CHAPTER 7

DESIGN OF FLYOVER AND ACCESS ROAD

7.1 BASIC POLICIES

(1) Basic Policies of Bridge Plan

i) Constraints by Climate Conditions

Due to the harsh climate conditions in temperatures lower than minus 40°C during midwinter, main construction work using concrete and asphalt cannot be conducted from October to March of the next year (6 months). Therefore, bridge plan minimizing work periods by utilizing factory and precast products are prioritized.

ii) Procurement Conditions of Materials and Equipment

Transportation of materials and equipment procured from a foreign country is limited to the use of railway and roads. Especially, since large-sized materials and equipment require transport by railway from China, the size of the material and equipment should meet these conditions.

iii) Bridge Erection above Railway Track

Structure types of bridge and the construction methods minimizing impact on railway operations are to be selected since the Project will cross the railways which are the most important lifeline of logistics in Mongolia.

iv) Construction adjacent to Railway Track

So as not to affect the railway operation, proper countermeasure is required for construction including foundation work adjacent to the railway track. The policy is that large-sized excavation should not be adopted for foundation works adjacent to the tracks. Additionally, since there is a future plan to increase from one to three multiline tracks, the location of the piers is designed to secure sufficient space for future installation of additional main tracks.

v) Construction in Urban Area with Heavy Traffics

Since the Project site is located in urbanized area, there are many underground utilities. Especially, the impact on hot-water pipes and high voltage lines should be minimized and pier locations should be considered to minimize the impact of utility relocation. So as to minimize the social impact due to traffic congestion induced by the construction work, the construction method with the shortest construction period and the minimum traffic control is prioritized. Besides, when piers are constructed in Narny Road, their shape and locations should be considered to fully ensure the visibility to the road users (drivers/pedestrians).

vi) Quality Control

Supply of re-bar and concrete becomes extremely tight from spring through summer when whole construction works are intensively concentrated in Ulaanbaatar City. Additionally, the quality of fresh concrete obtained in the market is quite fluctuating, and some concrete plants could not operate due to unstable power supply during the past construction works.

Since rapid temperature changes require proper modification of construction schedule, the severe natural environment also makes quality management of concrete works more difficult. Therefore, it is important to fully enhance the management system to ensure reliable quality by using steel structure or precast products.

(2) Basic Policies of Road Plan

i) Crossing Conditions of Roads and Railways

The following construction gauges should be ensured at the crossing points of roads and railways in the interchange according to Mongolian standards. The flyover section is designed to have a height of 6.9 meters from the track to correspond to the future electrification plan of railways.

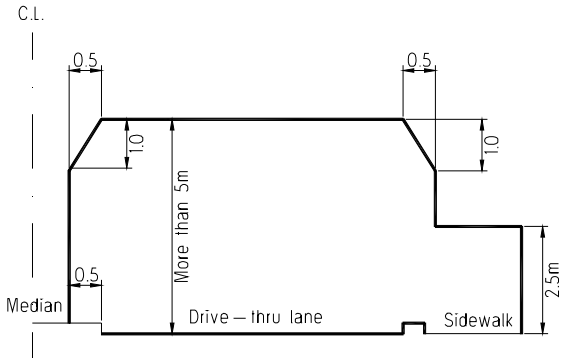


Figure 7.1.1(a) Construction Gauges of Road Crossing

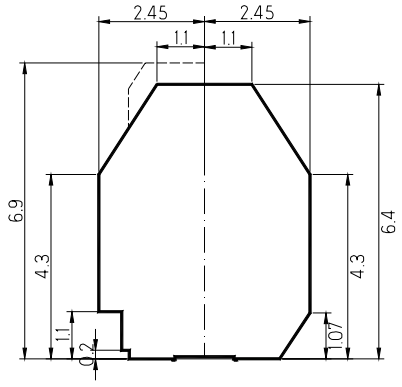


Figure 7.1.1(b) Construction Gauges of Railway Crossing

ii) Longitudinal Grade

Among the main roads having steep grades in the city, the road grade in sections with steep grades and many traffic accidents are Sansar Tunnel: 6.4%, and Chingunjav Street: 5.8%. Relatively steep grades in the other sections are Khusgol Street, the vicinity of Geser Temple: 5.1%, Southern area of Ikh Toyruu East Cross Road Intersection: 5.0%, Ard Ayush Avenue: 4.9%, Amarsanaa Street: 4.0%, Gurvaljin Bridge: 4.0%, and Peace Bridge: 3.3%, which means accident probability increases when the grade exceeds 5.0%. Considering the fact that the approach road is close to the intersection in this Project, the maximum longitudinal grade is designed to be I_{max}=4.5% or less.

iii) Countermeasures to Traffic Congestion in West Industry Road

Many plants stand in a row along the West Industry Road, which is an access road located on the west side of the flyover, and large-sized vehicles frequently come in and out of those plants. Merging of these vehicles with through traffic of the flyover will induce traffic jams, and thus the existing West Industry Road shall remain as a service road, and the main road connecting the flyover shall be designed to be on the outside of the service road. (Existing parking space is maintained.)

Figure 7.1.2(a) Improvement Plan of West Industry Road

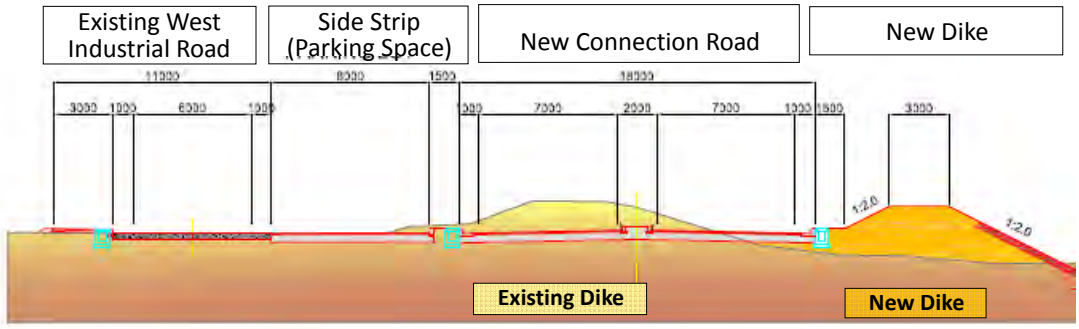


Figure 7.1.2(b) Typical Cross Section of West Industry Road

7.2 ROAD PLAN

(1) Target Year and Design Traffic Volume

Target year and traffic volume are as follows:
Target Year: 2030 (Compatible with UB M/P)
Design Traffic Volume: 57,000 vehicles (Based on the results of traffic demand forecast)

(2) Design Vehicles

Since there is no specific standard/guideline for road design in terms width and axle distance of vehicles, the following semi-trailer is used as object vehicles for road design:

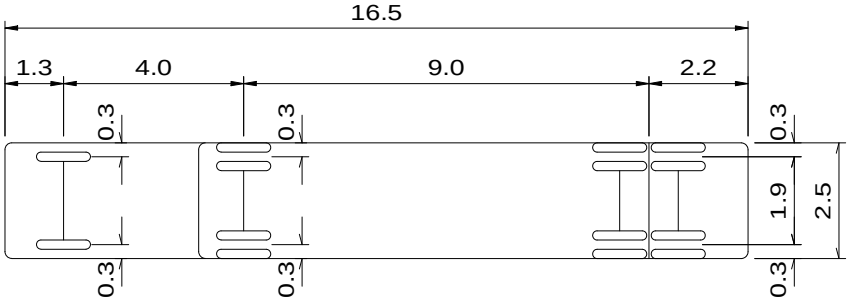


Figure 7.3.1 Design Vehicle (Semi-trailer)

(3) Geometric Criteria

i) Comparison of Road Planning Conditions

As for road planning conditions, comparison was made among the Mongolian standards (BNBD 32-01-04, 32-01-07), American standards (AASHTO) and Japanese standards (Government Order on Road Design Standards). In principle, road plan/design shall comply with Japanese standards with reference to such standards as follows:

- Lane width: as per Mongolian standard
- Shoulder width: as per Japanese standard since Mongolian standard does not stipulate width of shoulder and/or median strip to be applied in urbanized area with severe constraints of land availability.
- Horizontal alignment: as per both Mongolian and Japanese standards. Super-elevation in a curve section is max. 4% in accordance with AASHTO "Urban Arterial Road" considering freezing of carriageway in winter season.

Table 7.2.1 Comparison of Geometric Criteria for Main Road

Item		To be applied	Mongolian standard	AASHTO	Japanese standard
Road standard		2nd Main Road(32-01-07) Main Road (32-01-04)	2nd Main Road(32-01-07) Main Road (32-01-04)	Urban Arterials	Class 4 1st grade
Design Speed V (km/h)		60	60 (120 or 100)	50 - 100	60 (50 or 40)
Lane Width (m)		3.5m	3.5m	3.0-3.6m	3.25m (special area 3.5m)
Median Zone (Marginal Strip) (m)		2.0 (0.25)	5.0, min0.0	1.2	1.0 (0.25)
Shoulder Width	General Section (m)	1.0	2 - 2.5, 3.5	0.6	0.5
	Bridge Section (m)	0.5	-	1.8-2.4	0.5
Minimum Curve Radius R (m)		200m	150m	135	150m(Minimum)
Maximum Super-elevation (%)		4%	5%	-	6%
Minimum Radius without Super-elevation (m)		2000 (Standard Grade 2%)	1500	877	2000
Minimum Horizontal Curve Length (m)		100(θ<7:700/θ)	-	-	100(θ<7:700/θ)
Easement Curve	Curve Length (m)	50	40	33	50
	Minimum Parameter	90	-	-	90
	Minimum Radius without Clothoid Curve (m)	500	-	213	500
Maximum Longitudinal Grade		4.5%	7.0%	-	6% (snow/cold region)
Vertical Curve	Crest (m)	1400	1600	K=11	1400
	Sag (m)	1000	900	K=18	1000

Table 7.2.2 Comparison of Geometric Criteria for On/Off Ramp

Item		To be applied	AASHTO	Japanese standard	Remarks
Road standard		Class B	CASE-1 B	Class B	
Design Speed V (km/h)		V=40km/h	30-50	V=40km/h	
Lane Width (m)		3.25	5.5 (pavement width)	3.25	
Shoulder Width		0.75m (Internal side) 1.5m (External side)	0.6-1.2m (Internal side) 2.4-3.0m (External side)	0.75m (Internal side) 1.5m (External side)	
Minimum Curve Radius R (m)		50m(Minimum)	47m	50m(Minimum)	
Maximum Super-elevation (%)		4.0%	4%	6%	
Minimum Radius without Super-elevation (m)		800	441	800	
Minimum Horizontal Curve Length (m)		70	–	70	
Easement Curve	Curve Length (m)	35	22	35	
	Minimum Parameter	35	–	35	
	Minimum Radius without Clothoid Curve (m)	140	95	140	
Maximum Longitudinal Grade		4.5%	–	6% (snow/cold region)	
Easement Curve	Crest (m)	450	K=4.0	450	
	Sag (m)	450	K=9.0	450	

ii) Design Conditions of Road

As for geometric criteria, the design conditions suitable for this project are set as follows after comparing the standards in Mongolia (BNBD 32-01-04, 32-01-07), American standards (AASHTO) and Japanese standards (Government Order on Road Design Standards).

Table 7.2.3 Geometric Criteria to be applied for the Project

Item		Main Road	ON-OFF Ramp	Remarks
Road Standard		**2nd Main Road (32-01-07) Main Road (32-01-04)**	**–**	
Design Speed V (km/h)		60	40	
Lane Width (m)		3.5	3.25	
Median Zone (Marginal Strip) (m)		2.0 (0.25)	–	
Shoulder Width	General Section (m)	1.0	–	
	Bridge Section (m)	0.50	1.50 (External Side) 0.75 (Internal Side)	
Minimum Curve Radius R (m)		200	160	
Maximum Super-elevation (%)		4%	4%	
Minimum Radius without Super-elevation (m)		2000 (Standard Grade 2%)	800	
Minimum Horizontal Curve Length (m)		100 (θ<7:700/θ)	70	
Easement Curve	Curve Length (m)	35	35	
	Minimum Parameter	90	35	
	Minimum Radius without Clothoid Curve (m)	500	140	
Maximum Longitudinal Grade		4.5%	4.5%	
Vertical Curve	Crest (m)	1400	450 (Minimum Value)	
	Sag (m)	1000	450 (Minimum Value)	

(4) Typical Cross Section

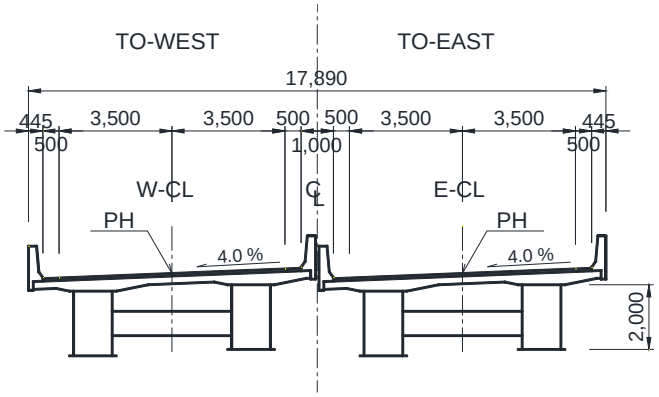


Figure 7.2.2(1) Typical Cross Section of General Bridge Section

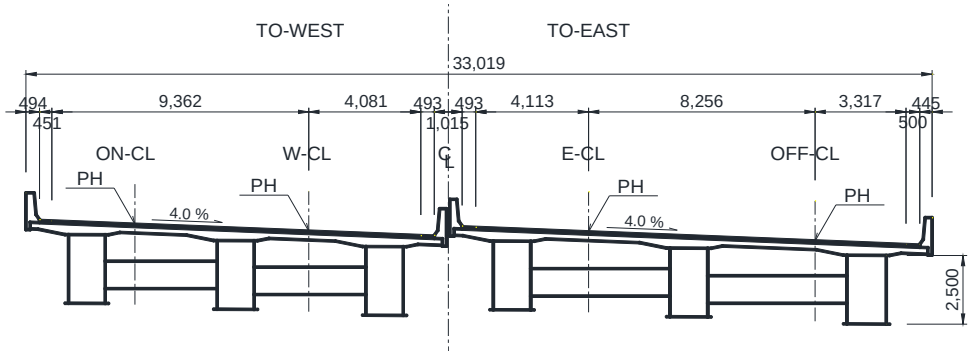


Figure 7.2.2(2) Typical Cross Section of Widening Bridge Section

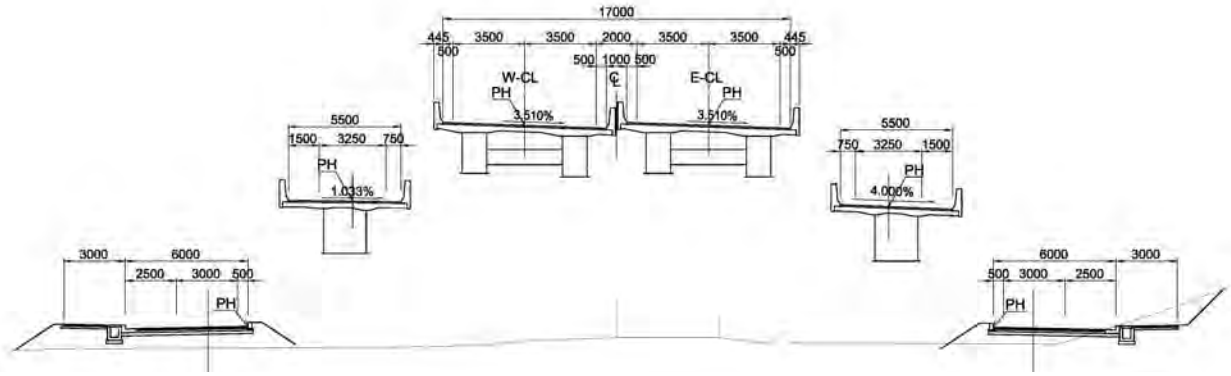


Figure 7.2.2(3) Typical Cross Section of ON-OFF Ramp Section

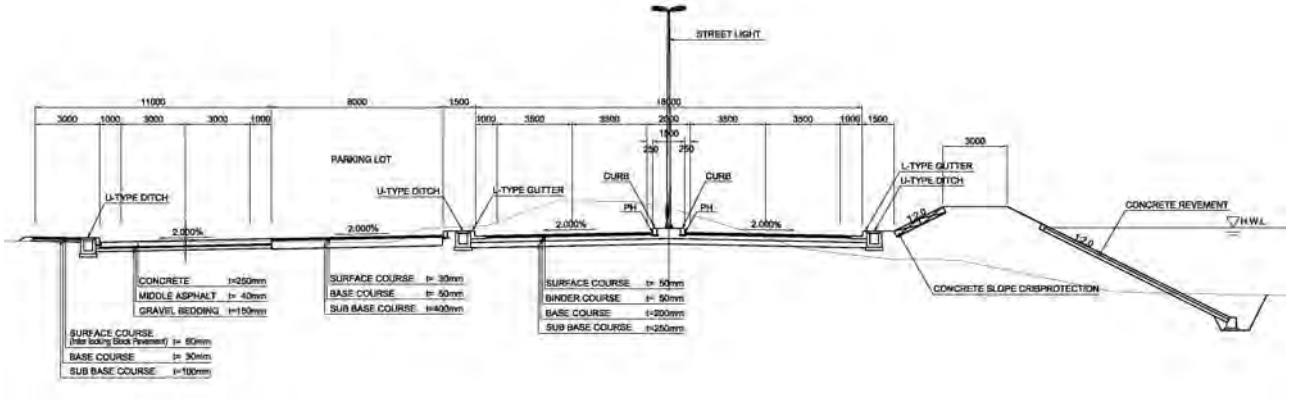


Figure 7.2.2(4) Typical Cross Section Parallel to West Industry Road

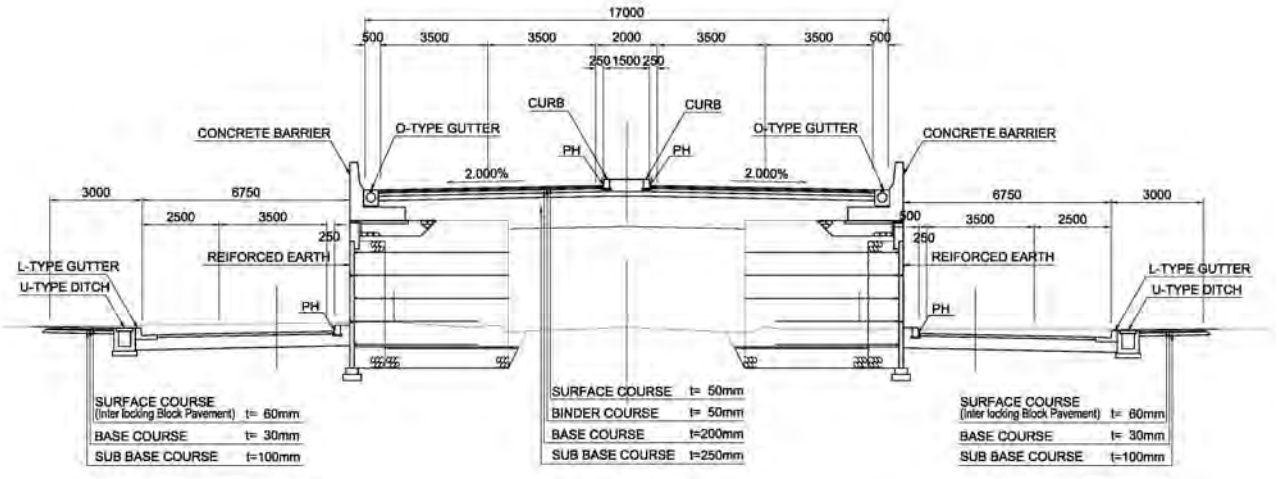


Figure 7.2.2(5) Typical Cross Section of Approach Road in Narny Road

(5) Intersection Plan in Narny Road

At the west end of Narny Road to be crossed by Ajilchin Flyover, traffic volume is currently 40,000 vehicles/day or more. After completion of the construction work of Ajilchin Flyover,

much more vehicles are expected to flow into this intersection. So the type of intersection shall be designed to accommodate the future traffic. The estimated traffic flow at the intersection after the construction of Ajilchin Flyover is as shown below.

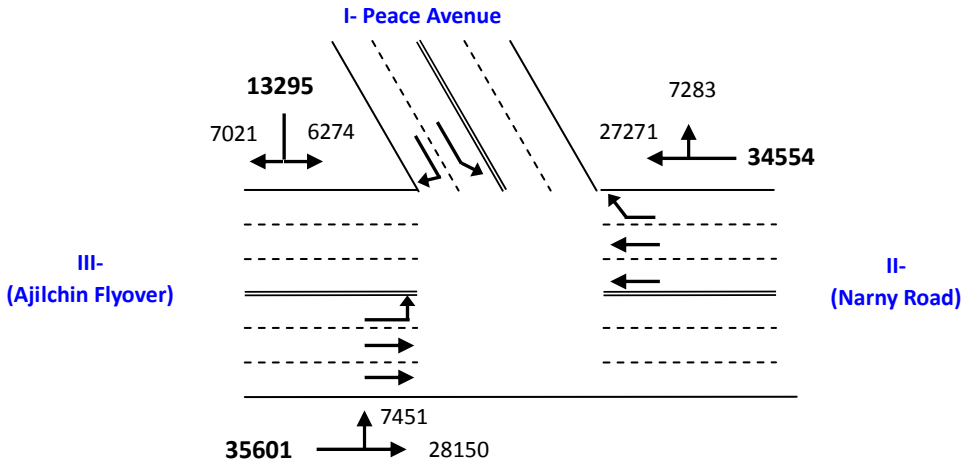
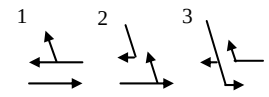
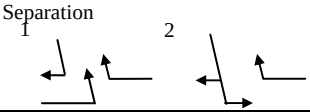


Figure 7.2.3 Estimated Traffic Volume (PCU/day) in 2030 at Narny Road Intersection

Intersection types of the Ajilchin flyover approach road and Narny Road will be either at-grade intersection or grade separation. At-grade intersection may induce congestion resulting in bottleneck. The followings are summary of "Saturation Index of Intersection" calculated for two cases of the at-grade intersection and the grade separation.

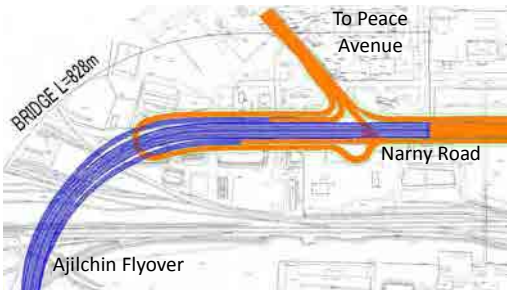
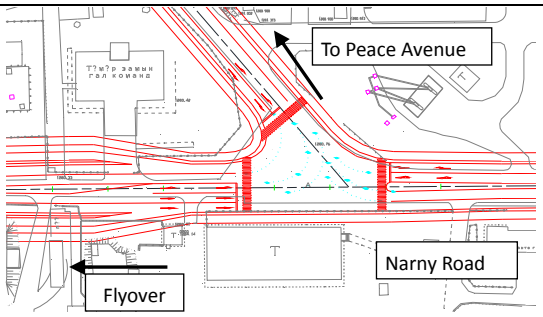
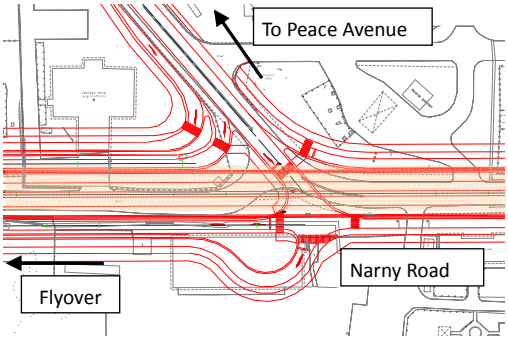
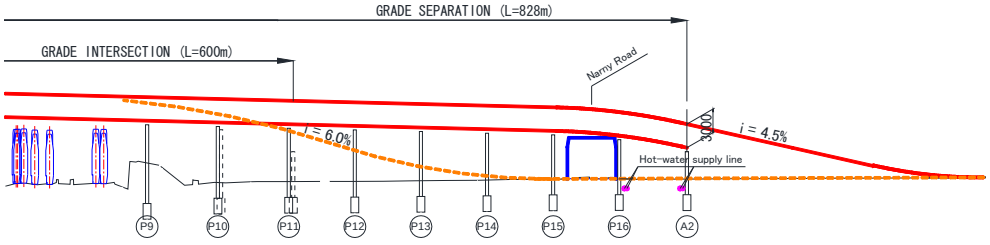
Table 7.2.4 Saturation Index of Intersections

Flowing Point		Peace Avenue		Narny Road		Ajilchin Bridge			
		Left Turn	Right Turn	Through	Right Turn	Left Turn	Through		
Number of Traffic Lanes		1	1	2	1	1	2		
Basic Value of Saturation Flow Rate		**2,000**	**2,000**	**4,000**	**2,000**	**2,000**	**4,000**	Saturation degree of signal phase	Saturation Index of intersection
Traffic Volume		**470**	**530**	**2,050**	**550**	**560**	**2,110**		
Flow Ratio		0.235	0.265	0.513	0.275	0.280	0.528		
Necessary Phase Ratio for At-grade 	1Φ			0.513	0.275		0.528	0.528	1.073
	2Φ		0.265		0.275	0.280	0.528	0.280	
	3Φ	0.235	0.265		0.275			0.265	
Necessary Phase Ratio for Grade Separation 	1Φ		0.265		0.275	0.280		0.280	0.515
	2Φ	0.235	0.265		0.275			0.235	
	3Φ								

Source: JICA Survey Team

In case of grade separation, the construction cost will increase due to additional 228m section of flyover, on/off ramps and corresponding land acquisition. However, detailed comparison in diverse aspects illustrated below reveals that grade separation is more superior than at-grade intersection for intersection of Narny Road and Peace Avenue.

Table 7.2.5 Intersection Structure Comparison of Narny Road

Crossing Method	At-Grade Intersection Plan		Grade Separation Plan	
Plan	 Bridge Section (L=600m) Connection road		 Bridge Section (L=828m + Ramp bridge) Connection road	
Close-up of Intersection Portion				
Longitudinal Figure	 Level crossing plan Grade Separation Plan			
Traffic Safety	NG	Since the intersection is congested, the number of accidents will increase. Due to the steep grade of the approach road, the risk of skidding accidents on icy roads will increase.	Good	The risk of traffic accidents can be drastically decreased in comparison to that of the at grade intersection.
Traffic Congestion at Intersection	NG	Saturation Index of intersection is 1.073(>0.8), so that severe traffic congestion will occur.	Good	Saturation Index of intersection is 0.515 (<0.8) so that the degree of congestion is less.
Landscape	Fair	No oppressive feeling by elevated structures.	Fair	The view of structures requires to be considered.
Environment	NG	Due to congestion, noise is increased and air pollution becomes worse.	Good	Due to free movement of traffic, the impact on the environment is smaller than the at-grade intersection plan.
Economic Performance	NG	The construction cost is cheaper but the social loss of time due to delays caused by congestion at the intersection is large.	Good	Though the project cost is more expensive (+1.3 billion JPY) than that of the level intersection plan, its economic effect by improvement of intersection is large.
Evaluation	NG	Mobility improvement effect by the flyover project is lost by traffic congestion at the intersection.	Good	High economic effect can be expected as traffic congestion can be eliminated by this plan.

(6) Plan for Other Intersections

i) Intersection with Ajilchin Street

The intersection of Ajilchin Street and West Industry Road is designed as follows:

a) It is on the premise that the Dund River Bridge is widened to four (4) traffic lanes by Ulaanbaatar City.

b) Since the Power Plant Road has two traffic lanes, the intersection shall be improved by installing a left-turn lane.

c) Since the Power Plant Road needs to be widened to four (4) lanes in the future, full-scale improvement such as grade separation and channelization shall be conducted at the timing of widening. Accordingly, improvement of the Power Plant Road shall be excluded from the Project scope.

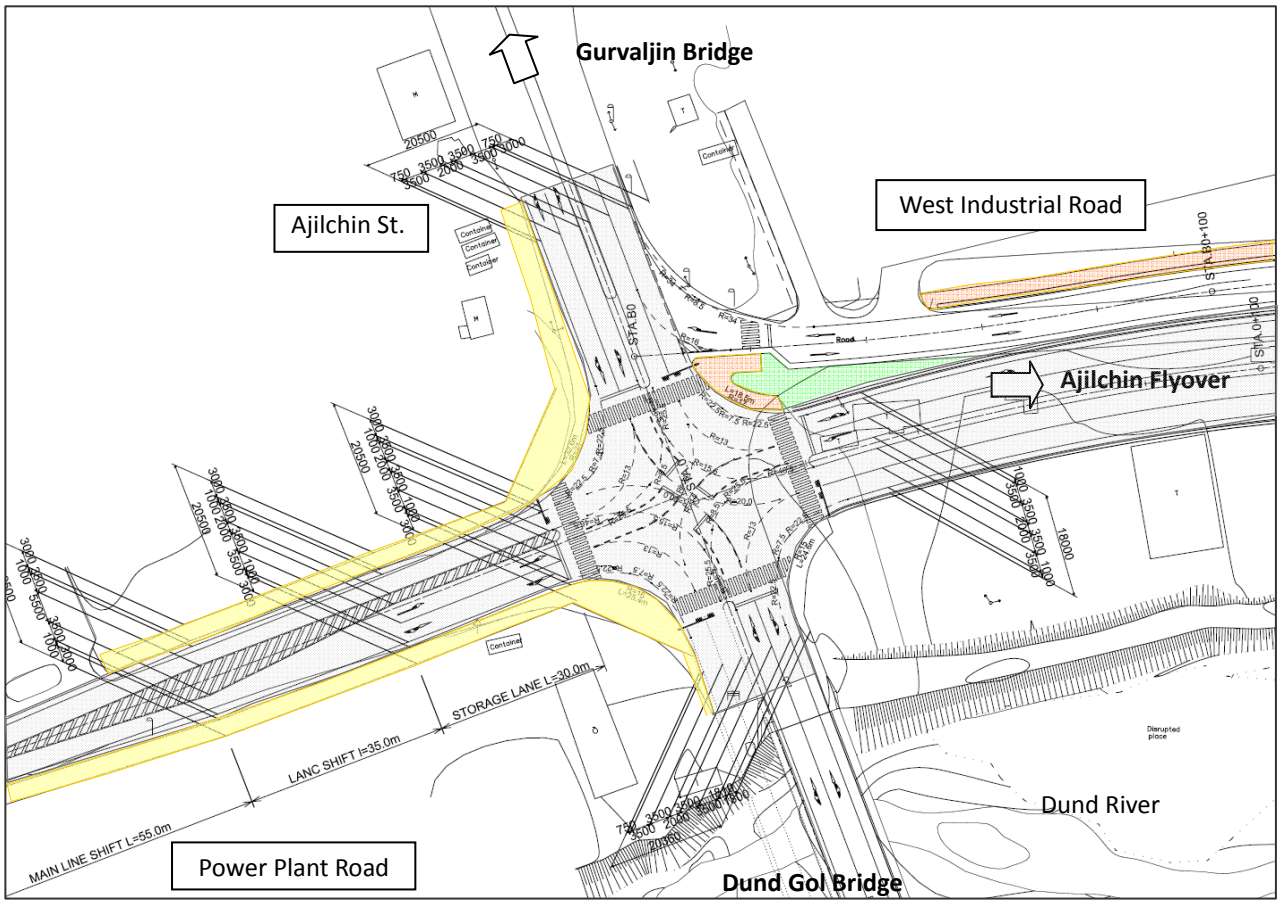


Figure 7.2.4 Plan of Intersection with Ajilchin Road

ii) Intersection of West Industry Road

Grade separation is applied the existing West Industry Road and the project road. At-grade crossing is adopted for West Industry Road and the existing railway feeder line. The Project will cover the limited section up to merging with existing access road.

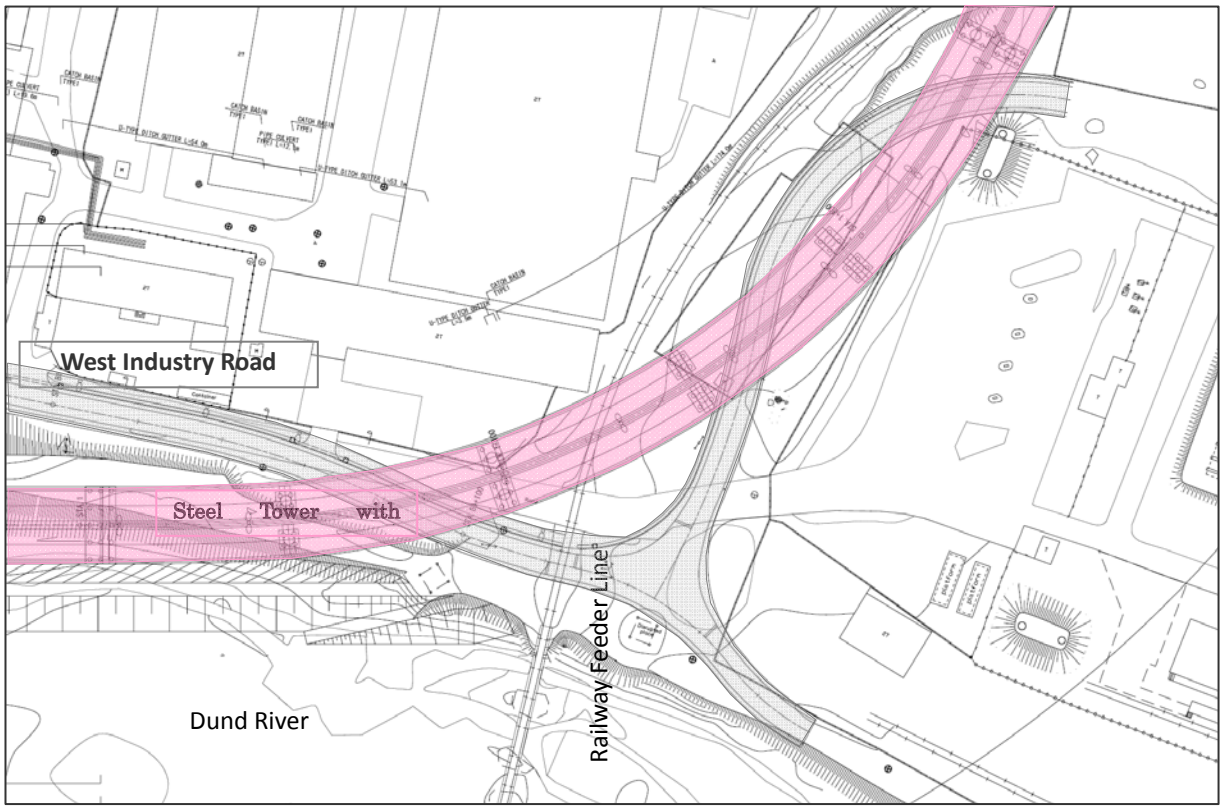


Figure 7.2.5 Plan of Intersection with Existing West Industry Road

(7) Pavement Design

Asphalt concrete pavement is adopted for the Project considering durability and the projected traffic volume. The design of asphalt concrete pavement is based on the "Guidance for Design and Construction of Pavement as revised in 2006" issued by the Japan Road Association.

The summary of the required structure number (SN) is given in Table 7.2.6, and the proposed configuration of pavement is illustrated in Figure 7.2.6. On the other hand, the pavement on bridge deck slab shall be Asphalt Pavement with 80mm thickness.

Table 7.2.6 Design CBR and Paving Thickness Design Conditions

	Design CBR[1)]	**Projected Traffic[2)]**	**Required SN (T_A)**
Narny Road	12	1,500 vehicles/day (C Traffic)	23.0 cm
West Industrial Road	12	1,500 vehicles/day (C Traffic)	23.0 cm

1) Design CBR : based on laboratory CBR test

2) 10 years design life from 2020 with 8% of heavy vehicle mixture

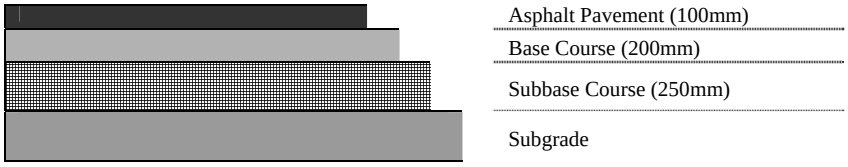


Figure 7.2.6 Configuration of Pavement

(8) Road Drainage System

Storm water on road surface in Project area should be drained to the existing channels and rivers. In Narny Road, the end of drainage system is connected to existing drainage connecting Peace Avenue. Meanwhile, the storm water on West Industry Road and west access road is discharged to the Dund River. Surface water discharge of flyover in northern and southern sides of the railway is designed to drainage along Narny Road and West Industrial Road, respectively.

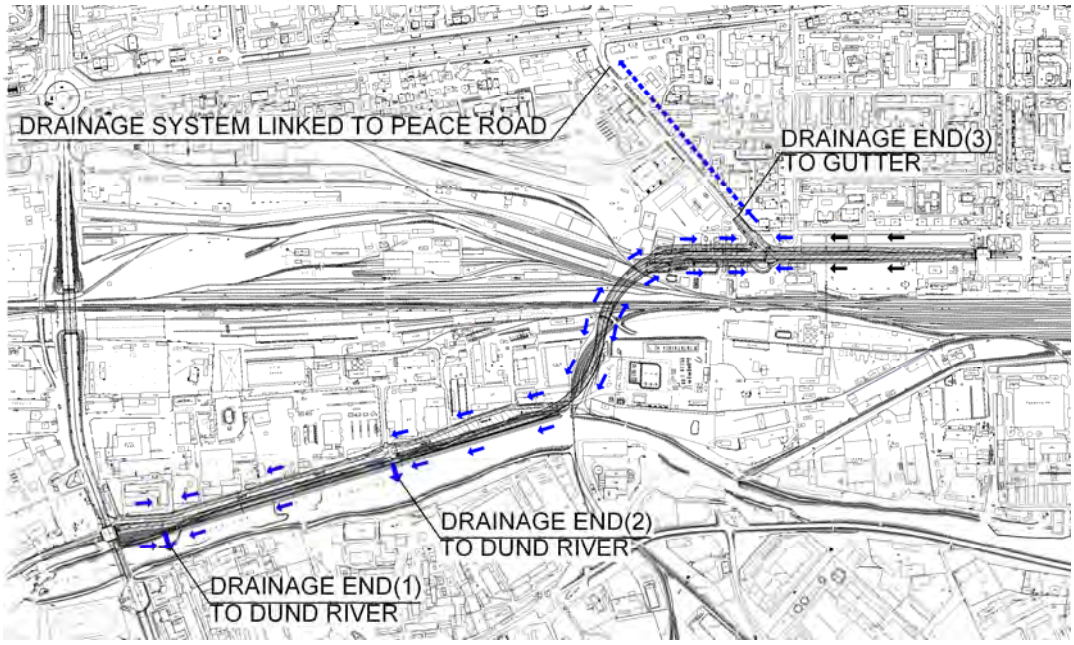


Figure 7.2.7 Drainage Distribution Diagram of the Project Area

(9) Hydraulic Conditions of Dund River and River Dike Design

New access road is planned to be constructed at the south side of the West Industry Road with the removal of the existing river dike at the right bank of Dund River and the construction of a new river dike along the new access load. Dike improvement work is ongoing in the upper stream of Dund River up to Engels Street, and will be extended to downstream after 2013. For design of the dike in this study, the design discharge is set forth to be 346m^3/sec (100-year probability) to calculate the high-water level of Dund River. Dike height in the river section is designed as the high-water level plus 0.8m as allowance height.

Table 7.2.7 High Water Level of Dund River

STA. No.	0+120	0+220	0+320	0+400	0+500	0+600	0+700	0+800	0+900
H.W.L.	1278.4	1277.9	1278.6	1279	1279	1278.7	1278.5	1279.5	1279.7
Dund River	←Downstream (Ajilchin Street)			←		←		←	(Upper Stream)

Note: These values are calculated by uniform flow calculation of Manning Formula. (Average river grade: 0.3%)

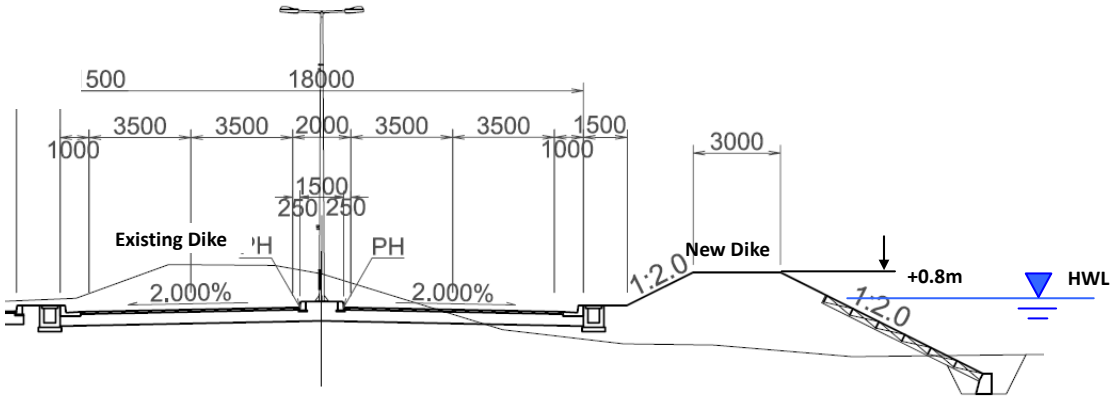


Figure 7.2.8 Typical Cross Section at Right Bank of Dund River

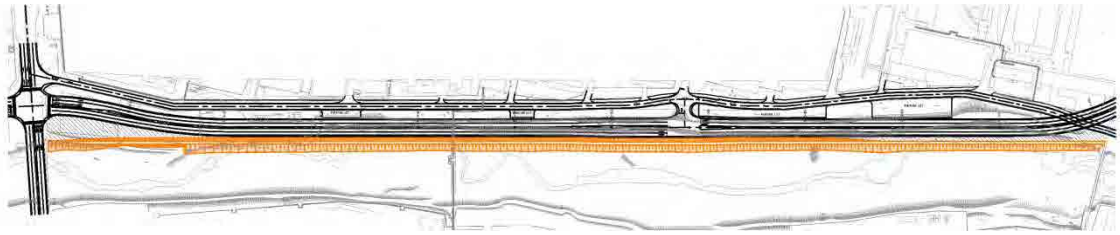


Figure 7.2.9 Construction Area of River Dike at Right Bank of Dund River

With respect to climate change to Mongolia, there will be no significant influence to river dike planning due to the following reasons.

- Survey result of Mongolia Assessment Report on Climate Change (UNEP, 2009) states that precipitation in the summer season has been decreasing since 1940. Other predictions, though with certain deviation in simulation conditions, show increment of precipitation in the summer season will be limited to 0～4%.
- Long-term climate change scenario for 2051-2081 of ci:grasp (Global and Regional Adaptation Support Platform) operated by Giz and PIK (Potsdam Institute for Climate Impact Research) predicts there will not be significant change in precipitation in the summer season.
- Planning flood flow has been calculated by Mongolian Meteorological Agency on the basis of recent flash flood analysis, and is adopted for design and construction of dike improvement work ongoing at upstream side.

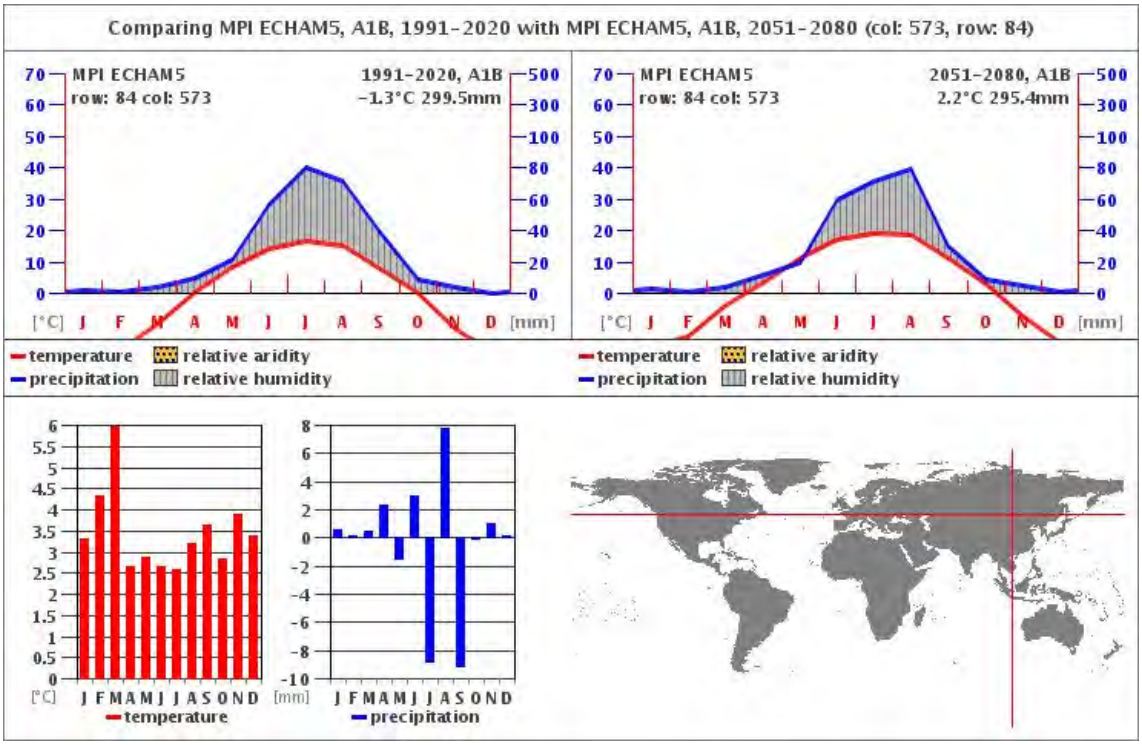


Figure 7.2.10 Prediction of Climate Change near Ulaanbaatar City by ci:grasp

(10) Safety Measure on Skidding Accident in Winter

In October through April in Ulaanbaatar City where the temperature drops below 0°C, traffic accidents tend to happen due to freezing of road surface. Accordingly, the following consideration and safety measures on skidding were proposed for road planning which requires the alignment with sharp horizontal curve (R=200m) and rather steep vertical slope (i=4.5%).

i) Road alignment

The road alignment is planned to be the combined grade of 6% or less without overlap of sharp curve and steep vertical slope in order to minimize driving operations such as steering and braking to follow the road alignment.

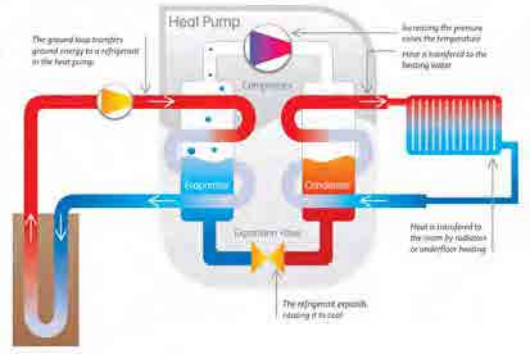
ii) Consideration for Low Speed Urban Street

Maximum super-elevation is controlled in 4% to prevent from sideslip at low speed driving.

iii) Physical Countermeasure against the Skidding

Anti-skid pavement is adopted as the most practical and sustainable measure to prevent skidding accident at sharp curve and long vertical slope. The Anti-skid pavement is applied to a bridge section with sharp horizontal curve (R=200m), and approach road with steep vertical slope (i=4.5%). The total area of the Anti-skid pavement at the Project site is estimated as 13,800 m^2 in total. More advanced technology on anti-freezing of road surface such as “Road Heating” is also possible to introduced as presented in Table 7.2.8. However, there is no experience of the road heating in Mongolian and the anti-skid pavement has been already demonstrated at the Narny Bridge that can secure the road safety in winter season with lower cost. Thus the road would not be applied for the Project.

Table 7.2.8 Comparison of Countermeasure for Prevention Slipping Accident

	Road Heating		Anti-slip Pavement
	Electrical Heating	Using Natural Heat (Groundwater or Earth thermal)	
Figure			
Summary	This system prevents the freezing on the road surface by electrical energy. Heating wire is embedded in the pavement, through electric warm there.	Steel pipe pile is used as a heat-exchanger. Natural heat such as groundwater and geothermal, is used as thermal source, and the thermal is flowed in the heat pipe embedded in the pavement and prevents freezing.	Hard aggregate is coated on the asphalt pavement using epoxy resin paint. Slipping resistibility is increased since frictional resistance become high.
Economic and Maintenance	Initial cost is high since to be made the system first. Additionally, this system needs to continue using electricity, so operation cost also is high. (Initial Cost) 50,000 yen/m2 (Operation Cost) 3,500 yen/m2 (Every year) (Maintenance Cost※1) 500 yen/m2	Steel pipe pile can be used as a part of this system, so additional excavation cost is unnecessary. But total initial cost is the highest. Operation cost is cheaper than electrical heating because natural heat use. (Initial Cost) 80,000 yen/m2 (Operation Cost) 2,000 yen/m2 (Every year) (Maintenance Cost※1) 800 yen/m2	Initial cost is the cheapest. Although repaving anti-slip layer is need once every several years, operation and maintenance cost are the cheapest. (Initial Cost) 3,000 yen/m2 (Operation Cost) 0 yen/m2 (Maintenance Cost) 3,000 yen/m2 (Every 7 years)
Other Facility	It will be required other facilities to manage the electricity.	It will be required other facilities to store the heat pump unit.	Unnecessary
Environmental impact	This system is warming road surface by using electric power. There is an environmental impact indirectly because it is to use fossil fuels when the power generation.	Environmental impact is almost zero because this system is natural heat use.	No environmental impact because coating hard aggregate on the asphalt pavement only.
Application for this project	Initial cost, operation cost and maintenance cost are very high. It is difficult to adopt this system. (There are some local governments in Japan which stop to operate this system causing high operation cost.)	This system can use natural heat, so operation cost is cheaper than electrical heating. However, the local groundwater temperature is too low, so it is not able to ensure enough thermal to prevent freezing in mid-winter.	Initial cost, operation cost and maintenance cost are the cheapest. Although repaving anti-slip layer is need once every several year, economic and maintenance burdens is smaller than other options which need much operation and maintenance costs.
Evaluation	Not Recommend	Not Recommend	Recommend

(11) Traffic Control Facility

Traffic Control Center in Ulaanbaatar City was established in 2010 with assistance by Korea, and are enhancing its facility and system with municipal budget. As per coordination with the Traffic Control Center, the Project plans to install the following equipment which is fully compatible with the existing system, as an additional part of ITS in Ulaanbaatar City.

Table 7.2.9 ITS Equipment to be installed in the Project

	Equipment to be installed	Objective	Quantity	Remark
1	Closed Circuit Television Camera (CCTV)	Real time monitoring at traffic control center on traffic situation of intersections	2	1 set for each intersection
2	Video Display System (VDS)	Video recording of traffic situation	2	1 set for each direction
3	Enforcement Machine for Speeding (EMFS)	Enforcement for speeding	2	1 set for each direction

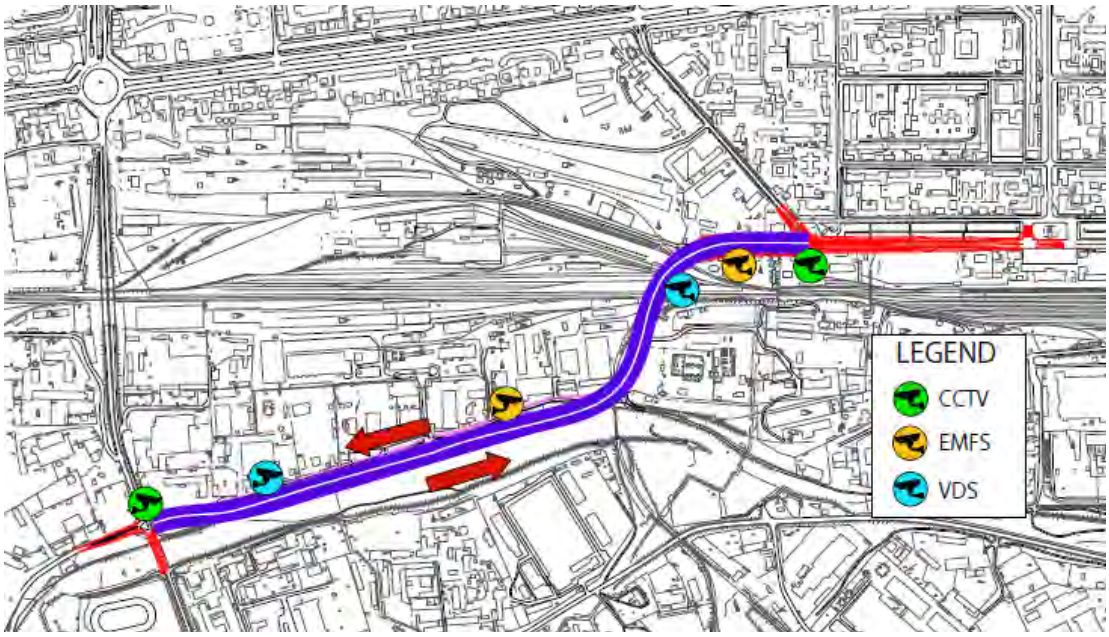


Figure 7.2.11 Proposed Location for Installation of ITS Equipment

7.3 BRIDGE PLAN

(1) Major Point to be discussed in Bridge Plan

With reference to the basic policies for the bridge planning described in 7.1(1), the issues to which special care shall be paid are summarized below. The plan should take into consideration diverse conditions unique to Mongolia

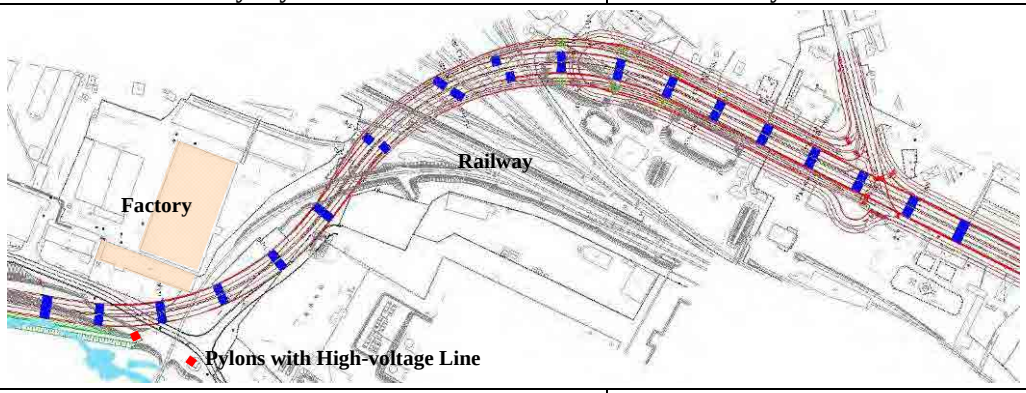
Table 7.3.1 Notes regarding Bridge Plan

	(1) Span Arrangement	(2) Superstructure Type	(3) Substructure Type	(4) Foundation Type
i) Climate Condition	Make span length selection plan that can correspond to the expansion and contraction caused by temperature changes.	Consider restriction of construction period for comparison of concrete bridges and steel bridges. Select materials that can endure -40 degrees Celsius temperature.	Minimize concrete consumption and shorten the construction period.	Consider frost penetration depth when selecting the foundation bearing stratum. Prioritize precast piles to secure quality and shorten the construction period.
ii) Condition of Transportation		Be fully aware of shape and dimensions of factory products.		
iii) Girder Erection above Railway Track		Select a construction method and a bridge type that will not hinder railway operations.		
iv) Construction adjacent to Railway Track	Plan span length to enable construction of piers in the railway premises.		Plan a structure that reduces work in the railway premises and use of large-sized heavy equipment.	Select a construction method that digging and foundation work will not affect the rail track.
v) Construction in the urban area with heavy traffic	Make span length long enough to secure visibility at intersections or on the street.	Need to select a construction method that enables construction on narrow construction yards. Prioritize construction method that minimizes impact on traffic control.	Minimize the construction period so as to keep influences by traffic control to a minimum. Select a structure type that ensures visibility at intersections and on the street.	Make a plan that will minimize relocating construction by considering impact on utility.
vi) Underground utility	Plan pier locations that minimize relocation of utility.			Design the foundation size as small as possible to minimize the relocation of underground utility.
vii) Quality control		Prioritize quality by making use of factory products. Select highly durable types that enable the reduction of maintenance costs.	Minimize cross-section of concrete members to minimize risk on construction sites.	

