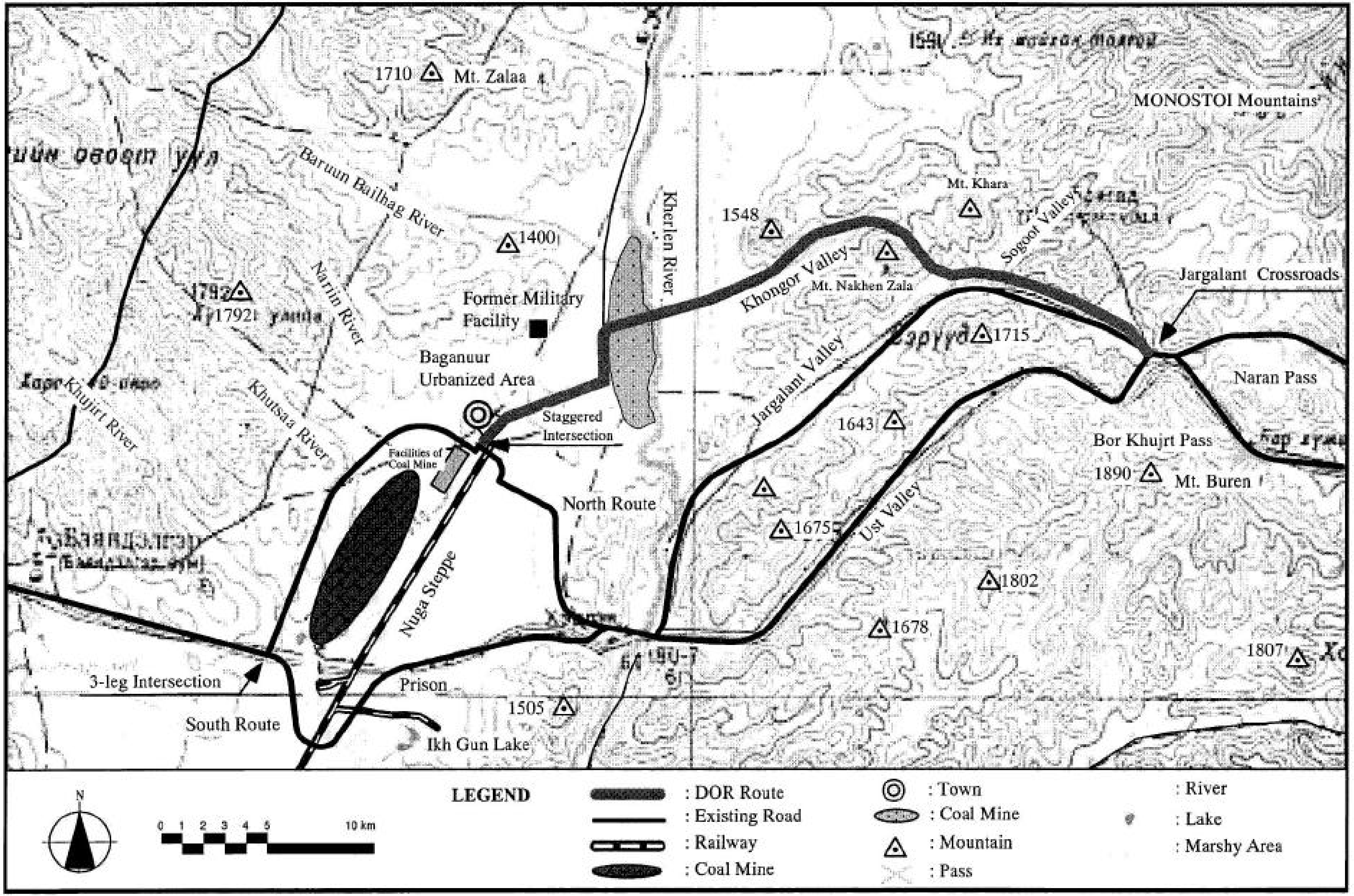


Figure 4-9-2 Designed Route by DOR surroundings Baganuur

(3) Route Description of DOR Proposed Route

The DOR proposed route shares the same route as that of the northern route in Baganuur urbanized area and it runs northward, passes the east side of Baganuur urbanized area, runs toward water source area through existing paved road, turns to the north and runs parallel to the fences of pumping facilities, crosses the Kherlen river and pass through Khongor valley as shown in Figure 4-9-2. After passing Khongor valley, the route runs southward, pass in between Nukhen Zala Mountain and Kharaat Mountain, merges Jargalant valley along Sogoot valley. The existing road of northern route passes south of Jargalant valley. While, the route passes north of the valley, runs eastward along the valley, reaches to Jargalant crossroads, and merges the existing road of northern route.