(2) Features of Bridge Location

Location of the bridge construction is classified to 1) railway flyover section and 2) Nary Road section. Features of each section are stated as below.

Table 7.3.2 Characteristics of Bridge Location

	Railway Flyover Section	Narny Road Section
Plan		
Characteristics	• Road alignment is a curve with radius of 200m. • Train operation is about 30 services/day. • As for the feeder line, a freight train travels 2 times a day for supplying coal to No. 3 Thermal Plant and over 10 times a day for transporting materials to other factories along the other railway line irregularly. • Factory building is close to the bridge. Consideration on construction plan shall be given. • Pylons for high-voltage line are under construction. • Ground condition is relatively good, but loose sedimentary layers exist in the railway premises and near Dund River.	• Road alignment is straight. • Traffic volume is over 40,000 cars per day. • In addition to the railway related facilities, commercial and public facilities are situated to the road, and many people utilize the road. • Traffic control is required when implementing construction. • Utility (hot-water pipes with φ1000 and φ800) that is difficult to be relocated is located. • Ground condition is relatively good.

(3) Railway Crossing Condition

Vertical clearance at the railway crossing shall be H=6.9m (future electrification is envisioned), and horizontal clearance from center of railway track to permanent structure such as piers and abutments shall be L=3.5m.

It is supposed that operation of the international passenger trains will not be adjusted for construction work of the Project, but work hours can be secured by adjusting operation of other trains such as cargo and container. Approximately 20 trains per day are operated on feeder lines, and it was confirmed based on discussion with Ulaanbaatar Railway that more than 6 hours per day would be secured for girder erection during construction.

(4) Span Arrangement

i) Each Lane Separated Structure

Each lane (to East and to West) separated structure is proposed for the Project due to reasons described below.

The width is broad; in case of integrated structure, 700mm or more elevation gap will be created in the transverse direction, and the longitudinal gradient will become excessively steep, which may cause traffic accidents such as slippage in the winter.

By separating each lane, the scale of each structure becomes small, which enables to simplify stress transferring mechanism and minimize the dimension of structures.

ii) Determination of Abutment Position

The proposed location of Ajilchin bridge has been highly Urbanized. The planned bridge will be easy for residents to access, and has many occasions of visual contact by residents and drivers. Thus, structures with high retaining walls or girders is not suitable for the proposed bridge from a viewpoint of landscaping and aesthetics. Also, the bearing on abutment should be of a height around 2.5m high from the existing ground surface to facilitate routine inspection and maintenance. Boundary fence will be installed in front of abutment to eliminate unnecessary access of pedestrians.

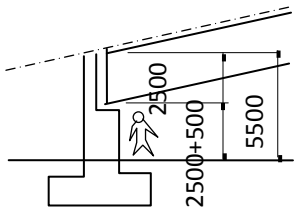


Figure 7.3.1 Image of Abutment Position

iii) Pier Allocation

Each pier position was determined considering the following matters.

P1-P4: Allocation was decided so that piers would not affect railway feeder lines bound for the No. 3 Thermal Power Plant.

P5-P8: Piers were positioned so as not to hinder railway tracks because the bridge will stride over the railway main line where there are many feeder lines going to the switchyard in the railway premises. (P6/P7/P8)

P9-P11: Piers were positioned avoiding the access road used to the railway premises.

P12-P16: Piers were located in places with adequate visibility to the intersection with Narny Road. Allocation of P15 and P16 were decided where relocation of hot-water pipe main line (φ1000, φ800) can be avoided.

iv) Span Arrangement and Bridge Length

The span length selection plan complying with above conditions is indicated in the figure below. Total bridge length is 828m based on the span arrangement.

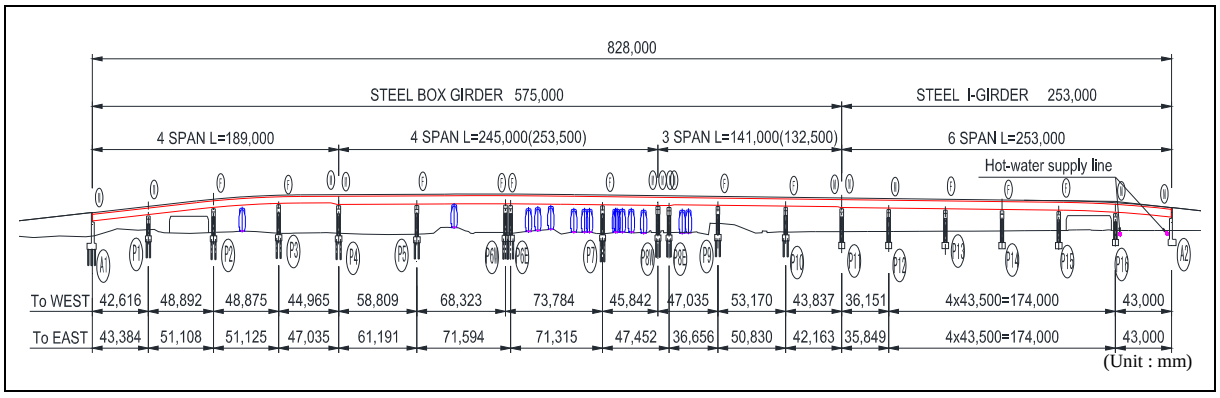


Figure 7.3.2 Bridge Span Arrangement

v) Criteria for Bridge Length

This bridge is 828m long with S-shaped horizontal alignment. Full length of bridge cannot be designed as a continuous structure, and thus shall be divided into four (4) structural elements. The length of each structural element (=bridge) was decided as follows.

-No. 1 Bridge (A1 to P4)-

The structure is continuous girder type with advantages of economical efficiency, maintenance ability, and drivability. A1 abutment is positioned at STA1+005 to secure sufficient visibility at the railway crossing, to minimize influence on the existing utilities during construction due to a large-scale footing, and to reduce the feeling of pressure in front of the building. Continuous girder section ends before the S-shape curve (P5) and extends to P4 pier considering the span length selection of No. 2 Bridge. Consequently, total length of No. 1 Bridge is 189m in center distance.

-No. 2 Bridge (P4 to P8)-

P8 pier position was decided to be where the ramp bridge is installed. To install a ramp bridge, P8 position is to be a jointed section so as to separate the structure. As the result, the length of No. 2 Bridge became 245m (central distance). As for the jointed section on P8, although it is in the railway premises, it was judged that maintenance problems would be small because the joint section cannot be avoided for installing the ramp and the railway premises have relatively sufficient space for maintenance work.

-No. 3 Bridge (P8 to P11)-

The position of P11 was decided to be in the place where the R200m curve section ends. The curve section and the straight section shall be structurally separated to make the superstructure cost at the straight section small. As the result, the length of No. 3 Bridge became 141m (central distance).

-No. 4 Bridge (P11 to A2)-

This will be a straight section, so the structure would be continuous girder type which has advantage in economic efficiency, maintenance ability, and drivability. The A2 abutment position was set so as not to require relocation of trunk line of heating pipe (φ1000 and φ800), reducing expenses for relocation and problems with future maintenance. As the result, it became as STA1+833, and the length of the No. 4 Bridge became 253m.

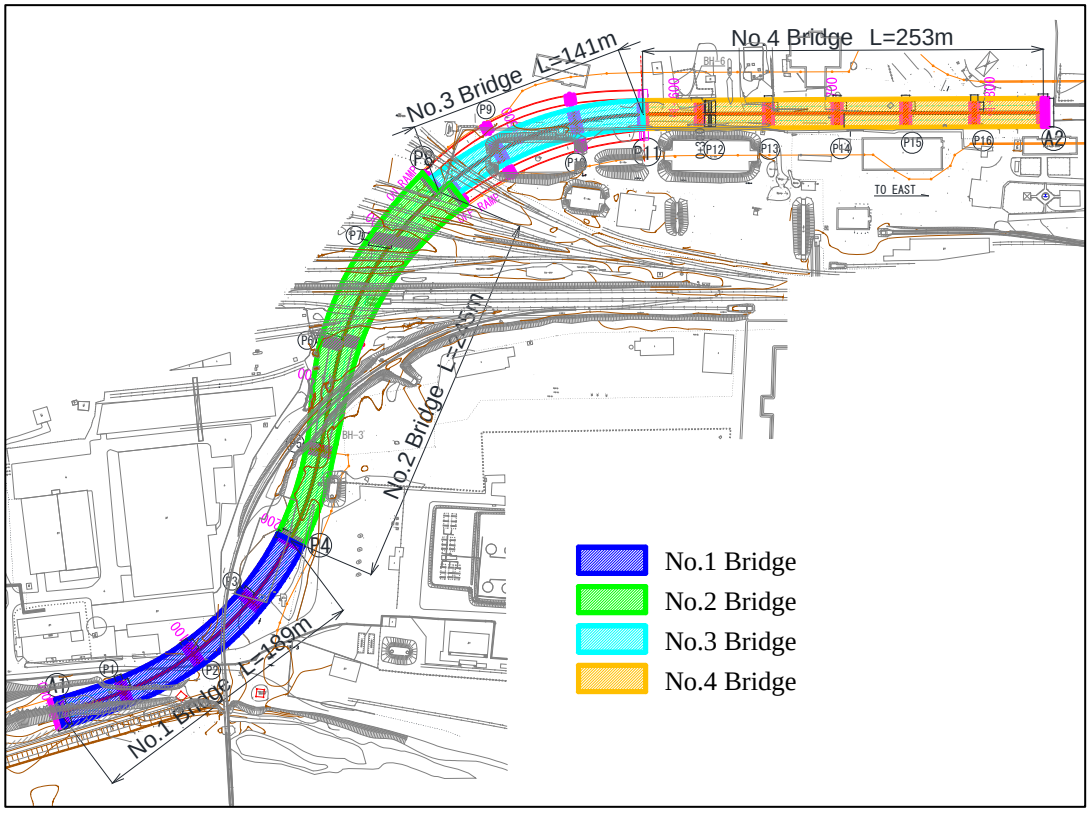


Figure 7.3.3 Bridge Partition

(5) Selecting Superstructure Type

i) Flyover Section

Twin steel box-girder bridge (Triple steel box girder for the flyover section on the main line) is adopted for the flyover section superstructure due to reasons below. (See Table 7.3.4 for details.)

- The flyover section has a curved section with radius of 200m, and its maximum span length is 73m. Therefore, selection of a box girder type with high torsional stiffness shall be required.
- Concrete construction cannot be implemented during the winter period (October to April), and securing quality is difficult. Select steel girders that can be produced at a factory and ensure high quality.
- Select a twin steel box girder bridge that is structurally sound because it can correspond to ramp width expansion and with or without negative reaction.
- The flyover section has a restriction of girder height (2.5m max.) because of the road longitudinal gradient and for securing railway construction gauges. Increase the number of girders (from 2 to 3 steel boxes) to cope with this restriction.

ii) Narny Road Section (Side Span)

Steel I girder bridge is incorporated in the superstructure of the Narny Road section due to the reasons below. (See Table 7.3.5 for details.)

- Select steel girders because this road is in the urban area with heavy traffic, construction yard is small, it is important to shorten the construction period to prevent traffic congestion caused by the construction, and steel girders are economical.
- Select a Steel I girder bridge based on reasons that the road alignment is straight and the maximum span length is about 43m.
- Select a continuous girder type that has advantages such as drivability, small impact (noise) on neighboring environment, and small risk of bridge collapse due to earthquake.

iii) Selection of Slab Type

The condition of the damaged concrete slabs of the existing bridges in Ulaanbaatar City is serious. The damage has been created by structural issues, quality control issues during construction, and overloaded vehicles. A steel-concrete composite deck slab will be used in this project due to the above issues and the following reasons. (See Table 7.3.6 for details.)

- Support for concreting is not required for working above the railway and the existing roads, and construction period can be shortened.
- Steel part is fabricated in factory, so it is easy to secure high quality and high durability.
- Risk of accident by falling concrete in the future and necessity of repair work are small.

iv) Selection of Corrosion Protection Method

As for the materials used for the bridge superstructure, corrosion protection using fluorine resin coating is usually applied to “welded structural rolled steel.” Steel materials called “welded structural weather resistant rolled steel” contain appropriate amounts of alloys to form a dense layer of rust on the surface through repeated exposure to the wet and dry in the atmosphere. This dense rust serves to protect the underlying steel surface. Therefore, this uncoated material can impede the progress of rust. Comparison between 2 materials is described below, and it was decided to use “Rolled Steel for Welded Structure + Coating” for this project.

Table 7.3.3 Comparison of Corrosion Protection

	Rolled Steel for Welded Structure + Coating (SM490+C5 Coating)	**Atmospheric Corrosion Resistant Rolled Steel for Welded Structure (SMA490)**
Image		
Anticorrosion	Corrosion of steel hardly occurs in the dry climate of Mongolia, and the anticorrosion property is high. Therefore, corrosion should not be an issue.	It takes time until stable rust is formed, and there is a possibility that the forming range of stable rust may become uneven.
Landscape	A color for coating that fits the landscape of the urban area can be selected, so the beauty of the landscape can be preserved.	The color has an image of rust and may not fit well to the urban landscape in many cases. In the early stage after being placed in service, rusty fluid may leach causing part of the pier to become brown. In general, the color goes well with the natural colors in the mountain area.
Economical Efficiency	Prices of steel + coating in Japan are equivalent to or higher by several percent compared to the weather resistant steel.	Costs in Japan are a little lower compared to coating specification.
Maintenance Ability	Steel girders need to be repainted regularly, but repainting will not be required for 30 years or so by applying a heavy-duty coating (C5 type).	It is possible that anti-freezing agents for road surface including NaCl causes corrosion of the steel members if no coating is applied.
Evaluation	Considering climate conditions in Mongolia, the past performance of steel bridges, high anticorrosion properties of coatings, and landscape of the urban areas, adopting this type is desirable. Recommended	Taking into account of physical appearance, this type can not be recommended to the Project which is located in Urban Area. Life cycle cost can be reduced in countries with high humidity and a great deal of precipitation, but the effect is possibly small in Mongolia. Not Recommended

Table 7.3.4 Comparison of Superstructure Types at Flyover Section (between A1 and P11)

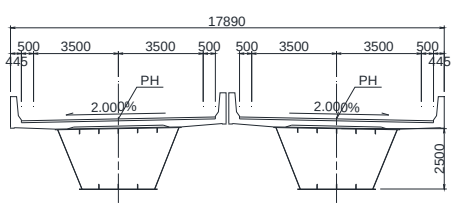
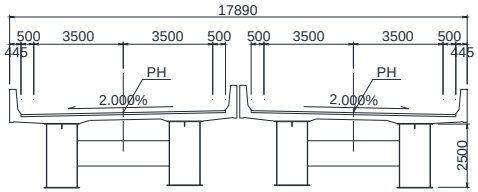
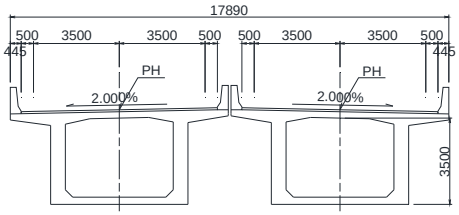
	Steel Bridge		**Concrete Bridge**
	1-Box Girder Bridge	**2-Box Girder Bridge**	**Box Girder Bridge**
Cross-sectional View			
Outline	1-box girder is the basic form, but 2-box girder is used for the flyover section (P5 to P8) with widening ramp. Steel girders are factory products, which realize high quality and high accuracy. With steel girders, a major construction period reduction can be realized. In winter, construction on site cannot be implemented, and the winter period can be effectively used for production of steel girders.	2-box girder is used for the entire length of the bridge, and widening section can be handled by adding a girder. Steel girders are factory products, which realize high quality and high accuracy. With steel girders, a major construction period reduction can be realized. In winter, construction on site cannot be implemented, and the winter period can be effectively used for production of steel girders.	Torsional stiffness is comparatively great with this type. This type is structurally excellent, but girder height is high. All works must be conducted on site, which makes work in winter period impossible. Construction period is longer than steel bridges. Precast block type is also applicable, however, the facility to fabricate the precast block is not available in Mongolia.
Direct Construction Cost of Superstructure	3,850 million JPY	3,700 million JPY	3,900 million JPY
Construction Period	18 months	18 months	30 months
Required Maintenance	Steel girders need to be repainted regularly, but repainting will not be required for 30 years or so by applying heavy-duty coating (C5 type). Coating is applied at a factory, so this type is excellent from a quality control point of view.	Steel girders need to be repainted regularly, but repainting will not be required for 30 years or so by applying heavy-duty coating (C5 type). Coating is applied at a factory, so this type is excellent from a quality control point of view.	Labor hours required for maintenance are shorter that compared with to those for steel bridges, but periodic repair needs to be repeated for the entire service period when a defect resulting from construction error is discovered.
Evaluation	Steel weight becomes heavy (approximately 3650 tons) compared to that of the 2-box girder bridge. Also, bearing spacing becomes narrow, and there is a concern that a negative reaction may be created. To widen the girder width, girders must be divided into pieces for transport, which reduces transport efficiency and increases transportation cost. Fair	Steel weight is small (approximately 3500 tons) compared to that of the 1-box girder bridge. This type is economical. Widening section can be handled by adding a girder. Structural continuity is created in full length, which fits well to the landscape. Transport efficiency is better compared to the 1-box girders, so transportation cost can be reduced. Good	Cantilever erection method is applied to the flyover section. Considering high girder and height of installation equipment, railway construction gauge cannot be maintained with the currently planned longitudinal grade, and planned height will become higher by 3m or so, and causing connection to the existing road will be difficult. Bad

Table 7.3.5 Comparison of Superstructure Types at Narny Road (between P11 and A2)

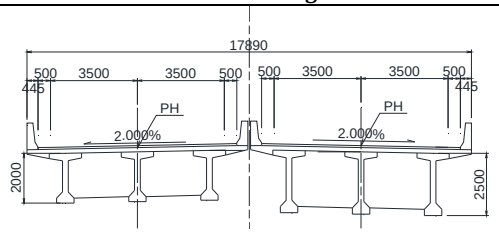
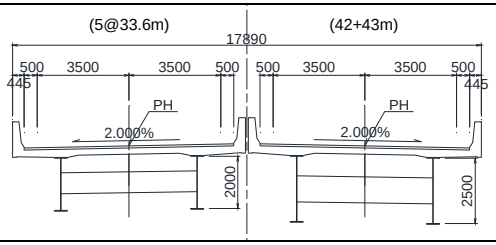
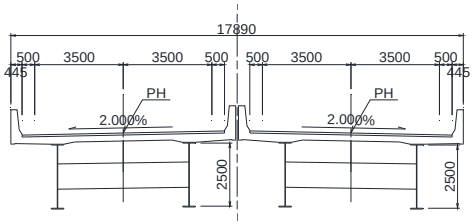
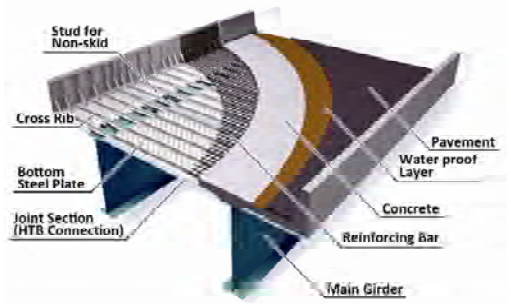
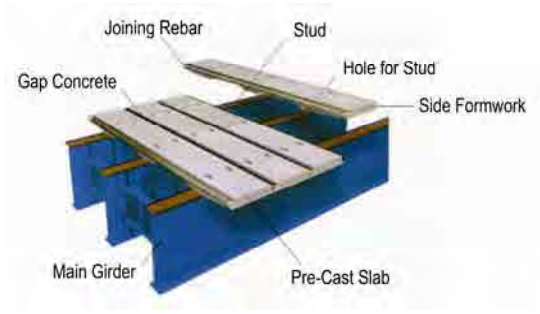
Idea	5-Span Connected PC Composite Girder Bridge + 2-Span Connected PC Composite Girder Bridge	7-Span Continuous Steel I Girder Bridge	6-Span Continuous Steel I Girder Bridge
Cross-sectional View			
Outline	PC composite bridge consists of 5-span connected PC composite girder bridge (5@33.6m) and 2-span connected (42+43m) PC composite girder bridge. Everything including precast PC plates is made on site.	This idea is to adopt continuous steel I girder bridge (5@33.6m+42+43) using the span length of PC composite girder. Slab is composite deck slab that is the same as the flyover section to shorten construction period.	This idea is to adopt 6-span continuous steel I girder bridge (5@42+43m) with almost equal span lengths. Slab is composite deck slab which is the same as the flyover section to shorten construction period.
Construction Cost	815 million JPY (superstructure: 725 + substructure: 90)	810 million JPY (superstructure: 725 + substructure: 85)	800 million JPY (superstructure: 730 + substructure: 70)
Construction Period	10 month	6.5 months	6 months
Required Maintenance	Labor hours required for maintenance are generally shorter compared to those for steel bridges, but periodic repairs need to be repeated for the entire service period when a defect resulting from construction error is discovered.	Steel girders need to be repainted regularly, but repainting will not be required for 30 years or so by applying heavy-duty coating (C5 type). Coating is applied at a factory, so this type is excellent from a quality control point of view.	Steel girders need to be repainted regularly, but repainting will not be required for 30 years or so by applying heavy-duty coating (C5 type). Coating is applied at a factory, so this type is excellent from a quality control point of view.
Evaluation	Main girder and PC slab need to be made on site. The actual construction period is limited, and construction requires an extended time period. A girder fabrication yard must be constructed on site, and a larger construction yard is required compared to the idea of using steel girder. Bad	Girders are made at a factory, so the winter period in which field operations cannot be conducted can be effectively used. Construction period is considerably short compared to that of PC bridges. By eliminating jointed sections and thereby creating a continuous structure, drivability and earthquake resistance improve, and impact (noise) on the neighboring environment is reduced. Compared to the Third Idea, 1 more substructure is used, which is economically inefficient and requires a longer construction period. Fair	With this idea, construction period can be reduced the most, and economical efficiency is good. The number of piers is low, which improves visibility for pedestrians and vehicles passing the service road resulting in improved traffic safety. Good

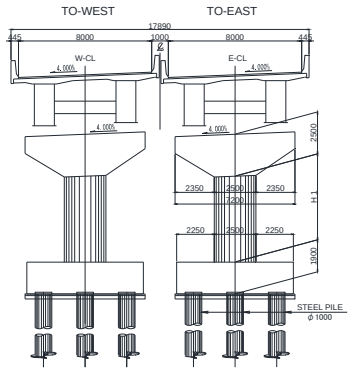
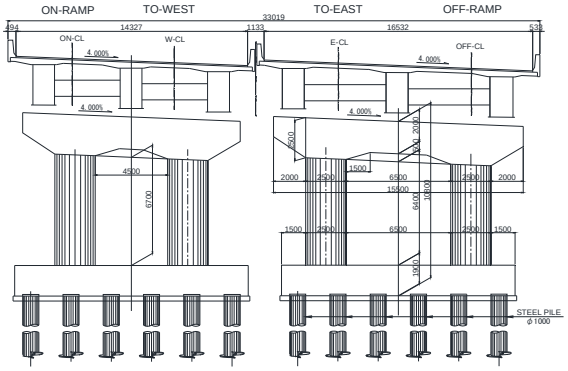
Table7.3.6 Comparison of Deck Slab Type

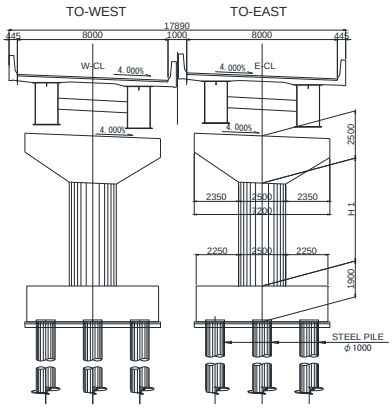
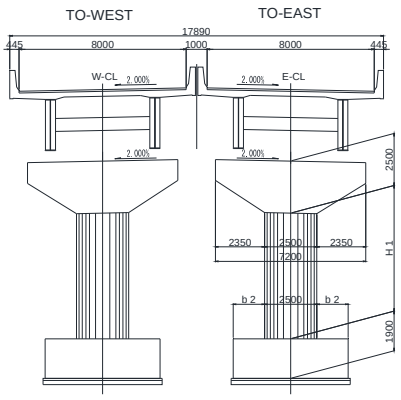
	Steel-Concrete Composite Deck Slab	Pre-stressed Concrete Slab	Reinforced Concrete Slab
Image			
Outline	This slab is integrated structure of steel and concrete to resist load.	Using pre-stressed concrete slab improves durability and enables reduction of the number of girders by lengthening the span of the slabs.	This slab is a conventional type made from a formwork installed on the supports, reinforcing bars assembled and concrete poured. Extra space under girders is required for work platforms and supports.
Economical Efficiency	Slab construction cost: 48,000 JPY/m^2 This slab construction cost is higher than prestressed concrete slab cost. However, superstructure construction cost can be reduced by lengthening slab span to reduce the number of girders.	Slab construction cost: 50,000 JPY/m^2 This slab construction cost is higher than reinforced concrete slab cost. However, superstructure construction cost can be reduced by lengthening slab span to reduce the number of girders.	Slab construction cost: 38,000 JPY/m2 This slab construction cost is low, but the number of main girders is more than the other slab types, therefore superstructure construction cost to be higher.
Construction Period	250 days (Assuming construction by 2 teams)	350 days (Assuming the slab is made on site and installed by 2 teams)	600 days (Assuming construction by 2 teams)
Durability and Required Maintenance	This slab is highly durable and longer lasting. Maintenance work can be saved and life cycle cost can be reduced.	Crack control is made possible by using pre-stressed concrete. This slab has higher durability than reinforced concrete slab. Life cycle cost can be reduced.	This slab is reinforced concrete, so durability is inferior to that of the other types. Concrete fall off and cracks often occur.
Evaluation	Steel panels are produced at a factory, so the winter period can be used efficiently. Formwork and work platforms and supports for the formwork are not needed, so construction period can be reduced. Also, space under the girders is free during construction. This type is good for bridges with grade separated crossing. Good	This type has excellent durability, but segments need to be made on site. Therefore, construction period is longer than that of the composite deck slab. Also, a fabrication yard and temporary storage yard are required for making segments on site. This type is not appropriate for this project as there are yard restrictions. Fair	Economical efficiency in the early stage is good, but life cycle cost is greatly higher to that of alternatives when considering long-term maintenance. Work platforms and supports are required. Construction period is very long compared to that of the other types. Bad

(6) Types of Pier

In the railway premises, the structure becomes complicated including S-shape curves and ramp widening sections. The substructure type should be selected to correspond to the complicated structure. Also, construction space is limited, and constructing a large-scale footing is difficult. Therefore, pile foundations will be used in the railway premises.

Table 7.3.7 Selection of Substructure Type

Section	**In the Railway Premises (Flyover Section)**	
	P1 to P5	**P6 to P8**
Type	Cylindrical Pier (with Beam)	Rigid Frame Pier
Cross-sectional View		
Reason for Selection	Curvature radius is R=200, so cylindrical pier is used as a pier shape because cylindrical piers can evenly resist loads in all directions.	This section requires widening the width for installing a ramp. Construction is implemented in the railway premises, so construction needs to fit in a narrow space. Width requires 15m or more, so the rigid frame pier is used for this section.

Section	**In the railway premises (Flyover Section)**	**Narny Road**
	P9 to P10	**P11 to P16**
Type	Cylindrical Pier	Cylindrical Pier
Cross-sectional View		
Reason for Selection	Curvature radius of this section is R=200 in the same way as A1 to P5, so cylindrical pier is used as a pier shape because cylindrical pier can evenly resist loads in all directions.	Horizontal alignment on Narny Road is straight. Supporting layer is confirmed in shallow position. Different from the railway premises, restriction of construction space is small. Therefore, economically efficient spread foundation + cylindrical pier are used for this section. Depth of spread foundation should be 4m taking into account freezing and thawing of the ground in winter.

(7) Selection of Foundation Type

i) Flyover Section

Select a construction type based on the following criteria. Influence of excavation work for foundation on railway track (feeder lines to the switchyard) should be minimized. Construction period in the railway premises should be shortened. Influence on train operation should be minimized. Based on the fact that the ground is mainly gravelly soil mixed with cobblestones, the following 3 construction methods were studied and compared.

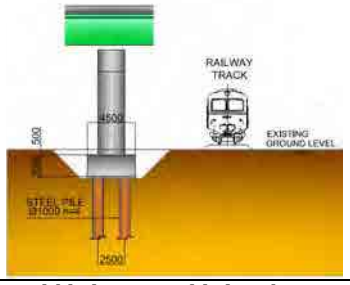
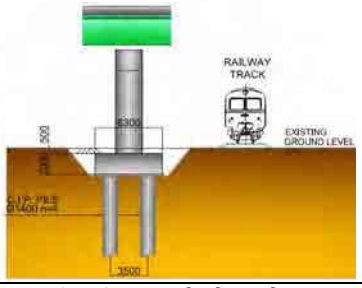
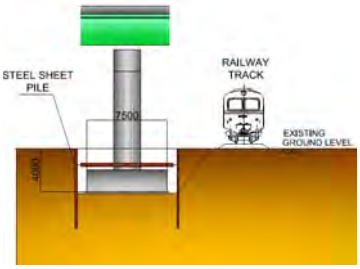
(1) Rotary penetration steel pipe pile

(2) Cast in place concrete pile

(3) Spread foundation

As the result, it was decided to use the "rotary penetration steel pipe pile" method because the method is economical and has excellent construction performance as well as having shown good results with the Narny Bridge.

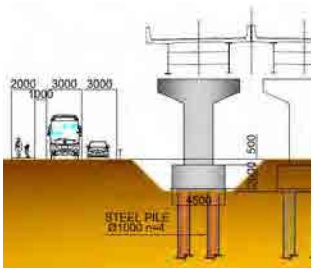
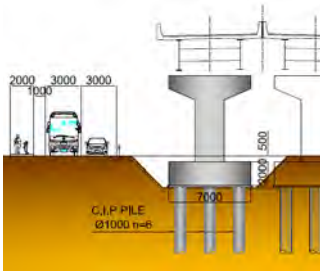
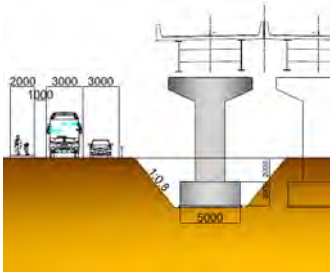
Table 7.3.8 Comparison of Foundation Type at Flyover Section (A1 to P10)

	(1) Rotary Penetration Steel Pipe Pile	(2) Cast in Place Concrete Pile	(3) Spread Foundation
Cross-sectional View			
Application for Construction Adjacent to Railway Track	Spiral blades are welded to the toe of the steel pipe piles, which are penetrated in the ground while rotating. Influence on the surrounding ground is small. Excavating range for footing is also small. Influence on railway is the least.	Casing (pipe) is pushed in the ground while rotating, earth and sand are dug using a hammer grab, concrete is poured while the casing is pulled out, and piles are formed. Displacement of the ground is likely to be caused when removing the casing.	Soil retaining work using steel sheet piles is required for digging down to GL-4.0m. Construction is conducted while performing measurement control so that the deflection of the sheet piles will not influence the railway. Groundwater level is relatively low, and influence such as boiling is small.
Construction Performance	Construction in narrow railway premises is possible. Amount of concrete used and earth removal is small, so frequency of construction vehicles' travel on the rail tracks is low. This method has little effect on railway operations.	Many types of equipment are required for setting piles, and this method is not suitable for a narrow railway track area. A lot of concrete and removed earth requires transport, so construction vehicles will frequently enter and exit the site. This method affects railway operations.	Boulders are mixed in the ground. As the ground is hard, special equipment and machines are necessary for setting steel sheet piles. Assembling and disassembling supports for the temporary earth-retaining structure require time. Due to the neighboring construction, many steel sheet piles cannot be pulled out and removed.
Construction Cost	180 Million JPY	150 Million JPY	200 Million JPY
Construction Period	70 days (1 party)	145 days (2 parties)	80 days (only sheet pile)
Evaluation	Economical efficiency is inferior compared to the Case (2) idea. However, construction performance is excellent, and this method can minimize effects on the railway during construction.	Economical efficiency is excellent, but the construction period is the longest. A large construction yard is necessary for materials and equipment. Also, excavation volume is greater than that of the 1st idea. Influence on railway is big.	Compared to the Case (1) idea, this method is time consuming for construction and greatly influences railway operations. Also, steel sheet piles must be left behind. This method is comparatively expensive.
	Good	Fair	Bad

ii) Narny Road Section

At the Narny Road section, construction should be conducted while the existing traffic is maintained, so the excavating range for the foundation work is limited. When the land acquisition for constructing the service road beside the bridge is completed, sufficient space can be kept for controlling the existing traffic. Based on the conditions above, foundation types were compared, and the spread foundation was selected for economical and construction performance reasons.

Table 7.3.9 Comparison of Foundation Types at Narny Road Section

	(1) Rotary Penetration Steel Pipe Pile	**(2) Cast in Place Concrete Pile**	**(3) Spread Foundation**
Cross-sectional View			
Outline	Spiral blades are welded to the toe of the steel pipe piles, which are penetrated in the ground while rotating. Driving force is created by a wedge effect at the toe of blades, and smooth penetration and high bearing capacity are achieved.	After setting the casing (pipe) in the ground with a hydraulic jack while rotating the casing repeatedly, drill earth and sand with a hammer grab, insert a reinforced frame, and pour concrete while pulling out the casing to form piles.	The railway is close, so make a temporary coffer, dig down to GL-4.00m which is not influenced by freezing and thawing, and construct a concrete foundation. A lot with sufficient space will be obtained, so open excavation is possible. (A temporary leased land is necessary.)
Construction Cost	230 Million JPY	180 Million JPY	50 Million JPY
Construction Period	45 days	180 days	(No pile)
Construction Performance	Footing size can be minimized, but economical advantages are few.	Many types of equipment for construction are necessary, and the construction period is long. Construction vehicles carrying materials and equipment need to enter and exit Narny Road which is heavily congested. This will increase traffic congestion.	Foundation size becomes large, but this method does not require special equipment. Construction period is short. There are many underground facilities, and temporary protection during construction is required.
Evaluation	As the spread foundation construction of the Case (3) idea can be conducted, application of this idea is not needed. Fair	Footing size becomes large, and a detour of the existing traffic is necessary. Construction period becomes long. There are no advantages with this method. Bad	Construction with open excavation is possible, so this idea is the best. Good

7.4 BASIC DESIGN OF BRIDGE

In this study, outline designing is implemented based on the design standards below. Allowable stress design method is used considering uncertainty of material properties.

(1) Design Condition

i) Design Standards for Reference

a) Specifications for Highway Bridges (Japan Road Association, March 2012)

b) Planning of Auto Road Bridge and Pipe Culvert (32-02-03, 2005)

c) Norm and Regulation for Design of Facility in Earthquake Region (22.01.01*/2006) Ministry of Construction and Urban Development)

ii) List of Design Conditions

Planned Location				Narny Road to West Industry Road, in Ulaanbaatar City
Bridge Length				828 m
Standard Road Width				8.0 m
Horizontal Alignment				A=100 ~ R=200 ~ A=100 ~ R=200 ~ A=100 ~ ∞
Design Live Load				B-Live Load in Specifications for Highway Bridge by Japan Road Association (See Figure 7.4.1 and Table 7.4.2)
Thermal Load				-40℃≦T≦40℃
Design Horizontal Seismic Coefficient				Level 1 Earthquake Motion: kh = 0.10 Level 2 Earthquake Motion: kh = 0.50
Superstructure	Type			Up and Down Line Separated Structure (Main Line) Continuous Structure Twin Box Girder Bridge, Continuous Structure Bridge with Minimized Usage of Steel Girder Plates (Ramp Section) Multi-span Continuous Box Girder Bridge
	Materials			SM520, SM490Y, SM490, SM400, SS400
	Slab Type			Steel-Concrete Composite Deck Slab: Slab thickness is 210 mm to 250 mm.
	Bearing Type			Steel bearing
Substructure	Type	Abutment and Pier		Reversed T Type Abutment, Overhang Type Cylindrical Pier, Rigid Frame Pier
		Foundation		Rotary Penetration Steel Pipe Pile: φ1000, Spread Foundation
	Materials	Structure	Reinforcing Bar	SD345
			Concrete	σck=24N/mm2
		Foundation		SKK490
	Bearing Stratum			GP-GC Layer
Crossing Condition	Railway Crossing Section			Construction Gauge: H=7.0m Maintain distance from the track center by L=3.5m for permanent structure. (See Figure 7.4.3.)
	Road Intersection			Construction Gauge: H=5.0m
Guard Fence				Concrete Guard Fence (Japan Guard Fence Installation Outline: SC Type, Florida Type)

iii) Materials

Materials applied to design should conform to the standards below.

Table7.4.1 Specification of Materials used for Basic Design of Bridge

Material	Application	Specification
Concrete	Abutment, Pier, Wall Rail	$\sigma ck=24$ N/mm^2
	Steel-Concrete Composite Deck Slab	$\sigma ck=30$ N/mm^2
Reinforcing Bar		SD345 (JIS)
Steel for Structure	Superstructure	SM520, SM490Y, SM490, SM400, SS400 (JIS)
Steel Pipe for Structure	Rotary Penetration Steel Pipe Pile	SKK490 (JIS)

iv) Live Load

According to Mongolian design standards, the design should be made based on “AK load consisting of biaxial load and uniform load modeling heavy vehicles” or “NK load of 4 axial heavy vehicles modeling large-sized trailers.” In association with the recent increase in vehicle size, revision of the design load is planned. As a result of comparing the following 5 loads including the current standards in Mongolia and live load that is planned to be revised (See Figure 7.4.1), it was decided to adopt Japanese B-live load (Figure 7.4.2, Table 7.4.3) which creates the largest bending momentum as a live load for this project.

a) Design Standard in Mongolia (before revision) (AK load or NK load; K=11)
b) Design Standard in Mongolia (after revision) (AK load or NK load; K=15)
c) Specifications for Highway Bridges in Japan (B-live load)
d) USA AASHTO LRFD (HL-93)
e) UK BS ENV 1991-1-1996 (Euro Code, LM-1)

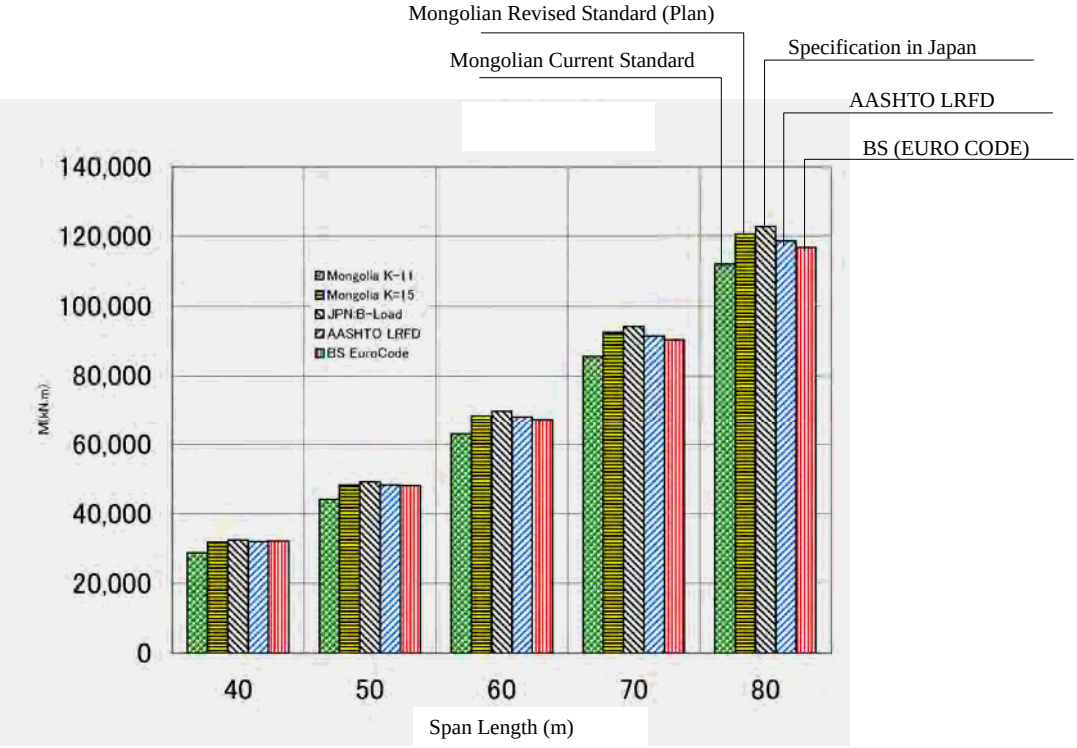


Figure 7.4.1 Comparison of Live Load Influence by Mongolia and Other Countries' Design Standards

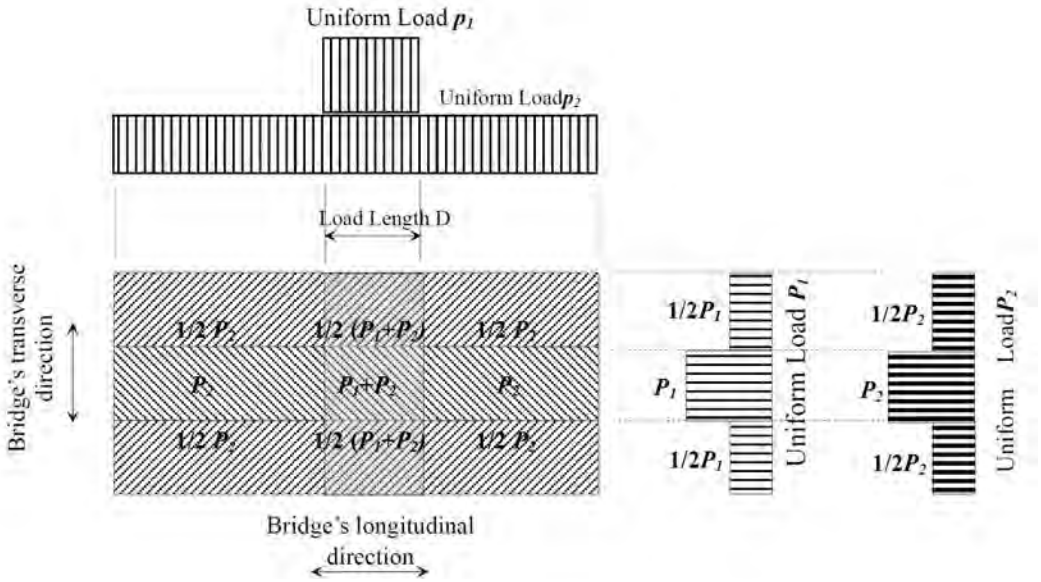


Figure 7.4.2 B-Live Load of Specifications for Highway Bridges in Japan

Table 7.4.2 B-Live Load Prescription of Specifications for Highway Bridges in Japan

Live Load on Main Lanes (Width: 5.5m)						**Live Load on Secondary Lanes**
Uniform Load p_1			Uniform Load p_2			
Load Length D (m)	Load (kN/m^2)		Load (kN/m^2)			
10	For calculation of bending moment	For calculation of shearing force	L≦80	80<L≦130	130<L	
	10	12	3.5	4.3-0.01L	3.0	50% of live load on main lanes

v) Thermal Load

According to weather data for the past 14 years (1998 to 2011), the lowest temperature/highest temperatures are ±40℃. Also, in the design standard (BNbD32.02.03), the same figure is indicated. Therefore, structure temperature referred to in this project is set to -40°C≦T≦40°C.

vi) Wind Load

Wind load is calculated using the maximum instantaneous wind speed, 30m/s, in Ulaanbaatar for the past 14 years (1998 to 2011).

vii) Soil Properties for Design

Boring investigation was conducted in the actual place to perform various geological investigations. Based on the results of boring, each soil modulus per layer were calculated. Schematic diagrams are shown in Figure 7.4.3. Each soil modulus is shown in Table 7.4.4.

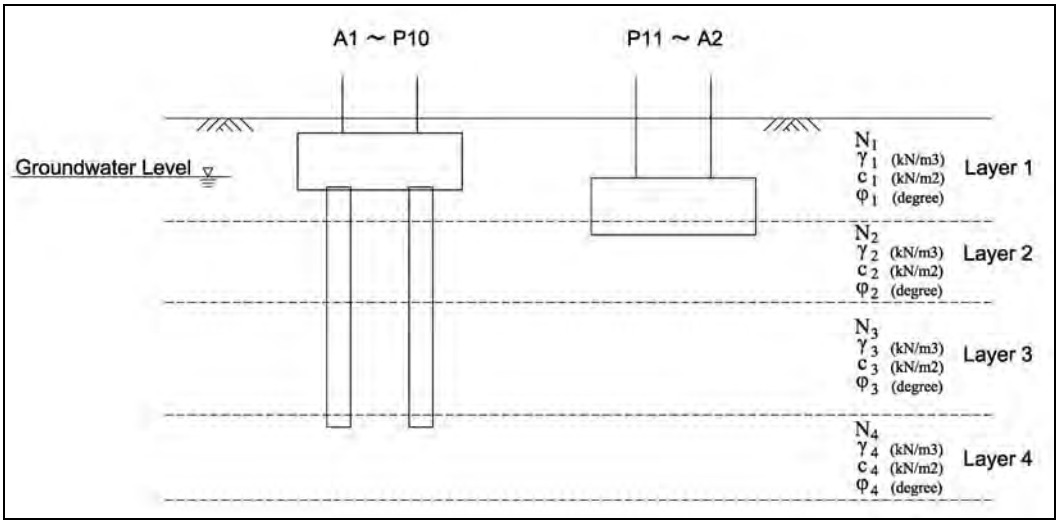


Figure 7.4.3 Schematic Diagram of Each Soil Modulus

Table 7.4.3 Soil Properties per Layer of Boring Point

Boring No.	BH-01	Design Target: Substructure	A1			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
tO_{IV}	14	19	0	34	39,200	78,400
GP	42	22	0	39	117,600	235,200
GP-GC	50	22	0	39	140,000	280,000
GP-GC	50	21	0	38	140,000	280,000
Boring No.	BH-02	Design Target: Substructure	P1, P2, P3, P4			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
GP	39	22	0	38	109,200	218,400
SC	45	20	0	38	126,000	252,000
GP	50	22	0	38	140,000	280,000
Boring No.	BH-03	Design Target: Substructure	P5, P6			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
GP	50	21	0	40	140,000	280,000
GP-GC	50	21	0	40	140,000	280,000
Boring No.	BH-05	Design Target: Substructure	P7, P8, P9, Ramp-P1			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
GP	40	21	0	40	112,000	224,000
GP	40	21	0	40	112,000	224,000
GP	50	21	0	39	140,000	280,000
GP-GC	50	21	0	39	140,000	280,000
Boring No.	BH-06	Design Target: Substructure	P11, P12, P13, Ramp-A2			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
GC	50	21	0	39	140,000	280,000
Boring No.	BH-08	Design Target: Substructure	A2			
Layer	Design N Value	Unit Weight γ (kN/m^3)	Cohesion c (kN/m^2)	Angle of Internal Friction φ (°)	Deformation Coefficients Eo (kN/m^2)	
					Ordinary Time	During Earthquakes
GP	50	22	0	39	140,000	280,000

viii)Allowable Stress

a) Steel Product

Allowable stress of steel products is as follows.

Table 7.4.4 Allowable Stress of Steel Products (N/mm^2)

Types of Stress	**SS400 SM400**	**SM490 SKK490**	**SM490Y SM520**	**SD345**
Tension	140	185	210	180
Compression	140	185	210	200
Shear	80	105	120	-

b) Concrete

Allowable stress of reinforced concrete members is as follows.

Table 7.4.5 Allowable Stress of Concrete (N/mm^2)

Types of Stress ＼ σck		21	24	30
Compressive stress	Bending compressive stress	7.0	8.0	10.0
	Axial compressive stress	5.5	6.5	8.5
Shearing stress	Only concrete	0.22	0.23	0.25
	With diagonal tension bar	1.6	1.7	1.9
	Punching shearing stress	0.85	0.90	1.00
Bond stress	Deformed bar	1.4	1.6	1.8

(2) Seismic Design

i) Earthquake Intensity Scale of Project Location

According to the Mongolian seismic design standard, BNbD22.01.01/2006, 6, 7, and 8 are prescribed as the applicable MSK earthquake intensity scale. Ajilchin Flyover construction site is located near the border of MSK 7 to 8 as shown in Figure 7.4.4. Based on the possibility of a magnitude 7 earthquake occurrence (pointed out by a French research institute in 2010), Mongolian Science Academy is reviewing seismic intensity in Ulaanbaatar City.

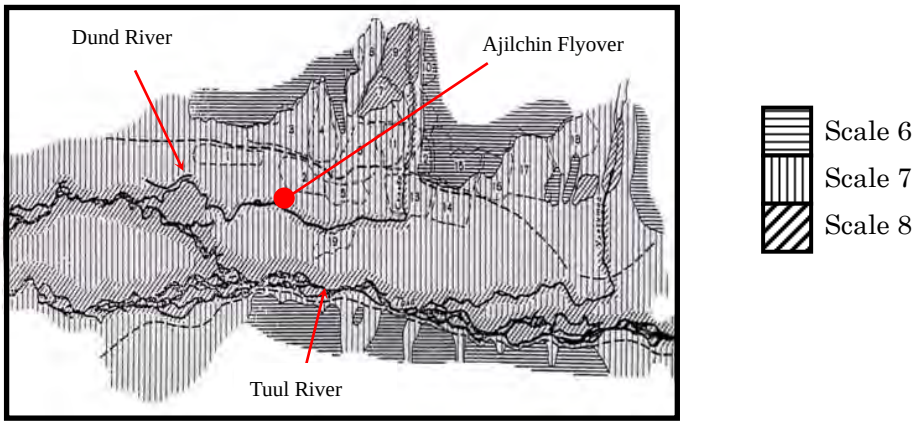


Figure 7.4.4 Map of Earthquake Intensity in Ulaanbaatar City

ii) Earthquake Load used for Seismic Design

According to Mongolian seismic design standard, use the following calculation formula to calculate by replacing earthquake load with static load. (Single Spectrum Calculation Method)

$S_{ik} = K_1 \cdot K_\varphi \cdot Q_k \cdot A \cdot \beta_i \cdot \eta_{ik}$

K_1 : 1.0 for elastic design, 0.12 to 0.35 for recognizing a plastic hinge

K_φ : Coefficient per ground type, Ground Type II (500<Vs<800) = 1.0

Q_k : Mass

A : 0.1g, 0.2g, and 0.4g for standard accelerated velocity set per MSK seismic coefficient 7, 8, and 9 respectively

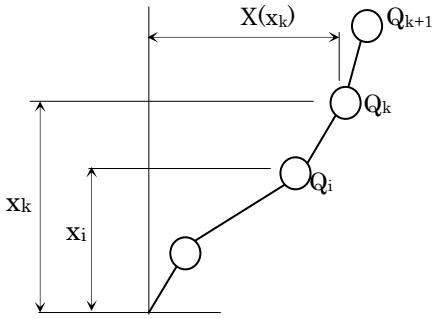


Figure 7.4.5 Explanation Drawing of Analysis Coefficient η

β_i : Acceleration Response Spectrum

Ti 0.1sec $\beta i = 1+15Ti$

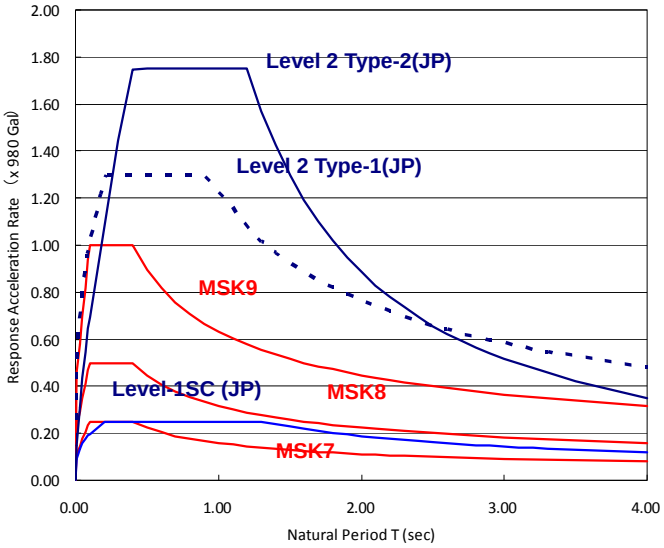
0.1sec Ti < 0.4sec $\beta i = 2.5$

0.4sec Ti $\beta = 2.5\ (0.4 / Ti)0.5$

η_{ik} : Analysis Coefficient

$\eta_{ik}=X_i(x_k) \cdot \Sigma(Q_j \cdot X_i(x_j)) / \Sigma(Q_j \cdot X_i^2(x_j))$

Response spectrum by an earthquake can be calculated using K_1(=1.0), K_φ(=1.0: Ground Type II), A, and β_i. In seismic design in Japan, response spectrum used for design structures within elastic range (Applied to Seismic Coefficient Method) and response spectrum used for design allowing localized damage that can be recovered in a short period are given (Level-1, Level-2).



Note: SC: Seismic Coefficient Method, Regional Factor for JP=1.0
Source: JICA Fact-Finding Team

Figure 7.4.6 Comparison of Response Spectrum (Source: JICA Fact-Finding Team)

Figure 7.4.6 shows a comparison between response spectrum for Type II Ground in Mongolia and Japan. With MSK7 (bridge construction site in Ulaanbaatar under prevailing regulations), an earthquake load smaller than that of Japanese seismic coefficient method is

given. With MSK8 and MSK9, an earthquake load is larger than the Japanese seismic coefficient method but the response acceleration rate is 2/3 and 1/2 of Level 2 Type 1 in Japanese specification. The bridge's own natural period T is approximately 0.5 to 1.0 second. When applying the Mongolian standard, MSk7 to MSK9, its acceleration rate becomes approximately 0.2g to 1.0g.

iii) Earthquake Motion in Mongolia under Consideration

At present, the "Earthquake Disaster Prevention Ability Improvement Project in Ulaanbaatar City" is studying earthquake motion based on the following 2 scenarios.

- Scenario I: Results by Hustai Fault
- Scenario II: More serious result caused by Emeelt Fault and Gunjiin Fault

As for the response acceleration applied to design, as shown in Figure 7.4.7, newly studied scenario type earthquake motion becomes approximately double of acceleration in the existing design guidelines. In discussion with the Ulaanbaatar City Road Bureau, it was decided to apply MSK8 of the current guideline based on the following matters; the recurrence interval of MSK8 that is prescribed in the existing standard is approximately 475 years; the bridge's own natural period is approximately 1.0 second; acceleration will be the biggest with Scenario-I (influenced by the Hustai Fault) but the recurrence interval with this scenario is not clear. According to trial analysis, quantity of reinforcing bar of piers increases 70% in weight of which cost would be equivalent to one (1) percent of the total construction cost in case the Senario-1 is adopted. This additional amount can be covered by contingency cost of the Project.

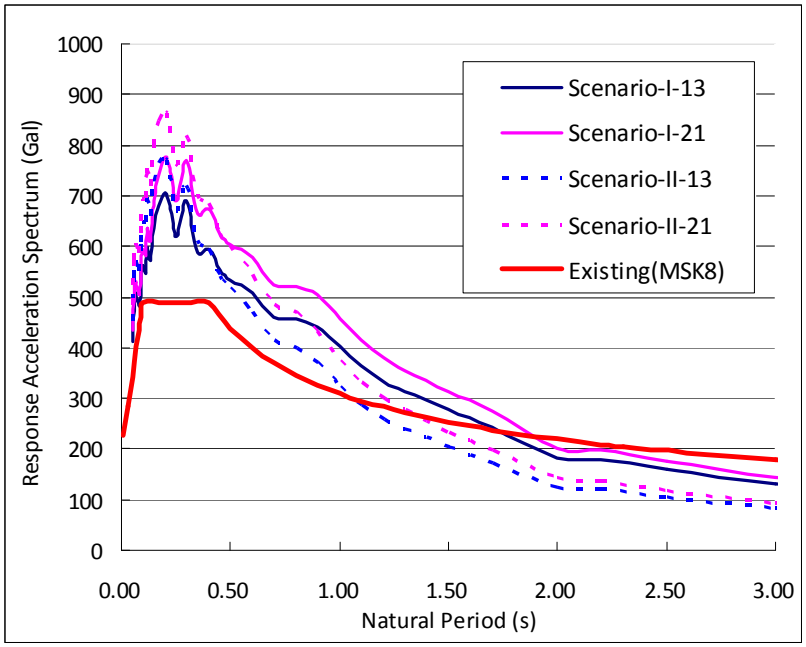


Figure 7.4.7 Comparison of Response Acceleration Spectrum of Scenario Earthquake Motion and the Current Guideline

iv) Seismic Design Policy for the Project

For seismic design of this bridge, based on the above reviews i) and ii), the following seismic design policy is adopted considering 2 levels of earthquake motion, which are Level 1 earthquake motion and Level 2 earthquake motion, in accordance with the method in the Specifications of Highway Bridges by the Japanese Road Association.

a) Time-proven Japanese seismic design method is used.
b) As for earthquake motion (Level 1) with high probability of occurrence during service period, the design should be made based on the Japanese seismic coefficient method (elastic design), and apply a design horizontal seismic coefficient Kh=0.10.
c) Earthquake intensity based on the Mongolian seismic design standard should be MSK8, which is handled as earthquake motion of Japanese seismic design Level 2 to allow deformation of bridge piers and piles to the nonlinear range.

Level 1 earthquake motion mentioned above is a medium-scale earthquake. The probability of such an earthquake motion affecting the structure once or twice during its service period is high. Against Level 1 earthquake motion, the structure is designed to behave within the elastic limit when subjected to a horizontal seismic coefficient of 0.1 (static horizontal load of 0.1 times of structure weight). Level 2 earthquake motion has low probability of occurrence and is very strong. Against Level 2 earthquake motion (design horizontal seismic coefficient 0.5), the structure would be damaged to a certain extent, but it should be designed to allow plastic deformation of the structure to the extent that a large-scale fall will not cause extensive damage to its surroundings but not to the extent that it exceeds the ultimate lateral strength.

v) Unseating Prevention System

In accordance with " Specifications for Highway Bridges Part-V Seismic Deign" (Japan Road Association, 2012), bridge unseating prevention system was examined. Basic ideas of selecting the bridge unseating prevention system are indicated in Figure 7.4.8.

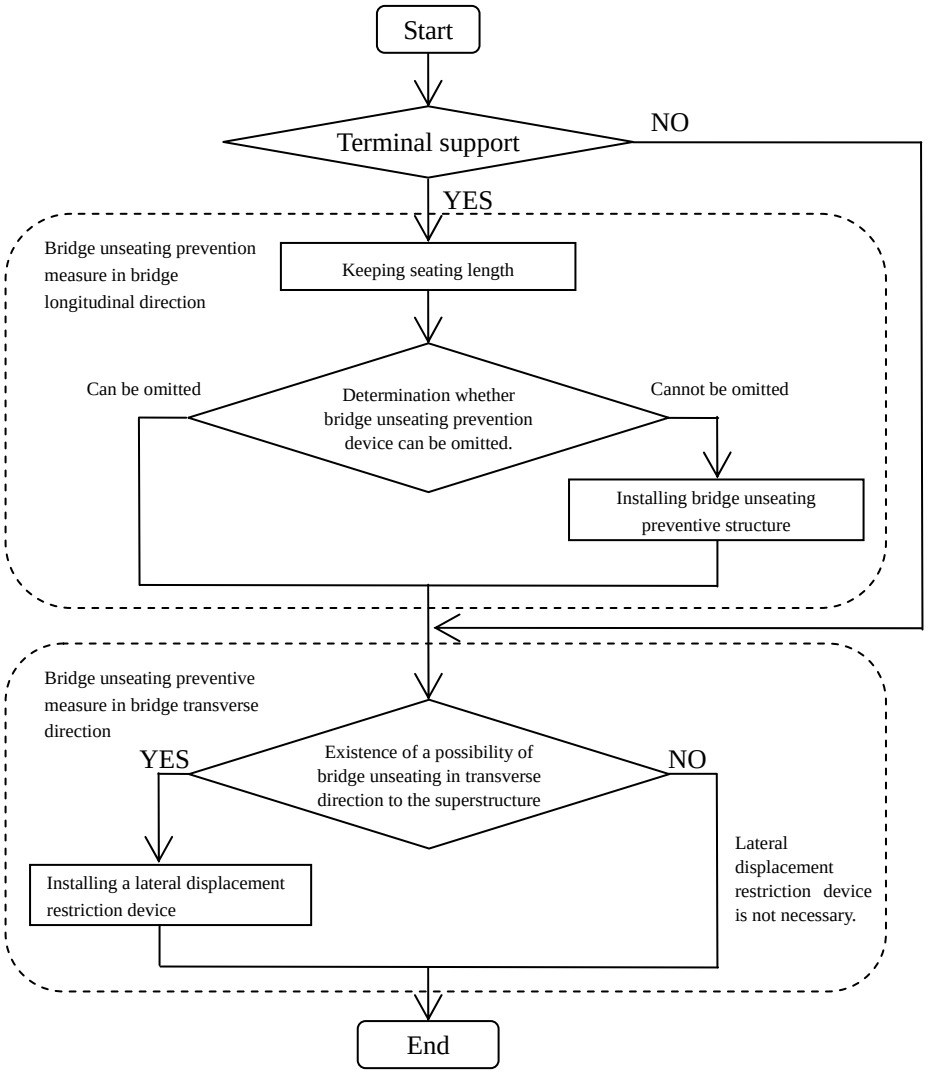


Figure 7.4.8 Flow chart for Examination of Bridge Unseating Prevention System

According to the above examination, it was concluded that bridge unseating preventive devices in the longitudinal direction are required but the lateral displacement restriction devices in the transverse direction are not required since each bridge has 3 or more spans and less chances that all bearings would be destroyed and the superstructure's response displacement become excessive are expected.

The bridge unseating preventive device to be installed should be a type to connect the superstructure to the substructure or to connect the superstructures using PC cables. Installation example of the bridge unseating preventive device is indicated in Figure 7.4.9.

Table 7.4.6 Study Result of Bridge Unseating Preventive System

Place to be Installed			Seating Length			Bridge Unseating Preventive Device	
			Check	S_E	S_{ER}	Necessity	Structure Type*
A1-P4	WEST	A1	○	1.35	0.910	○	TYPE A
		P4	○	1.35	0.922	○	TYPE B
	EAST	A1	○	1.35	0.914	○	TYPE A
		P4	○	1.35	0.932	○	TYPE B
P4-P8	WEST	P4	○	1.35	0.991	○	TYPE B
		P8W	○	1.35	0.935	○	TYPE C
	EAST	P4	○	1.35	1.003	○	TYPE B
		P8E	○	1.35	0.921	○	TYPE C
P8-P11	WEST	P8W	○	1.35	0.932	○	TYPE C
		P11	○	1.35	0.916	○	TYPE B
	EAST	P8E	○	1.35	0.880	○	TYPE C
		P11	○	1.35	0.908	○	TYPE B
P11-A2	WEST	P11	○	1.35	0.877	○	TYPE B
		A2	○	1.35	0.912	○	TYPE A
	EAST	P11	○	1.35	0.876	○	TYPE B
		A2	○	1.35	0.912	○	TYPE A
ON RAMP	WEST	P8W	○	1.35	0.944	○	TYPE C
		ON-P1	-	-	-	-	-
		ON-P2	-	-	-	-	-
		ON-A2	○	1.35	0.924	○	TYPE A
OFF RAMP	EAST	P8E	○	1.35	0.871	○	TYPE C
		OFF-P1	-	-	-	-	-
		OFF-P2	-	-	-	-	-
		OFF-A2	○	1.35	0.899	○	TYPE A

* Refer to TYPE A, TYPE B, and TYPE C in Figure 7.4.9 for the structure type.

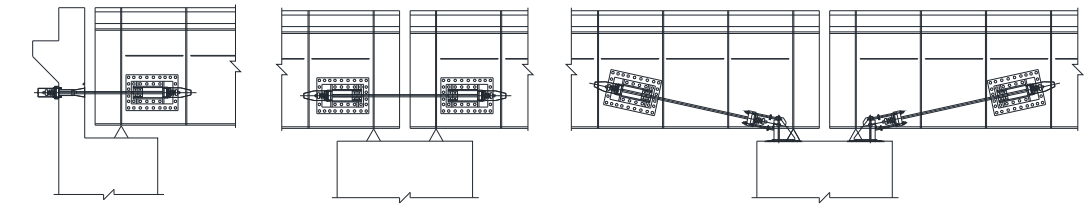


Figure 7.4.9 Installation Example of Bridge Unseating Preventive Structure

(3) Superstructure Design Results

i) Superstructure Reaction Force

A list of superstructure reaction force is shown below.

※ ▭ Grey shaded columns are substructures subject to check.

No. 1 Bridge		TO-WEST					TO-EAST				
		A1	P1	P2(F)	P3(F)	P4	A1	P1	P2(F)	P3(F)	P4
Reaction force of dead load	G1	929.4	3115.8	2832.6	3120.6	818.1	936.5	3209.4	2981.0	3274.1	842.6
	G2	1019.4	2988.8	2827.1	3149.1	1272.2	1035.8	3122.0	2986.3	3321.5	1348.5
	Total	1948.8	6104.5	5659.7	6269.7	2090.3	1972.3	6331.4	5967.3	6595.6	2191.1
Live load	G1	832.8	1575.6	1552.5	1578.0	773.7	838.7	1603.6	1594.3	1621.8	783.9
	G2	898.2	1553.6	1546.2	1581.5	1005.2	906.7	1582.5	1581.0	1618.1	1027.2

No. 2 Bridge		TO-WEST					TO-EAST				
		P4	P5(F)	P6(F)	P7(F)	P8	P4	P5(F)	P6(F)	P7(F)	P8
Reaction force of dead load	G1	944.4	5590.2	4331.8	5494.6	1310.1	1023.6	5281.1	4121.3	5330.1	1341.5
	G2			4786.8	3614.5	1143.6			4238.8	4736.2	1176.5
	G3	2097.6	4887.1	5498.3	5145.9	1029.8	2333.2	5498.8	5232.7	4848.9	1015.6
	Total	3042.1	10477.3	14616.9	14254.9	3483.5	3356.9	10779.9	13592.7	14915.2	3533.6
Live load	G1	805.3	2308.8	1729.4	2540.7	1092.9	812.0	2069.3	1599.3	2381.6	1131.2
	G2			1554.7	2663.9	818.2			1327.9	2694.2	858.0
	G3	1218.3	1933.4	2072.2	2338.4	881.0	1260.2	1951.5	2014.0	2205.2	900.4

No. 3 Bridge		TO-WEST				TO-EAST			
		P8	P9(F)	P10(F)	P11	P8	P9(F)	P10(F)	P11
Reaction force of dead load	G1	1344.1	3385.1	3201.6	1167.8	890.6	2907.6	3134.5	1093.1
	G2	843.4	3316.5	3196.6	841.0	689.3	2844.7	3132.2	797.6
	Total	2187.4	6701.6	6398.2	2008.8	1579.9	5752.3	6266.8	1890.7
Live load	G1	1026.0	1617.9	1582.3	968.8	894.4	1503.1	1546.0	945.3
	G2	784.1	1613.1	1589.7	789.6	743.2	1495.8	1553.7	777.1

No.4 Bridge		TO-WEST						
		P11(M)	P12(M)	P13(F)	P14(F)	P15(F)	P16(M)	A2(M)
Reaction force of dead load	G1	819.5	2545.5	2473.3	2511.2	2411.3	2771.6	985.3
	G2	750.7	2469.5	2452.3	2477.0	2382.8	2737.9	973.5
	Total	1570.1	5015.0	4925.6	4988.2	4794.1	5509.6	1958.8
Live load	G1	830.0	1487.2	1513.2	1536.3	1514.5	1548.4	868.0
	G2	795.2	1477.1	1514.1	1535.1	1514.3	1548.5	867.9
		TO-EAST						
		P11(M)	P12(M)	P13(F)	P14(F)	P15(F)	P16(M)	A2(M)
Reaction force of dead load	G1	799.9	2503.1	2445.7	2480.2	2380.4	2739.4	973.1
	G2	750.0	2490.8	2484.8	2508.1	2411.0	2772.8	984.8
	Total	1549.9	4993.9	4930.5	4988.3	4791.4	5512.1	1957.9
Live load	G1	827.6	1484.5	1513.2	1536.4	1513.5	1548.0	867.7
	G2	792.7	1474.9	1514.2	1536.2	1514.0	1547.9	867.7

Ramp		TO-WEST (ON)				TO-EAST (OFF)			
		P8	**P1(F)**	**P2(F)**	**A2**	**P8**	**P1(F)**	**P2(F)**	**A2**
Reaction force of dead load	G1	1336.3	2632.4	2488.0	984.4	685.0	2113.0	2328.9	859.3
	G2	454.8	3211.7	3003.4	644.8	470.3	2186.3	2435.3	531.1
	Total	1791.1	5844.0	5491.3	1629.3	1155.3	4299.2	4764.2	1390.5
Live load	G1	874.4	1111.1	1097.2	733.6	655.9	1016.9	1054.3	694.8
	G2	511.5	1266.4	1232.4	552.9	498.1	1040.5	1086.3	522.9

ii) List of Superstructure Design Results

The table below shows cross-sectional compositions and stress intensity in places where the cross-sectional force becomes maximum on each bridge (in the center of span and on the middle supporting point) taking To EAST side as an example.

a) No. 1 Bridge (EAST)

G1	**Section No.**		**Center of 1st Span**	**Pier No. 1**		**Center of 2nd Span**	**Pier No. 2**		**Center of 3rd Span**	**Pier No. 3**		**Center of 4th Span**
	Material		**SM490Y**	**SM490Y**		**SM490Y**	**SM490Y**		**SM490Y**	**SM490Y**		**SM490Y**
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	21	28		19	26		19	30		22
	Left Web.	H	1979	1972	1972	1981	1974	1974	1981	1970	1970	1978
		t	10	14		10	13		10	15		10
	Right Web.	H	1979	1972	1972	1981	1974	1974	1981	1970	1970	1978
		t	10	14		10	13		10	15		10
	Lower Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	18	28		14	27		14	30		20
STRESS	Upper Flg.	σ	-172	209	209	-158	205	205	-152	204	204	-180
	Lower Flg.	σ	199	-209	-209	185	-201	-201	179	-204	-204	203
	Web	τ	15	61	64	17	66	65	17	58	64	16
		Synthesis	0.88	1.11	1.13	0.77	1.10	1.09	0.72	1.04	1.08	0.91
G2	Section No.		Center of 1st Span	Pier No. 1		Center of 2nd Span	Pier No. 2		Center of 3rd Span	Pier No. 3		Center of 4th Span
	Material		SM490Y	SM490Y		SM490Y	SM490Y		SM490Y	SM490Y		SM490Y
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	22	31		21	29		20	34		26
	Left Web.	H	1978	1969	1969	1979	1971	1971	1980	1966	1966	1977
		t	10	14		10	14		10	15		11
	Right Web.	H	1978	1969	1969	1979	1971	1971	1980	1966	1966	1977
		t	10	14		10	14		10	15		11
	Lower Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	20	31		18	29		16	34		26
STRESS	Upper Flg.	σ	-174	206	206	-164	204	204	-166	207	207	-188
	Lower Flg.	σ	195	-206	-206	187	-204	-204	189	-207	-207	201
	Web	τ	15	61	64	17	64	62	18	59	66	15
		Synthesis	0.84	1.08	1.1	0.78	1.09	1.08	0.8	1.07	1.12	0.88
PIER				△			△			△		

b) No. 2 Bridge (EAST)

G1	Section No.		Center of 5th Span	Pier No.5		Center of 6th Span	Pier No.6		Center of 7th Span	Pier No.7		Center of 8th Span
	Material		**SM490Y**	**SM520-H/ SM490Y**		**SM490Y**	**SM520-H/ SM490Y**		**SM490Y**	**SM520-H/ SM490Y**		**SM490Y**
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	26	58		23	45		21	52		20
	Left Web.	H	2445	2387	2387	2456	2411	2411	2456	2396	2396	2464
		t	12	17		12	14		12	20		12
	Right Web.	H	2445	2387	2387	2456	2411	2411	2456	2396	2396	2464
		t	12	17		12	14		12	20		12
	Lower Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	29	55		21	44		40	52		16
STRESS	Upper Flg.	σ	-185	200	200	-184	206	206	-203	210	209	-169
	Lower Flg.	σ	185	-207	-207	203	-208	-208	193	-210	-209	196
	Web	τ	19	69	60	15	55	68	25	72	59	17
		Synthesis	0.76	1.13	1.06	0.92	1.06	1.15	0.92	1.16	1.09	0.86

G2	Section No.						Pier No. 6		Center of 7th Span	Pier No.7		Center of 8th Span
	Material						SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y
DIMENSION	Upper Flg.	W					1450		1450	1450		1450
		t					50		27	44		18
	Left Web.	H					2400	2400	2441	2412	2412	2467
		t					15		12	20		12
	Right Web.	H					2400	2400	2441	2412	2412	2467
		t					15		12	20		12
	Lower Flg.	W					1450		1450	1450		1450
		t					50		32	44		15
STRESS	Upper Flg.	σ					194	194	-193	194	194	-151
	Lower Flg.	σ					-194	-194	185	-194	-194	170
	Web	τ					50	63	25	59	72	23
		Synthesis					0.91	1.00	0.85	0.96	1.05	0.67

G3	Section No.		Center of 5th Span	Pier No. 5		Center of 6th Span	Pier No. 6		Center of 7th Span	Pier No. 7		Center of 8th Span
	Material		SM490Y/ SM520-H	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM490Y		SM490Y
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	38	57		22	49		19	40		18
	Left Web.	H	2413	2386	2386	2459	2402	2402	2455	2421	2421	2468
		t	12	17		12	17		12	19		12
	Right Web.	H	2413	2386	2386	2459	2402	2402	2455	2421	2421	2468
		t	12	17		12	17		12	19		12
	Lower Flg.	W	1450	1450		1450	1450		1450	1450		1450
		t	49	57		19	49		22	39		14
STRESS	Upper Flg.	σ	-207	208	208	-180	208	208	-177	194	196	-143
	Lower Flg.	σ	183	-208	-208	204	-208	-208	191	-197	-199	159
	Web	τ	20	68	63	15	57	72	27	57	77	18
		Synthesis	0.94	1.13	1.10	0.92	1.06	1.16	0.84	0.97	1.13	0.57

PIER Δ Δ Δ

c) No. 3 Bridge (EAST)

G1	Section No		Center of 9th Span	Pier No. 9		Center of 10th Span	Pier No. 10		Center of 11th Span
	Material		SM490Y	SM490Y		SM490Y	SM490Y		SM490Y
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450
		t	17	22		19	26		19
	Left Web.	H	2183	2178	2178	2181	2174	2174	2181
		t	11	13		11	13		11
	Right Web.	H	2183	2178	2178	2181	2174	2174	2181
		t	11	13		11	13		11
	Lower Flg.	W	1450	1450		1450	1450		1450
		t	10	25		15	27		15
STRESS	Upper Flg.	σ	-140	205	205	-159	206	206	-162
	Lower Flg.	σ	175	-192	-192	193	-202	-202	187
	Web	τ	15	56	62	15	63	62	13
		Synthesis	0.69	1.03	1.06	0.83	1.08	1.08	0.78
G2	Section No		Center of 9th Span	Pier No. 9		Center of 10th Span	Pier No. 10		Center of 11th Span
	Material		SM490Y	SM490Y		SM490Y	SM490Y		SM490Y
DIMENSION	Upper Flg.	W	1450	1450		1450	1450		1450
		t	16	21		18	25		18
	Left Web.	H	2184	2179	2179	2182	2175	2175	2182
		t	11	13		11	13		11
	Right Web.	H	2184	2179	2179	2182	2175	2175	2182
		t	11	13		11	13		11
	Lower Flg.	W	1450	1450		1450	1450		1450
		t	14	23		15	25		15
STRESS	Upper Flg.	σ	-125	194	194	-145	198	198	-147
	Lower Flg.	σ	133	-185	-185	172	-198	-198	166
	Web	τ	14	54	61	14	62	61	12
		Synthesis	0.40	0.93	0.96	0.66	1.02	1.01	0.61
PIER				Δ			Δ		

d) No. 4 Bridge (EAST)

G1	Section No		Center of 12th Span	Pier No. 12		Center of 13th Span	Pier No. 13		Center of 14th Span	Pier No. 14		Center of 15th Span	Pier No. 15		Center of 16th Span	Pier No. 16		Center of 17th Span
	Material		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM520-H/ SM490Y
DIMENSION	Upper Flg.	W	530	530		530	530		530	530		530	530		530	530		530
		t	39	44		29	45		29	47		31	43		27	51		49
	Web.	H	2361	2356	2356	2371	2355	2355	2371	2353	2353	2369	2357	2357	2373	2349	2349	2351
		t	12	16		12	16		12	16		12	16		12	18		12
	Lower Flg.	W	530	530		530	530		530	530		530	530		530	530		530
		t	39	57		29	58		29	60		30	55		26	66		49
STRESS	Upper Flg.	σ	-209	210	210	-203	208	208	-206	208	208	-205	207	207	-203	210	210	-208
	Lower Flg.	σ	209	-182	-182	203	-181	-181	206	-181	-181	208	-182	-182	207	-182	-182	208
	Web	τ	14	60	59	14	59	59	14	60	60	14	59	58	15	54	59	15
		Synthesis	0.70	1.18	1.18	0.91	1.15	1.16	0.93	1.16	1.16	0.95	1.15	1.14	0.94	1.13	1.16	0.92

G2	Section No		Center of 12th Span	Pier No. 12		Center of 13th Span	Pier No. 13		Center of 14th Span	Pier No. 14		Center of 15th Span	Pier No. 15		Center of 16th Span	Pier No. 16		Center of 17th Span
	Material		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM490Y	SM520-H/ SM490Y		SM520-H/ SM490Y
DIMENSION	Upper Flg.	W	530	530		530	530		530	530		530	530		530	530		530
		t	36	44		29	46		29	47		31	43		27	52		49
	Web.	H	2364	2356	2356	2371	2354	2354	2371	2353	2353	2369	2357	2357	2373	2348	2348	2351
		t	12	16		12	16		12	16		12	16		12	18		12
	Lower Flg.	W	530	530		530	530		530	530		530	530		530	530		530
		t	35	57		29	59		29	60		31	56		27	67		49
STRESS	Upper Flg.	σ	-206	208	208	-206	207	207	-206	209	209	-205	209	209	-203	208	208	-209
	Lower Flg.	σ	209	-180	-180	206	-181	-181	206	-183	-183	205	-181	-181	203	-181	-181	209
	Web	τ	15	59	60	14	60	60	14	60	61	14	59	58	15	55	59	15
		Synthesis	0.71	1.16	1.16	0.93	1.16	1.16	0.93	1.17	1.18	0.92	1.17	1.16	0.91	1.12	1.15	0.93
	PIER			Δ			Δ			Δ			Δ			Δ		

(4) Substructure Design Results

i) Pier Design

Pier design is calculated based on the conditions indicated in 7.4 (1) (2), and stresses at pier base and beam was checked as shown in Figure 7.4.10.

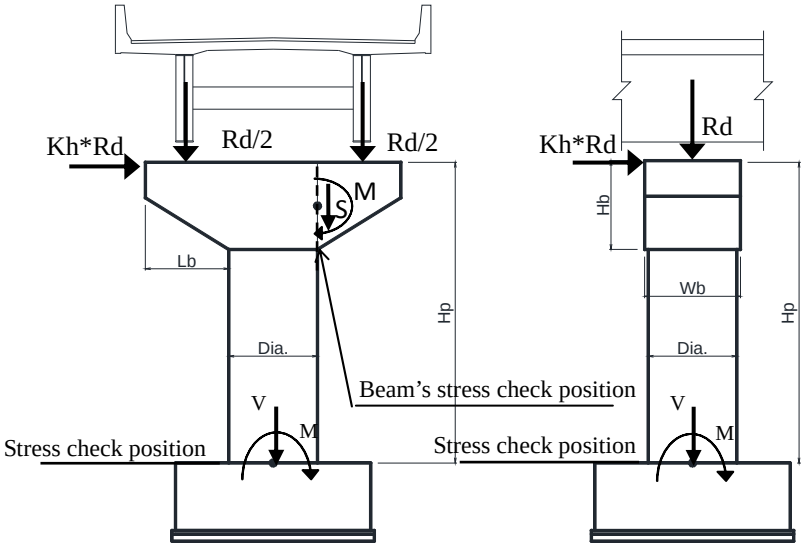


Figure 7.4.10 Stress Check Position of Pier

a) List of Beam Design Results

Group	Target Pier	Lb(m) xWb(m) xHb(m)	Main Reinforcing	Check for Bending Momentum			Check for Shearing	
				Bending Stress Check (When dead load applied)		Corbel Check (When dead load applied)	Average Shearing (Ordinary Time)	Stirrup Volume (Ordinary Time)
				σc < σca (σca = 8.0) (N/mm2)	σs < σsa (σsa = 100) (N/mm2)	Asu > AsuReq (mm2)	τm < τa1 (N/mm2)	Aw > AwReq (mm2) Reinforcing Alignment
Group1	P9W	2.35 x 2.7 x 2.5	D35x 2 levels 34 pieces	2.59	83.8	32524>27289	1.259>0.293 (*1)	3096.8 > 2500.6 D22-4 sets (8 pieces) ctc150
Group2	P5W	2.35 x 3.0 x 2.5※	D38 x 2 levels 42 pieces	3.02	82.7	47880>38939	1.417>0.293 (*1)	4053.6 > 3186.2 D25-4 sets (8 pieces) ctc150
Group3	P4E	2.35 x 3.0 x 2.5	D35 x 2 levels 38 pieces	2.53	81.7	36351>29739	1.345>0.294 (*1)	3096.8 > 3023.7 D22-4 sets (8 pieces) ctc150
Group4	P7W	2.00 x 2.7 x 2.5	D35 x 2 levels 34 pieces	2.79	97.1	32524>32013	0.922>0.290 (*1)	1548.4 > 1421.5 D22-2 sets (4 pieces) ctc150
Group5	P8W	2.50 x 3.0 x 2.5	D32 x 2 levels 34 pieces	2.59	95.6	32524>32013	0.857>0.308 (*1)	1373.4 > 1421.5 D22-2 sets (4 pieces) ctc150
Group6	Ramp-P1W	1.35 x 2.7 x 2.0	D16 x 1 level 34 pieces	0.20	19.8	—	0.012<0.152	—

*1 When τm < τa1, align necessary stirrup volume.

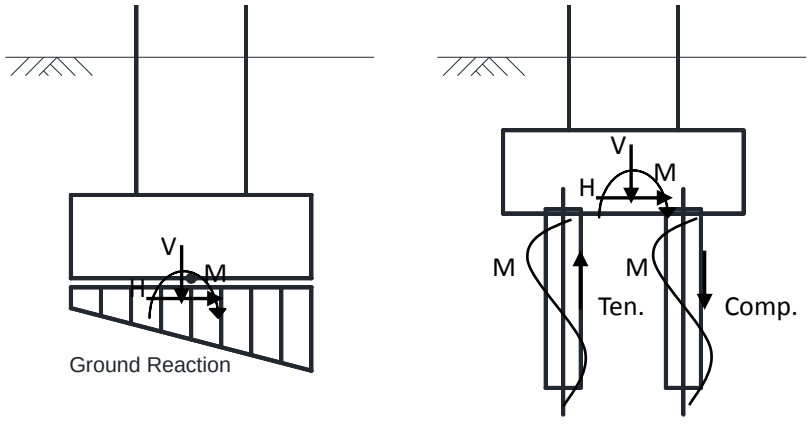
b List of Pier Design Results

Upper: Calculated value; Lower: Allowable value

	Substructure Type	Bearing Condition	Dia. (mm) ×Height(m)	Main Rebar	Level 1 Seismic Design (Stress)		Level 2 Seismic Design (Horizontal Strength)
					Concrete	Rebar	khcW < Pa
					(N/mm^2)	(N/mm^2)	(kN)
P1E	Column with Overhanging beam	M	φ2500×6.1m	D32 n=40	9.25 < 12.0	152.3 < 300	1632 < 2048
SP3E	Column with Overhanging beam	F	φ2500×9.2m	D38 n=78	9.27 < 12.0	134.9 < 300	2884 < 2993
P4E	Column with Overhanging beam	M, M	φ2500×9.2m	D35 n=52	10.33 < 12.0	184.3 < 300	1830 < 1887
P5E	Column with Overhanging beam	F	φ2500×9.6m	D38 n=92	10.50 < 12.0	122.0 < 300	3155 < 3231
P6W	Rigid Frame Pier	F	φ2500×9.3m	D38 n=80	9.33 < 12.0	139.1 < 300	2785 < 2790
P7E	Rigid Frame Pier	F	φ2500×8.9m	D38 n=88	9.43 < 12.0	127.9 < 300	3032 < 3146
P8W	Rigid Frame Pier	M, M	φ2500×8.8m	D32 n=44	8.70 < 12.0	189.2 < 300	1116 < 1334
P9W	Column with Overhanging beam	F	φ2500×8.6m	D35 n=88	8.10 < 12.0	106.5 < 300	2714 < 2844
P11W	Column with Overhanging beam	M, M	φ2500×10.3m	D35 n=48	8.03 < 12.0	147.9 < 300	1334 < 1529
P12W	Column with Overhanging beam	M	φ2500×10.1m	D38 n=48	7.78 < 12.0	117.7 < 300	1690 < 1836
P13W	Column with Overhanging beam	F	φ2500×9.9m	D38 n=52	8.33 < 12.0	133.8 < 300	2431 < 2567
Ramp-P1W	Column with Overhanging beam	F	φ2500×8.2m	D35 n=52	6.30 < 12.0	74.5 < 300	1972 < 2067

ii) Foundation Design

As for designing foundation construction, grouping was made based on the substructure type and bearing conditions; then design calculations were conducted using typical substructure types.



(a) Spread Foundation (b) Pile Foundation

Figure 7.4.11 Design of Foundation

a. List of Pile Foundation Design Results

Upper: Calculated value, Lower : Allowable value

	Height	Length・	Normal Condition				Level 1 Seismic Design				Level 2 Seismic Design		
	(m)	Number・ Thickness	Compression (kN)	Tension (kN)	Displacement (mm)	Stress (N/mm2)	Compression (kN)	Tension (kN)	Displacement (mm)	Stress (N/mm2)	Mmax<My (kN・m)	Pmax<PNU (kN)	Yield
A1	11.3	L=5.0m / n=15 / t=14mm	2689 < 4049	1687 > 0	1.89 < 15	100 < 185	3319 < 6073	533 > -847	2.64 < 15	154 < 210	—	—	—
P1E	8.0	L=5.0m / n=4 / t=14mm	2775 < 3951	2676 > 0	0.00 < 15	69 < 185	3763 < 5926	586 > -880	3.34 < 15	188 < 277	1906 < 2406	6026 < 10744	No
P3E	11.1	L=5.5m / n=6 本 / t=14mm	2120 < 4012	2005 > 0	0.00 < 15	53 < 185	3031 < 6018	327 > -951	2.25 < 15	138 < 277	2421 < 2565	5552 < 10709	No
P4E	11.1	L=5.5m / n=4 / t=14mm	2862 < 4012	2740 > 0	0.00 < 15	71 < 185	3921 < 6018	382 > -1007	3.31 < 15	186 < 277	1807 < 2384	6368 < 9777	No
P5E	11.5	L=5.0m / n=6 / t=14mm	2919 < 3839	2805 > 0	0.00 < 15	73 < 185	3987 < 5759	804 > -846	1.87 < 15	154 < 277	2232 < 2371	7201 < 11517	No
P6W	11.2	L=5.5m / n=10 / t=14mm	2141 < 4004	2029 > 0	0.00 < 15	53 < 185	3678 < 6007	494 > -1005	2.28 < 15	165 < 277	2331 < 2560	7046 < 11709	No
P7E	10.8	L=6.5m / n=12 / t=14mm	1872 < 3961	1772 > 0	0.00 < 15	47 < 185	3359 < 5942	285 > -1131	2.60 < 15	161 < 277	2383 < 2625	6902 < 11709	No
P8W	10.7	L=5.0m / n=8 / t=14mm	1814 < 3961	1661 > 0	0.05 < 15	45 < 185	3159 < 5942	317 > -729	3.02 < 15	168 < 277	1740 < 2639	4952 < 9777	No
P9W	10.5	L=5.0m / n=6 / t=14mm	2124 < 3962	2010 > 0	0.00 < 15	53 < 185	2816 < 5942	551 > -729	1.97 < 15	124 < 277	2211 < 2564	5410 < 10744	No
Ramp-P1W(ON)	10.1	L=5.0m / n=4 / t=14mm	2631 < 3951	2509 > 0	0.00 < 15	65 < 185	3274 < 5926	916 > -867	2.09 < 15	137 < 277	2017 < 2441	6142 < 10744	No

b) List of Spread Foundation Design Results

Upper: Calculated value, Lower: Allowable value

	Height	Dimension	Normal Condition				Seismic		
			Falling	Sliding	Ground Reaction	Bearing Capacity	Falling	Sliding	Bearing Capacity
	(m)	(m)	(m)	(－)	(kN/m2)	(kN)	(m)	(－)	(kN/m2)
P11W	12.2	4.5×4.5	0.000 < 0.750	－ > 1.5	474 < 700	9223 < 24050	1.431 < 1.500	5.050 > 1.2	7023 < 11604
P12W	12	4.5×4.5	0.000 < 0.750	－ > 1.5	532 < 700	10393 < 24050	1.298 < 1.500	4.790 > 1.2	8393 < 12766
P13W	11.8	5.0×5.0	0.000 < 0.833	－ > 1.5	449 < 700	10766 < 29720	1.387 < 1.667	4.403 > 1.2	8666 < 15640
A2	11.6	6.0×17.89	0.490 < 1.000	2.833 > 1.5	442 < 700	30490 < 58576	1.415 < 2.000	1.508 > 1.2	26513 < 29147
Ramp-A2W(ON)	11	6.0×6.394	0.444 < 1.000	3.134 > 1.5	426 < 700	10843 < 21655	1.386 < 2.000	1.599 > 1.2	9332 < 11495
Ramp-A2E(OFF)	10.8	5.5×6.390	0.425 < 0.917	2.874 > 1.5	418 < 700	9612 < 18719	1.363 < 1.833	1.504 > 1.2	8217 < 9151

7.5 APPLICATION OF JAPANESE TECHNOLOGY

This project is to construct a portion of the road forming the east-west major road indicated in the Ulaanbaatar City Master Plan of 2030, so its public nature is very high. However, design and construction conditions for building the bridge are very severe, and a high technological level is required. Assumed problems for building the Ajilchin Flyover and Japanese technology to deal with such problems are introduced below.

(1) Construction Adjacent in Railway Premises and a Narrow Space (Rotary Penetration Steel Pipe Method)

Ajilchin Flyover has a road alignment which strides over the railway premises where the railway mainlines and feeder lines are closely laid. Width of the railway premises is 350m in length. Therefore, multiple piers need to be placed in the railway premises, but railway tracks are closely laid and limit space for arranging the piers. Construction space is also very small.

Figure 7.5.1 Construction using Rotary Penetration Steel Pipe Pile

Therefore, the rotary penetration steel pipe pile method must be applied due to the space limitations. The method enables to downsize the structure and conduct construction in a narrow space. Spiral steel plates are attached to the toe of the pile, the pile is penetrated into the ground while the steel pile is rotated (see Figure 7.5.2), and a pile is established. Pile establishment is highly possible even in earth containing boulder

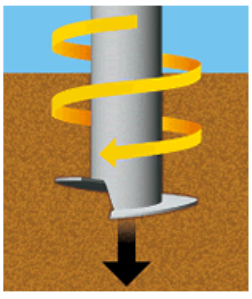


Figure 7.5.2 Image of Rotary Penetration

as is the case with this project site. Typical advantages are described below.

i) Large Bearing Capacity and Small Footing

Due to the effect of the steel plate's essentially widening the bottom end of the pile, approximately 1.5 times more bearing power is obtained compared to the general cast-in-place pile. Therefore, the number of piles can be reduced, and the footing size can be downsized. (See Figure 7.5.3)

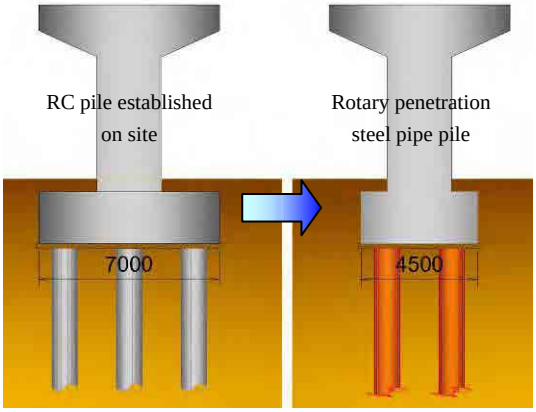


Figure7.5.3 Comparison of Footing Size per Pile Type

ii) Construction Adjacent to Railway Track

This construction will be conducted in the railway premises, and hindering train operations must be avoided. With this method, the rotating pile presses into and penetrates the ground, which can keep down vibration with a small risk of problems such as displacement of the train tracks. When suspending steel pipes, a crane is used. A full swing machine rotates and presses steel pipes into the ground, so there is no danger of steel pipes contacting the trains or falling down due to the crane's rotating movement. Also, no digging is necessary, so there is no risk of loosening the surrounding ground. This method is appropriate for neighboring construction.

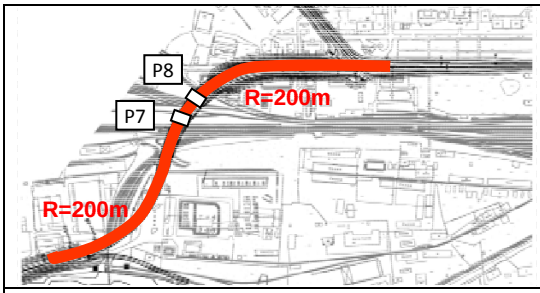
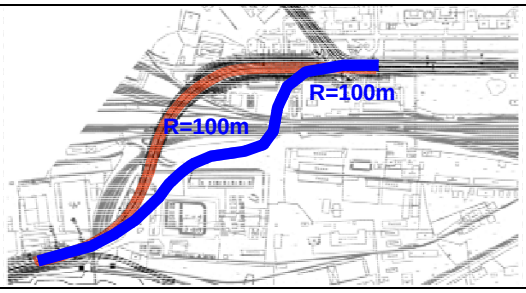
iii) Less Waste Soil

With this method, piles can be established without digging the ground, so the process of disposing of soil after drilling (drilling, transport, treatment) is eliminated, which reduces adverse effects on the environment. Also, space for installing drilling equipment is small. Construction can be conducted on a small site.

iv) Comparison of Rotary Penetration Steel Pipe Pile and Concrete Pile

Provided that rotary penetration steel pipe pile should not be applied and replaced by cast-in-place concrete pile, piling work for P7 and P8 is impossible due to limited working space, and thus alignment of the bridge needs to be modified to secure sufficient working space for installation of cast-in-place concrete pile. In this case, radius of curve is changed from 200m to 100m, which requires design speed to be decreased from 60km/h to 50km/h. Moreover, it will induce serious problem of accidental risk due to freezing of bridge deck.

Table 7.5.1 Comparison of Possible Routes as per Piling Methods

	
Rotary Penetration Steel Pipe Pile	Cast-in-place Concrete Pile

(2) Construction above Rail Tracks and the Existing Roads (Steel-Concrete Composite Deck Slab)

It is planned that the Ajilchin Flyover crosses over existing railway tracks and Narny Road. General RC slab requires construction of work platforms and supports for building the slabs. It requires extra construction space in addition to the construction gauge. Space under the girders is occupied during construction, so it is difficult to conduct safe control without hindering the existing traffic (trains and cars).

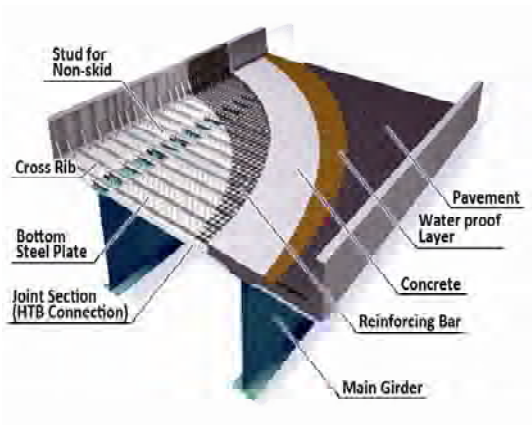


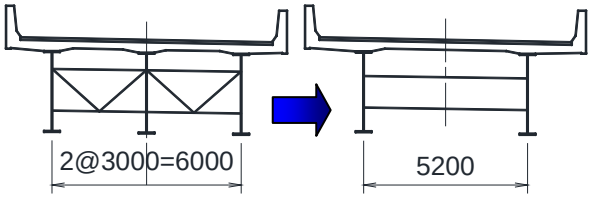
Figure 7.5.4 Image of Composite Deck Slab

The steel-concrete composite deck slab is applicable to those issues, of which technology is used for the Narny Bridge. The advantages of the slab are described below.

Figure 7.5.5 Construction of Composite Deck Slab

i) Formwork and construction of supports are not required.

Bottom steel plate of the composite slab functions as a mold form until concrete hardens, so no mold form is necessary. Also, the bottom steel plate is reinforced by longitudinal ribs, and it is self-sustainable which makes construction of supports unnecessary for building slab. There is no risk of influence on the existing traffic under the girders.



(a) RC Slab (b) Composite Slab

Figure 7.5.6 Difference of Girder Alignment per Slab Type

ii) Widening span of deck slab

Bottom steel plate of the composite slab functions as a structural member bearing sectional force after concrete hardens. It is a composite structure which effectively combines the steel member and concrete in charge of tensile force and compressive force respectively. Its rigidity is high, and the deck slab span can be lengthened, which reduces the number of girders and also contributes to cost reduction.

iii) High Durability

This slab type is a composite structure of steel plates and concrete, so it has high rigidity. Maintenance labor can be saved, and the life cycle cost also can be reduced. Also, the underside is covered with steel plates, so there is no concrete fall down. Thus there is no effect to the railway. When the main girder is launched, it can be used as a reinforcement member.

(a) Underside of Damaged (caved in) RC Slab

(b) Underside of Composite Slab

Figure 7.5.7 Bottom of Slab

(3) Erection Method above Railway Track (Launching Method)

Girders of the Ajilchin Flyover must be installed above the railway in a manner that will not hinder train operation. General construction method is to install a vent (a column temporarily bear a girder), place a girder on the vent, and connect each other. However, no space for installing a vent or placing a crane can be obtained over the railway, so the launching method which assembles the girders in advance next to the railway and slides them over the railway is to be used.

Figure 7.5.8 Erection Method over the Railway Track (Narny Bridge)

The launching method itself has been used for building the Narny Bridge. The method is generally used for places where vents cannot be installed, such as over a railway or road. When launching a girder, the girder stress inverts against ordinary time. This bridge is a curve line bridge, so three-dimensional control is required when launching a girder. High level construction technology is required for this method.

CHAPTER 8

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.1 ENVIRONMENT IN THE PROJECT AREA

(1) Natural Environment and Environmental Problems

Mongolia is a landlocked country surrounded by Russia, China and Kazakhstan, and its area of 1,566,500 km^2 is four times larger than that of Japan. Geographically, it is characterized by the 4,000m-class Altai Mountains on the south-western side, the Hangayn Mountains from the north-western side to the central part, the Gobi Desert in the south and large prairie from the central part to the eastern part. Ulaanbaatar City, where the project site is located, is in North-Central Mongolia, and lies at an elevation of about 1,310 meters in a valley on the Tuul River.

Due to its high elevation, the city features brief, warm summers and long, bitterly cold and dry winters. Its average temperature is below freezing for half a year, and central heating systems in the city are an essential lifeline in these periods. Most of the annual precipitation falls in the summer season from June to September. The wind mostly blows from the north-west during the winter time. Otherwise, the wind directions are largely dependent on the geographical features in each location. (Detailed climate information shall be referred to Chapter 4.)

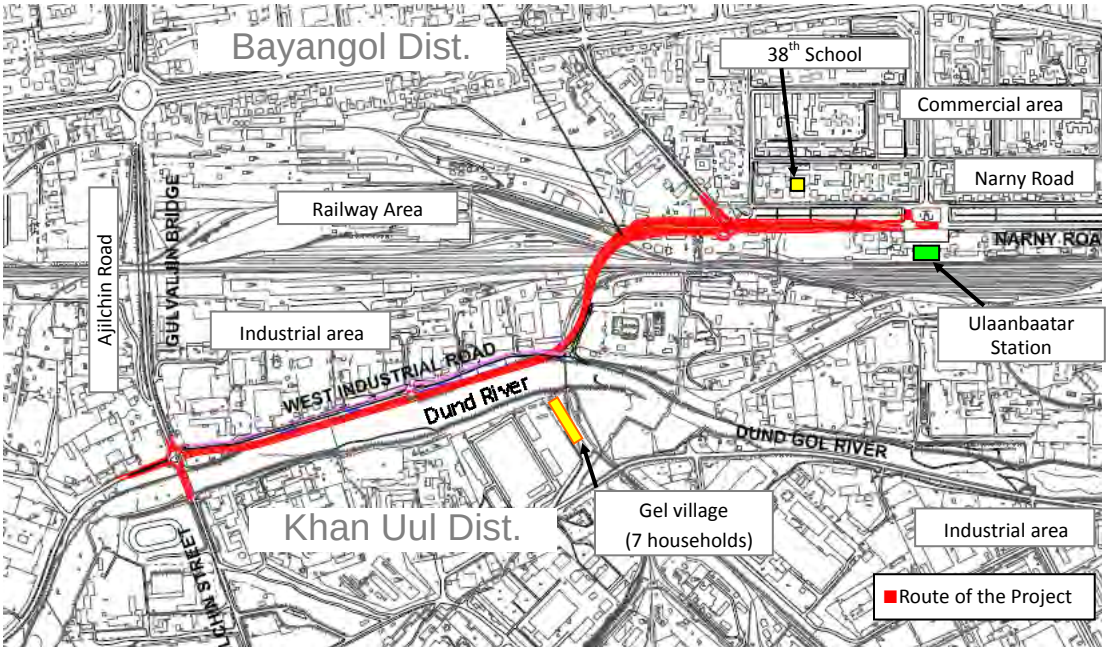


Figure 8.1.1 Land use around the project area

The project site, near Ulaanbaatar Railway Station, lies in an industrial area covering both Bayangol District and Khan Uul District. The project road extends in the east-west direction with a length of 2250m from the intersection with Ajilchin Street up to near Ulaanbaatar

Railway Station.

The Dound River, which runs between Bayangol District and Khan Uul District as a district border, is a dry river throughout most of the year. An access road at the west side passes through the industrial area and an east side access road connects to Narny Road in a commercial area. The major environmental problems faced by Ulaanbaatar City are summarized below.

i) Air Pollution

Air pollution, one of the most serious environmental problems in Ulaanbaatar City, and it has attracted the attention not only of the national agencies but also donor agencies; thus cooperation projects and studies in this field are indeed numerous[1]. In Ulaanbaatar City, wintertime air pollution mainly caused by coal combustion at three thermal power plants, 200 Heat Only Boilers (HOBs), more than 1,000 Coal Fired Water Heaters and around 140,000 ger stoves affect citizen's health seriously. Particulate Matter (PM) is considered particularly important as a targeted pollutant to treat among others such as dust, SO_2 and NO_2.

In addition to the above-mentioned sources, increasing transportation due to the robust economic growth especially in the highly urbanized Ulaanbaatar City has caused concern in recent years[2]. The current ambient air quality in comparison with the Mongolian environment standard (MNS4585) is summarized in Table 8.2 below.

Table 8.1.1 Air Quality in Ulaanbaatar (Yearly Average from Oct. 2010 to Sep. 2011)

Unit: $\mu g/m^3$

	MNS4585	**CLEM-1**	**CLEM-2**	**CLEM-4**	**CLEM-5**	**CLEM-7**	**CLEM-8**
SO_2	10	26	31	12	53	20	18
NO_2	30	40	93	49	42	37	31
PM_{10}	50	152	189	120	355	209	86
$PM_{2.5}$	25	—	154	49	—	—	—

Source: JICA's The Study on Implementation of Ulaanbaatar City Urban Transportation Project in Mongolia (Interim Report)

Note: Central Laboratory of Environment and Meteorology (CLEM) is institution of MNET. Mongolian national environmental standard on ambient air (MNS4585) is available at http://estandard.mn/file.php?sid=81 Also, an interview with a JICA expert of "Capacity Development Project for Air Pollution Control" confirmed that station number two (CLEM-2) in the table has a similar ambient environment in terms of traffic situation to the project site.

ii) Water Pollution

Due to the urbanization and concentration of industries in Ulaanbaatar City, deterioration of water quality is becoming another serious environmental issue[3]. The Tuul River originating

[1] For example, JICA started a technical cooperation project called Capacity Development Project for Air Pollution Control in Ulaanbaatar City in March 2010. The World Bank issued a discussion paper titled "Air Quality Analysis of Ulaanbaatar — Improving Air Quality to Reduce Health Impact" with special attention to Particulate Matter (PM).

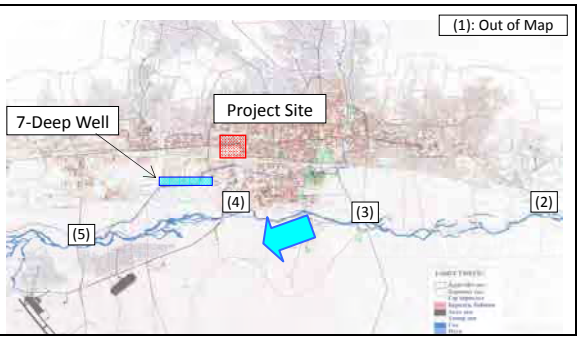
[2] According to the *Mongolia Environment Monitor 2004* issued by the World Bank, the source of air pollution in Ulaanbaatar reported a MNET estimation as CHP (44%), Transport (39%), HOB (9%), and Households (8%). Another publication of the World Bank, *Mongolia – Air Quality Analysis of Ulaanbaatar – Improving Air Quality to Reduce Health Impact (2011)* focuses on the single largest problem pollutant, particulate matter (PM); source of PM10 is estimated as ger households (36%), CHP (34%), Dust from roads (27%), HOB (2%) and Vehicle exhaust (2%).

[3] The ten-year trend of oxygen demand from 1997 on UNEP's Environmental Outlook 2007 shows a continuous deterioration in

in the Khentii Mountains is 819 km long and drains an area of 50,400 km^2. The River is considered an important water resource; however, the water quality especially in the lower stream, where discharged water from the city sewage plan flows in, has deteriorated seriously.

Table 8.1.2 Water Quality of the Tuul River

Sampling Points	COD (mg/L)	BOD (mg/L)	DO (mg/L)
Environmental Standard	<10	<10	>9
(1) Terelj	9.8	5.43	9.9
(2) Bayanzurkh bridge	29	4.54	9.61
(3) Zaisan	32.7	6.4	11.7
(4) Yarrmag	68.6	6.04	11.9
(5) Sonsgolon	58.8	6.38	11.6
(6) Songino bridge	117.6	2.41	5.61



Source: World Bank, Mongolia Environment Monitor 2004 (using WHO data on 2003)
Note: Mongolian national environmental standard on water quality (MNS4586) is available at: http://estandard.mn/file.php?sid=1288

In Mongolia, in order to assure the water quality, water sources and their basins are protected under Article 20.5 of the Law on Special Protected Area (1994), Article 5.1 of the Law on Sanitation (1998)[4], and the Law on Water (amended in 2004). The nearest water source to the project site is located on the western side of the third thermal plant, where seven deep wells exist.

iii) Soil Contamination

Soil contamination is another environmental issue that starts causing people concern. A wide spectrum of pollutants cause soil contamination from an extensive range of sources, i.e., vehicle exhaust and water discharged from factories[5]. Table 8.4 shows the status of soil contamination in 2010.

the water quality of the Tuul River.

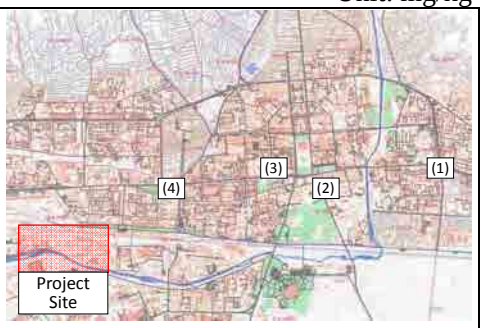
[4] The article says "Local administrative bodies, agencies in charge of water use, business entities and individuals shall take measures to establish security zones for drinking water sources, water distribution networks, main water reservoirs, pumping stations, and water distribution sites and protect them from contamination in accordance with the relevant regulations."

[5] For details of the soil contamination in each functional zone in the Ulaanbaatar City, see Ecological-Geochemical State of Soils in Ulaanbaatar, Eurasian Soil Science, 2011, Vol. 44, No. 7, pp. 709-721

Table 8.1.3 Status of Soil Contamination in Ulaanbaatar (2010)

Unit: mg/kg

Location	Position	Pb	Cd	Cr	Sr
(1) East Road Junction	South of road	18.2	0.16	120.1	305.7
	North of road	77.9	2.31	127.7	240.8
(2) The State Pedagogical University	South of road	116.8	0.78	165.2	546.5
	North of road	26.0	0.05	105.1	361.2
(3) Central Post Office	South of road	64.9	1.09	106.6	370.5
	North of road	90.9	2.60	166.7	740.4
(4) West Road Junction	South of road	84.4	1.50	165.2	518.8
	North of road	28.6	2.20	90.1	213.1
Average of the above four areas		63.4	1.3	130.8	412.1
Average of Ulaanbaatar City (2005)		43.7	1.9	90.5	375.1
Standard (MNS 58:50)		100.0	3	150	800



Location Map

Source: Environmental Outlook of the Ulaanbaatar City (2008) UNEP

Note: Mongolian national environmental standard on soil (MNS4550) is available at: http://estandard.mn/file.php?sid=436

(2) Social Environment

The Mongolian economy, which was negatively affected by the global downturn, experienced zero growth in 2009; however, the economy returned to robust growth in 2010 achieving more than 6% in real GDP growth rate. The engine for such growth is industrial development; industrial outputs grew 10.0% in 2010, achieving two-digit growth in spite of minus growth in 2009. In detail, the growth rate is as high as 10.1% in the mining sector and 11.4% in the manufacturing sector.

The above-mentioned steady economic growth attracts a migrant population and causes rapid urbanization, one of the serious social issues faced by Ulaanbaatar[6]. Likewise, socio-economic indicators such as literacy rate and educational attainment show a positive trend as seen in the tables below. In addition, it has been confirmed that the recent steady growth of the economy helps to reduce the poverty ratio in the country[7].

Table 8.1.4 Population and Economic Growth

Particulars	2000	2008	2009	2010	2011
Resident Population (1,000 persons)	2,373.5	2,666.0	2,716.3	2,761.0	2,811.6
Population in Ulaanbaatar (1,000 persons)	760.1	1147.4	1,196.8	1,244.4	1,287.1
Population in Ulaanbaatar (%)	32.0%	43.0%	44.1%	45.1%	45.8%
GDP Growth Rate	1.1	8.9	-1.3	6.4	17.3

Source: UNDP: Mongolia Human Development Report 2011, National Statistical Office of Mongolia, 2010 Population and Housing Census of Mongolia

[6] According to Mongolian Statistical Yearbook 2011, the population density of Ulaanbaatar City is as high as 253.85 while the national average is 1.80.

[7] See the World Bank: Mongolia Quarterly Economic Update, August 2011

Table 8.1.5 Comparison of Social Indicators

Particulars	Literacy Rate	Elementary Education	Secondary Education	Tertiary Education	Infant Mortality
Unit	%	%	%	%	per 1,000 birth
High HDI Countries	92.3	94.4	74.9	43.2	18
Medium HDI Countries	80.7	88.5	57.0	17.6	38
Low HDI Countries	61.2	73.4	30.9	6.0	83
Mongolia	97.3	88.7	82.0	49.8	34

Source: UNDP: Mongolia Human Development Report 2011
Note: HDI stands for Human Development Index. High HDI countries do not include OECD countries.