In winter, traffic from Baganuur urbanized area crosses the Kherlen River located approximately 7 km north in Baganuur without using of Kherlen Bridge located approximately 9 km south because the Kherlen River is frozen up.

The DOR proposed route is planned to utilize the existing paved road in Baganuur as much as possible along the winter route.

This route is planned to cross the Kherlen River at a skew angle, totaling 4.35km. Structures crossing the Kherlen River consist of six bridges and three gravel filter culverts. Six bridges were designed against main streams, totaling 550.2 m (343.5 m, 36.7 m, 24.0 m, 24.0 m, 55.0 m and 91.0 m) and three gravel filter culverts were designed against tributary, totaling 55 m (15.0 m, 20.0 m and 20.0 m). Revetments are designed not for stability of stream but for protecting abutment. Therefore, the length of revetment is rather short and the type is various; for example, rolling toward abutment in length 150 m, projection against stream in length 100 m located at 200 m set back from abutment, and so forth. Slope protection is designed using precast concrete block at revetment and masonry at embankment, without embedment both.

(4) Design Criteria and Typical Cross Section

Table 4-9-2 shows applied design element, typical cross section and pavement structure by each design section.

According to typical cross section, design section is classified into three: namely, the first part between Erdene (Section 1) and Baganuur (Section 3-A), the second part between Baganuur (Section 3-B) and Chandgana Steppe (Section 6) and the third part between Chandgana Steppe and Murun (Section 7). Each part is designed as Class I, II and I respectively referring to the design criteria.

Design speed is ambiguous and it is to be determined depending on the terrain.

Minimum horizontal curve radius and maximum vertical gradient were adopted 150 m and 6.07 % respectively at the first part. Applied design speed seems to be 60 km/h in mountainous of Class I, estimating the applied design element and referring road design criteria. Minimum horizontal curve radius and maximum vertical gradient were adopted

125 m and 8.52 % respectively at the second part. In the same way, applied design speed is corresponding with 40 km/h in mountainous of Class II. Minimum horizontal curve radius and maximum vertical gradient were applied 150 m and 2.5% respectively at the third part. In the same way, applied design speed is corresponding with 80 km/h in rolling of Class I.

Materials of road surface were designed asphalt concrete at the first part, gravel at the second part and the third.

Figures 4-9-3 and 4-9-4 show typical cross sections respectively.

Table 4-9-2 Design Component of Route by DOR

No.	Volume	Width (m)		Crossfall (%)		Minimum Radius	Maximum Grade		Slope Grade	Type of pavement	Thickness of Pavement
		Lane	Shoulder	Total	Lane	Shoulder	m	%			(mm)
1	-	3.5	2.5	12.0	2.0	4.0	150	6.07	1:1.5	Asphalt Concrete	360
2	-	3.5	2.5	12.0	2.0	4.0	250	6.00	1:1.5/ 2 /3	Asphalt Concrete	360
3	A	3.5	2.5	12.0	2.0	4.0	0	1.10	1:3	Asphalt Concrete	210
	B	3.0	1.0	8.0	3.0	4.0	200	3.60	1:1.5	Gravel	200
	C	3.0	1.0	8.0	3.0	4.0	250	7.60	1:1.5 /3	Gravel	200
	D	3.0	1.0	8.0	3.0	4.0	250	6.50	1:1.5 /3	Gravel	200
4	-	3.0	1.0	8.0	3.0	4.0	250	3.40	1:1.5	Gravel	200
5	A	3.0	1.0	8.0	3.0	4.0	125	7.18	1:1.5	Gravel	200
	B	3.0	1.0	8.0	3.0	4.0	500	5.18	1:1.5 /3	Gravel	200
	C	3.0	1.0	8.0	3.0	4.0	180	8.52	1:3	Gravel	200
6	-	3.0	1.0	8.0	3.0	5.0	200	2.00	1:1.5	Gravel	200
7	-	3.5	1.5	10.0	2.0	3.0	150	2.50	1:1.5 /3	Gravel	200