(3) Land Use

Land use in Ulaanbaatar City represented by the six (6) main districts is shown in Table 8.1.6. Development of urban areas and transportation land such as highways has not progressed in terms of land area; however, they such development has been rapidly promoted since UBMP was approved by the Parliament of Mongolia in January 2013.

Table 8.1.6 Land Use of Ulaanbaatar City

Land Use	Area	Occupancy
Total Area (six main districts in Ulaanbaatar City)	3256.6	100.0%
Agricultural Land	1791.1	55 %
Cities, Villages and Other Settlements Land	199.2	6 %
Transportation and Network Land	39.3	1 %
Forest Resources Land	746.7	23 %
Water Resources Land	40.4	1 %
Reserve Land for Special Use of the State	439.9	14 %

Source: Unified Land Territory Report (2006)

8.2 INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) IN MONGOLIA

(1) Legal Framework for Environmental Assessment

Mongolia has enacted a comprehensive policy and legal framework for environmental issues. It has policies, legislations and strategies in place to manage the protected areas, to satisfy its international obligations, and to protect the quality of the environment for the health and well-being of its citizens. Several of the laws, plans and programs approved by the Government of Mongolia are of particular importance to the Project and are discussed below.

Table 8.2.1 Major Laws and Regulations

Category	Names (Year)	Brief Description
General	Law on Environmental Protection (1995/2005, Amended in 2008)	The law obliges people to conserve soil, underground resources, water resources, fauna and flora and ambient air. It also clarifies the responsibilities of central and regional governments and also that of public and private business entities.
EIA	Law on Environmental Impact Assessments (1998/Amended in 2001)	It provides a legal basis on EIA. It also clarifies environmental protection, prevention of deterioration in ecological balance, regulation of resource utilization, environmental impacts from development activities and approval of such development activities.
Pollution Control	Law on Air (1995/Invalidated in 2010)	It regulates protection of air quality and appropriate usage of air.
	Law on Air Pollution Fine (2010)	It defines vehicle emission and usage of raw coal as main causes of air pollution, and also strengthens regulations on fines which were originally introduced by the Law on Air.
	Law on Water (1995/Amended in 2004)	It regulates appropriate usage of water sources and its basin and its conservation and regeneration.
	Law on Hazardous and Toxic Materials (2006)	It regulates appropriate management of hazardous and toxic materials in order to protect citizens' health and the environment.
	Law on Labor Safety and Hygiene (2008)	It regulates how to prevent work-related accidents and also how to promote labor safety and occupational health.
	Mongolian Law on State Inspection (2003)	It regulates the role and responsibility of the State Professional Inspection Agency (SPIA), which inspects if the laws and regulations of each industrial sector are complied with. The SPIA also monitors the status of environmental protection along with the local authorities in the respective regions.
Environmental Standard	Air and Noise (MNS4585: 2007)	
	Water (MNS4586: 1998)	
	Soil (MNS5850: 2008)	

Source: JICA Survey Team

(2) Environmental Impact Assessment

The EIA requirements of Mongolia are regulated by the Law on Environmental Impact Assessment (1998, amended in 2002). The terms of the law apply to all new projects, as well as rehabilitation and expansion of existing industrial, service or construction activities and projects that use natural resources. The purpose of the law is environmental protection, the prevention of an ecological imbalance, the regulation of natural resource use, the assessment of environmental impacts of projects and procedures for decision-making regarding the implementation of projects. The EIA process in Mongolia is summarized below.

The type and size of the planned activity defines the responsible body as either MNET or Aimag (provincial) government. There are two types of EIAs defined in the Law:

(i) General EIA (screening) — to initiate a General EIA, the project implementer submits to the Screening Agency[8] a brief description of the project including a feasibility study, technical details, drawings, and other information. The General EIA may lead to one of four conclusions: (i) no detailed EIA is necessary, (ii) the project may be completed pursuant to specific conditions, (iii) a Detailed EIA is necessary, or (iv) project cancellation. The General EIA is free and usually takes up to 12 days.

(ii) Detailed EIA — the scope is defined by the General EIA. The Detailed EIA report must be produced by a Mongolian company which is authorized by the Screening Agency by means of a special procedure. The developer of the Detailed EIA should submit it to the Screening Agency. An expert of the organization who was involved in conducting the General EIA should review the Detailed EIA within 18 days and present it to Screening Agency. Based on the conclusion of the expert, the Screening Agency decides whether or not to approve of the project.

The Detailed EIA[9] will be open to the public and registered in the database of the Screening Agency.

(3) Organizational Framework

i) The Ministry of Environment and Green Development (MEGD)

The Ministry of Environment and Green Development (MEGD), which was newly institutionalized as a successor to The Ministry of Nature, Environment and Tourism (MNET), is the lead environmental regulatory agency. MEGG's mission is to develop relevant environmental conservation and natural resource use policies, regulations and laws. It also has exclusive authority over nationally protected areas. The organizational structure of MEGD includes the central headquarters at national level with local branches in all *aimags* and *soms* nationwide. MEGD has different departments and divisions that bear responsibility for green development and policy planning, natural resources and the environment, policy coordination and implementation, protected areas, etc. (Figure 8.2.1). Additionally they are responsible for overseeing the EIA process in Mongolia which includes conducting an initial screening to determine whether a detailed EIA is necessary for a proposed activity and reviewing any subsequent EIA to determine whether the EIA complies with Mongolian Law.

[8] The Screening Agency here is the Ministry of Environment and Green Development.
[9] DEIA includes both the Environmental Protection Plan and Environmental Monitoring Plan which are parts of the Environmental Management Plan in this Project.

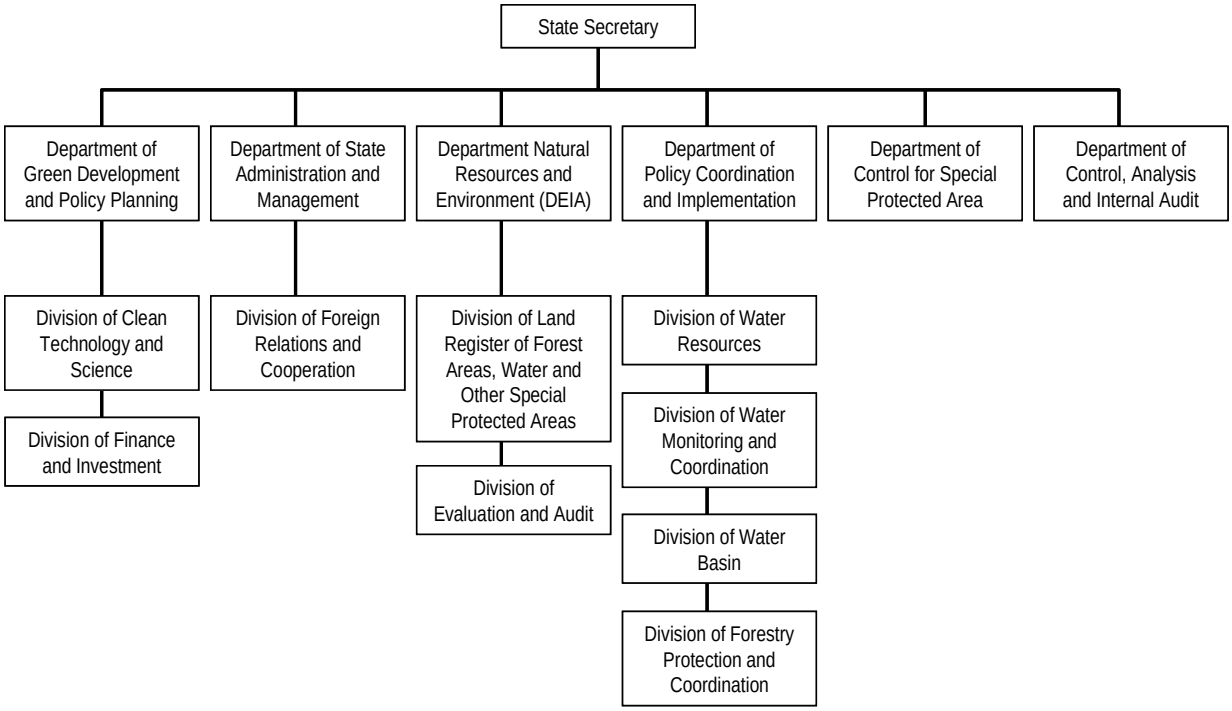


Figure 8.2.1 Organization of the Ministry of Environment and Green Development

ii) State Professional Inspection Agency (SPIA)

The SPIA is the essential government agency that enforces the Mongolian Law on State Inspection (2003) which regulates all state audits and inspections. The SPIA, formed in 2003, is responsible for environmental inspection services nationwide, and it covers Nature and Environment Inspection, Infrastructure Inspection (including transportation, road and communications), Industry and Trade Inspection and Food Safety and Agricultural Inspection. Environmental Inspectors are responsible for environmental monitoring, operational inspections and information collection. Inspectors have the authority to:

- require individuals, organizations or economic entities to eliminate activities that are harmful to the environment;
- suspend the operations of any entity in violation of environmental regulations, standards or permissible levels;
- enter any economic entity or organization to control environmental impacts, take samples and have samples analyzed; and
- impose administrative penalties as provided in law on those who violate environmental regulations and standards.

(4) Status of GEIA

The Road Department of Ulaanbaatar City Government submitted a GEIA application to MNET on April 5, 2012; as a reply, MNET provided the department with the result of GEIA on April 26, 2012, as per the attached document, instructing it to carry out the DEIA.

(5) Status of DEIA

DEIA was carried out by ENVIRON LLC[10] in cooperation with the JICA Survey Team and the DEIA report prepared by ENVIRON LLC in concurrence with the Ulaanbaatar City Government was submitted to the Ministry of Environment and Green Development[11] on December 7, 2012 and it was approved in January 2013. (See Annex 7) Approved DEIA report has been disclosed on the website of MEG (http://geodata.mne-ngic.mn/eia/).

8.3 SCOPING AND STUDY ON ENVIRONMENTAL AND SOCIAL CONSIDERATION

(1) Scoping and Assessment Method

The JICA Survey Team conducted the necessary studies as a JICA-financed project including preparation of scoping. The scoping matrix mentioned below was circulated among and explained to relevant officers in the Ulaanbaatar City Government[12].

Table 8.3.1 Scoping Matrix

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
Air Quality	B-	C/B+	(a) Surface dust, hazardous emissions from heavy vehicles and bitumen are assumed to temporarily deteriorate ambient air quality. (b) Negative impacts from vehicle emissions and dust are assumed although the exact size of such impacts depends on the incremental traffic volume. On the other hand, dust may be reduced tremendously since unpaved roads will be changed to asphalted ones in the Project.	1. Review environmental standards on air quality. 2. Ascertain existing air quality in Ulaanbaatar City. 3. Assess the potential impacts of construction on ambient air quality (i.e., confirm details of construction works, the period, area, and kinds of construction vehicles, and review cases of similar construction projects). 4. Assess the potential impacts due to changes in traffic variables. (i.e., speeds, traffic volume and flow). 5. Undertake a site visit (i) to identify sensitive receptors that may be affected during both construction and operation and (ii) identify features that can influence pollutant concentration such as road gradients and congestion points.
Water Quality	D	D	(a) Discharged water from construction works, heavy machinery, construction vehicles	N/A

[10] ENVIRON LLC is a consulting company qualified by the Government of Mongolia as a DEIA specialist.
[11] Government title and organization was restructured after the general election in June 2012.
[12] They are officers from the Road Department and the Environmental Protection Department of the Ulaanbaatar City Government.

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
			and workers' compounds may impose burden on drainage unless appropriate measures are taken, but it is unlikely to directly affect surface water bodies. (b) The Dound River near the Project site is dry throughout most of the year, and there are no other water bodies in the area. Moreover, washout of dust on the road surface will be limited due to low annual precipitation. Thus, deterioration of water quality is not considered to be significant.	
Waste	B-	D	(a) Construction waste will be generated. (b) Waste which may have negative impacts on environments is unlikely during operation	1. Review laws and regulations on hazardous waste. 2. Ascertain an appropriate method for disposing of construction waste by reviewing cases of similar construction projects, and by consulting relevant persons.
Soil Contamination	C/B-	D	(a) If not properly taken care and stored, hazardous substances such as lubricants, fuel and other chemicals could run off, and cause soil contamination. (b) Soil contamination is unlikely to be significant.	1. Review environmental standards on soil contamination. 2. Assess the potential impacts of construction on soil (i.e., confirm storage, disposal and discharge of hazardous substances, and review cases of similar construction projects).
Noise and Vibration	B-	C/B-	(a) Heavy machinery and construction vehicles are likely to temporarily generate noise (incl. low frequency noise) and vibration. (b) Construction of a flyover and its access roads and rehabilitation of the Dound Bridge may induce an increase in traffic volumes, and eventually may generate noise and vibration. However, since the Project site is located within the industrial area, any substantial impact, i.e., impacts to residents, might be limited. The impact will be assessed after the details such as locations of sensitive receptors are clarified.	1. Review environmental standards on noise. 2. Undertake a site visit to identify sensitive receptors that may be affected during both construction and operation. 3. Assess the potential impacts of construction on noise and vibration (i.e., confirm details of construction works, the period and hours of operation, area, and kinds of construction vehicles, and review cases of similar construction projects). 4. Assess the potential impacts due to changes in traffic variables. (i.e., speeds, traffic volume and flow, types and sizes of vehicles).

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
Subsidence	D	D	(a) No reports say that the land of the project site is not robust, and no activities that may cause subsidence, i.e., massive utilization of groundwater, are planned. Thus, the impacts in this regard are unlikely during construction. (b) Similarly, the impacts during operation are not likely to be significant. (Please note that the detailed study on natural and hydrogeological conditions, which was carried out separately, supplements the information regarding risks of subsidence.)	N/A
Odor	D	D	No construction activities that may create an odor are planned. Even during operation, creation of odor is most unlikely.	N/A
Sediment	D	D	(a) Since no works such as bridge piers which may cause some impacts on sediment of the Dound River are planned, no impact is likely during construction. (b) No impact is likely during operation.	N/A
Protected Areas	D	D	No protected areas such as national parks and sanctuaries are located in and around the project site.	N/A
Ecosystem	D	D	The project site is located in an industrial area, and not the habitat of rare animals and species. Also no activities which may affect banks of the Dound River, where certain animals and plants are observed to live, are planned. Moreover, no changes in land use including a massive loss of trees are planned. Thus, impacts on the ecosystem are not likely to be significant.	N/A
Hydrology	D	D	The Dound River is basically dry throughout the year. Also no activities such as installing bridge piers which may induce impacts on water volume and flow are planned. Thus no impact is expected.	N/A

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
Topography and Geology	C/B-	D	(a) No reports say that land of the project site is not robust, and it is unlikely that construction of a flyover will impose substantial impacts on topology and geology. On the other hand, during the course of expansion of the access road along the Dound River, filling and excavating earth or rehabilitation of embankments will be carried out, and this will lead to certain impacts on topology and geography. (b) No impact is likely during operation.	1. Undertake a site visit, especially along the Dound River embankment. 2. Assess the potential impacts of construction on topology and geology. (i.e., confirm details of construction works and review cases of similar construction projects).
Resettlement	C/B-	D	(a) If the South-North route is selected, approximately seven families living in gers are likely to be affected and resettled due to the acquisition of land necessary for the access road. Even if a route which does not require involuntary resettlement of citizens is selected, land acquisition will be necessary for the same purpose. (b) No impact is likely during operation.	1. Review laws and regulations regarding land acquisition, if necessary consult the relevant officers in Ulaanbaatar city government and check other similar cases. 2. Ascertain the size of involuntary resettlement (in the case of the South-North route) through site visits, interview surveys and analysis of satellite images. 3. Ascertain the land use (incl. the categories of land) of the project site through site visits and consultation with land acquisition officers of the Ulaanbaatar city government. 4. Prepare a resettlement plan (abbreviated).
Poverty	C	C	(a) Some of the *ger* families mentioned above may include poor families, and thus if the South-North route is selected, the special considerations will be necessary during the course of developing resettlement plan. (b) The project site is located within the industrial area and there are no residents other than those *ger* families. Thus no impact is likely in this regard. The effect on people, who do not usually use	1. Ascertain the size of the poor families (in the case of the South-North route) through site visits, interview surveys and analysis of satellite images. 2. Ascertain the effect on pedestrians due to severance through site visits and analysis of drawings (road plans).

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
			motorized vehicles, though they are not identical to the poor, will be analyzed during site visits.	
Ethnic Minorities and Indigenous People	D	D	No ethnic minorities and indigenous people live in and around the project site, and therefore no impact is likely.	N/A
Local Economy (Employment and Livelihood)	D	C/B+	The construction of a flyover is planned in order to improve the city's situation, where currently a railroad divides the entire city between the south and the north parts, and also to restore urban functions by mitigating traffic congestion. Thus, if the Project is implemented, it will be beneficial to the city's economy. Also, even from micro-perspectives, the improvement of traffic networks by the Project is likely to improve transportation with regards to heavy loaded vehicles coming from nearby warehouses and factories.	N/A
Utilization of Land and Local Resources	D	D	The Project aims to improve the existing road network by constructing a new flyover in the industrial area. Thus it is unlikely to cause changes in utilization of land and local resources.	N/A
Utilization of Water	C	C	As for water utilization of the *ger* families, details such as utilization of wells will be clarified during site visits.	1. Ascertain water supply systems of Ulaanbaatar city by reviewing existing reports and documents. 2. Undertake a site visit to clarify the water utilization of the *ger* families.
Existing Social Infrastructures and Services	B-	C	(a) Traffic congestion due to contraction work is likely. In addition, some impacts are likely to the railway schedule and to the existing utilities during construction. (b) Further impact from increased volumes of traffic, i.e., changes in congestion patterns and traffic accidents should be assessed.	1. Undertake a site visit to identify sensitive receptors and existing infrastructures. 2. Assess the potential impacts of construction on infrastructures (i.e., road, railways and existing utilities). 3. Assess the potential impacts on sensitive receptors due to changes in traffic variables.
Social Institutions (Social Capital and Local Decision-making Institutions)	D	D	The Project aims to improve the existing road network by constructing a new flyover in the industrial area. Thus it is unlikely to cause any impacts on social institutions.	N/A

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
Equality of Benefits and Losses	D	D	Due to the same reason mentioned above, it is unlikely to exert any negative impacts on equality of benefits and losses.	N/A
Local Conflicts of Interest	D	D	Due to the same reason mentioned above, it is unlikely to exert any impacts on local conflicts of interest.	N/A
Cultural Heritage	D	D	There is no cultural heritage in and around the project site, and no impact is expected.	N/A
Landscape	B-	B-	By considering the size of flyover, a certain impact to the landscape is unavoidable, though within the industrial area. Also, the expansion of access road in front of Ulaanbaatar central station will require replanting of several trees of the planting zone.	1. Undertake a site visit to observe the existing landscape and planting zone, and to identify sensitive receptors. 2. Review the existing urban development plan and examine the project's conformity with the plan.
Gender	C	C	In case involuntary resettlement of citizens is unavoidable, special consideration to gender issues is needed. So this item should be assessed only after the necessity of such resettlement is clarified.	1. Ascertain (in case involuntary resettlement of citizens is unavoidable) the numbers of women and women-headed households affected by the Project through conducting a census survey.
Children's Right	C	C	In case involuntary resettlement of citizens is unavoidable, special consideration to children's rights is needed. So this item should be assessed only after the necessity of such resettlement is clarified.	1. Ascertain (in case involuntary resettlement of citizens is unavoidable) the numbers of children affected by the Project through conducting a census survey.
Infectious Disease, i.e., HIV/AIDS	C	D	(a) Although a massive inflow of workers is not expected and consequently infectious diseases are less likely to spread during construction, impacts in this regards will be assessed only after confirming the current situation in Ulaanbaatar. (b) No impact is likely during operation.	1. Ascertain the prevalence rate of HIV/AIDS by reviewing the existing data. 2. Consult with NGOs and activists who are working to prevent HIV/AIDS.
Working Conditions (Occupational Safety)	B-	D	(a) Special consideration to occupational health and safety of construction workers is required. (b) Activities that create negative impacts on workers are not likely during operation.	1. Review laws and regulations on occupational health and safety. 2. Review similar construction projects (incl. the contract documents of such projects).
Accident Prevention	B-	B-	(a) Measures to prevent accidents during construction are necessary.	1. Assess the potential impacts of construction on safety. (i.e., congestions due to construction

Environmental Items	Assessment		Likely Impacts	IEE Assessment Method
	(a) Pre/During Construction	(b) Operation Maintenance		
			(b) Increased volumes and speeds of traffic may lead to more traffic accidents.	works, mitigation and safety measures). 2. Assess the potential impacts during operation.
Trans-boundary Impact and Climate Change	D	D	The Project aims to improve the existing road network by constructing a new flyover in the industrial area. No carbon sink is located in and around the project site. Consequently, no impacts on trans-boundary areas and climate change are likely.	N/A

Assessment:
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. A further examination is needed, and the impact could be clarified as the study progresses.
D: No impact is expected.

(2) Environmental Quality

As a part of DEIA, the following items were monitored in the field.

i) Air Quality

The air quality was measured at five (5) locations in the Project site. The analytical results of SO_2, NO_2, CO, PM10 and Pb are summarized in Figures 8.3.2 – 8.3.6. The red line shows air quality standards stipulated in "Mongolian Standard (MNS4585-2007)."

In the firefighting facilities in the railway property, SO_2 and NO_2 exceed the standard values. In the railway station, Gobi factory and Dund Gol railway bridge, NO_2 exceeds the standard. Both NO_2 and PM10 exceed the standard at Ajilchin intersection.

Table 8.3.2 Measurement Locations of Air Quality

	Locations	Latitude	Longitude
A1	Railway Fire Station	47°54'33.84"N	106°52'32.32"E
A2	Railway Passenger's Wagon Depot	47°54'31.10"N	106°52'18.29"E
A3	Southeastern corner of Gobi Factory	47°54'13.49"N	106°52'16.68"E
A4	Dundgol Railroad Bridge	47°54'22.27"N	106°52'13.41"E
A5	East of Ajilchin intersection	47°54'14.33"N	106°51'23.63"E

Figure 8.3.1 Measurement Locations of Air Quality

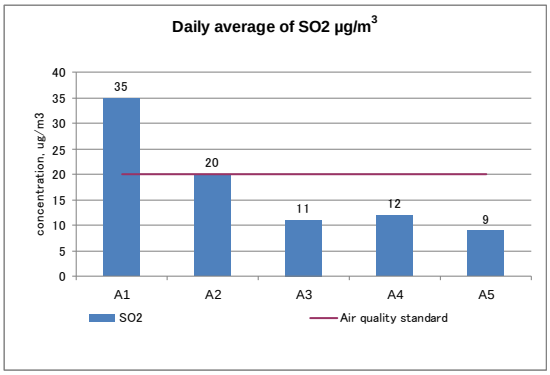


Figure 8.3.2 SO_2 (daily average)

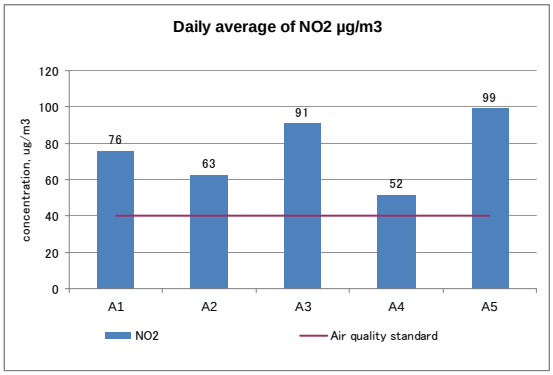


Figure 8.3.3 NO_2 (daily average)

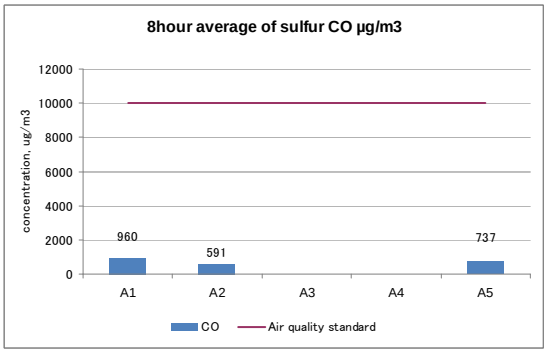


Figure 8.3.4 CO (daily average)

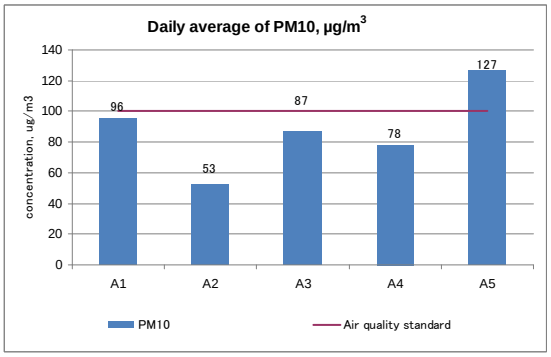


Figure 8.3.5 PM10 (daily average)

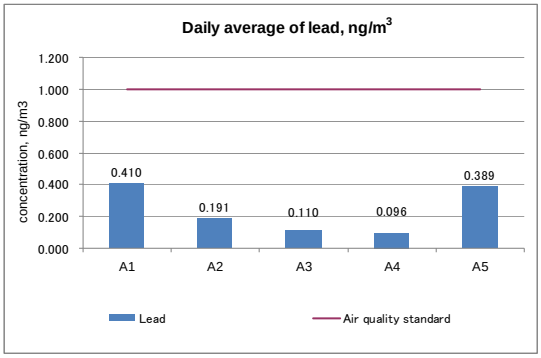


Figure 8.3.6 Pb (daily average)

Table 8.3.3 Air standard (MNS4585)

	Standard
SO_2	24 hour average < 20 μg/m
NO_2	24 hour average < 40 μg/m
CO	8 hour average < 10,000 μg/m
PM10	24 hour average < 100 μg/m
Pb	24 hour average < 1.0 μg/m

ii) Noise

Noise was measures at five (5) locations in the Project site as shown in Figure 8.3.7. The measurement results are summarized in Table 8.3.4, and are sorted as maximum, minimum and average in Figure 8.3.8. The standard of noise is also stipulated in "Mongolian air quality standard (MNS4585)."

Figure 8.3.7 Measurement Locations of Noise

Table 8.3.4 Result of Noise Measurement

Location	Maximum noise level (dB)	Minimum noise level (dB)	Average noise level (dB)	Environmental standard	
				07:00–23:00	23:00–07:00
N1	64.7-74.0	55.0-63.6	69.9	60 dB (16 hour average)	45 dB (8 hour average)
N2	76.7-104	66.0-83.0	73.4		
N3	62.3-77	55.0-68.4	66.7		
N4	62.8-91.0	57.9-69	68.3		
N5	66.6-89.0	62.9-71.7	68.6		

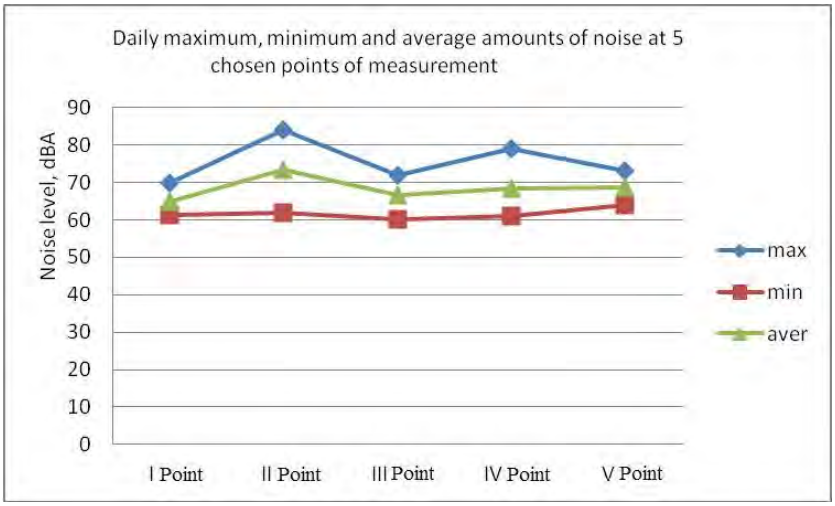


Figure 8.3.8 Measurement Result of Noise

iii) Vibration

Vibration was measured at five (5) locations in the Project site as shown in Figure 8.3.9. The measurement results are summarized in Table 8.3.5. There is no standard for vibration in Mongolia.

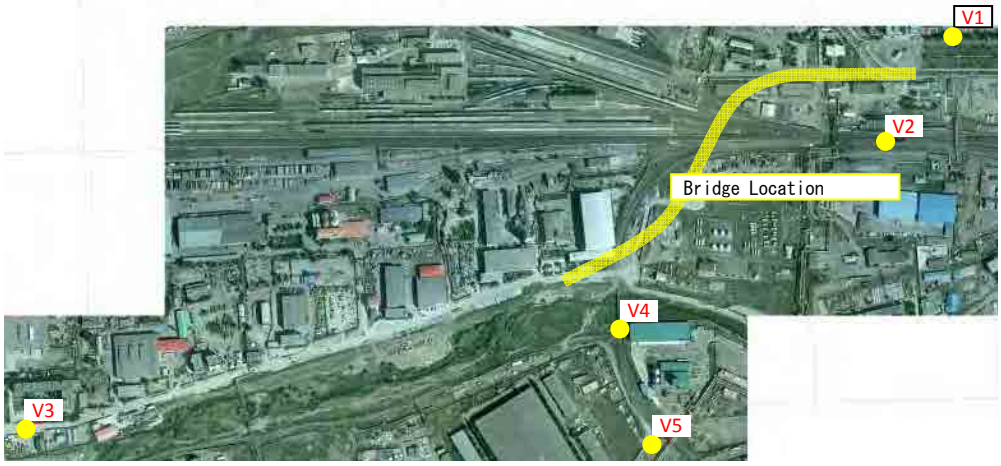


Figure 8.3.9 Measurement Locations of Vibration

Table 8.3.5 Result of Vibration Measurement

	Measurement Time							
Point 1 (Secondary school #38)	**15:00**	**18:00**	**21:00**	**00:00**	**03:00**	**06:00**	**09:00**	**12:00**
Hi m/cm^2	0.040	0.010	0.020	0.030	0.100	0.020	0.020	0.020
1 kHz/z cm/s	0.210	0.030	0.020	0.020	0.010	0.020	0.020	0.020
Low mm	0.015	0.014	0.015	0.003	0.003	0.005	0.003	0.004
Point 2 (pedestrian bridge)	**15:40**	**18:40**	**21:40**	**00:40**	**03:40**	**06:40**	**09:20**	**12:20**
Hi m/cm^2	0.040	0.040	0.020	0.030	0.070 (train pass)	0.170 (train pass)	0.210 (train pass)	0.120
1 kHz/z cm/s	0.110	0.050	0.020	0.030	0.070	0.270	0.080	0.020
Low mm	0.021	0.014	0.029	0.004	0.003	0.121	0.015	0.011
Point 3 (Ajilchin intersection**)**	**16:00**	**19:00**	**22:00**	**01:00**	**04:00**	**07:00**	**10:00**	**13:00**
Hi m/cm^2	0.030	0.020	0.040	0.040	0.010	0.020	0.020	0.020

1 kHz/z cm/s	0.010	0.040	0.040	0.040	0.010	0.020	0.010	0.020
Low mm	0.007	0.014	0.019	0.004	0.003	0.003	0.005	0.004
Point 4 (Dund River Railroad Bridge)	**16:20**	**19:20**	**22:20**	**01:20**	**04:20**	**07:20**	**10:20**	**13:20**
Hi m/cm^2	00.20	0.020	0.010	0.020	0.020	0.170 (train pass)	0.020	0.020
1 kHz/z cm/s	0.040	0.020	0.010	0.020	0.020	0.060	0.010	0.010
Low mm	0.005	0.003	0.003	0.003	0.003	0.005	0.005	0.005
Point 5 (Southeast of Gobi Factory)	**16:25**	**19:25**	**22:25**	**01:25**	**04:25**	**07:25**	**10:25**	**13:25**
Hi m/cm^2	0.010	0.010	0.030	0.020	0.010	0.010	0.020	0.010
1 kHz/z cm/s	0.020	0.020	0.020	0.010	0.020	0.010	0.010	0.020
Low mm	0.007	0.003	0.011	0.003	0.003	0.004	0.004	0.004

iv) Water Quality

Water quality was analyzed in surface water and groundwater (see Figure 8.3.10). Three (3) surface water samples and another three (3) groundwater samples were taken from the Dundgol River and adjacent existing wells, respectively. Additional sampling for microorganism analysis was done from the surface water of Dundgol River. The results of water quality analysis are summarized in Tables 8.3.6 and 8.3.7.

Figure 8.3.10 Locations of Water Quality Analysis

Table 8.3.6 Results of Water Quality Analysis

Item	Unit	Standard	Surface water (Dond Gol River)			Groundwater		
			SW1	SW2	SW3	UW1	UW2	UW3
1. Chloride	mg/l	500	24.8	24.8	24.9	24.8	24.9	25.0
2. Sulfate	mg/l	3,000	25.0	24.3	22.5	22.5	64.0	25.0
3. Substance to be weighed	mg/l	50,000	29.5	29.9	28.5	-	-	-
4. Alkalinity	mg/l	600	44	44	44	44	44	44
5. Corrosive CO_2	mg/l	<3.4	2.9	8.4	8.8	0.7	0.7	0.71
6. pH	-	>5.5	7.9	7.9	8.0	7.40	7.42	7.40
7. pH for surface water	-	6.6-8.5	7.9	7.9	8.0			
8. BOD	mg/l	3	0.637	0.676	0.676	-	-	-
9. COD	mg/l	10	5.10	5.41	5.41	-	-	-
10. DO	Mg/l	6	6.59	6.51	6.48	-	-	-

Standard for 1–6; MNS900:2005, Standard for 7–10; MSN 4586-1998

Table 8.3.7 Results of Water Quality Analysis on Microorganism (E-1)

	Number of microorganism	Microorganism in entro-group	Anaerobic microorganism	Disease-causing germs in entro-group
Referred Standard	MNS 00-2005	MNS 4697-98	MNS 7939:2000	MNS 6340-2003
Standard	100	0	n/a	No description
Measured	5 x 10^4	Colon detected	Perfringens germs	Disease-causing germs not detected

v) Soil

Soil was analyzed to identify soil pollution and the content of heavy metals in disposal land in residential areas. The locations of soil sampling are shown in Figure 8.3.11. Five (5) soil samples and another two (2) river sediment samples were taken from X1-X5 and Sed1-Sed2, respectively. The environmental standard for soil pollution refers to MNS 5850:2008.

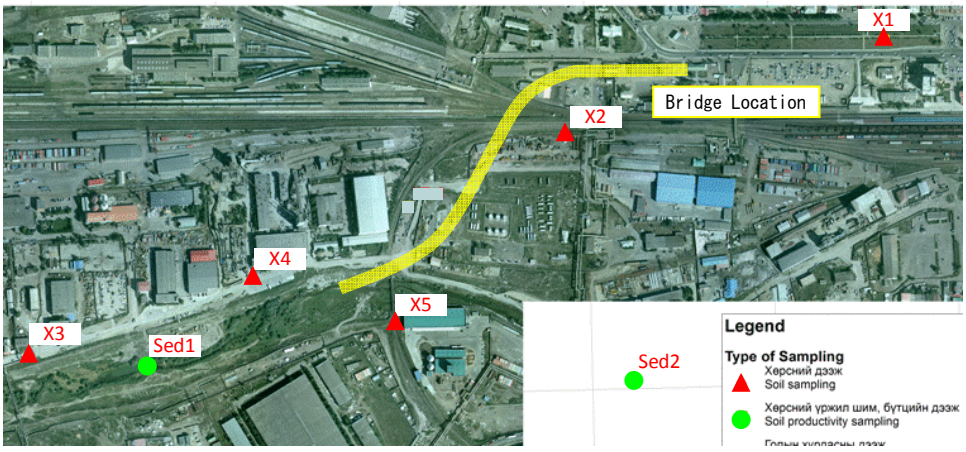


Figure 8.3.11 Locations of Soil Sampling

Table 8.3.8 Content of Heavy Metals in Soil

(unit: mg/kg)

	Hg	Cd %	As	Pb	Cr
X-1	0.15	<0.005	18	45	49
X-2	0.19	<0.005	11	27	68
X-3	0.13	<0.005	7	62	40
X-4	0.05	<0.005	6	25	44
X-5	0.19	<0.005	9	97	51
MNS 5850:2008	2	3	50	100	150

Table 8.3.9 Content of Heavy Metals in River Sediment

(unit: mg/kg)

	Hg	Cd	As	Pb	Cr
Sed-1	0.05	<0.005	11	481	23
Sed-2	0.11	<0.005	13	57	91
MNS 5850:2008	0.010–0.85	0.010–2.0	0.1–40	2–300	5–1500

(3) Study on Environmental and Social Consideration

Table 8.3.10 shows the result of Study on Environmental and Social Consideration based on the foregoing scoping.

Table 8.3.10 Result of Study on Environmental and Social Consideration

Environmental Items	Assessment at Scoping		IEE Assessment		Results
	(a) Pre/During Construction	(b) Operation/ Maintenance	(a) Pre/During Construction	(b) Operation/ Maintenance	
Air Quality	B-	C/B+	B-	B+	(a) Surface dust, hazardous emissions from construction vehicles and bitumen are assumed to temporarily deteriorate the ambient air quality, especially along access roads. (b) The current pollution level is worse than the level set by the Mongolian national environmental standard on ambient air (MNS4585) throughout UB City, and it is considered as one of the most serious environmental problems. PM is known to be particularly important as a targeted pollutant among others, and the following are considered to be the primary sources: (i) coal combustion from around 140,000 yurt stoves (36%), (ii) coal combustion at thermal power plants (34%) and (iii) traffic dust (27%), while on the other hand, vehicle emissions contribute only 2%. As for CO and NO_2, they may increase as the number of vehicles increases. However, an apparent positive impact (impact to reduce CO and NO_2) is expected through solving traffic congestion and improving driving speed. As a result, the Project is highly likely to have a positive impact in this regard.
Waste	B-	D	B-	D	(a) According to the Mongolian Law on Household and Industrial Waste (2003), the project owner and the contractor for construction work are obliged to hand over construction waste and soil to the approved contractors and make sure that wastes are disposed of appropriately. In response to the increasing problems of inappropriate management of construction waste in UB City in spite of the Law, UB City along with the Ministry of Environment, Natural Resources and Tourism is currently preparing rules and regulations on construction wastes. As for the Project, generation of soil and construction waste is expected especially through excavating access roads and such like.
Soil Contamination	C/B-	D	B-	D	(a) If not properly taken care and stored, hazardous substances such as lubricants, fuel and other chemicals could run off, and cause soil contamination.
Noise and Vibration	B-	C/B-	B-	B-	(a) Heavy machinery and construction vehicles are likely to temporarily generate noise (incl. low frequency noise) and vibration. However, since a certain distance

Environmental Items	Assessment at Scoping		IEE Assessment		Results
	(a) Pre/During Construction	(b) Operation/ Maintenance	(a) Pre/During Construction	(b) Operation/ Maintenance	
					from the sensitive receptors[13] is secured, the negative impact would not be substantial provided appropriate mitigation measures are taken. (b) Construction of a flyover and its access roads may induce an increase in traffic volume, and eventually may generate noise and vibration. However, the Project site is located within an industrial area near to the Ulaanbaatar Central Station, and a certain distance from sensitive receptors is secured. Thus, a substantial impact, i.e., impacts to residents, might be limited. However, it is appropriate to monitor the situation, and take countermeasures, if necessary.
Topography and Geology	C/B-	D	B-	D	(a) No reports say that the land of the project site is not robust, and it is unlikely that construction of a flyover will impose substantial impacts on topology and geology. In addition, during the course of expansion of the access road along the Dound River, filling and excavating earth or rehabilitation of embankment will be carried out, and it indeed leads to certain impacts on topology and geography. However, the project site is located in an industrial area, and rare topographical and geographical resources of scientific importance are not located there. Thus the actual negative impact is considered to be negligible.
Resettlement	C/B-	D	B-	D	(a) Although no involuntary resettlement of citizens is required, land acquisition is required from the Mongolian Railway and other several private enterprises in order to build access roads[14].
Poverty	C	C	D	B-	(a) Since involuntary resettlement is not required by the Project, no social impact in this regard is expected. (b) The project site is located within an industrial area and there are no residents other than seven yurt families. Thus no impact is likely in this regard. For the people, who do not usually use motorized vehicles, though they are not identical to the poor, some consideration such as sidewalks for access roads is required.
Local economy (employment and livelihood)	D	C/B+	D	C/B+	(a) The construction of a flyover is planned in order to improve the city's situation, where a railroad divides the entire city between the south and the north parts, and also to restore urban functions by mitigating traffic congestion. Thus, if the plan is implemented, it is likely to be beneficial to economy of the entire city. Also, even from microperspectives, the improvement of

[13] The nearest sensitive receptor is the 38th School across the access road, whose distance from the project site is approximately 80 m. The second nearest is the yurt families along the railway branch line whose distance from the project site is about 100 m.

[14] The exact size of land acquisition and its compensation scheme are detailed in section 8.5 in this chapter.

Environmental Items	Assessment at Scoping		IEE Assessment		Results
	(a) Pre/During Construction	(b) Operation/ Maintenance	(a) Pre/During Construction	(b) Operation/ Maintenance	
					traffic networks by the Project is likely to be advantageous with regards to transportation by heavy loaded vehicles from nearby warehouses and factories.
Utilization of water	C	C	D	D	(a)/(b) As for water utilization of the yurt families, it became clear that one household owns a well for domestic use, but not for drinking purposes. Moreover, the well is located more than 130 m away from the project site, and also no construction work which may cause pollution of groundwater is planned. Thus it is unlikely to affect utilization of water.
Existing social infrastructures an services	B-	C	B-	B-	(a) Traffic congestion due to contraction work is expected. In addition, some impacts are likely to be exerted on the railway schedule and on the existing utilities during construction. (b) Improvement of roads may improve road safety, but the increased traffic volume may induce accidents, although no simple correlation is observed between the number of vehicles and number of accidents[15]. For the people, who do not usually use motorized vehicles, considerations such as sidewalks along access roads are necessary.
Landscape	B-	B-	B-	B-	(a)/(b) Although, considering the size of the flyover, a certain impact on the landscape is unavoidable, it will be constructed in an industrial area and therefore the impact is not substantial. Also, the expansion of an access road in front of Ulaanbaatar Central Station will require replanting of several trees of the planting zone.
Gender	C	C	D	D	In case involuntary resettlement of citizens is unavoidable, special consideration to gender issues is needed. Resettlement is not required this time, so no impact is expected.
Children's Right	C	C	D	D	In case involuntary resettlement of citizens is unavoidable, special consideration to children's right issues is needed. Resettlement is not required this time, so no impact is expected.
Infectious Disease, i.e., , HIV/AIDS	C	D	D	D	(a) According to an interview with an NGO specialized in HIV/AIDS prevention and awareness raising, registered numbers of people who are living with

[15] Data from UNESCAP-Status Paper on Road Safety 2010, Mongolia.

	Items	2006	2007	2008	2009	2010
1	Registered vehicles (no.)	176,716	200,288	230,044	265,572	303,744
2	Fatal injury (cases)	530	455	372	415	447
3	Serious injury (cases)	2,013	1,443	1,285	1,431	1,497
4	Death rate (per 10,000 vehicles)	29.9	22.7	16.17	15.62	14.71
5	Death rate (per 100,000 people)	18.7	15.41	12.41	13.64	14.48

Environmental Items	Assessment at Scoping		IEE Assessment		Results
	(a) Pre/During Construction	(b) Operation/ Maintenance	(a) Pre/During Construction	(b) Operation/ Maintenance	
					HIV/AIDS is 106 persons as of April 2012. In addition, no influx of construction workers is expected. Thus, no substantial impact is expected.
Working Conditions (incl. Occupational Safety)	B-	D	B-	D	(a) Based on the Mongolian Law on Labor Safety and Hygiene (2008), special consideration to the occupational health and safety of construction workers is required.
Accident Prevention	B-	B-	B-	B-	(a) Measures to prevent accidents during construction are necessary. (b) Increased volumes and speeds of traffic may lead to more traffic accidents.

Assessment:

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. A further examination is needed, and the impact could be clarified as the study progresses.
D: No impact is expected.

8.4 MITIGATION MEASURES AND MONTORING PLAN

(1) Mitigation Measures

Table 8.4.1 shows proposed mitigation measures for the expected environmental impacts of the Project.

8.4.1 Mitigation Measures for the Project

Stage	Issue	Mitigation or Safeguard Measures	Executing Organization (Responsible Organization)	Cost (MNT)
During Preparation/ Construction	Air Quality	• To reduce dust generation: (i) use sheet covers and (ii) spray water on construction sites and material handling areas where dust is generated. • For mitigation of negative impacts from vehicle emissions: (i) plan routes and timetables carefully, (ii) comply with the speed limit, and (iii) conduct maintenance activities for vehicles and machinery appropriately.	Construction company (PIU). Construction company (PIU).	Included in construction cost. Included in construction cost.
	Waste	• Recycle construction	Construction company	Disposal of

Stage	Issue	Mitigation or Safeguard Measures	Executing Organization (Responsible Organization)	Cost (MNT)
	Management	residuals as much as possible. For un-recyclable construction waste and soil, hand over them to the approved contractors and make sure that they are disposed at the disposal site designated by the UB City Government.	(PIU).	construction residuals and its transportation cost are included in construction cost.
	Soil Contamination	• Appropriately store chemicals and hazardous materials such as oils for construction machinery.	Construction company (PIU).	Included in construction cost.
	Noise and Vibration	• Use low-noise and low-vibration machinery and apply such methods. • Use mobile noise barriers and comply with the environmental standard on noise. • Carry out any other measures which mitigate noise and vibration, i.e., (i) restrict construction activities at night, (ii) carefully plan routes and timetables of construction vehicles and (iii) appropriate maintenance of construction machinery and vehicles. • Monitor noise and vibration around construction sites.	Construction company (PIU). Constriction company (PIU). Construction company (PIU). Construction company (PIU).	Included in construction cost. Included in construction cost. Included in construction cost. Included in construction cost.
	Topography and Geology	• Design access roads to minimize difference of elevation between access road and the existing road. • Ensure conformity with the Dound River embankment planned by the UB City Government.	Detailed design consultant (PIU). Construction company (PIU).	Road design is included in detailed design cost. Bank protection work is included in construction cost.
	Resettlement	• Conduct land acquisition appropriately by Department of Road and Department of Property Relations in accordance with Land Acquisition and Resettlement Report (LARP) prepared by the JICA Survey Team.	UB Property Relations Dept. (PIU).	89.9 billion MNT.
	Existing Social Infrastructures	• Pay special attention to routes and timetables of	Construction company/Traffic police	Traffic police of UB City is in

Stage	Issue	Mitigation or Safeguard Measures	Executing Organization (Responsible Organization)	Cost (MNT)
	and Services	construction vehicles and place traffic control officers to avoid causing traffic jams. • Apply methods which require the least time for flyover construction above the railway, and coordinate with the railway authority in order to minimize the impact of the construction on railway timetables. • Secure users' access to existing facilities along the access roads.	(PIU). Construction company (PIU). Detailed design consultant.	charge of traffic control. Included in construction cost. Included in detailed design cost.
	Landscape	• Consider applying a method with many piers and fewer walls, which secure the least-obstructed view. • The expansion of an access road along Narny Road near Ulaanbaatar Central Station will require felling of trees. Transplant stumps and roots of such trees if possible or replant similar trees.	Detailed design consultant. PIU	Included in detailed design cost. 10 Million MNT
	Working Conditions (Occupational Safety)	• Pay attention to working conditions and occupational safety of construction workers in line with Mongolian laws and regulations and take measures in accordance with international standards on occupational health set by the International Labor Organization, if necessary. In concrete terms, activities relating to occupational safety and necessary personnel for such activities shall be clarified in a contract. In addition, it is mandatory to implement periodic safety inspections, safety patrol, etc. during construction.	Constriction company (PIU)	The cost to secure safety of workers is included in construction cost.
	Accident Prevention	• Measures to prevent work-related accidents are mentioned above. • Consult and coordinate with traffic police before the	Constriction company (PIU). Construction supervising consultant/PIU.	Included in consultant fee.

Stage	Issue	Mitigation or Safeguard Measures	Executing Organization (Responsible Organization)	Cost (MNT)
		construction starts, and follow their advice. • Place traffic control officers near exit/entrance points of traffic vehicles in order to secure pedestrians' safety and avoid traffic jams.	Constriction company.	Cost to hire traffic control officers is included in construction cost.
During Operation	Noise and Vibration	• Consider employing the consecutive bridge-girder method which requires fewer joints; as a result, noise and vibration caused by running over joints will be minimized. • Monitor noise and vibration around the project site, and take necessary measures such as placement of noise barriers, if necessary.	Detailed design consultant. PIU/Road Dept. of UB City	Included in detailed design cost.
	Poverty	• Secure sidewalks for pedestrians along the access roads.	Detailed design consultant.	Included in detailed design cost.
	Existing Social Infrastructures and Services	• Secure sidewalks for pedestrians along the access roads. • Take safety measures such as placement of traffic lights and traffic signs of speed limits, and also construction of medians.	Detailed design consultant/ Constriction company.	Included in detailed design cost/ construction cost.
	Accident	• Take safety measures such as placement of traffic lights and traffic signs of speed limits, and also construction of medians.	Detailed design consultant/ construction company.	Included in detailed design cost and construction cost.

(2) Monitoring Plan

As required in the DEIA, the Environmental Management Plan (EMP) is prepared. Environmental monitoring is considered to be a crucial activity of EMP and its implementation framework is as follows.

i) Institutional framework for Implementation of EMP

Once the DEIA report, which includes EMP, is approved by the Ministry of Environment and Green Development (MEGD) of Mongolia, the agencies mentioned in Table 8.4.2 below conduct environmental monitoring.

The Project Implementation Unit (PIU), which is organized by the MRT and the Road Department of Ulaanbaatar City, will be responsible for supervising the implementation of

the EMP, including environmental monitoring. Its monitoring activities will be primarily carried out by PIU along with officers of SPIA and the environmental inspectors of the local government of Bayangol District.

Table 8.4.2 Role of Agencies for EMP Implementation

Item No.	Name of Organization	Role in the Project	Role of EMP
1	Ministry of Environment and Green Development of Mongolia (MEGD)	State central body for environmental policy formulation and policy implementation	• Review DEIA report and EMP content. • Review yearly report of EMP implementation. • Approve EMP for next year.
2	Ministry of Road and Transportation of Mongolia (MRT)	Project executing agency	• Coordinate agencies responsible for project activities and convene project management committee meetings whenever necessary. • Provide guidance for implementation of EMP. • Conduct M&E for EMP implementation.
3	State Professional Inspection Agency (SPIA)	State central organization to inspect whether rules and regulations are confirmed in every sector, including environmental inspections.	• Review annual and quarterly EMP implementation report submitted by UB department and District division. • Report to MEGD on EMP Implementation.
4	Road Department of Ulaanbaatar City (UBRD)	Project implementing agency	• Coordinate activities of project implementation unit for EMP implementation. • Coordinate consultant and contractor activities related to EMP. • Review monthly, quarterly and annual EMP implementation reports and approve EMP for next year. • Submit EMP implementation report to SPIA and MEGD.
5	Project Implementation Unit (PIU)	Implementation unit for EMP	• Oversee contractor's activity on EMP implementation. • Coordinate consultant and contractor for bridge and road construction for EMP implementation. • Facilitate EMP implementation. • Organize and implement monitoring activities according to EMP. • Submit annual performance report for EMP implementation. • Develop EMP for next year.

ii) Monitoring Items

Based on the conclusion of environmental and social consideration and DEIA, environmental monitoring items were established as below. The frequency of the monitoring for the natural environment during the construction is basically two (2) times a year in the warm season and cold season, since the construction period is quite limited as half of the year is midwinter.

a) Air Quality

Item	Duration	unit	Standard	Frequency
SO	Average for 24h	μm/m^3	30	During construction: Bi-annual (June and Nov.) In-service: Annual (after 2 years)
CO	Average for 8h	μm/m^3	10,000	
NO_2	Average for 24h	μm/m^3	40	
Dust (TSP)	Average for 24h	μm/m^3	100	During construction: Bi-annual (June and Nov.)

The location of monitoring shall be as follows.

Locations	Latitude	Longitude
Railway Fire Station	47°54’33.84”N	106°52’32.32”E
Railway Passenger’s Wagon Depot	47°54’31.10”N	106°52’18.29”E
Southeastern corner of Gobi Factory	47°54’13.49”N	106°52’16.68”E
Dundgol Railway Bridge	47°54’22.27”N	106°52’13.41”E
East of Ajilchin intersection	47°54’14.33”N	106°51’23.63”E

b) Noise and Vibration

Item	Unit	Standard	Frequency
Noise	dB	07:00-22:00: 60dB (Average in 16h) 22:00-07:00: 45dB (Average in 8h)	During construction: Bi-annual (June and Nov.) In-service: Annual (after 2 years)
Vibration	dB	07:00-22:00: 65dB 22:00-07:00: 60dB	

The monitoring locations shall be as follows.

Location	Latitude	Longitude
V1 No.38 School	47°54’35.52”N	106°52’44.51”E
V2. Logistic Company	47°54’28.25”N	106°52’36.59”E
V3.Intersection of Ajilchin Road	47°54’14.40”N	106°51’21.80”E
V4. Dund Gol Railway Bridge	47°54’19.19”N	106°52’13.83”E
V5. Gobi Factory	47°54’10.05”N	106°52’13.73”E

c) Water Quality

The effect on water quality that the Project has is estimated as small; however, the following three items shall be monitored during construction since these items have been commonly monitored during construction work near a river in Mongolia and the DEIA recommended to monitor these items as well. The frequency of the measurement can be once a year at times when the river is not frozen.

Item	Unit	Standard*	Measuring Point	Frequency
pH	-	6.5-8.5	Two locations along Dund-gol River	Yearly (April to May)
BOD	mg/l	3	Two locations along Dund-gol River	Yearly (April to May)
COD	mg/l	10	Two locations along Dund-gol River	Yearly (April to May)

*Standard; MSN 4586-1998

d) Soil Contamination

A large amount of steel members for a bridge will be transported and temporarily placed in a stock yard. Most of these members are coated by galvanization or painting including components of Cd or Pb. Thus, these two items shall be monitored in the stock yard for steel members.

Item	Unit	Standard*	Location	Frequency
Cd	mg/kg	3	Construction Yard	Bi-annual (April and October)
Pb	mg/kg	100		

* Standard; MNS 5850:2008

e) Waste

Monitoring of industrial waste hauled during the construction should be carried out every month. The total amount of industrial waste transported to the disposal site specified, is monitored monthly.

f) Others

In addition to above, the following shall also be monitored during the Construction Period.

- Allocation of Security Guards for Traffic Control
- Planting
- Safety Measures for Construction (safety patrol and safety education to labor)
- Grievance Adjustment

iii) Monitoring Form

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results During Report Period
Number of Responses/Actions to Comments and Guidance from Government Authorities	Twice a year during construction Once a year during operation for two years

2. Pollution

(1) Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SO_2	µg/Ncm			30 (24 hour)	-	Semiyearly (June & Nov.) during Construction, Once a year during operation.
NO_2	µg/Ncm			40 (24 hour)	-	
CO	µg/Ncm			$1*10^4$ (8 hour)	-	
Dust(TSP)	µg /m^3			150 (24 hour)	-	

(2) Water Quality (Effluent/Wastewater/Ambient Water Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-			6.5 – 8.5	-	Upstream entry point and downstream exit point of Dund River within the project area (yearly from April to May during construction)
BOD	mg/L			3	-	
COD	mg/L			10	-	

（JP: Ministry of Environment of Japanese ）

(3) Soil Quality

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Cd	mg/kg			3	-	Semiyearly (April and October)
Pb	mg/kg			100	100 (WHO)	

(4) Noise/Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level/ Vibration Level	dBA			07:00–22:00: 60dB 22:00–07:00: 45dB	70 (Industrial & Commercial)/ WHO	50 m from the construction site; semiyearly during construction and once a year during operation.

(5) Waste

Monitoring Item	Location of Disposal Site	Monitoring Results During Report Period
Solid Wastes (tons/day) Unsuitable Soil (m^3/day)		Monthly during Construction

3. Others (Every Month)

Monitoring Item	Monitoring Results During Report Period
Security Guard for Traffic Control	Number and location
Planting	Number of trees and their locations
Safety Measures for Construction	Safety Education to Labors: (Date and Content) Safety Patrol: (Date and Result of the Patrol)
Grievance Adjustment	Number of Response / Received

8.5 LAND ACQUISITION

(1) Legal Framework for Land Acquisition and Resettlement (LAR)

In 1990, Mongolia began a comprehensive transition towards a new political and economic system, away from the communist regime and moved from a planned economy to a market-based economy. In accordance with the process of this epoch-making transition, a legal framework relating to land acquisition and resettlement (LAR) was formulated. The Constitution (1992), the Land Law, originally enacted in 1994 and amended several times later, and the Law on Land Allocation for Mongolian Citizens for Ownership (2002) are particularly important in terms of LAR.

i) Constitution of Mongolia

The Constitution of Mongolia guarantees the citizens of Mongolia the rights to own private property, have safe and peaceful living accommodation and receive material and financial assistance.

Article 6.4 of the Constitution is the source of the state's power to expropriate land owned or possessed privately. The grounds for involuntary acquisition are when there is a special public need. Article 16.3 obligates the State to make due compensation and payment in the case of taking private property for public use. Land may also be confiscated (i.e., without compensation) if it is used in a manner adverse to the health of the population, the interests of environmental protection or national security.

ii) Land Law

The Land Law contemplates three kinds of private land tenure: (1) *ownership*, which means a legitimate control of land with the right to dispose of it, and this may be granted only to the citizens of Mongolia; (2) *possession*, which means a legitimate control of the land in accordance with purpose of its use and terms and conditions specified in respective contracts, and this may be granted under license to Mongolian citizens, economic entities and organizations, for terms of 15 to 60 years, extendable up to 40 years at a time; (3) *use*, which means a legitimate and concrete activity to make use of some of the land's characteristics in accordance with contracts made with the owners or possessors of land, and this may be granted to Mongolian citizens or to foreign legal entities and so on for 5 years, renewable for 5 years at a time.

Article 43 of the same law explains compensation for expropriating land in *possession* with or without replacement prior to expiration of the contract. The article stipulates that possessors are entitled to replacement land and compensation at the current market price for buildings and other constructions plus all expenses related to relocation[16]. Details are negotiated individually and a contract is concluded between possessors and the respective

[16] According to an interview with the Department of Property Relations, compensation for structures is estimated based on the Government Resolution No. 336 (2010), which contains a list of budgetary information for public works.

governors of *soms* and districts.

The possessors shall vacate the concerned land and transfer it to the respective *soms* and districts within 90 days of entering into the contract. In detail, the governors of a *som* or a district shall pay compensation to the citizen, the company or the organizations which possessed the land, within 60 days after the contract is signed, unless stated otherwise in the contract. The land possessor shall vacate the land within 30 days after receiving the compensation in full.

There is no clear provision in the Land Law concerning LAR over land in *use*, except the obligation of the land office to provide prior notice. The Law is silent on negotiation and compensation. However, although appropriation of used land is not clarified, it will not cause any serious issue since the land that will need to be acquired for the proposed Ajilchin Flyover is all *possessed*.

iii) Law on Land Allocation for Mongolian Citizens for Ownership (Land Allocation Law)

The Land Allocation Law includes articles that explain the acquisition of *owned* land. Article 32.1 states that special needs for which owned land can be acquired are:

- Ensuring national defense and security;
- Creating a permanent exploitation field for scientific and technological experiment and environmental or climatic observation; and
- Building roads, lines and networks and other objects of a national scale.

The State must notify owners and enter into negotiations with owners at least one year prior to a decision to expropriate, attempting to agree on: i) the value of the lad and immovable property located on it; ii) transportation costs regarding resettlement or relocation; iii) investment made by the owner on the land; iv) location, size, characteristics and quality of replacement land that is provided by state; v) conditions and deadline for vacating the land; and vi) the amount of compensation, payment procedure and date. If an agreement is reached, the owner must vacate within one year of the agreement date. If no agreement is reachable, the dispute will be referred to the court.

Under Article 33, district governors may establish servitudes over private land for the purposes of access through the land, installing survey markets, drainage or other land management measures. No compensation need be paid for such access. If the land becomes difficult or impossible to use because of the servitude, the owner has the right to demand that the authority purchase the land or compensate for damages.

Article 37 of the Law outlines the principles applicable to compensation that landowners are entitled to upon exploitation[17]:

[17] Although the Land Law and Land Allocation Law require that (owned) land be compensated for at market value, this is not the case in practice. Rather the practice is to value land for compensation based on rates set by the government. Compensation for land is valued at 13,200 to 44,000 MNT per square meter, based on Cabinet Resolution No. 103 of 2003 and decided finally through negotiation with the land owners.

- Replacement land must be not worse in character and quality than the owner's land;
- Land and immovable property will be compensated for at market value;
- Improvements made to the land will be compensated for;
- Losses incurred by the owner due to the taking of the land and relocation must be compensated for; and
- No compensation is paid for immovable property built or improvements made after the notice given at the start of the process.

(2) Comparison of Land Acquisition and Resettlement Policies

There are several significant differences in policy between the Mongolian legal framework and policies of donor agencies, i.e., JICA's Guideline for Environmental and Social Conditions (April 2010) and the WB standards, including OP 4.12. According to Mongolian law or practice:

- Non-titled occupants of land (without ownership or possession license), including lessees of land and structures, are not eligible for compensation and rehabilitation entitlements.
- Compensation (unless alternative land is provided) for affected land is based on a government compensation tariff, not replacement rates, although there is room for negotiation with individual PAPs.
- A depreciation coefficient is applied in the valuation of affected structures.
- Income and livelihood rehabilitation are not normally considered in local land acquisition and resettlement practices.
- There are no grievance procedures internal to a project preceding dispute resolution by governors and the courts.
- Public consultation and information disclosure is not mandatorily practiced.
- An eligibility cut-off date is not declared.

Table 8.5.1 Comparison of Land Acquisition and Resettlement Policies

Item	Provision of Mongolian Laws	JICA/WB Policies[18]	Measures taken under the Project
Land Acquisition and Resettlement Policies	• Invoking eminent domain is only legally recognized when taking back land due to special needs of the State, including lines and networks and other objects of national scale (Land Allocation Law, Articles 32 and 37; Land Law,	Eminent domain is generally recognized and subject to policy provisions aiming at avoiding and minimizing land acquisition and resettlement and replacement of lost assets and rehabilitation of	Minimized land acquisition and avoided resettlement as much as possible through route selection and road design.

[18] The relevant policy papers are *Operational Manual OP4.12 Involuntary Resettlement* (December 2001, Revised February 2011) for the World Bank and *Guidelines for Environmental and Social Considerations* (April 2010) for JICA. Since the JICA Guideline clearly states that JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies in Section 2.6, Laws, Regulations and Standards of Reference, the Table covers both JICA's Guideline and OP4.12 of WB.

	Articles 42 and 43). This law does not apply to the Project. Current practice by government in local-scale projects entails a demand letter with threat of sanctions and offer of payment of compensation. • The Civil Code of Mongolia is the legal basis for contractual agreements on the transfer of land in the Right-of-Way (ROW) from Project Affected Persons (PAPs) to the government (Chapter 15, Articles 1, 6, 7, 8, 109 and 112, among others).	livelihoods.	
Eligible PAPs	• Licensed owners, possessors and users of land can transfer their titles to other legal persons recognized under the Land Law (Articles 35 and 38) and the Land Allocation Law (Article 27). • Non-titled occupants of land as illegal possessors are not eligible to transfer the land occupied or receive compensation (Land Law, Article 27.4). • The Civil Code recognizes the right of a long term non-owner occupant of ownerless immovable property (incl. land) to own it after 15 years, if registered in the State register (104.2).	Lack of formal legal title to land is not a bar to compensation entitlements. PAPs with formal legal rights and PAPs with recognizable claims to land/assets are entitled to compensation for affected assets at replacement cost. PAPs with no recognizable claims to the land they are occupying are not eligible for land compensation but be entitled to resettlement assistance such as land, other assets, cash and employment as necessary.	All the lands which will be acquired by the project are possessed lands; all PAPs hold formal legal titles. Thus, all PAPs are eligible for compensation entitlements.
Compensation for Land	• Contractually agreed payment for land transferred to the government. • Local practice applies the government land valuation	Land compensated for in-kind (replacement land of similar size and quality) and/or cash compensation at replacement cost (value to acquire land of similar	For full loss or in case the remaining land becomes economically unviable, the PAP may choose between

	tariff (Cabinet Resolution 103, 2003), but negotiates with PAPs as well. • Replacement land can be provided if AP's entire land or a large part thereof is acquired.	size, quality, location advantages and level of improvements, including transaction costs).	the following alternatives: i) provision of replacement land of comparable size, value, location, and utility as lost plot; ii) cash compensation at replacement rates or the government compensation tariff, whichever is higher, based on contractual agreement. For partial loss or in case the remaining land plot is economically viable, the above-mentioned ii) will be applied for the lost plot.
Compensation for Structures	Contractually agreed payment for transfer of structures located on land acquired. The value of structures is determined either by a government valuation tariff (Cabinet Resolution 336, 2010) or at market rates, with depreciation deducted from the gross value of the structure.	Structures compensated for in-kind (replacement of structure of similar size, quality and amenities) and/or cash compensation at replacement cost (equivalent to the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes, without deduction of depreciation). PAPs shall be permitted to salvage materials.	Compensation amount is estimated as replacement cost based on Cabinet Resolution 336, 2010 or market prices.
Income and Livelihood Rehabilitation	No provision in contractual agreements for transfer of	Assistance for economic rehabilitation due to loss of	PAPs are eligible for income and

	property.	income sources or means of livelihoods, including (i) income compensation or support for the period of interruption of business or employment, (ii) economic support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living; and (iii) additional development assistance, such as land preparation, credit facilities, training, or job opportunities.	livelihood rehabilitation.
Relocation and Transaction Cost	All registration and other fees, as well as cost of relocation, are the responsibility of parties to a contract and can be included in a contract.	Relocation and transfer expenses, including fees for the registration of properties and other administrative charges, are part of the replacement cost of lost assets and included in compensation.	PAPs are eligible for compensation for relocation and transfer cost.
Grievance Redress	The Land Law refers disputes over land to the governors of administrative units and eventually the courts (Article 60). The Civil Code and Land Allocation Law refer various types of disputes to the courts.	An adequate grievance redress mechanism for affected people is required.	Working group on land acquisition[19], which will be established in UB City, handles grievances.
Information Disclosure and Public Consultation	No provision for public consultation and information disclosure. In practice, all cases involve a period of negotiation.	PAPs are to be fully informed and closely consulted on compensation and resettlement options. Draft, final and revised Land Acquisition and Resettlement Plan (LARP) is to be disclosed to relevant PAPs through public consultation meetings, and discussed	Public consultations are organized to discuss the land acquisition plan. The final plan is disclosed also through public consultations.

[19] As for the details regarding the working group, please see iv) Institutional Arrangement and Implementation Schedule of (3) Land Acquisition and Resettlement for the Project.

		with PAPs in order to reflect their feedback in the LARP.	
Cut-off Date	No provision in Mongolian laws.	An eligibility cut-off date is typically the date the census begins. The cut-off date could also be the date the project area is delineated, prior to the census, provided that there has been an effective public dissemination of information on the area delineated.	A cut-off date has been defined by Dept. of Property Relation in Ulaanbaatar on May 10, 2013 and the notice was sent to Bayangol District. It is expected that the Cut-off date would be announced through the website of UB City and also through direct notification to PAPs.
Right-of-Way	BNbD (Building Norms and Regulations) Clause 6.24 state that 20 to 25m of ROW is required for Urban Arterial Road.	No conflict with WB requirements.	In order to minimize land acquisition, ROW is defined as road width plus 1 meter at the outside.

(3) Land Acquisition and Resettlement for the Project

i) Economic Activities in the Project Area

Land possessors and their economic activities in the Project area are summarized in Table 8.5.2.

Table 8. 5.2 Land Possessors and Economic Activities in the Project Area

	Possessors	Activities	Workers	Residents
PAP-01	Jamzam LLC	Car sales	8	0
PAP-02	SJBU LLC	Car sales		
PAP-03	UB Railway Mongolian-Russian Cooperation	Maintenance facility and storage for railway	-	0
PAP-04	Badral LLC	Gas station	7	0
PAP-05	Railway Department 2	Garage	120	0
PAP-06	Railway system's Commercial business center	Office	78	0
PAP-07	Just Group LLC	Gas station	7	0
PAP-08	Railway Fire Station	Firefighting station	128	
PAP-09	Road transport service center of Railway	Gas station	—	0
PAP-10	Khuvsgul Trade LLC	Fuel import	16	0
PAP-11	Tsuurden LLC	Yard for heavy equipment	-	0
PAP-12	Gatsuurt LLC	Mobile repair shop	5	0
PAP-13	NOTS LLC Khuvsgul Trade LLC	Transportation	100	0

PAP-14	Mon Carotage LLC (Zorigtbaatar)	Transportation	35	0
PAP-15	Erdenebaatar	Transportation / apartment	1	4
PAP-16	Erdenebayar	Garage / storage	1	3
PAP-17	MolgolTulkhuur LLC	Real estate	15	0

Note: PAP-15 and PAP-16 are private businesses in the residence. The number of families of PAP15 is four (4), i.e., husband, wife and two (2) children, and their monthly income consists of 4 million MNT from apartment rental and some irregular income from a transportation business. The number of families of PAP16 is three (3), i.e., husband, wife and a child, and their monthly income is approx. 1.3 million MNT.

ii) Affected Area and Facilities

- For the respective alternative routes, the area of each project affected building/facility was measured and confirmed with the concerned agencies of the Mongolian Government. Regarding definitive routes, the following are the major findings from the detailed survey.“Possessed Lands” are subject to the land acquisition for the Project. No owned land and or private land is located in the project site.
- Involuntary resettlement would not occur in the Project.

Table 8.5.3 shows the area of lands to be acquired and facility to be relocated and/or compensated.

Table 8.5.3 Area of Land Acquisition

Item No.	Possessor	Land Use	Area to be acquired (m^2)	Occupancy (%)
PAP-02*	SJBU LLC	Commercial	63.2	6.3
PAP-03*	UB Railway Mongolian-Russian Joint Venture	Commercial	375.6	0.6
PAP-03(2)*	UB Railway Mongolian-Russian Joint Venture	Green tract	3410	22.1
PAP-05*	Railway Department 2	Commercial	1,919.1	12.6
PAP-06*	Railway system’s Commercial business center	Commercial	4,701.8	31
PAP-07*	Just Group LLC	Commercial	512.4	25.6
PAP-08*	Railway Fire Station	Railway facility	1,890.0	41.5
PAP-09*	Road transport service center of Railway	Railway facility	1,786.4	6.3
PAP-10*	Khuvsgul Trade LLC	Commercial	687.5	2.6
PAP-11	Tsuurden LLC	Commercial	797.6	60.8
PAP-12*	Gatsuurt LLC	Commercial	147.7	1.4
PAP-13	NOTS LLC	Commercial	2,797.2	100
PAP-14	Mon Carotage LLC	Commercial	1230	71.2
PAP-15*	Erdenebaatar	Commercial + Housing**	400.0	40

Item No.	Possessor	Land Use	Area to be acquired (m^2)	Occupancy (%)
PAP-16*	Erdenebayar	Commercial	488.2	43.4
PAP-17*	Mongol Tulkhuur LLC	Commercial	559.6	3.2
Total			21,766	

Source: JICA Survey Team

* Partial Land Acquisition is required.

** No relocation is required.

Table8.5.4 Affected Facilities and Buildings

No.	Type of Structure	Unit	Quantity	Remarks
PAP-01	Steel Fence w/concrete foundation	m	50	
PAP-02	Steel Fence w/concrete foundation	m	20	
PAP-03	Steel Fence w/concrete foundation	m	120	
PAP-03(2)	Steel Fence	m	477	
PAP-04	Gas Station (Roof and Petrol Pump)	L.S.	1	
PAP-05	Fuel Storage Tank	L.S.	1	
	2 Story building	m^2	2,304	1 Nos.
	Brick Building	m^2	106.2	3 Nos.
	Cement square	m^2	54.6	
	Removable Concrete Panel	M	117	
	Steel Fence w/concrete foundation	m	26	
	Wooden Garage	m^2	1100	1 Nos.
PAP-06	Warehouses for vegetable storage pit	m^2	2,138	3 Nos.
	Removable Concrete Panel	M	220	
PAP-08	Office Building	m^2	1206.6	1 Nos.
	Shelter (corrugated-roof)	m^2	12.6	1 Nos.
	Cement square	m^2	124.5	
	Fountain	Nos.	1	
	Steel Fence w/concrete foundation	M	235	
PAP-09	2 story building for office	m^2	829	1 Nos.
	Guard Post	m^2	62	2 Nos.
	Cement square	m^2	135	
	Wooden fence/wire net	M	210	
PAP-10	Removable concrete panel	M	65	
	Steel Fence w/concrete foundation	M	16	
PAP-11	Concrete block building	m^2	15	1 Nos.
	Latrine	Nos.	1	
	Steel Fence w/concrete foundation	M	176	
PAP-12	Removable Concrete Panel	M	44	
PAP-13	Building	m^2	245.6	1 Nos.
	Pre-fabricated building	m^2	1000	1 Nos.
	Brick building	m^2	50	1 Nos.
	Garage (brick)	m^2	72.5	1 Nos.
	Cement square	m^2	120	
	Iron shed for high-voltage facilities	Nos.	1	
	Latrine	Nos.	1	
	Water kiosk	Nos.	1	
	Steel Fence w/concrete foundation	M	320	
PAP-14	Pre-fabricated building	m^2	133	1 Nos.
	Brick building	m^2	36	1 Nos.
	Green House	m^2	288	2 Nos.
	Latrine	Nos.	1	

	Removable Concrete Panel	M	244	
PAP15	Wooden Fence	M	37	
PAP-16	Wooden Building	m^2	52	2 Nos.
	Latrine	Nos.	1	
	Wooden Fence	M	53	
PAP-17	Steel Fence w/concrete foundation	m	150	

iii) Compensation Strategy and Livelihood Restoration Measures

The compensation strategy and livelihood restoration measures and required cost are summarized in Table 8.5.5 and Table 8.5.6, respectively. These costs will be secured by the MRT as a part of implementation cost for the Project.

Table 8.5.5 Entitlement Matrix

Type of Loss	Eligibility	Compensation Entitlements	Implementation Issues	Responsible Organization
Land (commercial, for full loss or in case the remaining land becomes economically unviable)	Possessor	The PAP may choose between the following alternatives: • Replacement land for land lost through provision of replacement plot of comparable size, value, location, and utility as lost plot. Possession license extended for longer periods up to 60 years as stated in Land Law. • At their choice or if equivalent replacement land is unavailable, cash compensation at replacement rates or the government compensation tariff, whichever is higher, based on contractual agreement.[20] • Assistance to find replacement land.	• Consult with relevant PAPs. • Identify the exact size of affected land and facilities. • Estimate the compensation amount/ Prepare the replacement land.Prepare LARP. • Approve LARP. • Disclose the contents of LARP. • Make contract for land acquisition and its compensation. • Pay compensation amount to relevant PAPs.	PIU/ WG for land acquisition
Land (commercial, for partial loss or in case the remaining land plot is economically viable)	Processor	• Cash compensation for the portion acquired at replacement rates or the government compensation tariff, whichever is higher, based on contractual agreement.[21] • If land is located in areas of	Same as the above.	PIU/ WG for land acquisition

[20] Due to the nonexistence of a matured land market, the replacement rates are not very well estimated. Thus, the practice is to value land for compensation based on rates set by the government. Usually, compensation for land is valued at 13,200 to 44,000 MNT per square meter, based on Cabinet Resolution No. 103 of 2003 and decided finally through negotiation with the land owners.

[21] The same as footnote 18.

		the City approved to allocate land for ownership in the land management plans, ownership certificate on the remaining land. • If land is not identified for land allocation for ownership, possession certificate on the remaining land.		
Structures (commercial) (This includes acquisition of a portion of land but the residual is no longer viable)	Possessor	Cash compensation for the lost part of a structure and reconstruction of the remaining structure at replacement cost based on market rates or the government tariff used for budgeting public works (Cabinet Resolution 336, 2010), whichever is higher, without deduction of depreciation, based on contractual agreement.	Same as the above.	PIU/ WG for land acquisition
Livelihood Rehabilitation Measures/Enterprise-based Income	All business entities so affected	• For temporary business loss with or without physical displacement due to land acquisition or construction activities by the Project, cash compensation equal to net income lost during interrupted period. • For permanent closure, compensation shall include any costs required for physical and financial re-establishment of business. If the business needs to be relocated, the business entities affected may choose between the following alternatives: (i) replacement land prior to relocation; or (ii) if an acceptable plot of land cannot be found, rehabilitation measures including outright cash payment for a limited time while the owner shifts to a new enterprise. The maximum cash payment will be equivalent of the net income of the enterprise for one year.	• Consult with relevant PAPs. • Conduct socio-economic survey on relevant PAPs. • Estimate income loss. • Pay compensation to relevant PAPs.	PIU/WG for land acquisition
Livelihood Rehabilitation Measures/Employment	All employees	• For temporary employment loss due to land acquisition	• Consult with relevant PAPs.	PIU/WG for land

	so affected.	or construction activities, cash compensation for lost wages for the period of interruption of employment. • For permanent employment loss, cash indemnity of 3 months' wages. In addition, skills development training and assistance to arrange new employment will be provided.	• Conduct socio-economic survey on relevant PAPs. • Estimate wage loss. • Pay compensation to relevant PAPs.	acquisition
Relocation Assistance	All DPs that are physically displaced, permanently or temporarily.	The following items on actual cost basis at current market rates will be provided. • Cost of developing residential resettlement sites; • Cost of transporting affected people and their assets to the resettlement sites. • Any transfer fees, taxes or other administrative costs; • Costs of identifying new housing or land. • Cost of consultation with the host community. • Any expense for temporarily sheltering physically DPs between the time of displacement and the time of relocation.	• Consult with relevant PAPs. • Estimate amount of relocation assistance. • Pay relocation assistance to relevant PAPs.	PIU/WG for land acquisition

iv) Required Cost for Compensation Strategy and Livelihood Restoration

Required cost for land acquisition was estimated as per the following conditions.

- There is no market price of possessed land for commercial purposes in Ulaanbaatar City. Therefore, the cost for land possession is set at 26,400MNT/m^2 consisting of (a) process fee for another land possession, (b) land acquisition cost applied for possessed land in the road improvement project until 2012 under ADB fund and (c) base price of land in Bayangol district set forth by Ulaanbaatar City.
- Demolishing cost and compensation cost for relocation/resettlement are set on the basis of (a) market price of real estate in Ulaanbaatar City and (b) actual compensation prices in the road improvement project by ADB.
- Compensation for facilities of Ulaanbaatar Railway Corporation is based on the letter 2013-3-27 Letter No.13/394 sent from Ulaanbaatar Railway Corporation to Road Department of Ulaanbaatar City. In the same letter, Ulaanbaatar Railway Corporation requests alternative land instead of monetary compensation.
- Amounts of business compensation to affected enterprises are computed on the basis of LARAP prepared in this preparatory survey.

Table 8.5.6 Required Cost for Compensation Strategy and Livelihood Restoration

Type	Unit	Rate (MNT)	Quantity	Amount (MNT)
1. Land Acquisition				
Possessed Land	m^2	26,400	21,766	574,622,400
Subtotal l				**574,622,400**
2. Buildings/Facilities Compensation				
Gas station (3 refueling + roof)	set	100,000,000	1	100,000,000
Petroleum reserve storage	set	200,000,000	1	200,000,000
Office (2 floors)	m^2	1,350,000	3,133	4,229,550,000
Office (1 floor)	m^2	619,270	1206.6	747,211,182
Office (1 floor, prefabricated)	m^2	509,800	1133	577,552,420
Office (1 floor, brick)	m^2	380,316	244.2	92,873,167
Vinyl house	m^2	50,000	288	14,400,000
Garage (wooden)	m^2	509,800	1100	560,780,000
Garage (brick)	m^2	380,316	72.5	27,572,910
Tin roof	m^2	50,000	12.6	630,000
Concrete lock shed	m^2	45,000	15	675,000
Security shed	m^2	380,316	62	23,579,592
Vegetable storage	m^2	509,800	2,138	1,089,952,400
Concrete base	m^2	195,000	434.1	84,649,500
Fountain	item	2,500,000	1	2,500,000
High voltage power shed	item	15,000,000	1	15,000,000
Toilet	item	246,000	4	984,000
Water-service pump station	item	6,000,000	1	6,000,000
Concrete panel	M	87,500	690	60,375,000
Steel fence	M	87,000	477	41,499,000
Wooden fence / wire mesh	M	30,000	300	9,000,000
Steel fence with foundation	m	45,000	1113	50,085,000
Subtotal 2				**7,934,869,171**
3. Business Compensation				
PAP-04	month	2,250,000	3.0	13,500,000
PAP-06	month	12,700,000	6.0	76,200,000
PAP-07	month	4,500,000	1.0	4,500,000
PAP-11	month	15,000,000	3.0	45,000,000
PAP-13	month	40,000,000	6.0	240,000,000
PAP-14	month	10,000,000	6.0	60,000,000
PAP-16	month	2,500,000	3.0	7,500,000
Subtotal 3				**446,700,000**
4. Fees for Relocation Process				
Notarial Certificate (1) (MNT 1 to 10 Million)	set	10,000	6	60,000
Notarial Certificate (2) (MNT 10 to 25 Million)	set	25,000	2	50,000
Notarial Certificate (3) (MNT 25 to 50 Million)	set	50,000	1	50,000
Notarial Certificate (4) (MNT 50 to 100 Million)	set	100,000	2	200,000

Type	Unit	Rate (MNT)	Quantity	Amount (MNT)
Notarial Certificate (5) (MNT 100 to 500 Million)	set	200,000	1	200,000
Notarial Certificate (6) (MNT 500 million +)	set	300,000	5	1,500,000
Cadaster survey	set	50,000	17	850,000
Service Fee	set	5,000	17	85,000
Property registration fee	set	12,000	17	204,000
Subtotal 4				**3,199,000**
5. Assistance for Relocation				
Relocation of container	nos.	250,000	55	13,750,000
Relocation of steel goods wagon	nos.	350,000	1	350,000
Workers for Labor	nos.	100,000	2	200,000
Movement of relocated enterprises (PAP11,13, 14)[22]	set	5,000,000	3	15,000,000
Subtotal 5				**29,300,060**
6.Compensation for Rental Fee				
Garage rental fee (PAP-08)	day	30,000	180	5,400,000
Subtotal 6				**5,400,000**
Total (MNT)				**8,994,090,571**

v) Institutional Arrangements and Implementation Schedule

For implementation of the Project, the Working Group (WP) for land acquisition shall be established in Ulaanbaatar City and consist of the following members.

1) Governor of Bayangol District (Chairman)
2) Governor of Khoroo (Vice Chairman)
3) Land acquisition specialist of UB City (Member)
4) Representative from the UB City Road Department (Member)
5) Representative from the UB City Property Relations Department[23] (Member)
6) Representatives of the PAPs (Member)

vi) Representative from a CBO or NGO registered by the government (Member), if available.

The WG for land acquisition, which includes representatives of the Property Relations Department, is responsible for identifying the owners and occupants of affected land and valuating the properties of PAPs. The PIU will be responsible for reporting the progress in implementing the LARP to the Ministry of Road and Transportation (MRT). Members of WG for land acquisition are as follows:

a) Internal Monitoring

Internal Mentoring is implemented to ensure: (i) proper execution of responsibilities of key stakeholders; (ii) protection of the rights of PAPs; (iii) adequate and prompt payment of

[22] Relocation cost was allocated to entities whose entire facility needs to be relocated due to land acquisition exceeding 60% of the original possessed area.

[23] Due to the organizational restructuring, the Land Administration Department was amalgamated into the Property Relations Department in 2013.

compensation; and (iv) timely grievance redress. The WG conducts its own internal monitoring of land acquisition and submits monthly reports to the PIU. The PIU compiles such information in its quarterly reports to MRT. Upon completion of land acquisition activities in the Project, the WG will prepare a resettlement completion report for submission to MRT.

In addition, the State Professional Inspection Agency (SPIA) will independently audit and monitor the agencies involved in the land acquisition and resettlement process, based on the relevant laws and regulations.

b) External Mentoring

The main objectives of external monitoring are to: i) assess the effectiveness, impact and sustainability of land acquisition and resettlement measures; ii) determine whether safeguard compliance has been met; and iii) learn strategic lessons for future policy formulation and planning. The PIU has to establish an External Mentoring Agency (EMA) by hiring consultants, NGO personnel, academicians, and such like; the EMA will investigate and assess the land acquisition process for the Project. Over four years, the EMA will conduct the monitoring and submit monitoring reports to the PIU. External monitoring consists of following activities:

- Review and verification of the internal monitoring reports submitted by the PIU;
- Review and augmentation of the socio-economic baseline surveys, if necessary;
- Assess the contents of compensation for land acquisition and business losses;
- Assess adequacy for measure to PAPs and living standards/incomes of PAPs before and after the Project;
- Assess PAP’s satisfaction level towards resettlement implementation;
- Assess compliance level regarding relevant laws and guidelines; and
- Assess the process of consultation with local stakeholders

c) Implementation Schedule

The following schedule for land acquisition activities is proposed.

Work Items	1st Year				2nd Year				3rd Year				4th Year				5th Year				6th Year			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Detailed engineering design																								
Tender and construction																								
Public consultation																								
Cadastral survey																								
Identification of affected plot and buildings																								
Review of Land Acquisition and Resettlement Plan																								
Valuation of compensation cost																								
Disclosure of compensation framework to PAPs																								
Approval for land acquisition plan																								
Processing of payment																								
Securing land for relocation																								
Restoration of affected structures on the remaining land and/or replacement land																								
Implementation of livelihood rehabilitation measures																								
Internal monitoring																								
External monitoring																								
Formation of Grievance Redress Committee																								

Figure 8.5.1 Implementation Schedule for Land Acquisition

vii) Grievance Redress Mechanism

The Khoroo Governor as Vice Chairman of the WG will be the initial recipient of the grievance and log it in the specialized format, tentatively named as the Grievance Action Form (GAF). The GAF will be signed by the Khoroo Governor and the PAP, who will receive a signed copy. All GAFs shall be consolidated by the Khoroo Governor and presented to the WG for deliberation and appropriate action, on a weekly basis. Grievances unresolved at the WG level within two weeks shall be referred to the respective District Governor for resolution within one week. Recommendations of the Governor will be referred to the Citizens' Representative Khural for approval and final action. If there are still unresolved grievances after another week, a case may be filed by the claimant in the appropriate courts.

Table 8.5.7 Grievance Redress Procedure

Item No.	Procedures	Period
PAP lodges grievance with Khoroo Governor		
1	Khoroo Governor prepares GAF and initiates WG meeting	2 weeks or less
	The WG addresses grievance, informs PAP and initiates action	
If grievance is not resolved		
2	WG submits grievance to District Governor	1 week or less
	District Governor addresses grievance, informs PAP and proposes resolution to District Citizens Representative Khural	
	District Citizens Representative Khural initiates action for resolution	1 week or less
If grievance is not resolved		
3	Grievance is referred to court system	Open

viii) Internal Monitoring Form (Draft)

Land acquisition and resettlement activities	Planned total	Unit	Progress in Quantity			Progress in %		Expected Completion Date	Responsible Organization
			During the quarter	Till the last quarter	Up to the quarter	Till the last quarter	Up to the quarter		
Preparation Stage									
Employment of consultants		Man-Month							PIU/WG
Implementation of Census Survey (incl. Socioeconomic Survey)									PIU/WG
Public Consultation (1st)		Date							PIU/WG
Finalization of LARP		Date							PIU/WG
Finalization of PAPs List		No. of PAPs							PIU/WG
Public Consultation (2nd)		Date							PIU/WG
Implementation Stage									
Progress of Compensation Payment									
PAP-		No. of entities							PIU/WG
PAP-		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
Progress of Land Acquisitions									
PAP -		ha							PIU/WG
PAP -		ha							PIU/WG
PAP -		ha							PIU/WG
PAP -		ha							PIU/WG
Progress of Livelihood Rehabilitation Measures/ Enterprise-based Income									
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
Progress of Relocation Assistance									
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
PAP -		No. of entities							PIU/WG
Number of Grievance Adjustment									
PAP -		responded / received							WG
PAP -		responded / received							WG
PAP -		responded / received							WG
PAP -		responded / received							WG

8.6 PUBLIC CONSULTATION

(1) First Public Consultation Meeting

In cooperation with the JICA Survey Team, the First Public Consultation Meeting (PCM) organized by the Road Department of Ulaanbaatar City took place on July 27, 2012, when the Scoping Matrix (Draft) is ready to be open to participants. Nine (9) households and seven (7) entities in the vicinity of the project site were invited through directly delivered invitation letters with an agenda of the meeting five days before the PCM. In addition, Ulaanbaatar Railway and two (2) NGOs for environmental conservation were invited as well. An overview of the 1st PCM is shown as below.

Table 8.6.1 Record of First Public Consultation Meeting

The First Public Consultation Meeting	
Date & Time	July 27, 2012　14:00 – 16:00
Venue	Meeting room at Suuri LLC
Participants	Twenty-six (26) in total including the following persons: • Officer-in-charge (OIC) from Road Department, UB City • OIC from Land Administrations Department, UB City • Four (4) persons from the ENVIRON LLC • Two (2) persons from Ulaanbaatar Railway • One (1) person each from two environmental NGOs • Sixteen (16) persons from affected business entities
Presentation/ Q&A Sessions	**Presentation** • An expert from ENVIRON LLC, a DEIA company hired by the JICA Survey Team, made a presentation to explain the purpose of public consultation meetings (PCMs), DEIA and resettlement survey. • OIC from Road Department, UB City, explained an outline of the Ajilchin Flyover Project. **Q&A Session** As seen below, most questions were related to land acquisition reflecting the participants' strong concerns. Those questions were mainly answered by OICs of UB City. The major points raised during Q&A Sessions are as follows: • (Affected Entity); I would like to know which are the affected areas exactly. When are we able to get such information? (Answer: A separate survey for land acquisition is planned. The survey team is going to visit each affected entity with detailed ROW. You will know the exact areas at that time.) • (Affected Entity); Why do you need such a great bridge width especially above the railway line? (Answer: Indeed it looks wide since it includes ramp ways. We would like you to understand that we carefully reviewed several options before selecting the best plan we introduced to you today.) • (Affected Entity); The railway is a joint venture of Mongolian and Russian sides. As for land acquisition in the railway premises, we have to explain to our partner beforehand. We request you to hold a meeting at our headquarters to explain the project. (Answer: Another public consultation meeting will be conducted later. Let us discuss later if we should invite railway officials to the

	next PCM or visit your office to explain our project.) • (Affected Entity) We understand the difficulty of land acquisition, but the long-term benefits should be seriously considered especially for any big-scale project. Heavy vehicles should smoothly go through without causing traffic jams. (Answer: OICs in UB City appreciates the participants' understanding. In addition, the current issues as to land acquisition were explained by the OIC from the Land Administration Department, UB City)

(2) Second Public Consultation Meeting

Upon the completion of Draft DEIA Report and Draft Land Acquisition and Resettlement Report, Ulaanbaatar City Government held the Second Public Consultation Meeting (2nd PCM) in cooperation with ENVIRON LLC on November 17, 2012. Five (5) households and eight (8) business entities were invited through directly delivered invitation letters with an agenda five to seven days before the 2nd PCM. Two NGOs for environmental preservation were invited, the same as the 1st PCM. An overview of the 2nd PCM is shown as below.

Table 8.6.2 Second Public Consultation Meeting

The Second Public Consultation Meeting	
Date & Time	Nov. 17, 2012 15:00-17:20
Venue	Conference room at the "Suuri" LLC
Participants	Twenty-six (26) in total, which include the following persons: • One (1) representative from UB Road Dept. • One (1) representative from UB Land Administration Dept. • Four (4) persons from ENVIRON LLC. • Two (2) persons from Environmental NGO • Five (5) citizens from nearby living households • Thirteen (13) persons representing 8 affected entities
Consultation Process	**Presentation** 1) Results of environmental studies on air, water and soil qualities and pollution levels against the national standards and projected negative and positive impacts from the flyover bridge construction and operation. 2) Study results of land acquisition and resettlement. **Q&A Session** Participants were interested in the environmental study results as to whether or not air pollutants exceed the acceptable level and whether the quality of the water they drink is acceptable or bad. Also, they are interested in how much the proposed bridge construction will reduce the current traffic jams and if there would be an increase or decrease in air pollution due to the flyover bridge. Land acquisition and resettlement issues were crucial for participants especially for some affected entities. Q (Affected Entity); If you want to build, why don't you plan to build a road along and above the Dundgol River? If the river is somewhat polluted already as

	your study shows, then you can construct columns along both sides of the river banks and make a road. You do not need to make too broad a road and impact peoples' property. (Answer: A feasibility study for various alternatives was done and many road and traffic experts were involved and various factors have been examined to propose the optimum route.) Q (Affected Entity); Can you show whose objects are affected and how much they are affected? (Answer: ENVIRON LLC shared the results of a land acquisition plan and introduced the legal environment of Mongolia and JICA guidelines; resettlement impacts; affected entities, citizens and properties; compensation and livelihood restoration measures; grievance redress mechanism and LARP implementation arrangements.) Q (Affected Entity); Who defines this Cut-off-Date? Is there any provision in a regulation? (Answer: There is no Mongolian regulation in this regard, but we follow international best practices and JICA guidelines. It is essentially meant to restrict people who try to make profit on others' issues.) Q (Affected Entity): Mongolia has an inadequate legal basis for land resettlement. In addition to this, recently, there was a road expansion in front of our entity. Why are you talking about another expansion? (Answer: We have a weak regulation on land acquisition and resettlement. Existing legal gaps are complemented by compensation measures on this project, which JICA and the World Bank have been applying successfully for many other countries. Moreover, in Mongolia, a draft law on Land Acquisition and Resettlement is being discussed publicly and if this passes through the Parliament, the legal environment will be much improved.) Q (Affected Entity): An ROW line passes through a water reservoir with a volume of 200 m^3 located to the northwest corner of our company. Is it possible not to dismantle the reservoir? (Answer: Part of the flyover bridge will be constructed in the airspace along your portion of land.) Q (Affected Entity): Can't you move ROW to this garden area instead of passing through my entire land area? I am not against improving the road. Regarding the property compensation, you should be aware while making a valuation that costs will change with the passing years. (Answer: Regarding compensation and livelihood restoration strategy, the affected person's living condition should not be reduced with this project implementation. We would like to re-emphasize Tuvdendorj's introduction of the resettlement results. As was explained, every affected person/entity will receive compensation/assistance differently according to the provisions indicated in the entitlement matrix.) Q (NGO): When will the Project be started? (Answer: Optimistically, we anticipate the loan agreement may be signed in 2014; otherwise, in 2016 or even later.)

CHAPTER 9

FORMULATION OF THE CONSTRUCTION PLAN

9.1 CONDITIONS FOR THE CONSTRUCTION PLAN

(1) Conditions for the Work Schedule

In general, outdoor construction work including concrete work and asphalt work can be executed in the period between May and the end of September (5 months/year) in Mongolia. Six (6) days with rainfall of 10 mm or more are expected during this period on average. In addition, there are 20 Sundays and 4 holidays in this period. Therefore, the number of workable days in this six-month period is estimated to be approx. 120 days, and so the working ratio in the period is estimated to be around 0.80. These figures imply the need for efficient construction planning including shop fabrication and manufacturing of secondary products during the winter season.

(2) Construction Yard

Since the Project site of the Ajilchin Flyover is located in a city area, which includes railway properties and lots of operating plants, the availability of space that can be used for the construction yard of this Project is extremely limited. At the moment, the two (2) lots mentioned below have been identified as candidate lots for the construction yard.

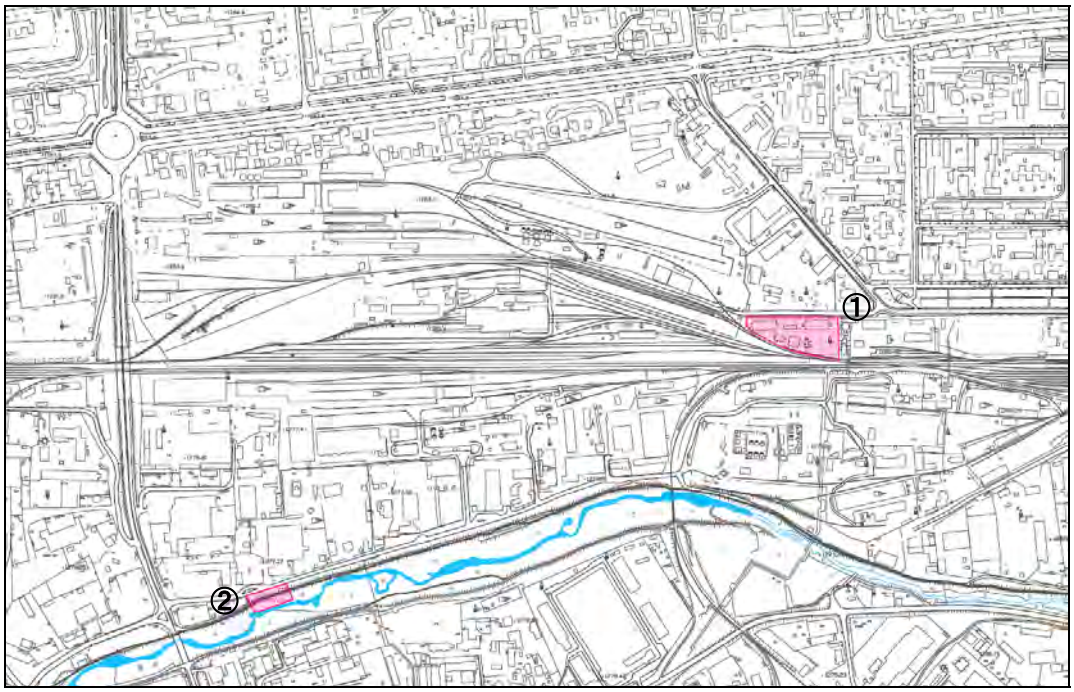


Figure 9.1.1 Location of Candidate Lots for the Construction Yard

- Facility lot of Ulaanbaatar Railways (approx. 12,000 m^2): Ulaanbaatar Railways own the lot and rents out the facilities in it to tenants engaged in the physical transportation business. Since the facilities in the lot are old and dilapidated, their reconstruction is planned.
- Container Yard on the West Industrial Road (4,500 m^2): The entire container yard will have to be relocated since the work to improve the intersection in which the yard is located is included in this project. Therefore, it will be possible to use this lot as a construction yard after it has been purchased for the improvement work.

9.2 BASIC POLICY OF THE CONSTRUCTION PLANNING

(1) Procurement of Materials and Equipment and Work Schedule

As outdoor construction work can be implemented only in the period between April and the early September, shop fabrication and procurement and transport of materials and equipment will be implemented in the rest of the year. A plan with careful consideration given to efficient implementation will be formulated so that the project can be completed in the shortest time. Concrete, asphalt, and so forth will be procured from the closest existing plants as much as possible.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Construction period	Severe winter season				Period for outdoor construction work					Severe winter season		
Rainy season						Rainy season						
Activities	Shop fabrication and transport of materials and equipment				Concrete work, paving work and girder erection work					Shop fabrication and transport of materials and equipment		

Figure 9.2.1 Basic Policy for the Formulation of Work Schedule

(2) Conditions around the Project Sites

The figure below shows the locations of the concrete plant, asphalt plant, borrow pit and quarry around the project sites in Ulaanbaatar City expected to be used in the Project. It takes around one hour to transport industrial waste from the city to the industrial waste disposal site in Ulann Chuluut. Since a large number of construction works are implemented in the city during the short period of six months between April and September, there are concerns about a shortage in the supply of concrete during this period. Therefore, the amount of concrete supply from the existing concrete plant is estimated to be approx. 200 m^3/day in the construction plan.

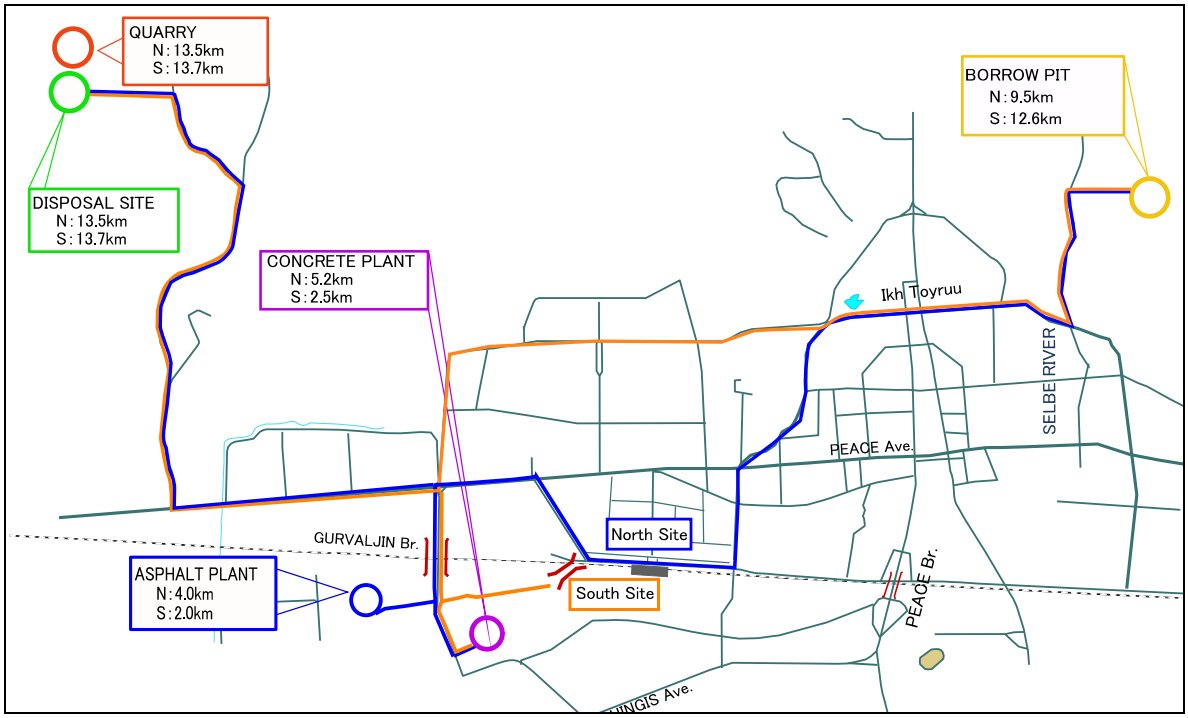


Figure 9.2.2 Locations of Sources of Construction Materials, such as Borrow Pit around Construction Sites

(3) Bridge Girder Erection Methods

Either the “launching erection method” or the “crane erection method” will be used for the construction of a viaduct in accordance with the positional relation between the construction sites and the railway line and the existing roads. Although the schedules of international passenger trains on the main tracks cannot be changed, those of freight trains can be rescheduled for the construction work. It is estimated that the length of such time in which trains can be stopped (window time) will be six (6) hours per day.

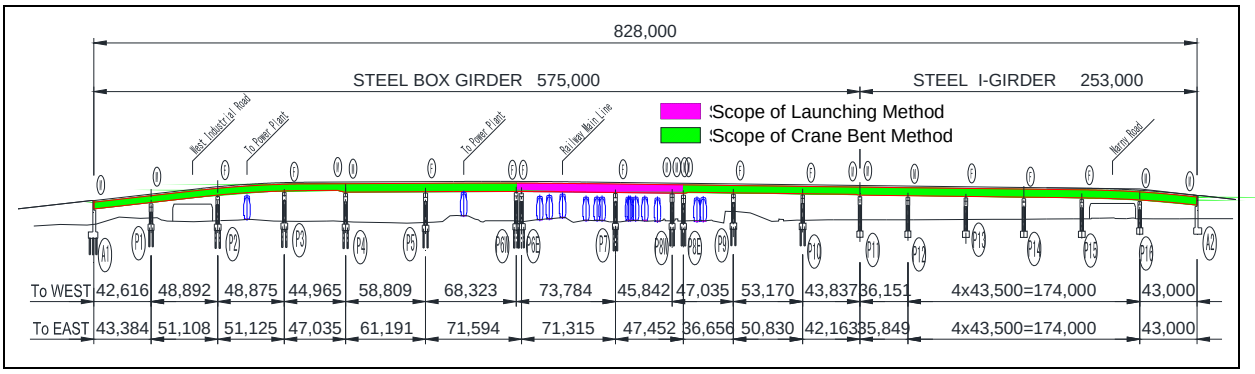


Figure 9.2.3 Girder Erection Methods for the Construction of Viaduct

i) Girder Erection Method for the Section above the Railway Line (Main Tracks)

The launching erection method will be used for girder erection in the section above the main tracks and the adjacent sections (between P5 and P8) so that the erection work does not interfere with train operations. In the launching erection method, hydraulic motors and jacks are used to launch prefabricated girders. The same method was used on the overpass part of the Narny Bridge. However, it will have to be performed on a curved overpass part of the viaduct in this Project. Since such girder erection is technically complicated, a contractor with ample experience in this method shall be selected.

Figure 9.2.4 Launching Erection

ii) Erection Method for the Other Sections

The most widely used girder erection method, the crane-bent erection method, will be used for girder erection in sections where it is possible to install a crane and bents (temporary support structures to support bridge girders). Despite the requirement for temporary detours at grade-separated intersections between the viaduct and roads, this method will enable the quickest and most cost-efficient girder erection to be carried out.

Figure 9.2.5 Crane-Bent Erection

(4) Construction near the Railway Line

The construction work near the railway main/feeder lines will be implemented with a fence erected at the distance of 2.5 m from the nearest railway track to demarcate the construction area clearly. Excavation near the railway line will be implemented with monitoring of displacement (horizontal displacement and subsidence) and change in the inclination of the ground, in accordance with the agreement with the railway authorities.

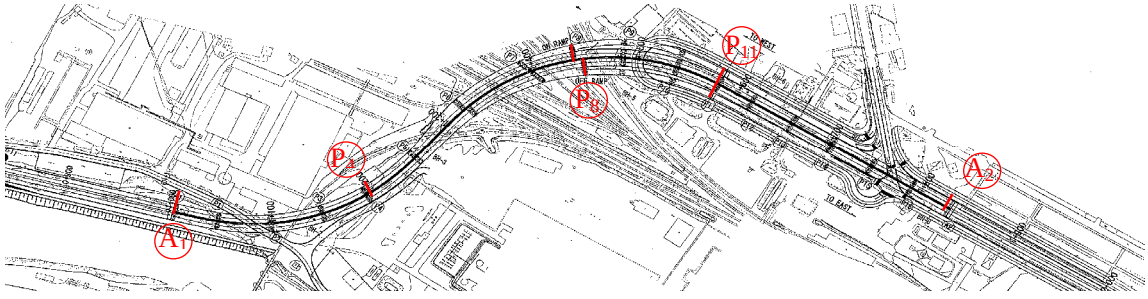
9.3 DIRECT CONSTRUCTION WORK

(1) Types of Work to be Implemented

The viaduct construction in this project consists of the types of work mentioned in the table below.

Table 9.3.1 List of Types of Work to be Implemented

Types of Work	Descriptions		Application
Superstructure Erection Work	4-span continuous steel box girder: A1-P4	42.616 + 48.892 + 48.875 + 44.965	West-bound lanes
		43.384 + 51.108 + 51.125 + 47.035	East-bound lanes
	4-span continuous steel box girder: P4-P8	58.809 + 68.323 + 73.784 + 45.842	West-bound lanes
		61.191 + 71.594 + 71.315 + 47.852	East-bound lanes
	3-span continuous steel box girder: P8-P11	47.035 + 53.710 + 48.837	West-bound lanes
		36.656 + 50.830 + 42.163	East-bound lanes
	6-span continuous steel plate girder: P11-A2	36.151 + 4 × 43.500 + 43.0	West-bound lanes
		35.849 + 4 × 43.500 + 43.0	East-bound lanes
	3-span continuous box girder: P8-P11	47.035 + 53.710 + 48.837 (shown as the length of CL on the main road)	On-ramp
		36.656 + 50.830 + 42.163 (shown as the length of CL on the main road)	Off-ramp
	Bridge deck slab work	Steel-concrete composite deck slab A = 20,000 m^2	
	Bearing installation work	106 pieces	
	Expansion device installation work	4 × 17.780 m + 32.98 m + 2 × 6.390 m = 116.88 m	7 locations
	Bridge deck work	Water-proofing work, paving work	A=16,600m^2
Substructure Work	Abutments	Single abutments for the lanes in both directions on the main road at A1 and A2	2 each
		Ramps	2 each
	Piers	T-type, column piers at P1, P2, P3, P4 and P5, separate piers for the lanes in the opposite directions	10 each
		Rigid frame, column piers at P6, P7 and P8, separate piers for the lanes in the opposite directions	6 each
		T-type column piers for on- and off-ramps at P9 and P10	4 each
Foundation Work (with piles)	Rotary penetration piles: φ1000	A1, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10	
Roadwork	Reinforced soil wall work		
	Length of the road on the origin side	L=1,005 m	
	Length of the road on the terminus side	L=412 m	



(2) Selection of Construction Methods

The planned locations of the piers of the viaduct, P2, P3, P5, P6, P7, P8 and P9, are near the railway tracks. Pile foundation has been selected for the construction of A1 to P10 because of the relatively deep bearing ground at those sites. Therefore, a construction method which minimizes the impact of the pile driving on the operation of railways will have to be used in this project. The rotary penetration steel piles used in viaduct construction with similar conditions (construction of the Narny Bridge) have been selected as the foundation piles to be used in this project. The details of the comparative study of different types of foundation have been described in "7.3 Bridge Plan (6) Selection of the Type of Foundation."

A rotary penetration pile is a steel pile with a wing attached to its tip. The characteristic of this pile is that it can be driven into the ground without loosening the ground around it as a rotary penetration (RP) machine forces it to rotate and penetrate the ground without generating waste soil. In addition, since the RP machine used with rotary penetration piles is smaller than machines used for other types of foundation work, it requires a small operating space. Therefore, the use of rotary penetrating piles is considered appropriate for this project in which foundation work will have to be implemented in the small spaces between the railway tracks.

Figure 9.3.1 shows the arrangement of equipment and materials for the implementation of the rotary penetration steel pile method and Table 9.3.2 shows its implementation procedure.

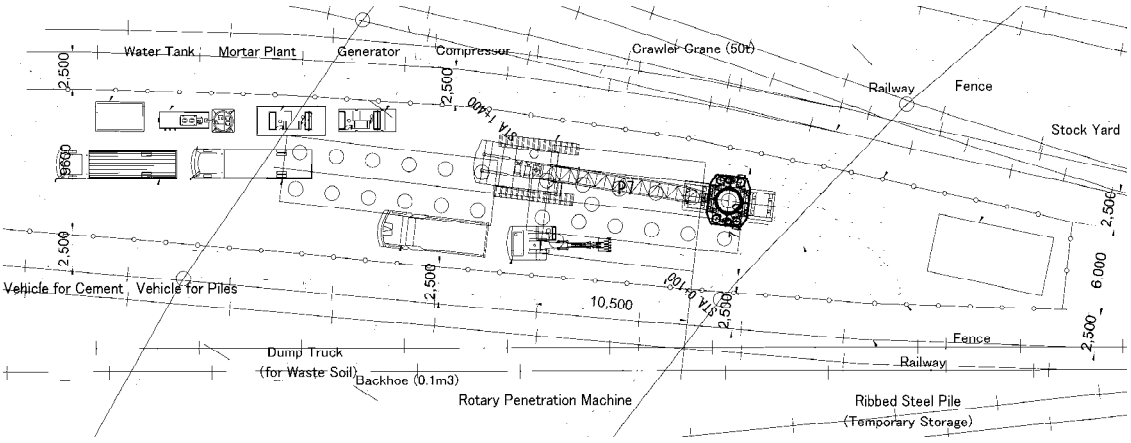
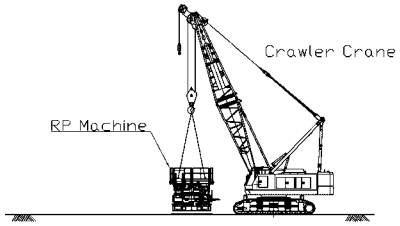
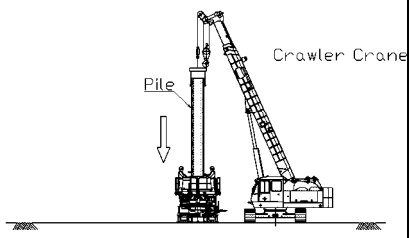
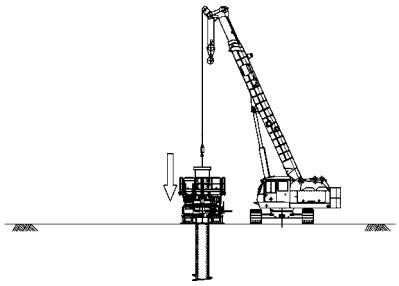
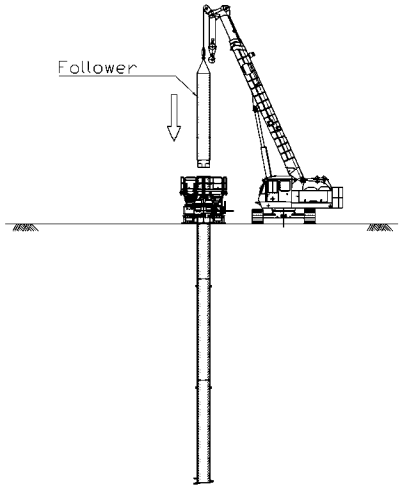
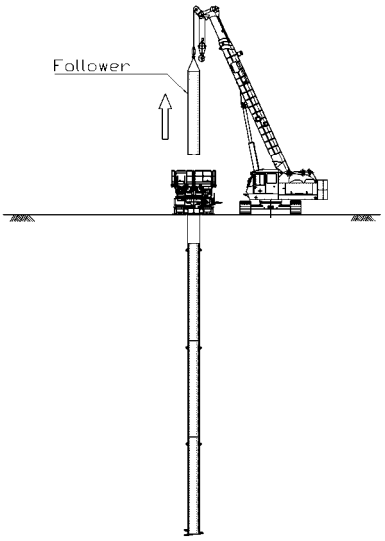
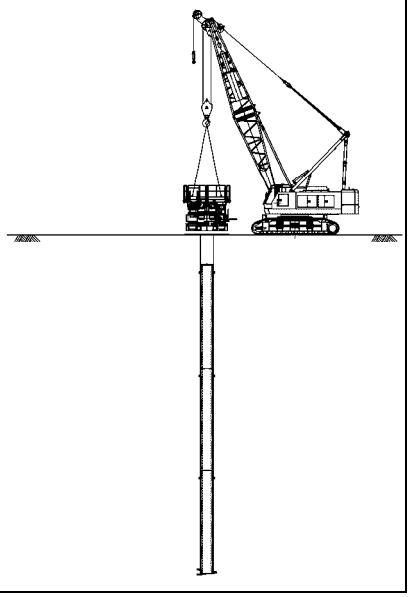


Figure 9.3.1 Arrangement of Equipment and Materials for the Implementation of the Rotary Penetrating Pile Method (P7)

Table 9.3.2 Implementation Procedure of the Rotary Penetrating Pile Method

1) Install rotary penetration (RP) machine	2) Install steel pile	3) Rotary-penetrate the pile
		
4) Install follower and penetrate	5) Pull out the follower	6) Remove RP machine
		

(3) Substructure Work

Different types of substructure work have been selected for the section with the original width and the section widened for the connection with the ramps. The reverse T-type abutment, the T-type pier and the rigid-frame pier have been selected as the structures of the abutments, the piers in the section with the original width and those in the widened section on the basis of cost-efficiency and workability (minimizing the amount of materials and the construction period), in principle.

Safety of the operation of the railways and the traffic on the roads near the construction site, level of groundwater and the period in which the construction work can be implemented (between May and the end of September) shall be taken into consideration when preparing the construction plan. The procedure shown in the figure below shall be used for the construction of

both the pile and spread footing foundations on the assumption of the use of open-cut excavation after the traffic on the existing roads has been detoured.

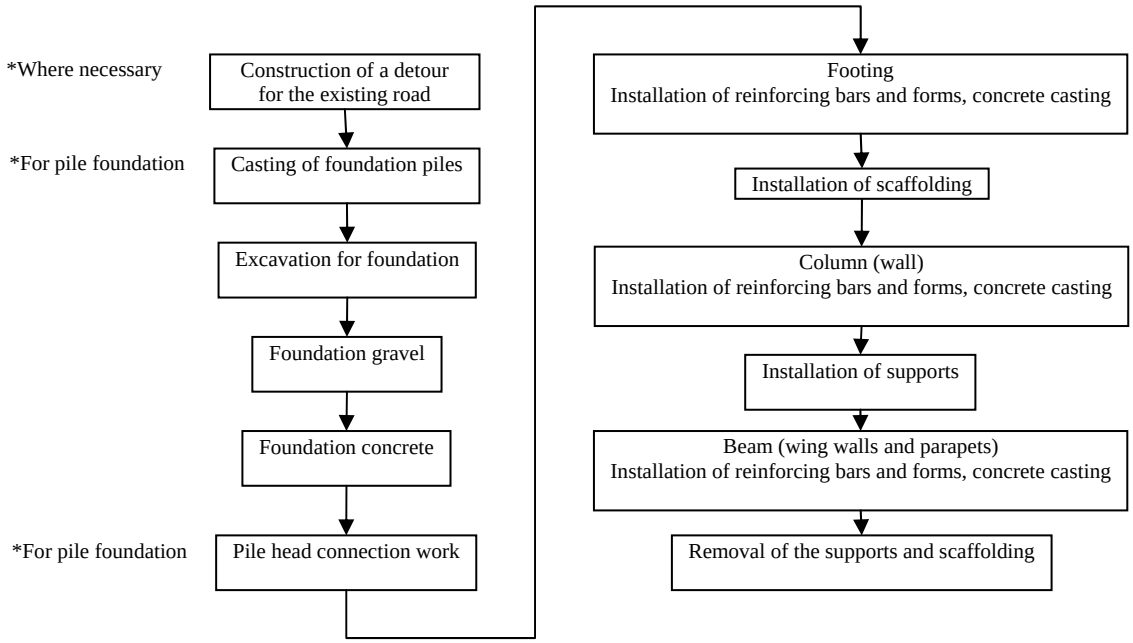


Figure 9.3.2 Implementation Procedure of the Substructure Work

(4) Superstructure Work

Either the “launching erection method” or the “crane erection method,” will be used for the girder erection of this viaduct in accordance with the positional relation between work sites and the railway line/the existing roads.

1) Erection of the Section between P6 and P8 (of the main road)

The inflection point of a horizontal S-curve is located in the section between P5 and P8. The minimum radius of curvature in this section is R200. The bridge girder constructed beyond P8 will be used as a yard for the assembling and launching of girders. As many temporary bents as possible will be constructed for the girder launching. A launching plan which allows completion of girder launching within the window time of the railway line, i.e., six (6) hours, shall be formulated.

Figures 9.3.3 and 9.3.4 show the procedure for the launching erection and the arrangement of equipment and structures for the launching erection, respectively.

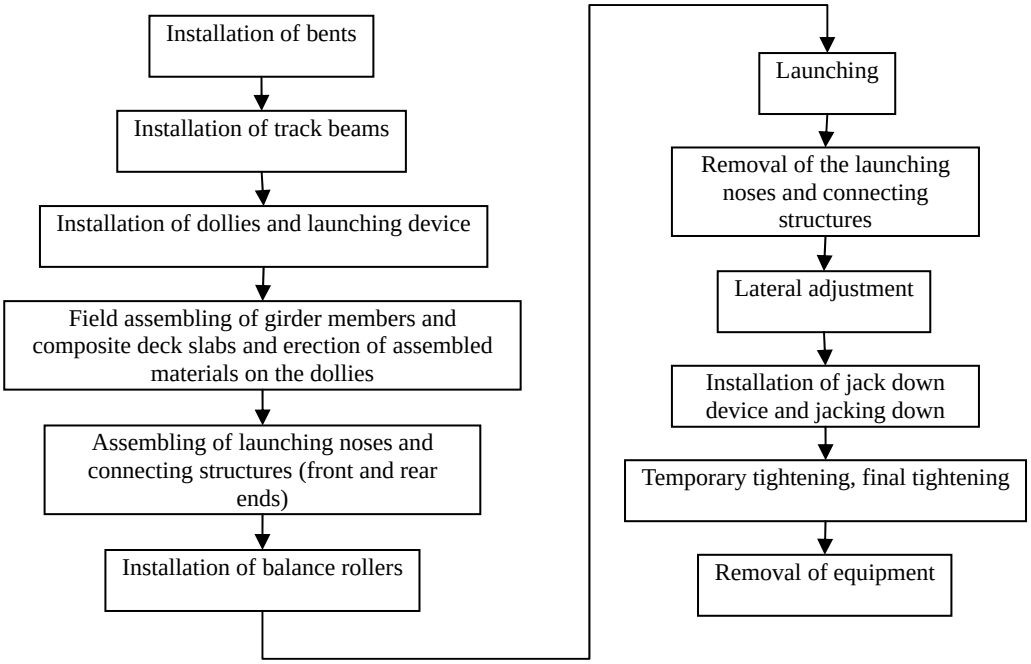


Figure 9.3.3 Procedure for the Launching Erection

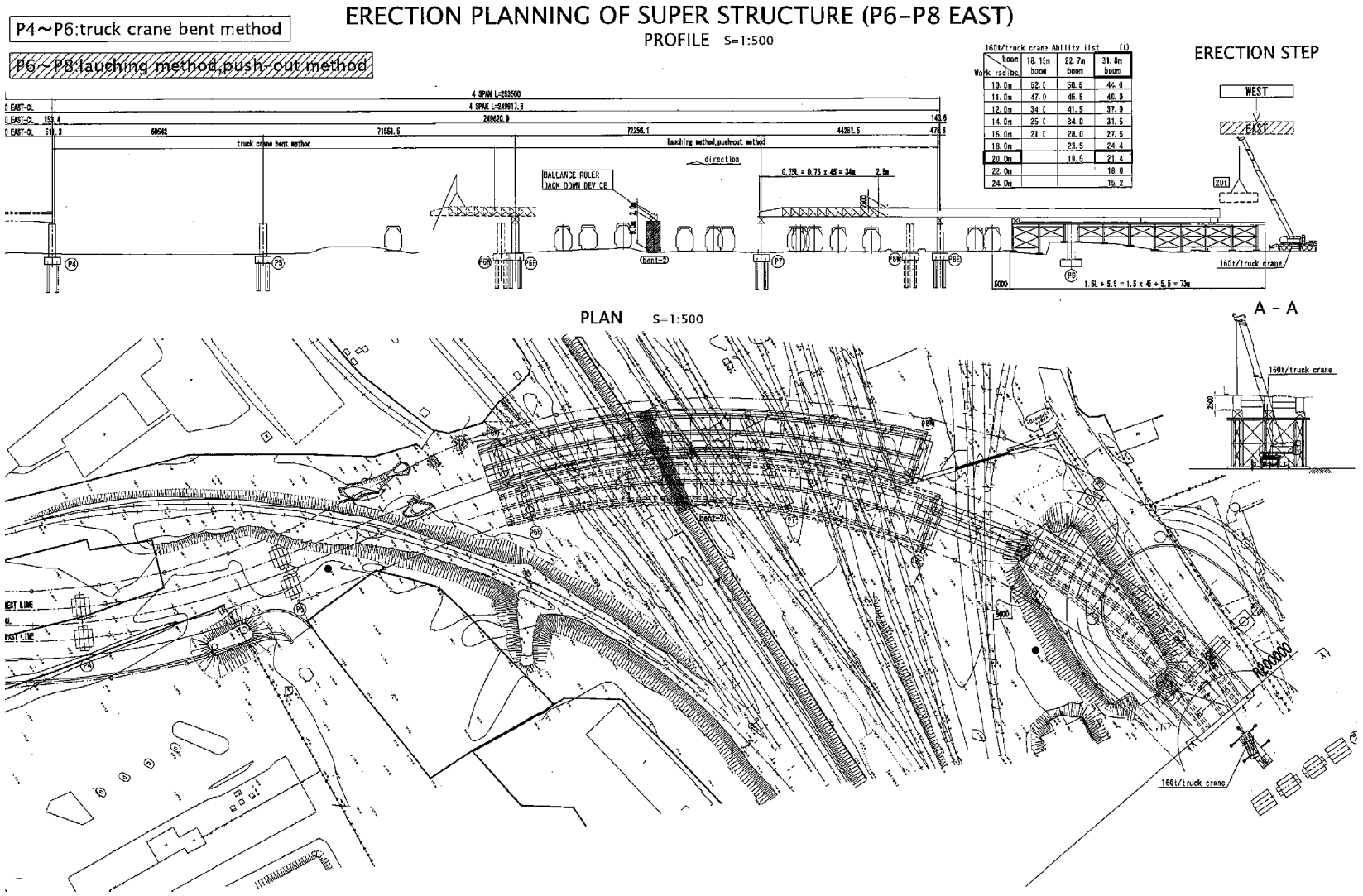


Figure 9.3.4 Erection Planning with Launching Method

2) Girder Erection in the Sections between A1 and P6 and between P8 and A2

The crane erection method will be used for the erection of girders in the section between A1 and P4. The erection shall commence after construction spaces, approaches to the spaces and parking spaces for the cranes have been leveled and a bent has been constructed at a location between P1 and P2 where it will not interfere with the traffic on the existing road.

Figure 9.3.5 shows the order of the erection decided on the basis of the restriction on the parking spaces for the cranes and for the work efficiency.

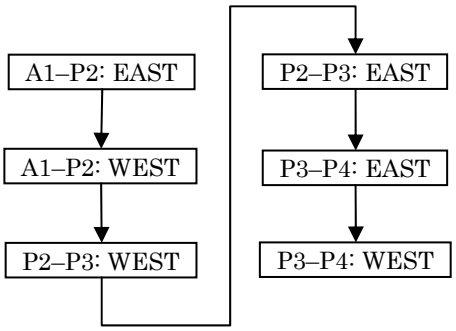


Figure 9.3.5 Order of the erection of the superstructure
(section between A1 and P4)

The erection of girders in the section between P4 and P6 with the crane erection method will commence after the completion of the launching erection in the section between P6 and P8. Before the erection, construction spaces, approaches to the spaces and parking space for the cranes will have been leveled and a bent will have been constructed at a location between P5 and P6 where it will not disturb the railway trucks.

Figure 9.3.6 shows the order of the erection decided on the basis of the restriction on the parking spaces for the cranes.

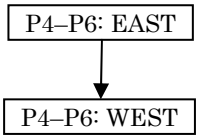


Figure 9.3.6 Order of the erection of the superstructure
(section between P4 and P6)

The crane erection method will be used for the erection of girders in the section between P8 and

P11. The erection shall commence after construction spaces, approaches to the spaces and parking spaces for the cranes have been leveled and a bent has been constructed at a location between P8 and P9 where it will not interfere with the operation of the existing railways.

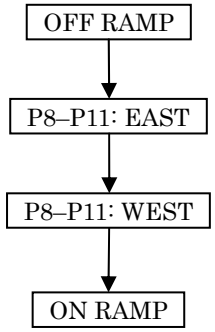


Figure 9.3.7 Order of Erection of the Superstructure
(Section between P8 and P11)

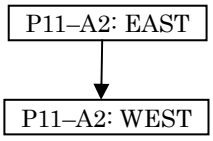


Figure 9.3.8 Order of Erection of the Superstructure
(Section between P11 and A2)

Figure 9.3.7 shows the order of the erection decided on the basis of the restriction on the parking spaces for the cranes.

The crane erection method will be used for the erection of girders in the section between P11 and A2. The erection shall commence after construction spaces, approaches to the spaces and parking spaces for the cranes have been leveled, a required detour for the existing road has been constructed for the maintenance of the traffic flow on the existing road and a bent has been constructed.

Figure 9.3.8 shows the order of the erection decided on the basis of the restriction on the parking spaces for the cranes.

Figures 9.3.9 and 9.3.10 show the arrangement of equipment and structures for the crane-bent girder erection.

Figure 9.3.11 shows the detour for the existing traffic during the erection of the girder.

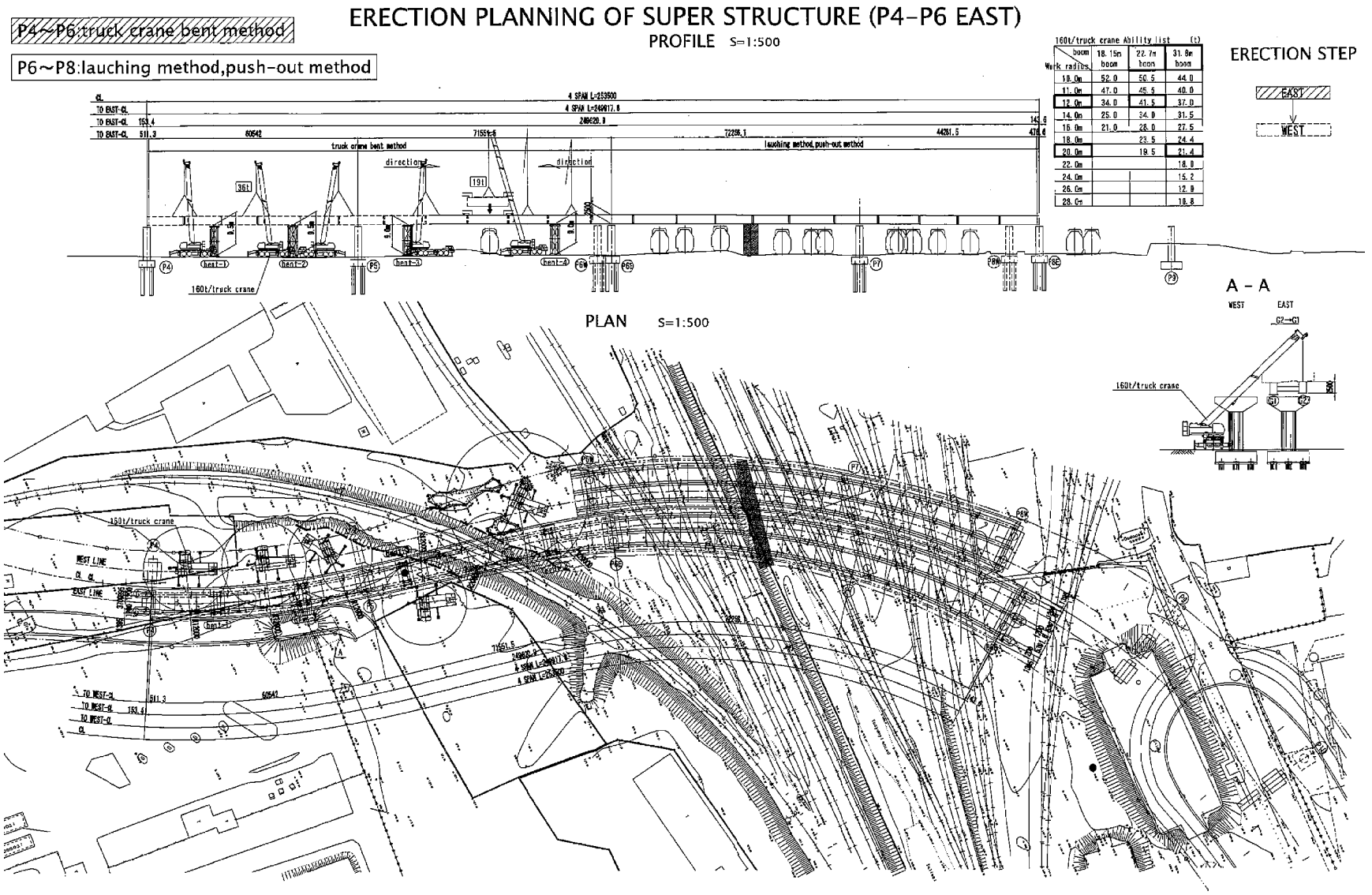


Figure 9.3.9: Arrangement of Equipment and Structures for the Crane-Bent girder Erection (between P4 and P6)

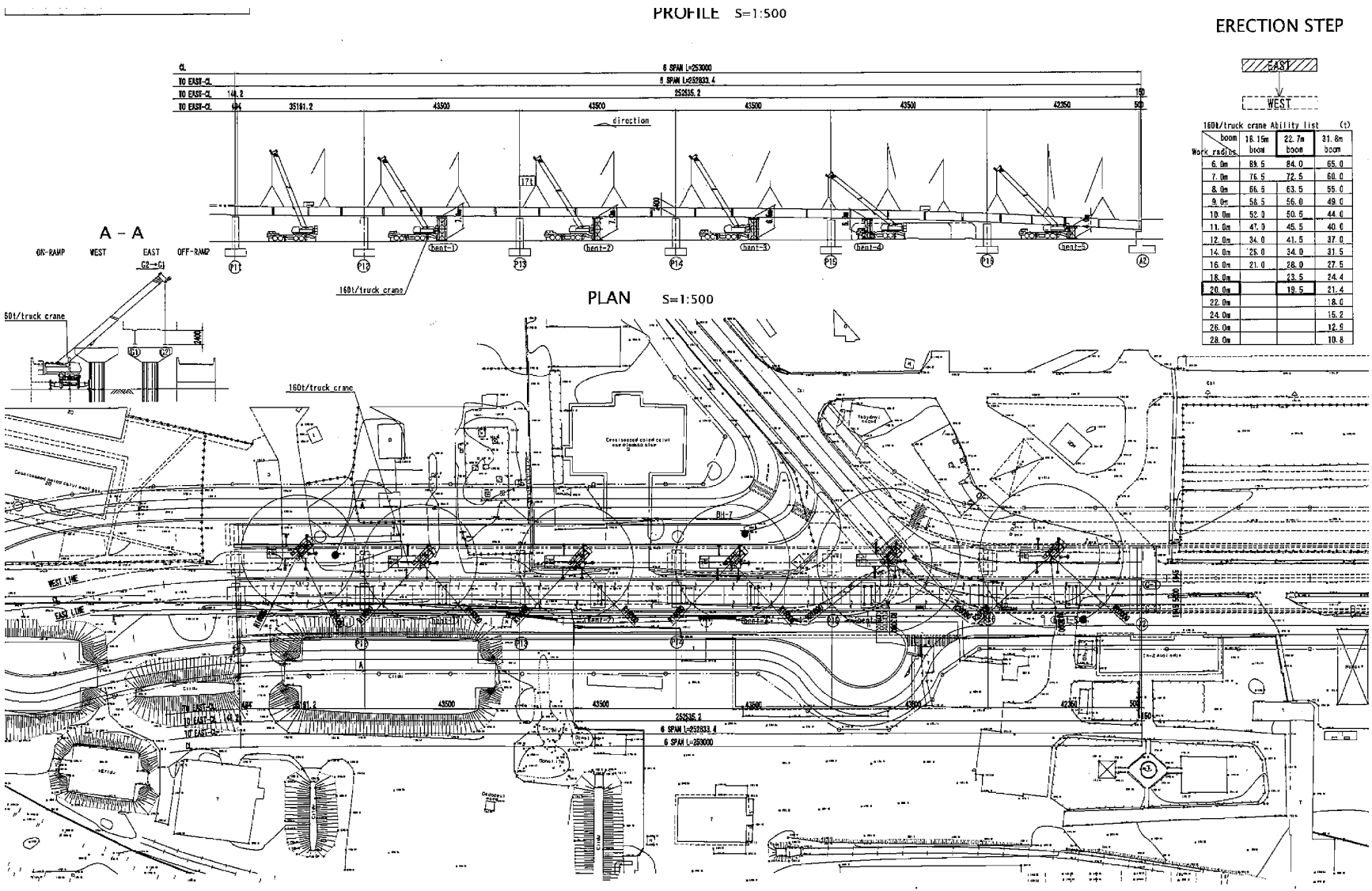
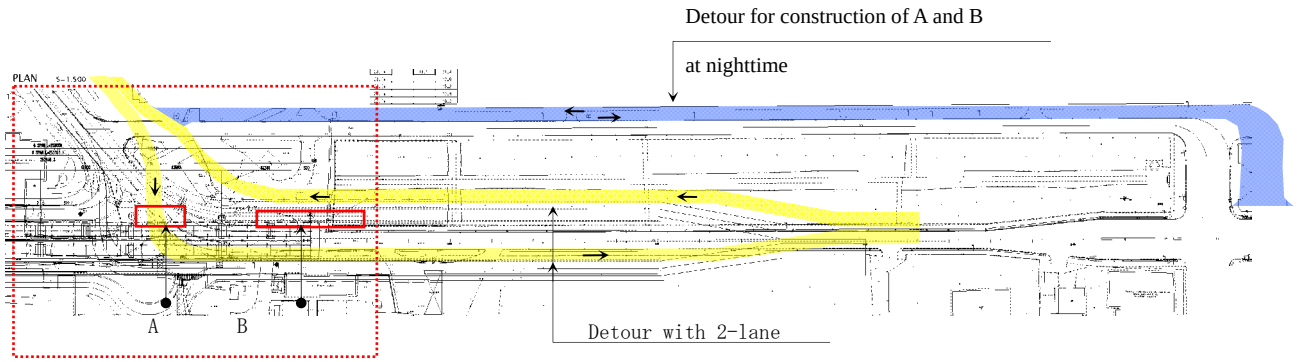
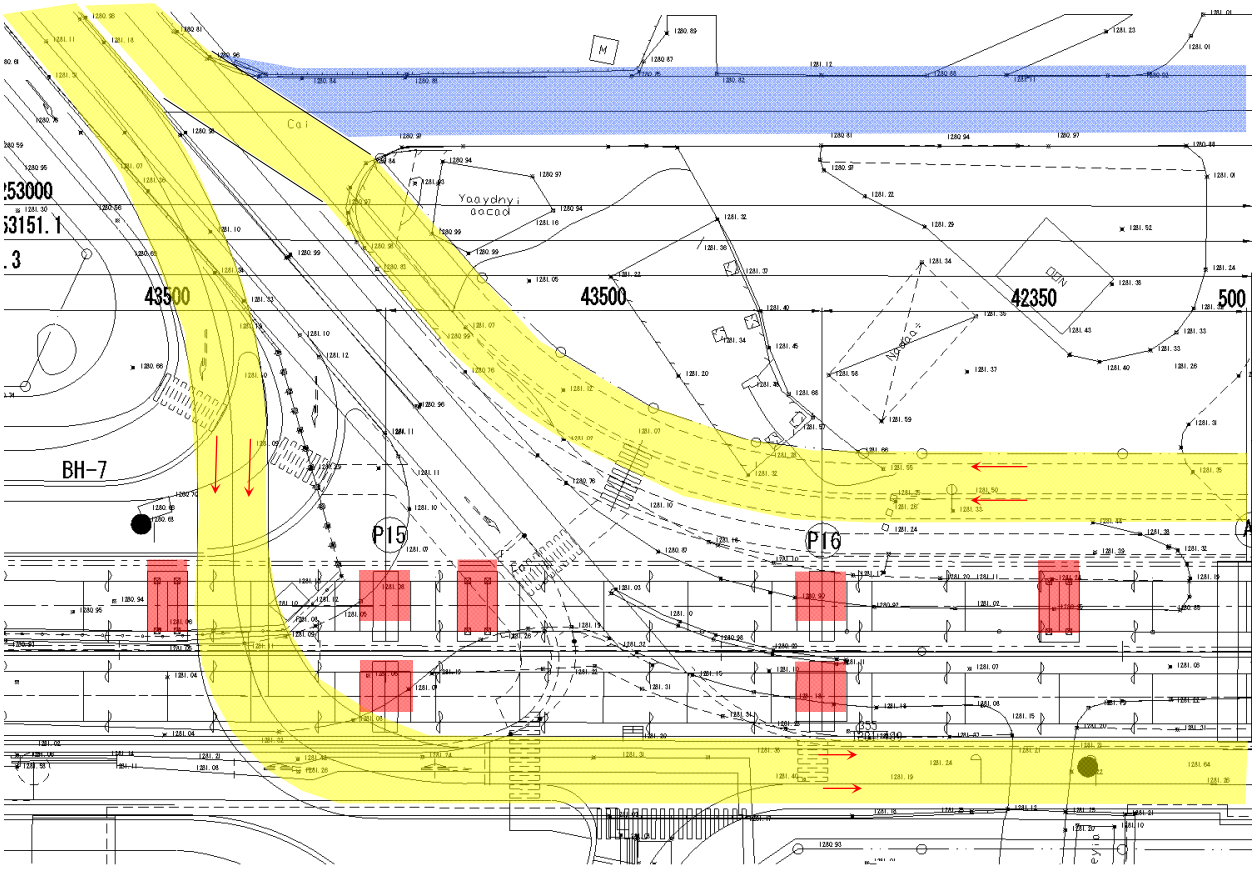


Figure 9.3.10: Arrangement of Equipment and Structures for the Crane-Bent Girder erection (between P11 and A2)



(a) Overall View of Detour



(b) Detailed Drawing of the Detour

Figure 9.3.11 Detour during Construction between P14 and A2

(5) Bridge Deck (Slab) and Wearing Surface Work

The applied deck (slab) type is a steel-concrete composite deck system. Steel panels should be prefabricated and transported to the site in winter. The panels will be installed on the girders using a mobile crane. After sealing at joints and installation of re-bars, concrete is placed and cured.

The bridge wearing surface work shall be planned to enable a reduction in the entire construction period of the viaduct, taking into consideration the superstructure erection methods, the order of the entire erection procedure and the period in which construction work can be implemented (between May and September). The bridge wearing surface work includes 80 mm-thick asphalt paving (application of two 40 mm layers), construction of railings (concrete wall railings), installation of expansion joints, and such like.

(6) Roadwork

The roadwork shall be implemented on the condition that it does not disturb the traffic on the existing roads. Therefore, it will be implemented with construction of detours for the existing roads as required. A construction plan for the roadwork shall be formulated carefully so as to eliminate the risk of reworking in the process from the bridge girder erection to the road paving work because such reworking will increase the construction costs and lengthen the construction period.

The road structure work includes construction of water drainage facilities, subgrade work, base course work, and paving work. The figure below shows the general implementation procedure of the paving work.

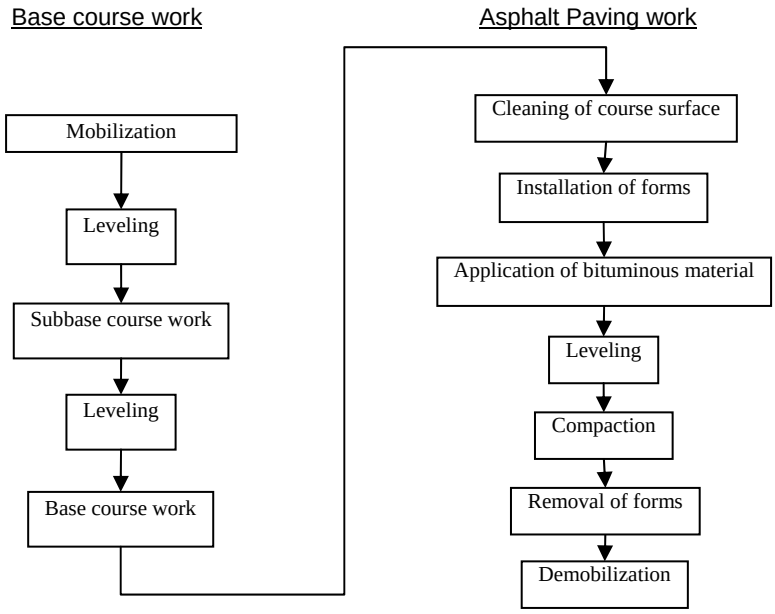


Figure 9.3.12 Implementation Procedure for the Paving Work

9.4 WORK SCHEDULE

(1) Work Implementation Order

Figure 9.4.1 shows the order of the work implementation and the relationships between different types of work.

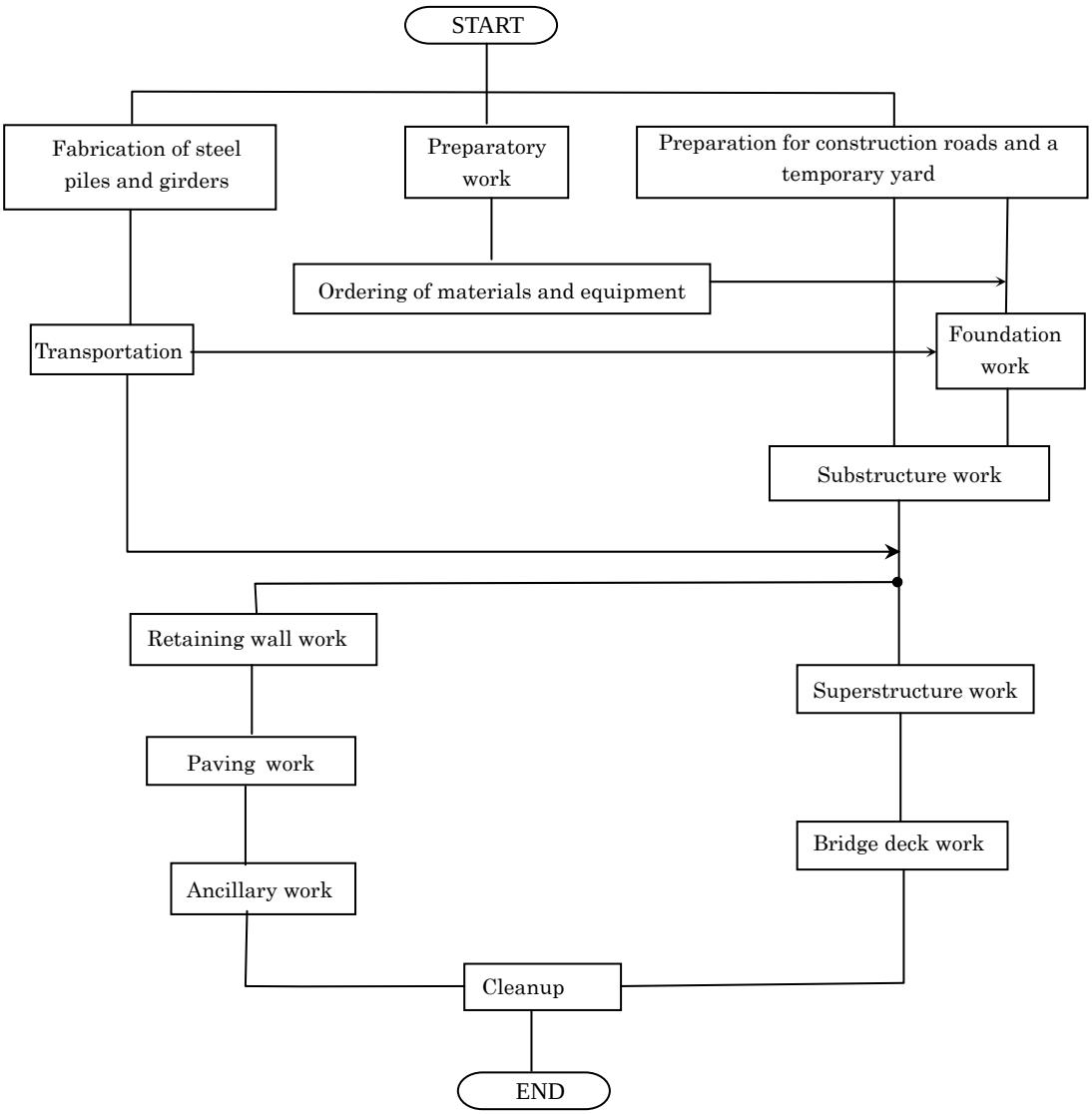


Figure 9.4.1 Order of Work Implementation

(2) Conditions for the Work Scheduling

Concrete work and asphalt work can be implemented when the average temperature is 5ºC or above. The five-month period between May and September generally satisfies this temperature requirement at the project site. The construction work shall be implemented intensively in this period in this project in order to eliminate risk of quality control due to low temperatures.

(3) Estimation of the Work Suspension Factor

Days with rainfall of 10 mm or more, Saturdays, Sundays and Mongolian holidays are considered as non-working days. The ratios of the number of actual working days to the number of working days (work suspension factors) have been defined as follows:

During the summer (May to end of September):	= 1.20
Rest of the year: 1/0.7	= 1.44

(4) Work Schedule

The decision on the orders of work implementation by type and site of work has been made so that the work can be implemented most efficiently. The following were taken into consideration when the work schedule was formulated.

The pile work will be implemented by one (1) party since an imported rotary penetration machine (procured in Japan) will be used.

The number of substructures to be constructed is 18. Construction of them in two years will require construction of at least nine substructures per year. Since the period in which construction work can be done is too short for just one party to construct more than one substructure, several work parties will be inevitably required for this project.

The plan for this project includes use of nine (9) substructure work parties at the construction site in the first year.

Among the types of superstructure work, work in the section for the launching erection (between P6 and P8) will be implemented in the second year because of the tight schedule for this section.

Therefore, the construction of the section between P6 and P10 including the yard work shall be completed in the first year.

Among the types of superstructure work, the girder erection and the deck slab work will be implemented in the first year (in the five-month period in the summer) and the bridge deck work and paving work will be implemented in the next summer.

The roadwork including construction of retaining walls will be implemented after the substructure and superstructure work has been completed so that it will not interfere with the other works.

Required Period for Major construction procedure is shown in the Table 9.4.1.

Table 9.4.1 Required Period for Major Construction Procedure

Item	Unit	Quantity	Remarks
Screwed Steel Pileφ1.0m	nos/day	0.7	Not applied adjustment factor
Construction of A1 (A2)	day/nos	90(82)	Adjustment factor = 1.2
Construction of P1–P5	day/nos	52	Ditto
Construction of P6–P8	day/nos	94	Ditto
Constriction of P9–P10	day/nos	53	Ditto
Construction of P11–P16	day/nos	50	Ditto
Assembly/disassembly of Temp. Prop	t/day	6～7	Not applied adjustment factor
Foundation of Temp. Prop (Steel Plate)	m^2/day	33	Ditto
Erection of Girders	t/day	25～65	Ditto
Assembly of Girders at Site	t/day	48	Ditto
High Tension Bolt	nos/day	1,900	Ditto
Installation of Bearings	nos/day	3.5	Ditto
Launching Erection	m/day	0.67	Length of Launching erection / Required period of Launching erection
Erection of Composite Slab	m^2/day	25	Per 1-party、Adjustment factor = 1.2
Installation of Barrier	m/day	5.7	RC-wall
Asphalt pavement (Bridge)	m^2/day	998	Not applied adjustment factor
Gravity Type Retaining Wall	m/day	2.8	Ditto
Reinforced Earth Retaining Wall	m/day	2.3	Ditto
Pavement (Approach Road)	m^2/day	328	Ditto
Drainage Structure	m/day	4.5	Ditto

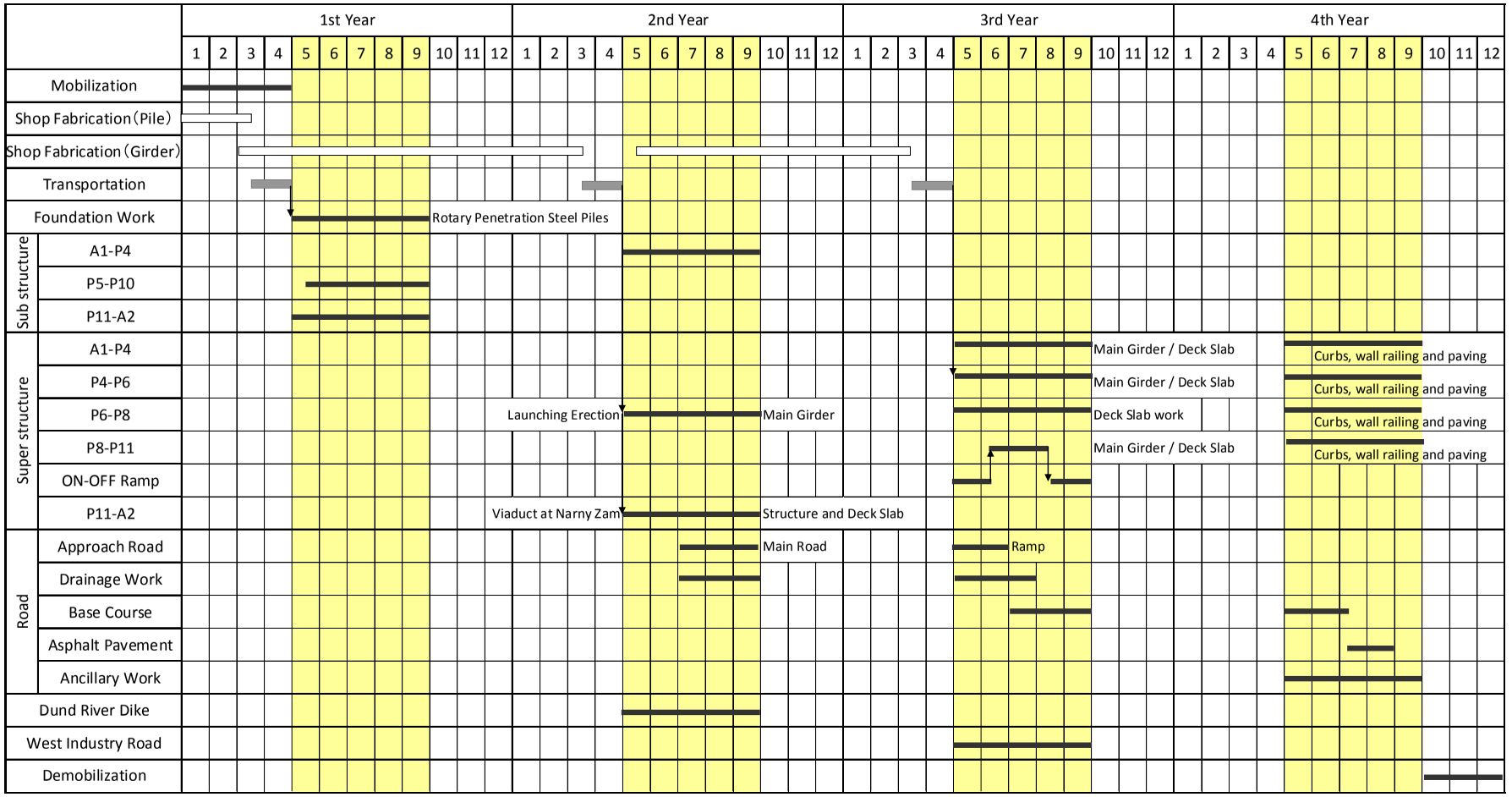


Figure 9.4.2 Schedule of Construction Work

CHAPTER 10

OPERATION AND MAINTENANCE SYSTEM

10.1 OPERATION AND MAINTENANCE SYSTEM OF ROAD FACILITIES IN ULAANBAATAR CITY

(1) Organization of Ulaanbaatar City Road Department

The Road Department established in 2005 is presently composed of 97 personnel who are responsible for planning, designing, construction and maintenance of road facilities in Ulaanbaatar City. The Operation and Maintenance Division of the Department has 12 personnel who are responsible mainly for the following operations:

- Widening, maintenance and daily monitoring of road facilities.
- Rebuilding damaged road facilities.
- Early repairing of road facilities damaged by disasters and ensuring traffic convenience.
- Maintenance of traffic management, signals and road traffic signs.

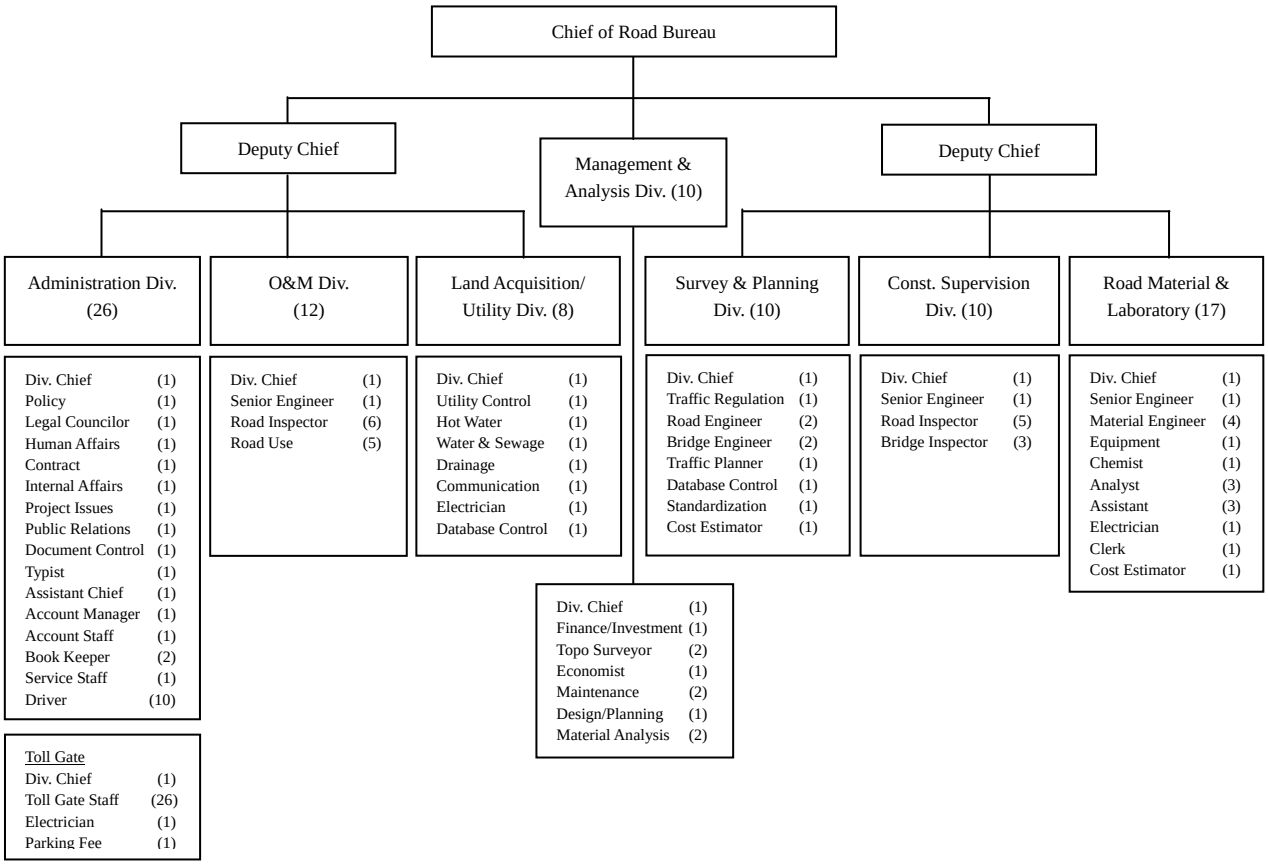


Figure 10.1.1 Organizational Chart of the Ulaanbaatar City Road Department

(2) Organization of Ministry of Roads and Transportation (MRT)

When the government ministries were restructured in August 2012, the Ministry of Road, Transportation, Construction and Urban Development (MRTCUD), i.e., the counterpart of the Survey Team at the commencement of the preparatory survey, was reorganized into the Ministry of Roads and Transportation (MTR).

In the former MRTCUD, design work, operation and maintenance of road facilities was conducted by the Road Agency which was established when the government ministries were reorganized in 2009. The maintenance section of this agency consisted of seven (7) members including the section chief, professionals of each area (5) and staff in charge of the database (1). Maintenance operations have been outsourced to 21 of the state-owned firms and private companies. The main activities of the Road Agency are as follows:

- Conducting government action plans and annual plans
- Creating the database of national roads and inputting of information
- Conducting researches on traffic volume
- Planning, applying, monitoring and evaluating maintenance plans
- Management of tollgates
- Selection, management and technical guidance of road maintenance providers
- Taking emergency countermeasures for road facilities damaged by natural disasters or other causes.

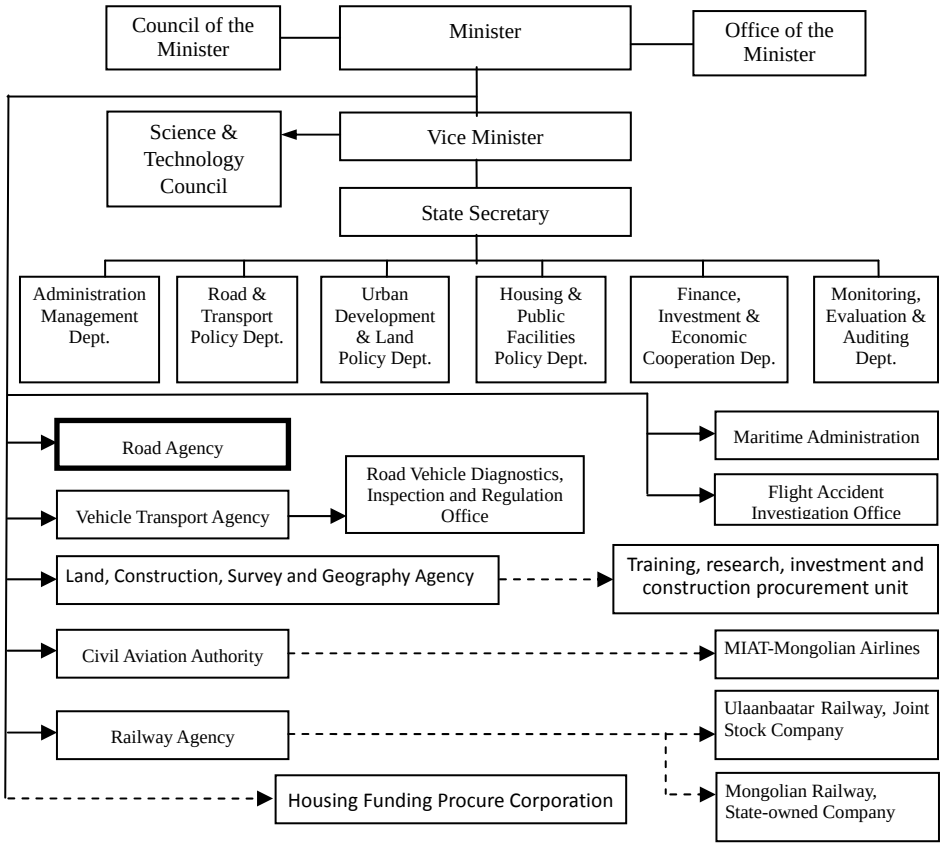


Figure 10.1.2 Organizational Chart of the Former MRTCUD

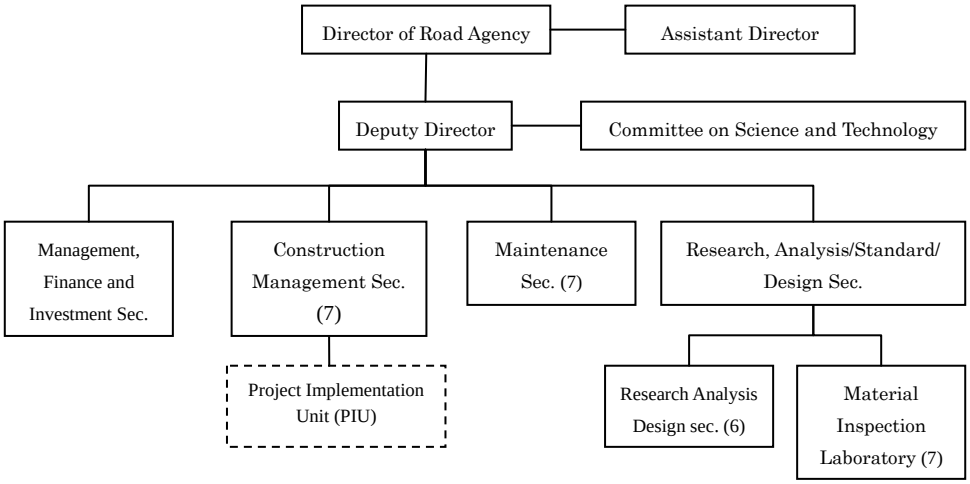


Figure 10.1.3 Organizational Chart of the Road Agency in the former MRTCUD

On the other hand, the new organization and the number of staff members were determined in 2012, and the Road Agency which had been in charge of construction and maintenance of national roads was divided into the Road Construction Section and the Road Maintenance Section in the Road Policy Implementing Agency Administration Office.

As a subsidiary of MRT, the Road Supervision, Science and Technology Center was established in October 2012 for research and investigation of road policies, preparation of design standards, and introduction of new technology, capacity building of operation and management, and so forth.

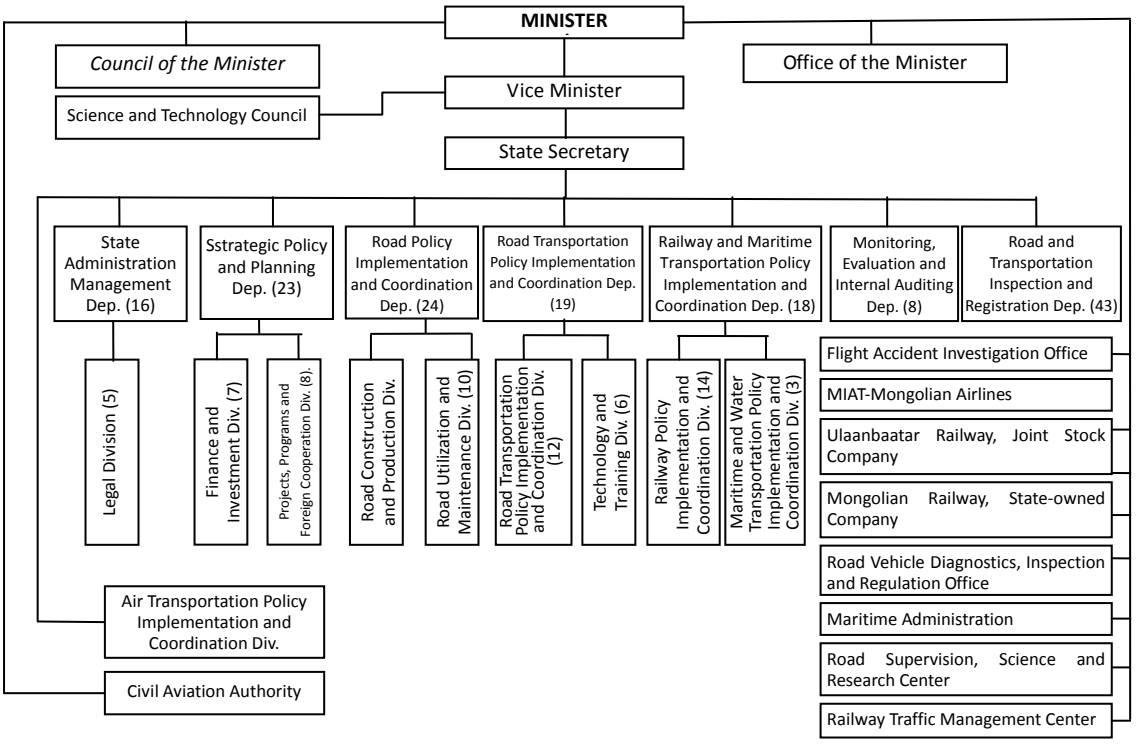


Figure 10.1.4 Organizational Chart of the New Ministry of Road and Transportation (MTR)

10.2 FINANCIAL CONDITION FOR MAINTENANCE

(1) Financial Resources for Maintenance of Road Sector in Mongolia

i) State Road Fund

The Road Fund established in 1991 as a stable source of revenue for the Road Sector became a legal system in 1995 and was divided into the "State Road Fund" and the "Local Road Fund" when the Road Act was promulgated in 1998. The main source of the fund is the fuel tax imposed on gasoline and diesel. The rate of fuel tax was 13% of the import price of fuel at first; however, it was replaced with a fixed rate on fuel weight in 1995.

The Fund was also supported by revenue from vehicle tax, road tolls, driver's license tax, and subsidies or loans from the national budget, and managed by the Ministry of Roads and Transportation. At present, most of State Road Fund is covered by the national budget with an annual growth rate of 12–18%.

Table 10.2.1 Changes in the State Road Fund

(Unit: Million MNT)

	2008	2009	2010	2011	2012
Revenue	**9,743.3**	**9,949.0**	**9,968.1**	**11,243.5**	**13,360.3**
- Total of Fuel Tax, Vehicle Tax, and national budget	8,878.5	9,061.2	8,874.0	9,824.7	11,155.3
- Toll revenue	864.8	887.8	1,094.1	1,418.8	2,205.0
Expenditure	**9,740.0**	**9,949.0**	**9,722.4**	**10,726.2**	**14,610.0**
- Maintenance of National Roads	8,878.5	9,061.2	8,874.0	9,824.7	11,155.3
- Operation cost of Toll Gate	379.5	380.1	446.3	455.3	587.0
- Maintenance and Investment for Toll Gate	271.6	280.8	402.1	249.7	337.0
- Transfer to National Budget	210.4	226.9	0.0	196.5	2,530.7

Source: MRT

ii) Local Road Fund

Financial sources of the Local Road Fund are the vehicle tax, the annual license processing fee and the road toll fee collected by each municipality and the Ulaanbaatar City Government. Changes in income/expenditure of the Road Fund in Ulaanbaatar are as indicated in the table below.

Table 10.2.2 Income/Expenditure of Road Fund in Ulaanbaatar

(Unit: Million MNT)

Year		2006	2007	2008	2009	2010	2011	2012
Income		3,368	4,350	4,350	5,350	6,467	9,460	13,245
Expenditure		3,279	3,717	4,352	5,863	6,020	9,460	13,945
	Road maintenance	1,303	2,432	2,454	2,704	3,948	1,948	11,774
	Road construction	1,528	388	1,404	1,777	966	5,715	—
	Traffic management	—	60	46	694	—	279	550
	Traffic safety	248	290	299	350	778	478	650
	Others	200	547	149	338	328	1,040	971

Source: Department of Roads, Ulaanbaatar City

iii) Technical Support by ADB

The Road Sector Capacity Development Project (TA-7844 Mongolia) financed by the ADB and started in March 2012 is providing technical assistance in the capacity development of the road sector. The “Restructuring of the Road Fund and Reestablishing of Road Board” consists of the following sub-items which are included in these types of technical assistance.

a) Adequate Use of Road Fund for Maintenance
   (i) Evaluation of road user’s cost coverage and identification of current and future coverage gaps or misalignments between charges, costs and resources;
   (ii) Recommendation of preferred options for securing sufficient and stable financial resources for the Road Fund;
   (iii) Recommendation of allocation procedures for the Road Fund;
   (iv) Recommendation of Road Fund financial management procedures;
   (v) Recommendation of composition and selection methods of the Road Board members
   (vi) Recommendation of the roles and responsibilities of the Road Board, e.g., related to (a) road fund management and budget allocation, (b) adjusting user tariffs, (c) maintenance planning and execution, and (d) investment planning;
   (vii) Recommendation of the nature and function of the Road Board Secretariat, (e.g., 1 to 2 people);
   (viii) Financing mechanism for operating the Road Board; and
   (ix) Proposal of amendments to the Road Act or updating the draft legislation for the Road Board;

b) Selection of members of the Road Board and Defining their Roles
   (i) Assistance in Road Board members’ identification and nomination;
   (ii) Assistance in Road Board Secretariat recruitment, including the preparation of job descriptions;
   (iii) Definition of procedures for updating or recommending user’s fee increases;

(iv) Definition of Road Fund auditing requirements, e.g., terms of reference for external audit;

(v) Definition of procedures for requesting and reporting use of funds;

(vi) Definition of annual reporting needs;

(vii) Organization of initial Road Board meetings, and training Road Board members in their new functions; and

(viii) Training of MRT staff and Road Board Secretariat in new procedures.

(2) Road Maintenance Budget Status in Ulaanbaatar City

Budgets for road development and maintenance in the last five (5) years are as shown in Table 10.2.3 and Table 10.2.4. Since 2009, the proportion of maintenance costs to the overall budget for the road sector has not expanded steadily, while both have largely increased. As compared to foreign countries (see Table 10.2.4), the proportion of maintenance costs in Ulaanbaatar is not larger than its average. Although the proportion should change in the future, the current maintenance budget can be expected to satisfy the prospective road maintenance cost in 2016 if properly used. (See Table 10.2.5.)

Table 10.2.3 Overall Budget for the Road Sector in Ulaanbaatar City

(Unit: Million MNT.)

Particulars	2007	2008	2009	2010	2011
Budget in Ulaanbaatar	7,770	1,421	453	1,643	9,884
Road Fund	3,408	4,352	5,863	6,020	10,605
National Subsidy	5,741	7,958	5,352	9,921	49,415
Total	16,920	13,730	11,668	17,583	69,905

Source: Department of Roads, Ulaanbaatar City

Table 10.2.4 Budget for Maintenance of Roads and Bridges in Ulaanbaatar City

(Unit: Million MNT)

Particulars	2008	2009	2010	2011	2012 (Budget)
Maintenance of Main Roads	1,040	1,600	1,614	1,877	1,200
Maintenance of Roads in Gel and Residential Area	728	500	1,220	3,345	8,315
Total	**1,768**	**2,100**	**2,834**	**5,222**	**9,515**
Proportion of Maintenance Cost	**13%**	**18%**	**16%**	**7%**	**—**

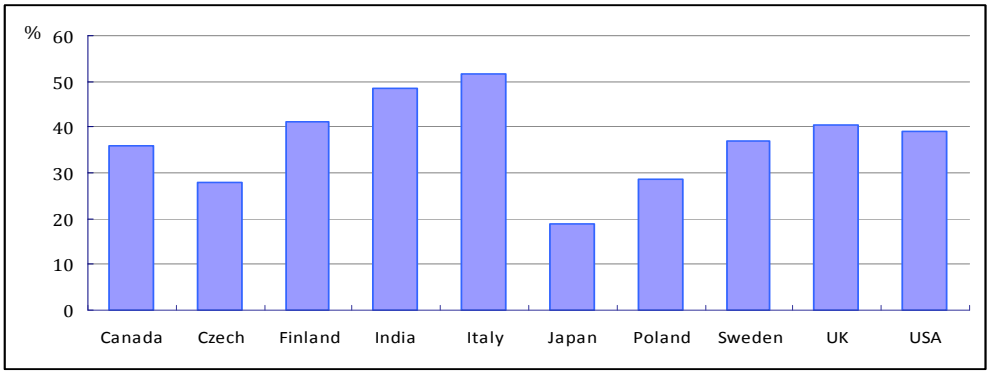
Source: Department of Roads, Ulaanbaatar City

Table 10.2.5 Required Cost for Annual Maintenance in Ulaanbaatar City

	2012			2016		
	Extension	**Maintenance Cost/km (Million MNT)**	**Total (Million MNT)**	**Extension**	**Maintenance Cost /km (Million MNT)**	**Total (Million MNT)**
Road	450km	11.8	5,310	662 km	11.8	7,812
Bridge	3.9km	172.8	674	6.1 km	172.8	1,054
Total			5,984			8,866

Reference: Maintenance Cost of Roads/km; Mongolia Road Sector Development to 2016 (2011, ADB)

Note: Routine Maintenance (3,000 USD/km) and Periodic Maintenance (5,750 USD/km) are booked for Maintenance Cost/km. Additionally; 0.5%/year of bridge construction cost briefly estimated is placed on maintenance cost of bridges.



Reference: International Transport Forum, Statistics Brief 2012

Figure 10.2.1 Proportion of Maintenance Cost in Road Maintenance Budget of Foreign Countries (2009–2010)

10.3 FORMER PRACTICE AND EXPERIENCE IN OPERATION AND MAINTENANCE

(1) Experience of Road Maintenance in MRT

Road maintenance conducted by MRT (formerly, MRTCUD) is outsourced to road maintenance companies and private road construction companies all over the country. Personnel of the Maintenance Section of the reorganized Road Agency are responsible for the area they are respectively assigned. ADB has provided technical support required for road maintenance including creating databases of road facilities (mainly pavement). At the same time, several grant aid projects financed by other foreign donors have been for implemented to procure road maintenance equipment for road maintenance companies. The performance on road maintenance has gradually increased; however, there are some problems in systematic maintenance plans based on daily inspection and quality management on construction. Besides, although the database of road facilities was created with the assistance of ADB, the data has not been updated continuously or adequately. In this connection, since ADB has been providing further technical assistance, certain improvement is of maintenance capacity expected in the future.

(2) Experience of Road Maintenance in Ulaanbaatar City

The Road Department of Ulaanbaatar City was established in 2005 and the maintenance of city roads was started. General maintenance such as repair of pavement is outsourced to the road maintenance companies. MRT places comprehensive contract with regional maintenance companies on annual basis. On the other hand, Ulaanbaatar City copes with specific damage by means of individual restoration contracts. The maintenance of bridges such as repair of deck slabs or reconstruction of extensively damaged bridges has been conducted on an irregular basis.

There is only one steel road bridge in Ulaanbaatar City; thus, experience in the maintenance of steel bridges is insufficient. Moreover, the Operation and Maintenance Division in the Department of Road of Ulaanbaatar City has not been familiar with bridge inspection and rehabilitation technology relevant to "Preventive Maintenance." From now on, it is crucial to establish a bridge operation and maintenance cycle consisting of inspection, maintenance and restoration along with improvement of an operation and maintenance system (institution, budge, guideline, etc.).

(3) Issues on Maintenance of Ajilchin Flyover

After completion of the Project, maintenance of access roads will be carried out by the Road Department of Ulaanbaatar City. So far, many bridges in Ulaanbaatar City were left without proper maintenance, and some bridges were reconstructed after damage extended to fatal conditions. Approx. 25% of the bridges in Ulaanbaatar City were constructed more than 30 years, and this length of time means they crucially require sound maintenance. However, capacity building or human resource development for bridge inspection and rehabilitation has not been attained due to lack of experience.

Technical Assistance by JICA for bridge maintenance and rehabilitation is scheduled for between 2013 and 2015, and it will contain technology transfer of steel bridge maintenance and preparation of corresponding manuals. Accordingly, it is expected that bridge maintenance and rehabilitation skills will have been improved with the completion of the Ajilchin Flyover Project.

The total budget for the road sector has been increased steadily in Mongolia. It must be noted that budget allocation for road maintenance and rehabilitation needs to be duly reviewed and updated as road infrastructures are further expanded.

10.4 RECOMMENDATION FOR OPERATION AND MAINTENANCE OF AJILCHIN FLYOVER CONSTRUCTION PROJECT

(1) Institutional Framework of Project Implementation

According to "the Law of Mongolia on Coordination of Foreign Loans and Grant Aid (2003)," it is stipulated that the Project Implementation Unit (PIU) shall be organized in the implementation agency (e.g., Ministry of Roads and Transportation for the Project) to manage implementation of the individual projects financed by foreign loan and/or grant aid.

In the case of the Narny Bridge construction project under Japan's Grant Aid, three (3) staff members of the PIU were in charge of quality control, schedule control, land acquisition, coordination for relocation of utilities, and so forth.

In the case of road projects in Ulaanbaatar City, the city government has to play a role as an implementing agency in ways such as coordination with connecting roads improvement, drainage plans, and relocation of underground utilities and land acquisition. The Road Department of Ulaanbaatar City has established the Land and Utility Department for smooth and efficient project implementation. Therefore, it is important that land acquisition and relocation of existing utilities be executed by sound coordination and collaboration of the PIU and Land and Utility Department of the Road Department of Ulaanbaatar City.

In the detailed design stage of the Project, it is necessary for the consultant to get approval for design products by the Expertise assigned by the MRT. The Expertise are classified in such special fields as bridges, roads, electricity and so forth.

Under Mongolian Law, the State Professional Inspection Agency (SPIA) has the power to intervene in the quality control and inspection for any project other than the Client. The responsibility and authority should be clearly stipulated in the conditions of a contract to create an effective quality control system for the Project.

With respect to construction work in the property of Ulaanbaatar Railway, it is necessary to execute sound coordination regarding a facility plan, pier location and required space, relocation of existing utilities, train operation management during construction work, and so forth.

Figure 10.4.1 illustrates the organization for implementation of the Project.

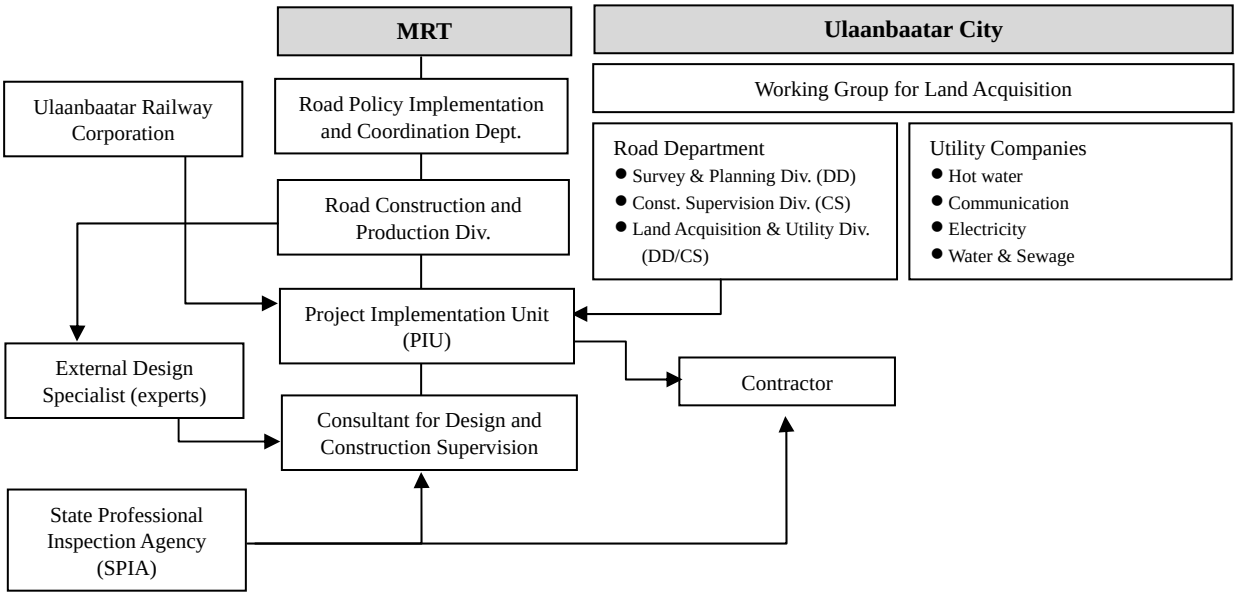


Figure 10.4.1 Organization Chart of Project Implementation

(2) Maintenance System

After completion of the Project, maintenance is to be managed by the Road Department in Ulaanbaatar City. As special maintenance work without routine maintenance such as cleaning and minor repair of surfacing of the bridge is not required for the Ajilchin Flyover for 10 to 20 years after construction, it is expected that Ulaanbaatar City will accumulate and improve the technologies necessary for steel bridge maintenance through several opportunities such as the Technical Cooperation Scheme implemented by JICA.

CHAPTER 11

COST ESTIMATES

11.1 GENERAL

The Project cost of the Ajilchin Flyover consists of direct construction cost, indirect cost, detailed design cost, supervision cost, contingency fund, administration expenses, land acquisition cost, compensation, utility relocation cost, VAT and interest.

11.2 BASIC CONDITION FOR COST ESTIMATES

(1) Price Level

The cost estimates have been updated to the price level as of January 2013.

(2) Exchange Rate

Exchange rates are fixed as:

- 1.0 MNT = 0.060 JPY
- 1.0 USD = 89.2 JPY = 1,390.5 MNT
- (The above rates are the JICA control rates in January 2013.)

(3) Currency for Cost Estimates

The project cost component consists of foreign currency and local currency portions.

i) Local Currency Portion

- Local labor costs and local engineering services
- Part of operation cost of construction equipment
- Part of construction material costs
- Land acquisition and compensation costs
- Utility relocation costs
- All costs of administration for the government staff
- Value added tax (10%) for locally procured material/equipment and customs clearance

ii) Foreign Currency Portion

- Part of operation costs of equipment
- Part of construction material costs
- Foreign engineering services

11.3 UNIT PRICE ANALYSIS

(1) Direct Construction Cost

i) Labor Cost

Local labor costs for the cost estimates are as shown in Table 11.3.1 below. These are the results of a survey conducted for each item in local businesses, and compared with the unit price of actual construction bids in Ulaanbaatar City in the past.

Table 11.3.1 Labor Cost in Ulaanbaatar City (Unit : MNT)

No.	Item	Standard	Unit	Unit Price	No.	Item	Standard	Unit	Unit Price
1	General Facilitator		man/day	120,000	13	Civil Engineer	20 years experience	man/month	5,500,000
2	Special Worker		man/day	65,000	14	Civil Engineer	10 years experience	man/month	4,250,000
3	Worker		man/day	45,000	15	Architect	20 years experience	man/month	5,500,000
4	Rebar Worker		man/day	55,000	16	Architect	10 years experience	man/month	4,250,000
5	Operator	Special	man/day	65,000	17	Surveyor		man/month	2,350,000
6	Carpenter		man/day	50,000	18	Assistant Surveyor		man/month	1,200,000
7	Plasterer		man/day	50,000	19	Mechanical Engineer	20 years experience	man/month	5,500,000
8	Welder		man/day	55,000	20	Mechanical Engineer	10 years experience	man/month	4,250,000
9	Electrician		man/day	55,000	21	Electrical Engineer	20 years experience	man/month	5,500,000
10	Mechanic		man/day	60,000	22	Electrical Engineer	10 years experience	man/month	4,250,000
11	Piper		man/day	55,000					
12	Operator	Crane	man/day	65,000					

ii) Material Cost

Material costs applied for the cost estimates are as shown in Table 11.3.2 below. These are the results of a survey conducted for each item in local businesses, and compared with the unit price of actual construction bids in Ulaanbaatar City, Mongolia, in the past.

Table 11.3.2 Material Cost in Ulaanbaatar City (Unit: MNT)

No.	Item	Standard	Unit	Unit Price	No.	Item	Standard	Unit	Unit Price
1	Cement	Except Bridge	kg	400	11	Chipboard	12mm	m^3	520,000
2	Sand		m^3	32,500	12	AS Mixture	For Base layer	ton	189,300
3	Crushed Stone	0–40 mm	m^3	29,900	13	Concrete	250 kg/cm^2	m^3	155,000
4	Lower Subbase		m^3	29,300	14	Concrete	300 kg/cm^2	m^3	165,000
5	Upper Subbase		m^3	31,500	15	Concrete	350 kg/cm^2	m^3	175,000
6	Crusher-run		m^3	24,900	16	Mortar	1:3	m^3	135,000
7	Cobble		m^3	57,900	17	Gasoline		liter	1,800
8	Embankment Material		m^3	4,800	18	Diesel Oil		liter	1,900
9	Straight AS	80/100	ton	1,425,000	19	Heavy Oil		liter	4,500
10	Cutback AS		liter	3,300	20	Kerosene		liter	2,500

iii) Equipment Cost

A survey on the capacity and rental fee of construction equipment was carried out by conducting an interview with and asking for a quotation from local contractors. Equipment that cannot be procured in Mongolia is to be procured in a foreign country.

Table 11.3.3 Equipment Rental Fee in Ulaanbaatar City (Unit: MNT)

No.	Item	Standard	Unit	Unit Price	No.	Item	Standard	Unit	Unit Price
1	Bulldozer	21 t	day	1,500,000	14	Sprinkler Truck	6,000 liters	day	700,000
2	Bulldozer	32 t	day	3,190,000	15	AS Finisher	2.4–4.5 m	day	2,340,000
3	Small Backhoe	0.13 m^3	day	390,000	16	Grader	3.1m	day	1,120,000
4	Backhoe	0.45 m^3	day	700,000	17	Macadam Roller	10–12 tons	day	770,000
5	Backhoe	0.8 m^3	day	950,000	18	Vibration Roller	10ton	day	760,000
6	Wheel Loader	2.1 m^3	day	890,000	19	Vibration Roller	0.8─1.0 tons	day	180,000
7	Truck	4 tons	day	200,000	20	Tire Roller	8–20 tons	day	800,000
8	Dump Truck	4 tons	day	200,000	21	Rammer	60–100 kg	day	80,000
9	Trailer	30–32 tons	day	700,000	22	AS Cutter	45–56 cm	day	100,000
10	Truck with Crane	4/2.9 t	day	580,000	23	Hand Breaker	30 kg	day	56,700
11	Truck Crane	25 tons	day	3,000,000	24	Concrete Cutter	30 cm	day	56,700
12	Concrete Mixer	1.0 m^3	day	250,000	25	Breaker	1,300 kg	day	2,900,000
13	Concrete Pump	100 m^3/hr	m^3	10,000	26	Generator	100 kVA	day	440,000

(2) Indirect Cost

The indirect cost and overhead cost of construction work are set in the following proportions. Indirect costs consist of equipment transportation cost in the site, safety management cost, technical administrative expenses, and upkeep expenses. Overhead expenses include supervision, transportation allowance, office expenses, Contractor's all risk insurance, and financing cost.

- Indirect Cost: 30% of direct construction cost
- Overhead Expenses: 10% of direct construction cost

(3) Consultancy Service Cost

Consultancy service cost relating to project implementation is calculated on the basis of the staffing schedule. The cost consists of (a) Remuneration for engineers and support staff; and (b) Direct Cost including airfare, vehicle rental, and so on.

Table 11.3.4 Consultancy Service Cost for the Project

Particulars	Unit	Qty.	Foreign Portion		Local Portion		Combined Total JPY ('000)
			JPY		MNT		
			Rate	Amount ('000)	Rate	Amount ('000)	
A Remuneration							
1 Professional (A)	M/M	278	2,562,000	712,236	0	0	712,236
2 Professional (B)	M/M	297	0	0	3,900,000	1,158,300	69,498
3 Support Staff	M/M	343	0	0	1,500,000	514,500	30,870
Sub-Total of A				712,236		1,672,800	812,604
B Direct Cost							
1 International Airfare		30	200,000	6,000	0	0	6,000
2 Domestic Airfare		0		0	0	0	0
3 Domestic Travel		30	2,400	72	0	0	72
3 Accommodation Allowance	Month	278			4,830,000	1,342,740	80,564
	Month	297			0	0	0
	Month	343			0	0	0
4 Vehicle Rental	Month	144			1,820,000	261,625	15,698
5 Office Rental	M/M	70			2,380,000	166,600	9,996
6 International Communications	M/M	70			240,000	16,800	1,008
7 Domestic Communications	M/M	70			80,000	5,600	336
8 Office Supply	M/M	70			560,000	39,200	2,352
9 Office Furniture and Equipment	M/M	70			320,000	22,400	1,344
10 Report Preparation	Month	70			400,000	28,000	1,680
11 Topographic Survey	L.S.	1			56,000,000	56,000	3,360
12 Geotechnical Survey	L.S.	1			72,000,000	72,000	4,320
Sub-Total of B				6,072		2,010,965	126,730
Total				718,308			939,334

(4) Contingency Fund

i) Price Contingency and Price Escalation

The annual inflation rates applied for the price contingency are:

- 2.1% for the foreign currency portion per year
- 9.0% for the local currency portion per year

ii) Physical Contingency

5.0% of the construction cost with reference to the case in the past.

(5) Administration Expenses

Administration cost includes expenses to be incurred by the Mongolian Government until completion of the construction works of the Ajilchin Flyover Construction Project. It is computed at 5.0% of the construction cost and consulting service charge. All of these expenses are included in the local currency portion.

(6) Preparation Expense

i) Land Acquisition Cost and Social Cost

Based on environmental impact assessment results, total of land acquisition cost and social cost (compensation for removal and/or resettlement) is estimated at 8.99 billion MNT.

ii) Utility Relocation Cost

Following identification of utilities which will interfere with the scope of the project, relocation cost was estimated by the concerned utility agencies corresponding to hot water supply lines, communication cables, electric power cables, water supply pipeline, sewage line and the railway. The total cost for the necessary relocation is estimated at 3,594 million MNT.

(7) Tax

i) Value Added Tax

Non-entity service providers in Mongolia are to be charged 10% VAT. Therefore 10% of the total of construction cost, detailed design fee, and construction supervision fee is estimated as the tax.

11.4 OPERATION AND MAINTENANCE COST

Operation and maintenance works consist of routine maintenance, periodical maintenance and rehabilitation. Maintenance items are as shown in Table 11.4.1 and the periodical maintenance cost of each item is as shown in Table 11.4.2.

Table 11.4.1 Item of Operation and Maintenance

Item	Contents of Maintenance		Frequency	Calculating Formula	Cost
Routine Maintenance Cost	Cleaning in drainage pipe, around of bearing and street gutter		12 times / Year	3 men × 45000 MNT × 12 days	1,620,000 MNT /Year
	Snow Removal Work		30 days / Year	5 men × 30000 MNT × 30 days	6,750,000 MNT /Year
	Check of Deformed Structures and Crack on Road Surfaces		4 times / Year	4 men × 45000 MNT × 4 days	720,000 MNT /Year
Periodical Maintenance Cost	Superstructure, Substructure, Bearing, Approach Road, Auxiliary Facilities, Pavement		Once / 3 years	5 men × 45000 MNT × 10 days Vehicles: 200,000 MNT × 10 days Scaffolding, Tools: 2,000,000 MNT	2,083,000 MNT /Year
Rehabilitation Cost	Painting	Partial Repainting	Every 30 years	5% of All Painting Costs	308,509,000 MNT /30 years
	Expansion Joint	Partial Repair	Every 10 years	3% of Product Cost of EJ	9,474,000 MNT /10 years
	Bearing	Partial Repair	Every 10 years	1% of Product Cost of Bearing	43,860,000 MNT /10 years
	Pavement	Partial Repair	Every 3 years	100 m^2 Patching	3,509,000 MNT /3 years
	Antiskid Pavement	Re-cover	Every 7 years	All	70,175,000 MNT /7 years
	Road Marking	Re-marking	Every 5 years	All	35,088,000 MNT

Item	Contents of Maintenance		Frequency	Calculating Formula	Cost
					/5 years
	Other Concrete Structure	Partial Repair	Annual	3 people × 350,000 MNT × 1 day Scaffolding, Tools: 1,000,000 MNT	2,350,000 MNT /Year

Table11.4.2 Periodical Cost for Operation and Maintenance

Description	Frequency	Estimated Cost (MNT)	Remarks
Routine Maintenance Cost	Every year	9,090,000	
Periodic Maintenance Cost	Every 3 years	6,250,000	
Rehabilitation Cost	Every 10 years	361,800,000	

11.5 Project Cost

The total project cost for the Ajilchin Flyover is as shown in Table 11.5.1. Details of direct construction cost are shown in Table 11.5.2. As for annual fund requirements, direct construction cost and consulting service cost (design and supervision) are provided in Table 11.5.3, and the overall project expenditure is summarized in Table 11.5.4.

Table 11.5.1 Summary of Project Cost

	Item		Local Cost (1000MNT)	Foreign Cost (1000JPY)	Total (1000JPY)	Remark
[1]	Construction Cost		**29,276,305**	**5,698,582**	**7,455,160**	
	(1)	Direct Construction Cost	20,911,646	4,650,415		
	(2)	Indirect Cost	6,723,494	845,792		30% of direct construction cost*
	(3)	Overhead Cost	2,091,165	202,375		10% of direct construction cost*
[2]	Consultant Service		**3,627,460**	**718,308**	**939,334**	
	(1)	Design	1,157,180	271,564		
	(2)	Supervision	2,526,585	446,744		
[3]	Contingency		**18,396,366**	**908,431**	**2,012,213**	
	(1)	Price Escalation	15,950,822	559,606		([1]+[2])×2.1% (yen) × 9% (MNT)
	(2)	Physical Contingency	2,445,545	348,825		([1]+[2]+[3](1)) × 5%
[4]	Administrative Expense		**9,457,441**		**567,446**	([1]+[2]+[3]+[5]) × 5%
[5]	Preparation Expense		**15,703,706**		**942,222**	
	(1)	Land Acquisition Cost	8,994,091			
	(2)	Utility Relocation	3,594,000			
	(3)	Price Escalation	2,367,820			
	(4)	Physical Contingency	747,796			
[6]	VAT		**5,135,644**	**732,532**	**1,040,671**	VAT=10%
[7]	Interest		**301,525**	**46,815**	**64,907**	
	(1)	Interest during Construction	198,415	32,101		([1]+[3]) × 0.1%, ([2]+[3]*2) × 0.01%
	(2)	Commitment Charge	103,110	14,715		([1]+[2]+[3]+[7](1)) × 0.2%
	Grand Total		**81,954,753**	**8,104,668**	**13,021,954**	

Exchange Rate: 1.0 MNT = 0.06 JPY / 1.0 USD = 89.2 JPY = 1390.5MNT Shaded area "■": Scope of Japanese Yen Loan

Table 11.5.2(1) Breakdown of Direct Construction Cost (Flyover Section)

1	Price Level	January 2013
2	Country	Mongolia
3	Project	Ajilchin Flyover Construction Project
4	Itemization	Bridge

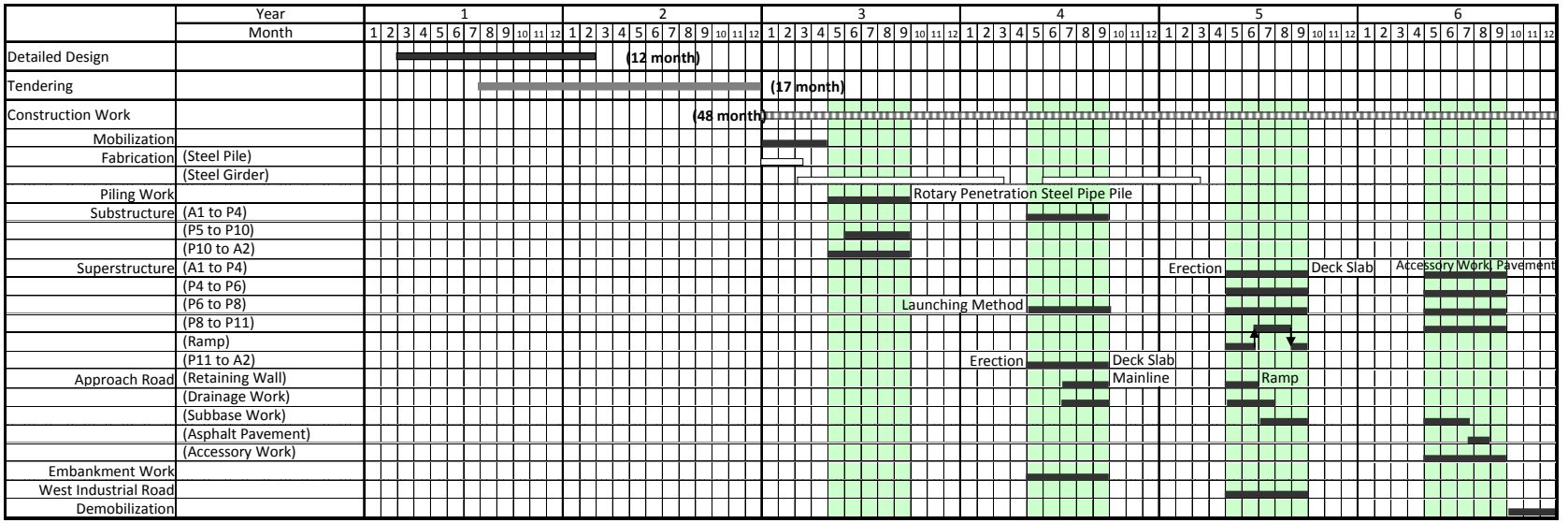
Exchange Rate 1 MNT = 0.060 JPY

Item			Standard	Unit	Quantity	Unit Price		Amount		Amount (Converted JPY)
						MNT	JPY	MNT	JPY	
Main Bridge										
Substructure	Pile	Rotary Penetration Steel Pile	SKK490/ϕ1000×14t×5000	No.	75	1,640,000	1,504,000	123,000,000	112,800,000	120,180,000
			SKK490/ϕ1000×14t×5500	No.	52	1,640,000	1,504,000	85,280,000	78,208,000	83,324,800
			SKK490/ϕ1000×14t×6500	No.	24	1,640,000	1,504,000	39,360,000	36,096,000	38,457,600
	Structure	Excavation		m3	10,583	13,000		137,584,200	0	8,255,052
		Leveling Concrete	σ=18N/mm2	m3	140	180,000		25,218,000	0	1,513,080
		Form for Leveling Concrete		m2	88	23,000		2,028,600	0	121,716
		Rebar	Rebar	t	810	700,000	61,550	566,720,000	49,830,880	83,834,080
		Form work	Footing, Beam of pier	m2	4,583	49,000		224,542,500	0	13,472,550
			Pier	m2	1,932	65,000		125,599,500	0	7,535,970
		Concrete	σ=24N/mm2	m3	5,916	180,000		1,064,844,000	0	63,890,640
		Scaffolding		m2	9,905	23,000	355	227,815,000	3,516,275	17,185,175
		Backfill		m3	7,272	20,600		149,797,020		8,987,821
Superstructure	Fabrication	A1 - P4	4 Span Continuous 2 Boxes Girder	t	429.1		470,000	0	201,677,000	201,677,000
				t	402.1		460,000	0	184,966,000	184,966,000
		P4-P8	4 Span Continuous 3 Boxes Girder	t	992.4		460,000	0	456,504,000	456,504,000
				t	1,011.3		455,000	0	460,141,500	460,141,500
		P8-P11	3 Span Continuous 2 Boxes Girder	t	286.4		500,000	0	143,200,000	143,200,000
				t	329.6		490,000	0	161,504,000	161,504,000
		P11-A2	6 Span Continuous I Girder	t	363.2		410,000	0	148,912,000	148,912,000
				t	363.6		420,000	0	152,712,000	152,712,000
		Heat Insulating Plate	P4-P8 EAST	t	27.9		430,000	0	11,997,000	11,997,000
			P4-P8 WEST	t	30.2		430,000	0	12,986,000	12,986,000
	Girder Erection	A1 - P4	4 Span Continuous 2 Boxes Girder	t	831.2	300,000	70,000	249,360,000	58,184,000	73,145,600
		P4-P8	4 Span Continuous 3 Boxes Girder	t	2,003.7	300,000	200,000	601,110,000	400,740,000	436,806,600
		P8-P11	3 Span Continuous 2 Boxes Girder	t	615.9	300,000	70,000	184,770,000	43,113,000	54,199,200
		P11-A2	6 Span Continuous I Girder	t	726.8	200,000	64,600	145,360,000	46,951,280	55,672,880
	Heat Insulating Plate		P4-P8 EAST	t	27.9	1,385,000	70,000	38,641,500	1,953,000	4,271,490
			P4-P8 WEST	t	30.2	1,385,000	70,000	41,827,000	2,114,000	4,623,620
	Slab	Installation	Steel Concrete Composite Slab	m2	16,200.0	150,000	40,000	2,430,000,000	648,000,000	793,800,000
		Concrete		m3	4,050.0	180,000		729,000,000		43,740,000
	Bearing	TypeB	1750kN, MOVE	No.	4	190,000	709,000	760,000	2,836,000	2,881,600
		TypeC	2000kN, MOVE	No.	10	190,000	817,000	1,900,000	8,170,000	8,284,000
		TypeD	2250kN, MOVE	No.	4	190,000	959,000	760,000	3,836,000	3,881,600
		TypeE	2500kN, MOVE	No.	12	190,000	1,050,000	2,280,000	12,600,000	12,736,800
		TypeF	3500kN, MOVE	No.	2	190,000	1,740,000	380,000	3,480,000	3,502,800
		TypeG	4000kN, MOVE	No.	4	190,000	1,910,000	760,000	7,640,000	7,685,600
		TypeH	4500kN, MOVE	No.	6	190,000	2,212,000	1,140,000	13,272,000	13,340,400
		TypeI	5500kN, MOVE	No.	4	190,000	2,542,000	760,000	10,168,000	10,213,600
		TypeK	4000kN, FIX	No.	10	190,000	1,734,000	1,900,000	17,340,000	17,454,000
		TypeL	4500kN, FIX	No.	8	190,000	2,047,000	1,520,000	16,376,000	16,467,200
		TypeM	5000kN, FIX	No.	8	190,000	2,345,000	1,520,000	18,760,000	18,851,200
		TypeN	5500kN, FIX	No.	2	190,000	2,884,000	380,000	5,768,000	5,790,800
		TypeO	7500kN, FIX	No.	5	190,000	4,398,000	950,000	21,990,000	22,047,000
		TypeP	8000kN, FIX	No.	8	190,000	4,588,000	1,520,000	36,704,000	36,795,200
		TypeQ	8500kN, FIX	No.	3	190,000	5,731,000	570,000	17,193,000	17,227,200
	Unseating Prevention Device			LS	1	25,000,000	33,930,000	25,000,000	33,930,000	35,430,000
Bridge Deck Slab	Concrete Railing	Concrete	σ=24N/mm2	m3	738.6	180,000		132,948,000		7,976,880
		Form work		m2	5,163.7	48,000		247,857,600		14,871,456
		Rebar	Fabricating and Assembling	t	65.0	700,000	61,550	45,500,000	4,000,750	6,730,750
	Waterproofing		Coating Film	m2	14,800.0		1,590	0	23,532,000	23,532,000
	Pavement	80mm		m2	14,800.0	55,000		814,000,000	0	48,840,000
	Expansion Joint	Installation		No.	7.0	206,000	36,600	1,442,000	256,200	342,720
		Fabrication		m	89.0		150,000	0	13,350,000	13,350,000
	Drainage	Drainage Pipe		m	1,500.0	86,000		129,000,000	0	7,740,000
	Approach Slab	Concrete	σ=24N/mm2	m3	100.0	180,000		18,000,000	0	1,080,000
		Form work		m2	30.0	49,000		1,470,000	0	88,200
		Rebar	Fabricating and Assembling	t	6.0	700,000	61,550	4,200,000	369,300	621,300
		Excavation		m3	110.0	13,000		1,430,000	0	85,800
		backfill		m3	10.0	24,000		240,000	0	14,400
	Steel Guard Fence			m	372.0	11,700	6,790	4,352,400	2,525,880	2,787,024
Ramp										
Substructure	Pile	Rotary Penetration Steel Pile	SKK490/ϕ1000×16t×12000	No.	16.0	1,645,000	1,504,000	26,320,000	24,064,000	25,643,200
	Structure	Excavation		m3	1,841.0	13,000		23,933,000	0	1,435,980
		Leveling Concrete	σ=18N/mm2	m3	18.7	180,000		3,366,000	0	201,960
		Form for Leveling Concrete		m2	13.3	23,000		305,900	0	18,354
		Rebar	Fabricating and Assembling	t	89.2	710,000	61,550	63,332,000	5,490,260	9,290,180
		Form work	Footing, Beam of pier	m2	915.4	49,000		44,854,600	0	2,691,276
			Pier	m2	145.3	66,000		9,589,800	0	575,388
		Concrete	σ=24N/mm2	m3	783.5	180,000		141,030,000	0	8,461,800
		Scaffolding		m2	1,154.0	23,000	355	26,542,000	409,670	2,002,190
		Backfill		m3	1,313.9	20,500		26,934,950	0	1,616,097
Superstructure	Fabrication	ON Ramp	3 Span Continuous Box Girder	t	256.6		511,000	0	131,122,600	131,122,600
		OFF Ramp	3 Span Continuous Box Girder	t	172.9		547,000	0	94,576,300	94,576,300
	Erection	ON Ramp	3 Span Continuous Box Girder	t	256.6	300,000	65,000	76,980,000	16,679,000	21,297,800
		OFF Ramp	3 Span Continuous Box Girder	t	172.9	300,000	65,000	51,870,000	11,238,500	14,350,700
	Slab	Installation	Steel Concrete Composite Slab	m2	1,800.0	150,000	40,000	270,000,000	72,000,000	88,200,000
		Concrete		m3	450.0	180,000		81,000,000	0	4,860,000
	Bearing	TypeA	1500kN, MOVE	No.	2	190,000	686,000	380,000	1,372,000	1,394,800
		TypeB	1750kN, MOVE	No.	4	190,000	709,000	760,000	2,836,000	2,881,600
		TypeD	2250kN, MOVE	No.	2	190,000	959,000	380,000	1,918,000	1,940,800
		TypeJ	3500kN, FIX	No.	2	190,000	1,627,000	380,000	3,254,000	3,276,800
		TypeK	4000kN, FIX	No.	2	190,000	1,734,000	380,000	3,468,000	3,490,800
		TypeL	4500kN, FIX	No.	4	190,000	2,047,000	760,000	8,188,000	8,233,600
	Unseating Prevention Device			LS	1	4,500,000	8,050,000	4,500,000	8,050,000	8,320,000
Bridge Deck	Side Wall	Concrete	σ=24N/mm2	m3	329.6	180,000		59,328,000	0	3,559,680
		Form work		m2	2,304.2	49,000		112,905,800	0	6,774,348
		Rebar	Fabricating and Assembling	t	30.0	700,000	61,550	21,000,000	1,846,500	3,106,500
	Waterproofing		Coating Film	m2	1,800.0		1,590	0	2,862,000	2,862,000
	Pavement	Base Layer and Surface Layer		m2	1,800.0	55,000		99,000,000	0	5,940,000
	Expansion Joint	Installation		No.	2.0	206,000	36,600	412,000	73,200	97,920
		Fabrication		m	25.6		145,000		3,712,000	3,712,000
	Drainage	Drainage Pipe		m	200.0	86,000		17,200,000	0	1,032,000
	Approach Slab	Concrete	σ=24N/mm2	m3	20.0	180,000		3,600,000	0	216,000
		Form work		m2	10.0	49,000		490,000	0	29,400
		Rebar	Fabricating and Assembling	t	1.4	700,000	61,550	980,000	86,170	144,970
		Excavation		m3	15.0	13,000		195,000	0	11,700
		Backfill		m3	5.0	24,000		120,000	0	7,200
	Steel Guard Fence			m	217.0	11,700	6,790	2,538,900	1,473,430	1,625,764

Table 11.5.2(2) Breakdown of Direct Construction Cost (Road Section)

	Item		Standard	Unit	Quantity	Unit Price		Amount		Amount (Converted JPY)
						MNT	JPY	MNT	JPY	
Road Construction	Embankment	Approach to Main Bridge	Roadbed	m3	15,151.5	5,500		83,333,250	0	4,999,995
		Approach to ON Ramp	Roadbed	m3	616.0	5,500		3,388,000	0	203,280
		Approach to OFF Ramp	Roadbed	m3	563.0	5,500		3,096,500	0	185,790
	Cut Earth	Origin Side of Main Line		m3	16,514.5	8,000		132,116,000	0	7,926,960
		Ending Side of Main Line		m3	4,766.0	8,000		38,128,000	0	2,287,680
		Intersection		m3	2,195.0	8,000		17,560,000	0	1,053,600
		Feature Compensation Road		m3	7,320.0	8,000		58,560,000	0	3,513,600
		Side Walk		m3	2,500.0	8,000		20,000,000	0	1,200,000
		West Industrial Road		m3	6,818.1	8,000		54,544,800	0	3,272,688
	Sub Base Course	Main Road	t=250mm	m2	15,700.0	11,500		180,550,000	0	10,833,000
		ON Ramp	t=250mm	m2	968.3	11,500		11,135,450	0	668,127
		OFF Ramp	t=250mm	m2	966.5	11,500		11,114,750	0	666,885
		Frontage Road	t=250mm	m2	2,823.9	11,500		32,474,850	0	1,948,491
		Service Road	t=250mm	m2	3,653.6	11,500		42,016,400	0	2,520,984
		Intersection	t=250mm	m2	3,653.6	11,500		42,016,400	0	2,520,984
		Side Walk	t=100mm	m2	5,007.3	6,500		32,547,450	0	1,952,847
	Base Course	Main Road	t=200mm	m2	22,567.6	11,500		259,527,400	0	15,571,644
		ON Ramp	t=200mm	m2	968.3	11,500		11,135,450	0	668,127
		OFF Ramp	t=200mm	m2	966.5	11,500		11,114,750	0	666,885
		Frontage Road	t=200mm	m2	2,823.9	11,500		32,474,850	0	1,948,491
		Service Road	t=200mm	m2	3,653.6	11,500		42,016,400	0	2,520,984
		Intersection	t=200mm	m2	3,653.6	11,500		42,016,400	0	2,520,984
		Side Walk	t=30mm	m2	5,007.3	6,500		32,547,450	0	1,952,847
	Pavement	Main Road	Surface Course 50mm + Binder Course 50mm	m2	22,567.6	60,000		1,354,056,000	0	81,243,360
		ON Ramp	Surface Course 50mm + Binder Course 50mm	m2	968.3	60,000		58,098,000	0	3,485,880
		OFF Ramp	Surface Course 50mm + Binder Course 50mm	m2	966.5	60,000		57,990,000	0	3,479,400
		Frontage Road	Surface Course 50mm + Binder Course 50mm	m2	2,823.9	60,000		169,434,000	0	10,166,040
		Service Road	Surface Course 50mm + Binder Course 50mm	m2	3,653.6	60,000		219,216,000	0	13,152,960
		Intersection	Surface Course 50mm + Binder Course 50mm	m2	3,653.6	60,000		219,216,000	0	13,152,960
		Side Walk	Interlocking Block Pavement	m2	2,919.5	34,000		99,263,000	0	5,955,780
	West Industrial Road	Gravel Bedding	t=150mm	m2	10,869.6	10,000		108,696,000		6,521,760
		Concrete Pavement	t=250mm	m2	10,869.6	20,000	187	217,392,000	2,032,615	15,076,135
		Side Walk	Base course (t=30mm)+Interlocking	m2	2,087.8	40,000		83,512,000	0	5,010,720
		Parking Lot	30+50+400mm	m2	2,248.7	53,000		119,181,100	0	7,150,866
	Anti Skid Pavement			m2	13,838.1	1,600	1,840	22,140,960	25,462,104	26,790,562
	Drainage	U Shape Ditch		m	4,086.6	450,000		1,838,970,000	0	110,338,200
		Catch basin		No.	67.0	1,145,000		76,715,000	0	4,602,900
		O type Ditich	Dia.300	m	944.9	17,000		16,063,300		963,798
		Pipe Culvert	Dia.400		485.1	66,048		32,039,885		1,922,393
		Pipe Culvert	Dia.900	m	65.3	73,000		4,766,900		286,014
	L-Gutter			m	3,215.3	138,800		446,283,640	0	26,777,018
	Street Lighting			LS	1.0	180,000,000	38,160,000	180,000,000	38,160,000	48,960,000
	Traffic Signal			No.	15.0	33,000,000		495,000,000	0	29,700,000
	Traffic Line			m	14,780.8	800	95	11,824,640	1,404,176	2,113,654
	Road Marking			No.	52.0	8,400	1,140	436,800	59,280	85,488
	Traffic Control Device			LS				500,000,000		30,000,000
Reinforced Earth Wall	Skin Plate Manufacturing			m2	3,052.3	260,000		793,598,000	0	47,615,880
	Installing Skin Plate			m2	3,052.3	17,500		53,415,250	0	3,204,915
	Steel Strip Installation			m	28,551.0	400	1,070	11,420,400	30,549,570	31,234,794
	Embankment and Compaction			m3	19,840.0	5,800		115,072,000	0	6,904,320
	Top Concrete	Concrete	σ=24N/mm2	m3	164.6	500,000	4,650	82,300,000	765,390	5,703,390
		Form work		m2	1,081.8	49,000		53,008,200	0	3,180,492
		Rebar	Fabricating and Assembling	t	11.3	700,000	61,550	7,910,000	695,515	1,170,115
Gravity-type Retaining Wall		Concrete		m3	402.8	370,000		149,036,000	0	8,942,160
Dike Construction	Cut Earth			m3	6,491	8,000		51,928,000	0	3,115,680
	Dike Embankment			m3	25,747	5,500		141,608,500	0	8,496,510
	Concrete Block			m2	11,475	185,000		2,122,875,000	0	127,372,500
Transportation	Steel Pile, Steel Girder		From Japan to Ulaanbaatar	LS	1.0		466,363,436	0	466,363,436	466,363,436
Amount of Direct Construction Cost								20,911,646,395	4,650,414,781	5,905,113,565
Indirect Cost								6,273,493,918	845,791,928	1,222,201,563
Overhead Cost								2,091,164,639	202,375,295	327,845,173
Grand Total								29,276,304,953	5,698,582,003	7,455,160,300

Table 11.5.3 Implementation and Disbursement Schedule



Disbursement Schedule

Consultant Service Fee		Amount	Expense (Local : 1000MNT, Foreign : 1000JPY)											
DD Stage	(Local)	1,157,180	867,885	(75%)	289,295	(25%)								
	(Foreign)	271,564	203,673	(75%)	67,891	(25%)								
T/A and C/S stage	(Local)	2,526,585	101,063	(4%)	404,254	(16%)	505,317	(20%)	505,317	(20%)	505,317	(20%)	505,317	(20%)
	(Foreign)	446,744	17,870	(4%)	71,479	(16%)	89,349	(20%)	89,349	(20%)	89,349	(20%)	89,349	(20%)
Sub Total	(Local)	3,683,765	968,948	(26%)	693,549	(19%)	505,317	(14%)	505,317	(14%)	505,317	(14%)	505,317	(14%)
	(Foreign)	718,308	221,543	(31%)	139,370	(19%)	89,349	(12%)	89,349	(12%)	89,349	(12%)	89,349	(12%)
Construction Work														
Fabrication	(Local)	0												
	(Foreign)	2,626,662					1,444,664	(55%)	1,181,998	(45%)				
Piling Work	(Local)	383,544					383,544	(100%)						
	(Foreign)	351,635					351,635	(100%)						
Substructure	(Local)	4,009,652					3,207,722	(80%)	801,930	(20%)				
	(Foreign)	82,946					66,357	(80%)	16,589	(20%)				
Superstructure	(Local)	9,334,875							2,333,719	(25%)	4,667,438	(50%)	2,333,719	(25%)
	(Foreign)	2,498,559							624,640	(25%)	1,249,279	(50%)	624,640	(25%)
Approach Road	(Local)	11,488,601							2,872,150	(25%)	3,446,580	(30%)	5,169,871	(45%)
	(Foreign)	135,934							33,984	(25%)	40,780	(30%)	61,171	(45%)
Embankment Work	(Local)	3,242,976							3,242,976	(100%)				
	(Foreign)	0												
West Industrial Road	(Local)	816,656									816,656	(100%)		
	(Foreign)	2,846									2,846	(100%)		
Sub Total	(Local)	29,276,305	0	(0%)	0	(0%)	3,591,266	(12%)	9,250,776	(32%)	8,930,674	(31%)	7,503,589	(26%)
	(Foreign)	5,698,582	0	(0%)	0	(0%)	1,862,656	(33%)	1,857,210	(33%)	1,292,905	(23%)	685,810	(12%)
Grand Total	(MNT)	32,960,070	968,948	2.9%	693,549	2.1%	4,096,583	12.4%	9,756,093	29.6%	9,435,991	28.6%	8,008,906	24.3%
	(JPY)	6,416,890	221,543	3.5%	139,370	2.2%	1,952,005	30.4%	1,946,559	30.3%	1,382,254	21.5%	775,159	12.1%
Grand Total (Conversion JPY)		8,394,494	279,680	3.3%	180,983	2.2%	2,197,800	26.2%	2,531,925	30.2%	1,948,414	23.2%	1,255,693	15.0%

Table 11.5.4 Annual Fund Requirement

Unit Local: 1000MNT, Foreign: 1000JPY

		1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	Total
Construction Cost	Local			3,232,139	8,325,698	8,037,607	6,753,230	0	2,927,630	29,276,305
	Foreign			1,676,390	1,671,489	1,163,615	617,229	0	569,858	5,698,582
Consultant Service	Local	968,636	692,301	503,757	503,757	503,757	503,757	3,900	3,900	3,683,765
	Foreign	221,338	138,550	88,324	88,324	88,324	88,324	2,562	2,562	718,308
Price Escalation	Local	87,177	130,222	1,208,150	4,014,786	5,081,611	5,421,775	3,229	3,871	15,950,822
	Foreign	4,648	5,880	125,511	168,645	151,250	102,807	401	463	559,606
Construction Cost	Local	0	0	1,059,527	3,807,449	4,810,275	5,080,681	0	0	14,757,933
	Foreign	0	0	119,829	160,989	141,578	91,078	0	0	513,473
Consultant Service	Local	87,177	130,222	148,623	207,337	271,336	341,094	3,229	3,871	1,192,889
	Foreign	4,648	5,880	5,682	7,656	9,672	11,730	401	463	46,133
Physical Contingency	Local	52,791	41,126	265,159	688,466	725,802	671,456	356	389	2,445,545
	Foreign	11,299	7,222	103,825	105,709	76,624	43,847	148	151	348,825
Construction Cost	Local	0	0	232,540	652,911	687,047	629,214	0	0	2,201,712
	Foreign	0	0	99,124	100,910	71,724	38,844	0	0	310,603
Consultant Service	Local	52,791	41,126	32,619	35,555	38,755	42,243	356	389	243,833
	Foreign	11,299	7,222	4,700	4,799	4,900	5,003	148	151	38,222
Administrative	Local	253,168	954,744	2,095,346	2,572,796	2,103,011	1,472,353	2,967	3,055	9,457,441
	Foreign									0
Preparation Expense	Local	0	15,703,70	0	0	0	0	0	0	15,703,706
	Foreign	0	0	0	0	0	0	0	0	0
i) Land acquisition & Social Cost	Local		8,994,091							8,994,091
	Foreign		0							0
ii) Utility relocation	Local		3,594,000							3,594,000
	Foreign		0							0
iii) Price escalation	Local		2,367,820							2,367,820
	Foreign		0							0
iv) Physical	Local		747,796							747,796
	Foreign		0							0
TAX	Local	110,860	86,365	556,833	1,445,778	1,524,184	1,410,058	749	816	5,135,644
	Foreign	23,729	15,165	218,032	221,989	160,910	92,079	311	318	732,532
Interest during	Local	111	197	5,149	18,940	33,468	46,803	46,850	46,897	198,415
	Foreign	24	39	2,130	4,262	5,782	6,614	6,621	6,628	32,101
Construction Cost	Local	0	0	4,883	18,599	33,046	46,292	46,339	46,385	195,545
	Foreign	0	0	2,082	4,203	5,713	6,535	6,541	6,548	31,621
Consultant Service	Local	111	197	266	340	422	511	511	512	2,870
	Foreign	24	39	49	59	69	80	80	80	479
Front-End Fee	Local	103,110								103,110
	Foreign	14,715								14,715

JICA PORTION	Local	1,108,715	863,846	5,214,354	13,551,64	14,382,24	13,397,02	54,336	2,982,687	51,554,852
	Foreign	237,309	151,691	1,996,180	2,038,429	1,485,595	858,822	9,733	579,663	7,357,421
OTHERS	Local	467,138	16,744,81	2,652,179	4,018,575	3,627,196	2,882,411	3,716	3,871	30,399,901
	Foreign	38,443	15,165	218,032	221,989	160,910	92,079	311	318	747,247

Total	Local	1,575,853	17,608,66	7,866,533	17,570,22	18,009,44	16,279,43	58,052	2,986,559	81,954,753
	Foreign	275,752	166,856	2,214,212	2,260,418	1,646,505	950,901	10,044	579,981	8,104,668
JPY Equivalent		**370,303**	**1,223,376**	**2,686,204**	**3,314,631**	**2,727,072**	**1,927,667**	**13,527**	**759,174**	**13,021,954**

Exchange rate 1MNT= 0.06 JPY

11.6 Study on Reduction of Construction Cost and Schedule

The cost and schedule of the Project are stipulated by such factors as an 828m long bridge construction, necessary measures for railway crossing, constraints of construction space in the railway property and urbanized area and so forth.

The following is the perspectives of a study on optional measures for reducing the construction cost and schedule.

- Application of concrete bridge: Advantages of a steel bridge have been already mentioned in 7.3 (5). Possibility for reduction of construction cost and schedule will be reviewed in detail with some portioned application of a concrete bridge.
- Measures for reduction of construction cost: Review will be extended to bridge length, on/off ramps and shape of intersections to reduce construction cost.
- Measures for shortening of construction schedule: Construction schedule will be reviewed taking into consideration additional mobilization of construction equipment, utilization of pre-cast materials and so forth.

(1) Application of Concrete Bridge

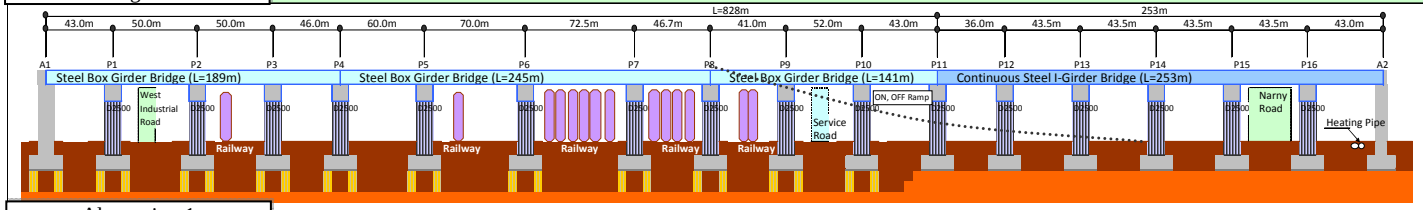
Transportation of pre-fabricated steel members from overseas to Mongolia incurs a high cost. Thus, in a comparative manner with a steel bridge, applicability of a concrete bridge which can be procured and erected in Mongolia was studied. The results are summarized below, and the concept of the respective alternatives is illustrated in Table 11.6.2 on the following page.

Table 11.6.1 Comparison of Steel Bridge and Concrete Bridge

	Outline	Composition	Construction Cost (M.USD)	Construction Period (Years)
Original	Steel for all section (to be adopted)	Steel Box Girder: 575 m Steel I Girder: 253 m	83.10 (1.00)	4 years
Alternative 1	Concrete for all sections	PC Box Girder: 575 m Post tension PC-T Girder: 253 m	85.79 (1.03)	5 years
Alternative 2		PC Box Girder: 575 m Post tension PC-T Girder: 85 m Pre tension PC-T Girder: 168 m	86.02 (1.04)	5 years
Alternative 3	Combination of steel and concrete sections	Steel Box Girder: 575 m Post tension PC-T Girder: 253 m	83.42 (1.00)	4 years
Alternative 4		PC Box Girder: 189 m Steel Box Girder: 386 m Post tension PC-T Girder: 253 m	83.68 (1.01)	4.5 years

Table 11.6.2 Comparison of Cost and Schedule between Steel Bridge and Concrete Bridge

Original

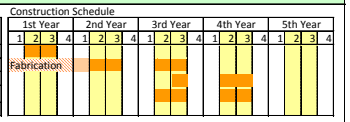


Construction Cost

Item	Q'ty	Cost (M.USD)
Substructure	6699 m3	7.83
Super Structure	4812 t	63.48
Approach Road		1.69
Access Road & Others		10.10
Total		83.10

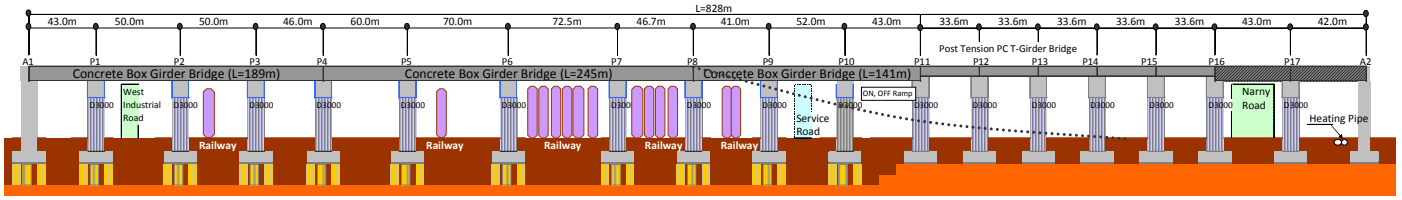
1USD=89.20JPY

Construction Schedule



Ranking: 1

Alternative-1

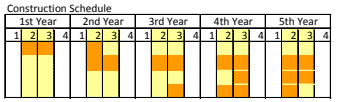


Construction Cost

Item	Q'ty	Cost (M.USD)
Substructure	10,049m3	11.75
Super Structure		62.26
Approach Road		1.69
Access Road & Others		10.10
Total		85.79

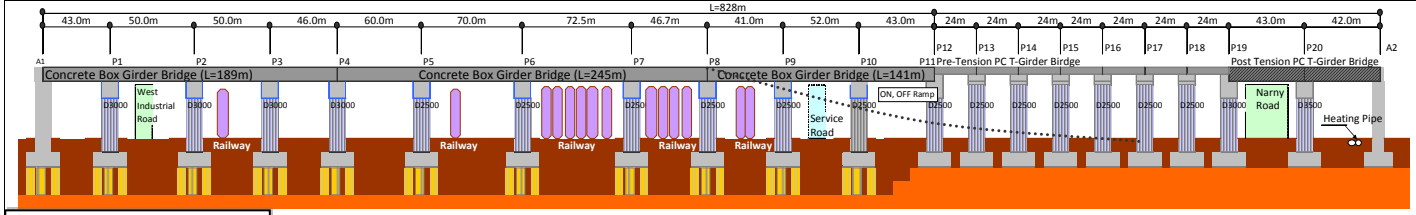
1USD=89.20JPY

Construction Schedule



Ranking: 4

Alternative -2

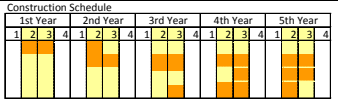


Construction Cost

Item	Q'ty	Cost (M.USD)
Substructure	10,202m3	11.84
Super Structure		62.40
Approach Road		1.69
Access Road & Others		10.10
Total		86.02

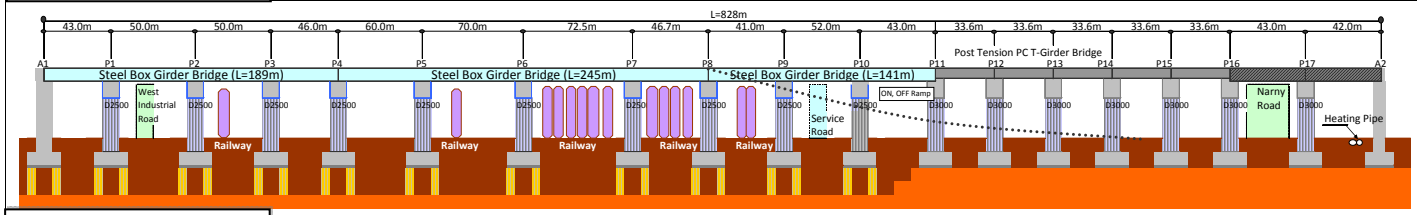
1USD=89.20JPY

Construction Schedule



Ranking: 5

Alternative -3

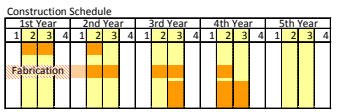


Construction Cost

Item	Q'ty	Cost (M.USD)
Substructure	7564.5 m3	8.30
Super Structure		63.33
Approach Road		1.69
Access Road & Others		10.10
Total		83.42

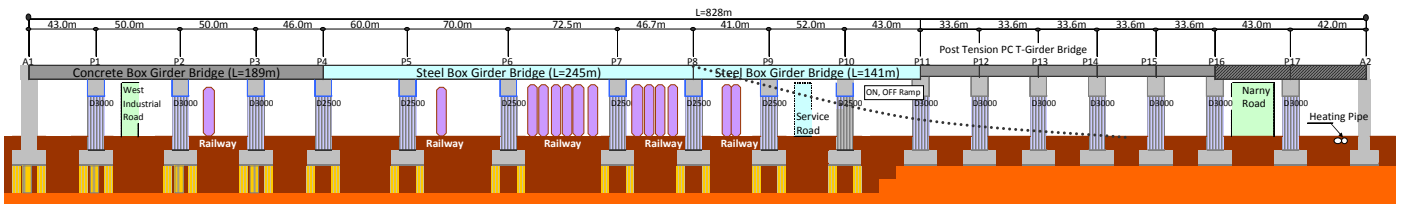
1USD=89.20JPY

Construction Schedule



Ranking: 2

Alternative -4

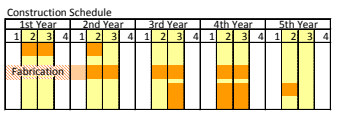


Construction Cost

Item	Q'ty	Cost (M.USD)
Substructure	7764.5 m3	9.10
Super Structure		62.79
Approach Road		1.69
Access Road & Others		10.10
Total		83.68

1USD=89.20JPY

Construction Schedule



Ranking: 3

(2) Measures for Construction Cost Reduction

As for an appropriate scheme to reduce the construction cost, the Survey Team considered restricting a function as a grade separation and consequently reducing the size of bridge. The Survey Team confirmed the tradeoff between construction cost and project effect in terms of bridge length, grade separation type and so forth.

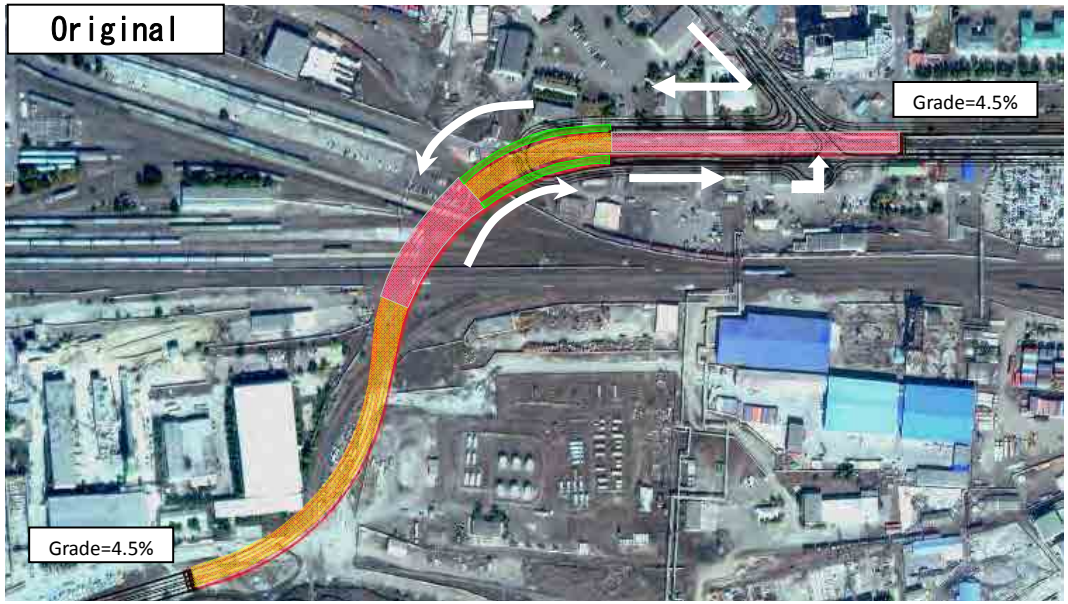
Table 11.6.3 Cost/Schedule Reduction by Modification of Bridge Types

Option	Outline	Construction Cost/Schedule	Traffic function and Safety	Remark
Original	Bridge: L=828 m ON-OFF Ramp: L=275 m	83 Million USD / 48 months	Grade separation with Narny Road. Elimination of traffic congestion and highest traffic safety is secured.	
Alternative 1	ON-OFF Ramp: Do not use Bridge: L=828 m ON-OFF Ramp: L=0 m	76 Million USD /47 months	No access to Peace Avenue due to lack of ramps leads to 30% decrease in projected traffic volume resulting in less economic benefit.	
Alternative 2	At-grade Intersection with Narny Road Bridge: L=507 m ON-OFF Ramp: L=0 m	64 Million USD /36 months	Congestion at intersection with Narny Road causes less project effect. Longitudinal slope to Narny Road reaches 6.0%, which induces certain problems with traffic safety.	
Alternative 3	At-grade Intersection with railway feeder lines at southern section Bridge: L=492 m ON-OFF Ramp: L=0 m	62 Million USD /36 months	Only at-grade crossing is provided at major trunk road and feeder lines. Extra land acquisition in the property of a fuel storage company is required. Longitudinal slope of southern approach reaches 6.0%, most disadvantageous in terms of traffic safety.	

Table 11.6.4 Cost/Schedule Reduction Scheme as per Modification of Bridge Length and ON/OFF Ramp

PLAN	OUTLINE

Original



Bridge Length: L=828 m
ON Ramp: L=151 m
OFF Ramp: L=124 m
Traffic Volume 58,000 veh/day
Construction Cost: 83 Million USD (1USD = 89 JPY)
Construction Period 48 months

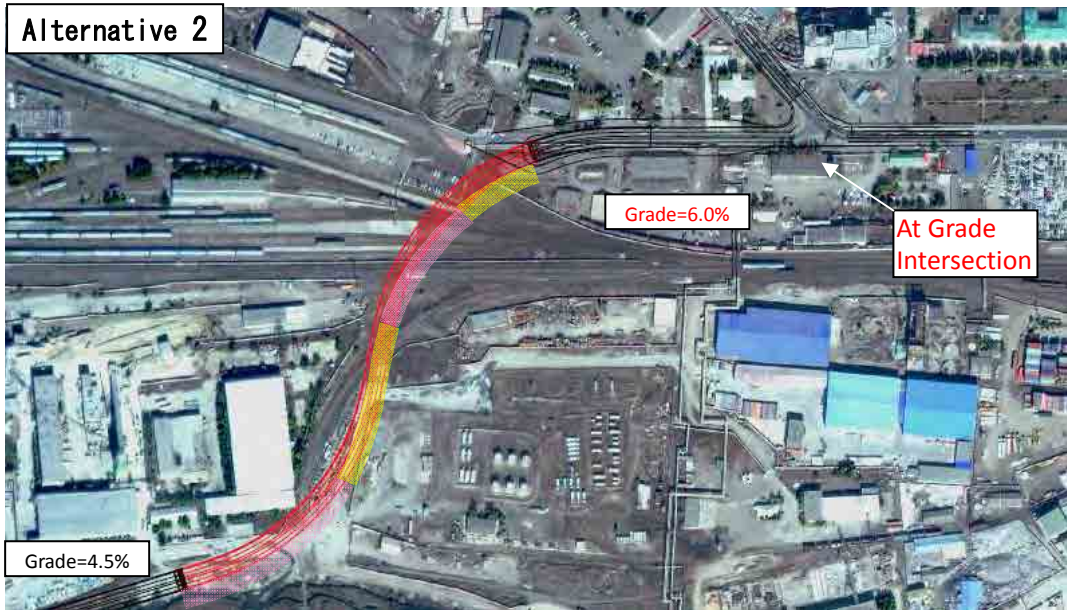
		1st Year				2nd Year				3rd Year				4th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mobilization																	
Shop Fabrication																	
Steel Pile	167 pcs																
30-Pier & 4-Abutment	10,900m3																
Girder on Railway	L=119m																
Girder on Narny Road	L=253m																
Girder at North side	L=141m																
Girder at Southside	L=316 m																
ON-OFF Ramp	L= 275m																
Bridge Surface	16,600m2																
Demobilization																	

Alternative 1

Bridge Length: L=828 m
ON Ramp: L=0 m
OFF Ramp: L=0 m
Traffic Volume 43,500 veh/day
Construction Cost: 76 Million USD (1USD = 89 JPY)
Construction Period 47 months

		1st Year				2nd Year				3rd Year				4th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mobilization																	
Shop Fabrication																	
Steel Pile	156 pcs																
26-Pier & 2-Abutment	10,100m3																
Girder on Railway	L=119m																
Girder on Narny Road	L=253m																
Girder at North side	L=141m																
Girder at Southside	L=316 m																
Bridge Surface	15,100m2																
Demobilization																	

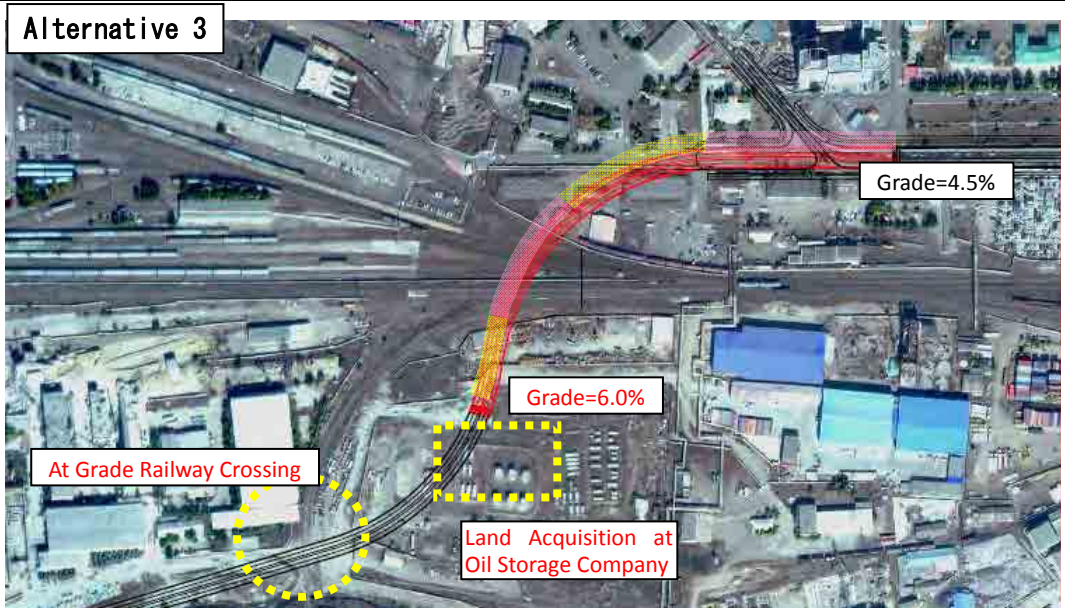
Alternative 2



Bridge Length: L=507 m
ON Ramp: L=0 m
OFF Ramp: L=0 m
Traffic Volume 43,500 veh/day
Construction Cost: 64 Million USD (1USD = 89 JPY)
Construction Period 36 months

		1st Year				2nd Year				3rd Year				4th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mobilization																	
Shop Fabrication																	
Steel Pile	132 pcs																
16-Pier 2-Abutment	3,500m3																
Girder on Railway	L=119m																
Girder at South side-1	L=189m																
Girder at South side-2	L=127 m																
Girder at North side	L=72m																
Bridge Surface	8,900m2																
Demobilization																	

Alternative 3



Bridge Length: L=492 m
ON Ramp: L=0 m
OFF Ramp: L=0 m
Traffic Volume 58,000 veh/day
Construction Cost: 62 Million USD (1USD = 89 JPY)
Construction Period 36 months

		1st Year				2nd Year				3rd Year				4th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mobilization																	
Shop Fabrication																	
Steel Pile	96 pcs																
16-Pier & 2-Abutment	4,200m3																
Girder on Railway	L=120m																
Girder on Narny Road	L=153m																
Girder at North side	L=141 m																
Girder at South side	L=78m																
Bridge Surface	8,640m2																
Demobilization																	

(3) Measures for Shortening of Construction Schedule

Several measures as specified in the following i) - iv) will help to shorten the construction schedule of the Project.

i) Increase of Piling Equipment

The number of pieces of piling equipment shall be increased from 1 set to 2 sets in the first year of the construction work.

Conceptual image of piling machine for installation of Rotary Penetration Steel Pile	
Outline	Period of piling work will be reduced to 50%.
Shortening of Construction Work	-2.7 months
Increment of Construction Cost	+0.38 Million USD

ii) Application of Steel Pier

A concrete pier takes rather a long time for installation under serious constraints of construction schedule and weather conditions. A steel pier can be installed in cold temperature, resulting in shortening of the construction period.

	Concrete Pier (Study result)	Steel Pier (Alternative)
Conceptual image of Pier		
Outline	Workable even in October, which will lead to shortening of construction period	
Shortening of Construction Work	-2.0 months	
Increment of Construction Cost	+7.8 Million USD	

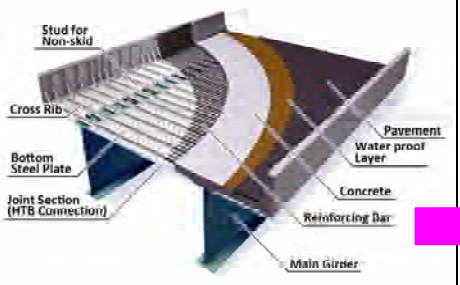
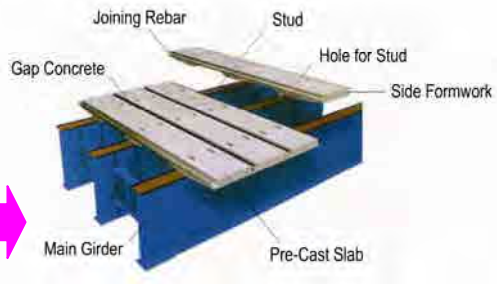
iii) Application of Steel Railing

Application of steel railing instead of concrete railing in the bridge section will lead to a shortening of the construction period.

	Concrete Railing (Proposed)	Steel Railing (Alternative)
Conceptual Image of Railing Types		
Outline	Construction period can be shortened by minimizing concrete casting. Installation work can be conducted in low temperature, say in October.	
Shortening of Construction Work	-0.5 Months	
Increment of Construction Cost	+0.72 Million USD	

iv) Application of Precast PC Slabs

Application of precast PC slabs with high durability the same as a steel-concrete composite deck will make it possible to shorten the construction period at the site.

Type	Steel-Concrete Composite Deck (Proposed)	Precast PC Slab (Alternative)
Conceptual Image of Deck Types		
Outline	PC slabs can be manufactured in Mongolia. The construction period can be shortened, but manufacturing cost is still high.	
Shortening of Construction Work	-1.0 month	
Increment of Construction Cost	+0.41 Million USD	

The following is a summary of the above four (4) options, i.e., the original plan and three (3) alternatives.

In case i) and ii) are adopted:

1) construction period will be reduced from 48 months to 43 months.

2) construction cost will be increased from 83.1 Million USD to 91.3 Million USD.

3) partial opening of flyover 3 years after commencement of construction work.

In case all of i) through iv) are adopted

1) construction period will be reduced from 48 months to 36 months.

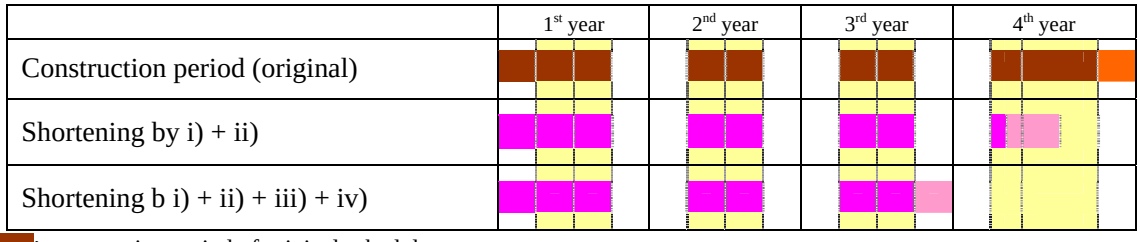
2) construction cost will be increased from 83.1 Million USD to 92.4 Million USD.

Table 11.6.5 Summary of Measures for Reduction of Construction Period

Measures	Reduction of construction period	Increment of construction cost
i) Increase No. of Pieces of Piling Equipment	-2.7 months	+0.38 Million USD
ii) Application of Steel Pier	-2.0 months	+7.80 Million USD
iii) Application of Steel Railing	-0.5 months	+0.72 Million USD
iv) Application of Precast PC Slab	-1.0 month	+0.41 Million USD
Total	**-6.2 months**	**＋9.31 Million USD**

Estimated construction period considering application of i) and ii) with a significant effect of schedule reduction as well as application of all the measures of i) through iv) are illustrated below.

Table 11.6.6 Modified Construction Schedule with Shortening Measures



: construction period of original schedule
: site clean-up period of original schedule
: construction period of shortened schedule
: site clean-up period of shortened schedule

Table 11.6.7 Comparison of Schedule Reduction

	Construction Period	Construction Cost	Remarks
Original	48 months	83.1 Million USD	
Shortening by i) + ii)	43 months	91.3 Million USD	Partial opening 3 years after commencement of construction
Shortening b i) + ii) + iii) + iv)	36 months	92.4 Million USD	

Exchange rate: 1 USD = 89.2 JPY

(4) Summary of Comparative Study on Cost/Schedule Reduction

The results of a comparative study on the above (1) through (3) are described below and also summarized in Table 11.6.8. Conclusively, the original construction plan is deemed to be the most appropriate for implementation of the Project.

- Reduction of construction cost and schedule is not expected for a concrete bridge due to diverse constraints of construction conditions in railway property and urban area.
- Reduction of construction cost and schedule is possible by limiting bridge section. However, it will induce such demerits as causing a disadvantage for road users and reducing traffic safety resulting in undesirable limitation of project effect.
- Possible reduction of construction period from 48 months to 36 months forces increment of construction cost by 10–11%, which induces decrement of EIRR by 1%.

Table 11.6.8 Summary of Comparative Study on Cost/Schedule Reduction

	Original	Alternative 1	Alternative 2	Alternative 3	Alternative 4
(1) Application of concrete bridge	Construction cost 83.1 M.USD Construction period 48 months	85.79 M.USD 60 months	86.02 M.USD 57 months	83.42 M.USD 48 months	83.68 M.USD 54 months
(2) Measures for reduction of construction cost		76 M. USD 47 months	64 M. USD 36 months	62 M. USD 36 months	—
(3) Measures for shortening of construction period		91.3 M.USD 43 months	92.4 M.USD 36 months	—	—

CHAPTER 12

ECONOMIC EVALUATION

12.1 OUTLINE OF ECONOMIC EVALUATION

Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit/Cost Ratio (BC) have been studied to verify the economic feasibility of the Project. EIRR and NPV are calculated using the widely applied DCF (discount cash flow) method, and BC analysis compares economic cost with economic benefit.

Economic Evaluation Indicators

The study refers to the following three indicators for economic evaluation based on the costs and benefits accrued in each year throughout the project life[1].

(a) EIRR: EIRR is a ratio to evaluate project efficiency. EIRR is given when the present value of the cost is equal to the present value of the benefit, i.e., NPV=0.

(b) NPV: NPV is an amount to evaluate project value. NPV is defined as the difference between the sum of the present value of the project benefit and the sum of the present value of the project cost.

(c) B/C: B/C is the ratio to evaluate economic efficiency. B/C is defined as the ratio of the sum of the present value of the project divided by the present value of the project cost.

12.2 ASSUMPTIONS OF ECONOMIC EVALUATION

(1) Principal Methodology of the Economic Evaluation

Based on the traffic demand forecast, the economic evaluation compares the scenarios of "With Project" and "Without Project." The study defines the economic benefit achieved by project implementation as the difference in vehicle travel cost (vehicle operating cost "VOC", and travel time cost "TTC") between the "With Project" and "Without Project" situations.

In the specific calculation of economic analysis, the study adds up yearly economic benefit calculated as differences in traffic demand between "With Project" and "Without Project"

[1] Since the period for economic evaluation is long enough, future cost and benefit should be converted to present value with a certain discount rate. The future n^{th} year value of present value F is represented as $P(1 + i)^n$ in compound interest (i stands for interest rate). Converting the above, the present value of the future n^{th} year value P is represented as F/ (1 + i) n. Further, the discount rate which equates present value of the total cost to total benefit is called the "internal rate of return," where NPV=0 and B/C=1 in other words.

multiplied by the unit cost of VOC corresponding to driving speed and travel time as well as yearly project (and O&M) cost, then discounted to the present value[2].

(a) Benefit from reduction in Vehicle Operating Cost: $BR = BRo - BRw$

$$BRi = \sum_{j} \sum_{l} (Q_{ijl} \times L_l \times \beta_j) \times 365$$

Where,

BR : Benefit from Reduction in Vehicle Operating Cost (Yen/Year)
BRi : Total Vehicle Operating Cost of the Project Status i (Yen/Year)
Q_{ijl} : Traffic Volume of the ith Project Status of the jth Category Vehicle of the lth Link ('vehicle /Day)
L_l : The Length of the lth Link (km)
β_j : Unit Vehicle Operating Cost of the jth Category Vehicle (Yen/Vehicle·km)
i : Project Status, if With Project; i=W / Without Project i=O
j : Vehicle Category
l : Link

(b) Benefit from Reduction in Travel Time: $BT = BTo - BTw$

$$BTi = \sum_{j} \sum_{l} (Q_{ijl} \times T_{ijl} \times \alpha j) \times 365$$

Where,

BTi : Total Travel Time Cost of the Project Status i
Qijl : Traffic Volume of the ith Project Status of the jth Category Vehicle of the lth Link (Vehicle /Day)
Tijl : Travel Time of the ith Project Status of the jth Category Vehicle of the lth Link (Hour)
αj : Unit Time Value of the jth Category Vehicle
i : Project Status, if With Project; i=W / Without Project i=O
j : Vehicle Category
l : Link

(2) Project Life

Detailed Design will be carried out in 2014 and the construction period including bidding will be five (5) years from 2015 to 2019. Therefore, a total of six (6) years is assumed as the implementation period. Benefit from the opening year 2019 up to 2049, or 30 years, is considered to be the project life.

(3) Opportunity Cost of Capital

Opportunity Cost of Capital (OCC) is a benchmark of the EIRR to evaluate project feasibility. This project applies 12.0% OCC, following ADB, WB and other similar road project studies in Mongolia.

[2] The evaluation is based on real terms, adjusting and eliminating price fluctuation. Figures such as costs, benefits (in every year's cash flow), economic growth rate and EIRR all are represented in real terms, unless otherwise noted.

(4) Project Cost

i) Construction Cost

The overall estimated construction cost is as shown in Table 12.2.1. Since the sum of the construction cost is a financial cost, the study assumes 9.88 billion yen as the construction cost, subtracting from the total the figures for price escalation, contingency cost and tax. The study also assumes that construction cost accrues during the construction period from year 2014 to 2019 as shown in Table 12.2.2.

Table 12.2.1 Construction Cost

Cost Breakdown	Amount (million JPY)
Construction	7,455
Design and Supervision	939
Physical Contingency	496
Administration Cost	201
Land and Resettlement Compensation	567
Utility Relocation	226
Total	9,884

Source: JICA Survey Team

Table 12.2.2 Construction Costs for Each Fiscal Year (Unit: million JPY)

Year	2014	2015	2016	2017	2018	2019
Construction Cost	297	1,034	2,334	2,772	2,115	1,382

Source: JICA Survey Team

ii) Operation and Maintenance Cost

The O&M (Operation and Maintenance) cost is classified into daily maintenance, periodic maintenance and rehabilitation as shown in the below table. The study assumes that O&M costs accrue at the end year of the cost cycles.

Table 12.2.3 Operation and Maintenance Cost

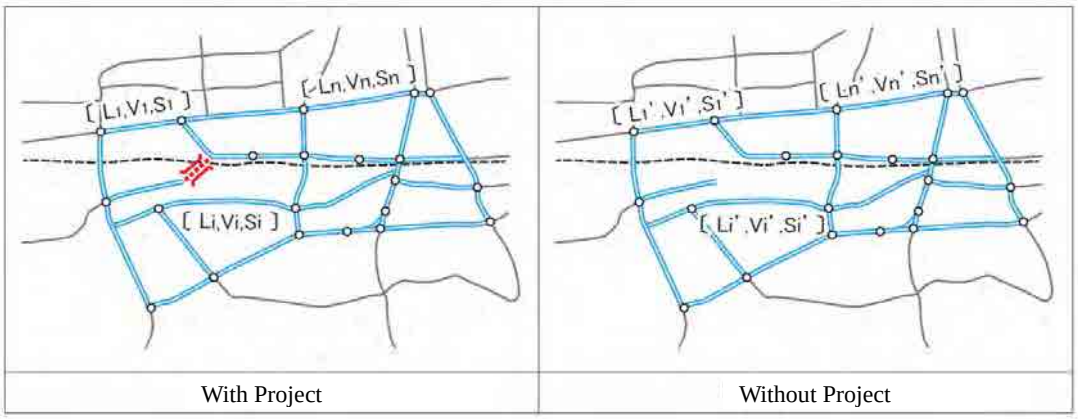
Maintenance Type	Cost Cycle	Amount	
		1,000 MNT	1,000 JPY
Routine Maintenance	1 year	6,840	390
Periodic Maintenance	3 years	6,250	350
Rehabilitation	10 years	361,800	20,623

Source: JICA Survey Team

(5) Project Benefit

i) Road Network for Evaluation

By applying the road network model of traffic demand forecast, the study in principle evaluates the effectiveness of the railway bridge project to traffic congestion mitigation of the nearby road network. The study therefore selects 120 links supposed to be impacted by the project from all the 154 links of the traffic demand forecast.



With Project | Without Project

Figure 12.2.1 Road Network for Economic Evaluation

ii) Traffic Demand Forecast

With regard to the traffic demand for the benefit estimate, the study forecasts 2020 and 2030 traffic demand in a computer simulation, then linearly interpolates from 2020 to 2030 and extrapolates after 2031 assuming an increase of 6% per annum (p.a.).

iii) Vehicle Category for Evaluation

The study assumes “CAR (for passenger use)” and “TRUCK (for freight use)” as the vehicle categories. “CAR” includes large vehicles such as pick-up vehicles and “TRUCK” includes small, medium, large and articulated trucks.

iv) Vehicle Operating Cost

The study has referred to the VOCs of the "Urban Transport Development Project in Mongolia (ADB, 2009)." Since the "CAR" and "TRUCK" categories in this evaluation include large-sized vehicles, the study assumes a multiplier of 1.2 for "CAR" and 2.0 for "TRUCK" with regards to the VOC of the passenger car category in the "Urban Transport Development Project in Mongolia."

Table 12.2.4 Vehicle Operation Cost (2009, Unit: VOC per 1000 km in USD)

Speed (km/h)	Urban Transport Development Project in Mongolia			Study's Assumption	
	Car	Standard Bus (60 pax)	Trolley Bus (130 pax)	CAR	TRUCK
10 km/h	0.384	0.589	1.318	0.461	0.922
20 km/h	0.228	0.367	0.77	0.274	0.547
30 km/h	0.174	0.284	0.558	0.209	0.418
40 km/h	0.145	0.239	0.445	0.174	0.348
50 km/h	0.131	0.227	0.393	0.157	0.314

Source: JICA Survey Team, based on the Urban Transport Development Project in Mongolia, ADB (2009)

v) Time Value

Time value is calculated as the weighted sum of business trips (100% time value) and non-business trips (30%[3] time value of business trip), based on the assumption that time value is equivalent to an hourly wage inclusive of fringe benefits in Mongolia.

The study assumes a vehicle occupancy rate of 1.83 for a passenger car and 1.77[4] for a truck. With regard to trip purposes, it is assumed that 6% are business trips (i.e., 94% are non-business trips) for a passenger car and 100% are business trips for a truck[5].

The average monthly wage in Mongolia in 2009 is 300.5 thousand MNT[6], of which fringe benefits[7] are assumed to be 12%, and thus the Survey Team calculated the time value for a passenger car as 1,197MNT/vehicle and for a truck 3,385/vehicle. Further, referring to the 2009 yearly average exchange rate of 1,438MNT/USD[8], the time values for a passenger car and a truck are converted to 0.83USD/vehicle and 2.35USD/vehicle, respectively.

3 Referred to "Lending Operation of the World Bank (sekai ginkou no lending operation)," World Bank Tokyo Office (2005).

4 Urban Transport Development Project in Mongolia (ADB). The vehicle occupancy for a truck is a weighted average of a small truck and large truck by vehicle fleet composite.

5 THE STUDY ON CITY MASTER PLAN AND URBAN DEVELOPMENT PROGRAM OF ULAANBAATAR CITY (UBMPS) Final Report Volume 4: Technical Appendices (March 2009, JICA) Table 4.1.5 Travel Demand by Mode and Purpose (% by Purpose), which shows To Home 38%, To Work 21%, To School 3%, Business 6%, Private 32%.

6 Statistical Yearbook Mongolia 2012, Table 4.12.

7 Company provided health insurance, unemployment insurance and casual insurance, as well as pension and welfare, which amounts to 11–12% of the wage (interview in Mongolia).

8 Key Indicators for Asia and the Pacific 2011 Mongolia, Asian Development Bank (ADB).

Table 12.2.5 Time Value per Vehicle (2009)

	Wage (MNT/Month)	Wage+ Fringe Benefit (MNT/Month)	Monthly Business Hour* (Hour)	Business/ Non-business Trip (%)	Non-Business Trip Value (%)	Time Value/ Person (MNT)	Vehicle Occupancy ** (Person/ Vehicle)	Time Value per Vehicle	
								MNT	USD
CAR	300,500	336,560	176	6/94	30	654	1.83	1,197	0.83
TRUCK				100/0			1.77	1,158	0.81

Note: Refer to the number of the Urban Transport Development Project in Mongolia, ADB (2009).

Source: JICA Survey Team based on Statistical Yearbook Mongolia, 2012, The Study on City Master Plan and Urban Development Program of Ulaanbaatar City, Urban Transport Development Project in Mongolia, "Lending Operation of the World Bank," etc.

With regard to time values, there are some instances studied in past master plans and feasibility studies, all of which correspond to the above figures, if the difference in subject vehicle categories and price level of the study years is taken into consideration.

Table 12.2.6 List of Time Values in Past Studies

Source	Agency	Unit	Year	Vehicle Category	VOC
The Study on City Master Plan and Urban Development Program of Ulaanbaatar City	JICA	USD/Hour	2007	Private (car, truck)	0.632
				Public (bus, trolley bus, taxi)	0.287
Urban Transport Development Project in Mongolia	ADB	USD/Hour	2009	Passenger Car	0.509
				Bus	0.231
Feasibility Study on Construction of Sonsgolon Fly-Over	ADB	USD/Vehicle·km	2012	Car	0.03
				Bus	0.62
				LT	0.04
				HT	0.04
				AT	0.08
				Other	0.03

Source: The Study on City Master Plan and Urban Development Program of Ulaanbaatar City, Urban Transport Development Project in Mongolia, Feasibility Study on Construction of Sonsgolon Flyover.

The study follows the GDP growth during the evaluation study period as shown in the table below and calculates figures assuming time value increases in proportion to income level.

Table 12.2.7 GDP Growth Rate (Unit: %)

	2010 (Result)	2011 (Result)	2012 (Forecast)	2013–15 (Forecast)	2016–20 (Forecast)	2021–30 (Forecast)	2031– (Forecast)
GDP Growth Rate	6.1	17.3	16.0	11.8	9.1	7.0	6.0

Note: The source of the 2010, 2012 is the Statistical Yearbook, 2012, 2012 "Recent Mongolian Economy (Saikin no Mongol Keizai) (Quoted from Moody's, whose World Economic Outlook 2012 predicts 17.2%), from 2013 to 2015 and from 2016 to 2020 World Economic Outlook 2012 and after 2031 JICA Survey Team.

Source: JICA Survey Team Statistical Yearbook, 2012, "Recent Mongolian Economy" (Mongolian Embassy in Japan), World Economic Outlook 2012.

Assuming that vehicle value per hour increases in proportion to (real) income increase, yearly time values during the project period are as shown in the table. The time values per vehicle in 2020 are 2.61 USD for "CAR" and 2.52 USD for "TRUCK," and in 2030 are 4.67 USD for "CAR" and 4.52 USD for "TRUCK."

Table 12.2.8 Time Values per Vehicle (2010–2049; Unit: USD)

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
CAR	0.89	1.04	1.21	1.35	1.51	1.69	1.84	2.01	2.19	2.39
TRUCK	0.86	1.01	1.17	1.31	1.46	1.63	1.78	1.94	2.12	2.31

	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
CAR	2.61	2.76	2.93	3.11	3.29	3.49	3.70	3.92	4.16	4.41
TRUCK	2.52	2.67	2.83	3.00	3.18	3.37	3.58	3.79	4.02	4.26

	2030	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
CAR	4.67	4.95	5.25	5.56	5.90	6.25	6.62	7.02	7.44	7.89
TRUCK	4.52	4.79	5.07	5.38	5.70	6.04	6.41	6.79	7.20	7.63

	2040	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**
CAR	8.36	8.86	9.40	9.96	10.56	11.19	11.86	12.57	13.33	14.13
TRUCK	8.09	8.57	9.09	9.63	10.21	10.82	11.47	12.16	12.89	13.66

Source: JICA Survey Team

12.3 ECONOMIC EVALUATION RESULT

The result of the economic evaluation is as shown in Table 12.3.1.

Table 12.3.1 Result of Economic Evaluation (Unit: Million Yen)

Year	**Cost**			**Benefit**			**Total**
	Construction	**O&M**	**Sub Total**	**VOC Reduction**	**TTC Reduction**	**Sub-Total**	
2014	308		277.2	0.0	0.0	0.0	-277.2
2015	1031		927.9	0.0	0.0	0.0	-927.9
2016	2422		2,179.8	0.0	0.0	0.0	-2,179.8
2017	2790		2,511.0	0.0	0.0	0.0	-2,511.0
2018	2147		1,932.3	0.0	0.0	0.0	-1,932.3
2019	1383		1,244.7	0.0	0.0	0.0	-1,244.7
2020	3	0.4	3.4	515.1	398.7	913.8	910.5
2021	3	0.4	3.4	607.7	599.2	1,206.9	1,203.5
2022		0.7	0.7	700.3	799.7	1,500.0	1,499.2
2023		0.4	0.4	792.8	1,000.2	1,793.0	1,792.6
2024		0.4	0.4	885.4	1,200.7	2,086.1	2,085.7
2025		0.7	0.7	977.9	1,401.2	2,379.1	2,378.4
2026		0.4	0.4	1,070.5	1,601.6	2,672.2	2,671.8
2027		0.4	0.4	1,163.1	1,802.1	2,965.2	2,964.8
2028		0.7	0.7	1,255.6	2,002.6	3,258.3	3,257.5
2029		21.0	21.0	1,348.2	2,203.1	3,551.3	3,530.3
2030		0.4	0.4	1,440.8	2,403.6	3,844.4	3,844.0
2031		0.7	0.7	1,527.2	2,547.8	4,075.0	4,074.3

2032		0.4	0.4	1,618.8	2,700.7	4,319.5	4,319.1
2033		0.4	0.4	1,716.0	2,862.7	4,578.7	4,578.3
2034		0.7	0.7	1,818.9	3,034.5	4,853.4	4,852.7
2035		0.4	0.4	1,928.1	3,216.5	5,144.6	5,144.2
2036		0.4	0.4	2,043.8	3,409.5	5,453.3	5,452.9
2037		0.7	0.7	2,166.4	3,614.1	5,780.5	5,779.7
2038		0.4	0.4	2,296.4	3,831.0	6,127.3	6,126.9
2039		21.0	21.0	2,434.1	4,060.8	6,495.0	6,474.0
2040		0.7	0.7	2,580.2	4,304.5	6,884.7	6,883.9
2041		0.4	0.4	2,735.0	4,562.7	7,297.7	7,297.4
2042		0.4	0.4	2,899.1	4,836.5	7,735.6	7,735.2
2043		0.7	0.7	3,073.1	5,126.7	8,199.7	8,199.0
2044		0.4	0.4	3,257.4	5,434.3	8,691.7	8,691.3
2045		0.4	0.4	3,452.9	5,760.3	9,213.2	9,212.8
2046		0.7	0.7	3,660.1	6,106.0	9,766.0	9,765.3
2047		0.4	0.4	3,879.7	6,472.3	10,352.0	10,351.6
2048		0.4	0.4	4,112.4	6,860.7	10,973.1	10,972.7
2049		21.4	21.4	4,359.2	7,272.3	11,631.5	11,610.1
					EIRR = 15.8% NPV = 3,978 Million JPY B/C = 1.61		

Source: JICA Survey Team

With a 12% discount rate (opportunity cost of capital), the EIRR of this project is calculated at 15.8%. B/C is 1.61 and NPV is 3,978 million JPY each, all of which are at a sufficient level.

Table 12.3.2 shows how EIRR sensitivity analysis changes construction cost and benefit by ±20%. Since the six-year implementation period of the project is long, the sensitivity to cost escalation is relatively low. In the case of a 20% cost increase and 20% benefit reduction, the resultant EIRR is 12.5%, which is still at a sufficient level.

Table12.3.2 Result of Sensitivity Analysis (EIRR)

Cost \ Benefit	-20%	-10%	±0%	+10%	+20%
-20%	15.8%	16.9%	17.9%	18.8%	19.7%
-10%	14.8%	15.8%	16.8%	17.6%	18.5%
±0%	14.0%	14.9%	15.8%	16.7%	17.5%
+10%	13.2%	14.1%	15.0%	15.8%	16.6%
+20%	12.5%	13.4%	14.0%	15.1%	15.8%

Source: JICA Survey Team

CHAPTER 13

SURVEY ON EXISTING ROAD STRUCTURES

13.1 ROAD CONDITIONS IN ULAANBAATAR CITY

(1) General

Ulaanbaatar City has advantageous conditions for an asphalt pavement such as little precipitation and a relatively strong subgrade. On the other hand, because of drastic changes in the temperature over the year, thermal cracks tend to appear on the asphalt surface and accelerate pavement deterioration. Since few road drainage facilities have been developed in the city, the roads become inundated by intensive heavy rain in the summer season, which is one of the causes of pavement deterioration. Furthermore in recent years, a rapid increase in the maount of heavy traffic, mainly for construction work in the city, has been accelerating pavement fatigue degradation. This survey examined the pavement types and state of damage at 42 spots on the major roads in the city.

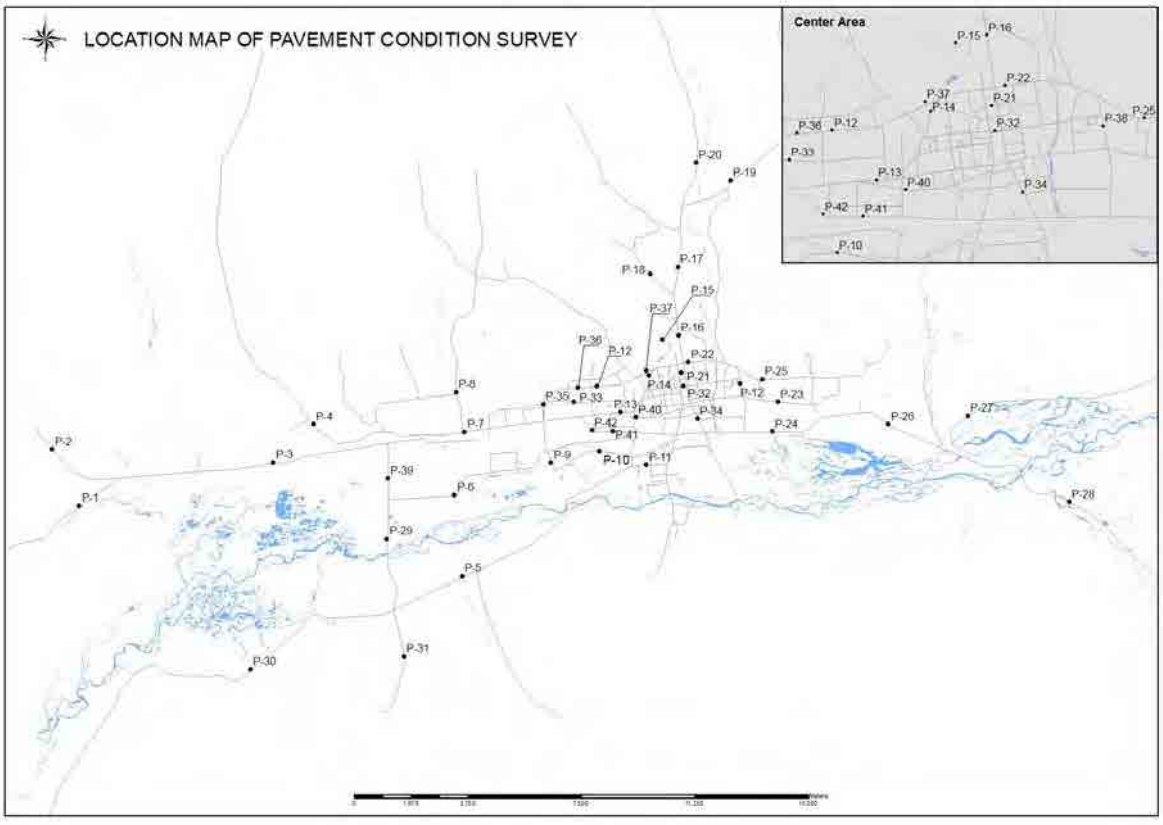


Figure 13.1.1 Location Map of Pavement Condition Survey

(2) Survey Results

This survey classified the pavement damage conditions into three grades (A, B and C) to figure out the condition of pavement damage in the city. The results showed that developed pavement

damage affecting traffic performance was confirmed in 62% of the survey spots in a visual inspection. On the other hand, maintenance work such as patching and sealing were observed on the existing roads, which means a certain level of road maintenane work has been implemented in the city.

Table 13.1.1 Summary of Pavement Condition Survey

Grade	Damage Type	Number of Spots	Composition Ratio
A	Ranging from no damage to a light crack in a transverse direction	16	38.1%
B	Ranging from an alligator crack to a rut or partial detachment of pavement	17	40.5%
C	Ranging from a pothole 20cm or more in diameter to pavement destruction	9	21.4%

A: No Damage – Cracking in a transverse direction
After construction, the surface tends to have cracks in a transverse direction due to temperature changes.

B: Alligator crack – Rutting or to a rut or partial detachment of pavement.
Cracks have expanded and the pavement strength has been reduced significantly.

C: Pothole 20cm in diameter – pavement destruction
After the potholes had formed, they became serious obstacles to traffic.

Figure 13.1.2 Typical Pavement Damages in Ulaanbaatar City

13.2 ROAD BRIDGE CONDITION IN ULAANBAATAR CITY

(1) General

A bridge condition survey was implemented on existing 67 road bridges in Ulaanbaatar City. Soundness and seismic resistance was analyzed and evaluated for each bridge on the basis of an inventory survey (collection of drawing data), visual inspection of structures, measurement of major structural dimensions, concrete strength, bar arrangement and grade of damage.

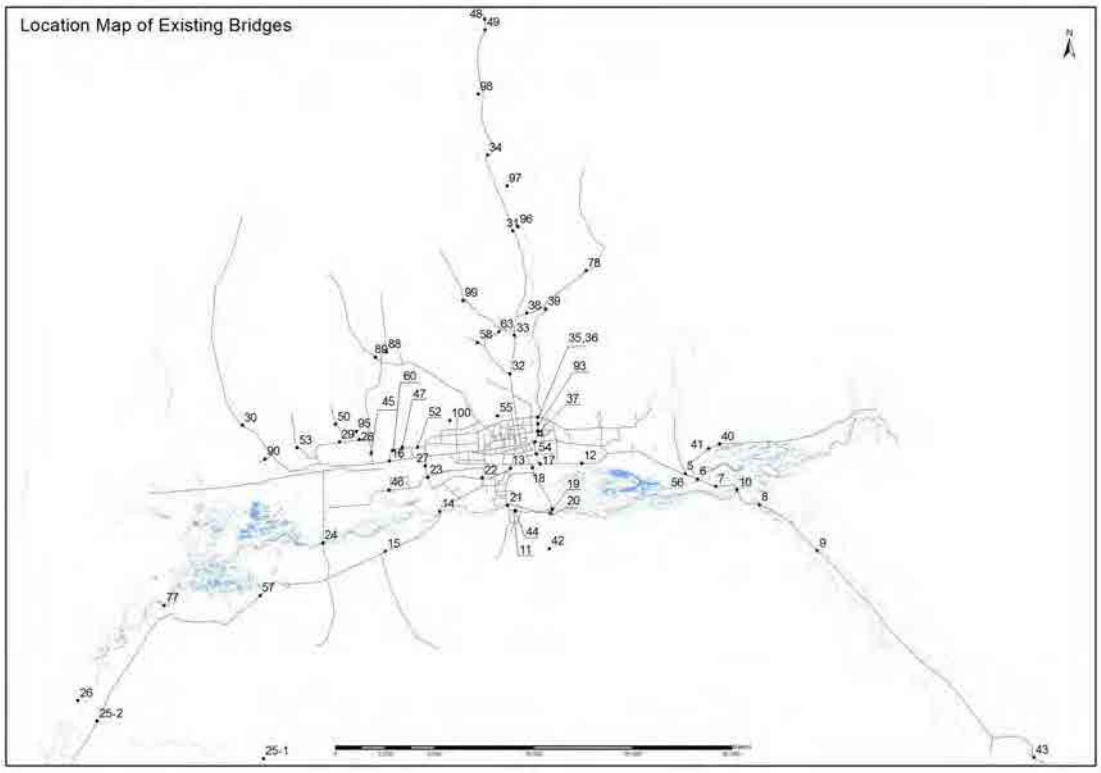


Figure 13.2.1 Location Map of Existing Bridges in Ulaanbaatar

(2) Survey Results

Most bridges in Ulaanbaatar City are reinforced concrete bridges, and there is one steel bridge and one wooden bridge. The oldest bridge was constructed in 1960 and about 25% of all bridges were constructed more than 30 years ago. Regarding the soundness of bridges, serious damage that needs to be repaired urgently was observed in seven bridges (10% of all bridges), and damage that needs to be repaired was observed in 48 bridges (72% of all bridges). Regarding seismic resistance, a relatively small number of bridges would be considered high risk due to their limited height. However, five bridges (7% of all bridges) have serious issues with regards to safety and thus require certain measures to enhance their seismic resistance.

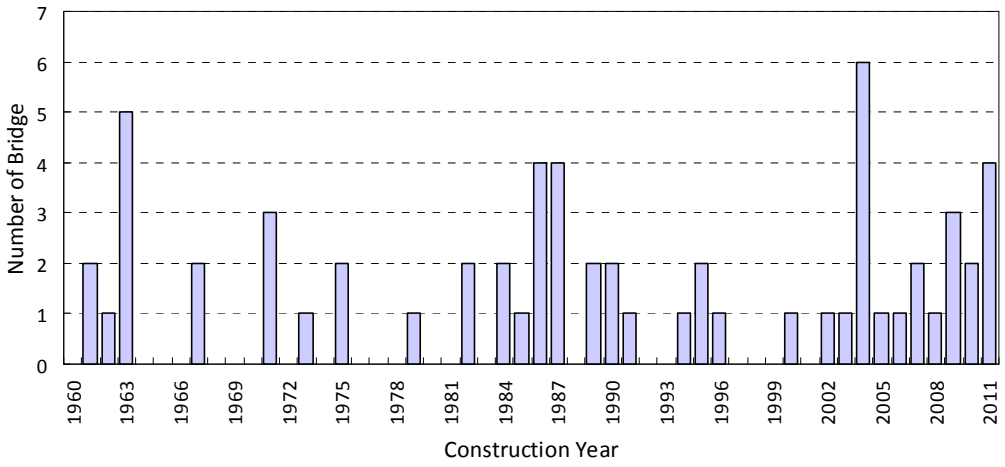
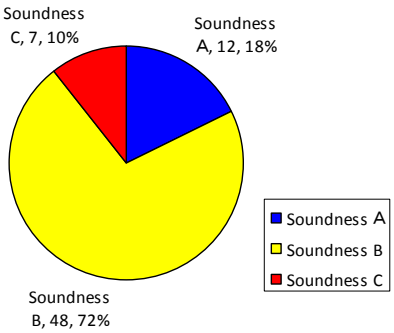
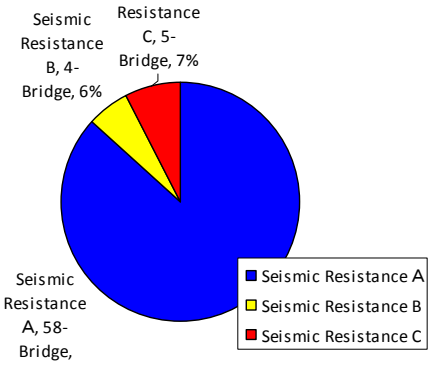


Figure 13.2.2 Construction Year of Road Bridges in Ulaanbaatar City



A: Less damage and few problems in bridge soundness
B: Some damage but the risk pertaining to the entire bridge is low
C: Damage in a wide area and low soundness

Figure 13.2.3 Summary of Bridge Soundness



A: Less problem in earthquake resistance
B: Seismic resistance is partially deteriorated.
C: Low earthquake resistance

Figure 13.2.4 Summary of Seismic Resistance

		
Damage in deck slab	Exposed steel bar	Subsidence of abutment
The concrete filled between girders is damaged by repetitive traffic loads. Major courses are poor workmanship, insufficient waterproofing on bridge deck, and unstable displacement of main girder due to lack of cross beams.	Sufficient thickness of concrete cover was not secured when fabricating the main girders. Concrete surface is deteriorated in Mongolia due to freezing, and thus steel bars are easily exposed due to stripping of insufficient cover.	Insufficient bearing capacity of foundation ground or decrement of bearing capacity due to scoring. The spread (direct) foundation applied to most old bridges in Mongolia is vulnerable to scoring.

Figure 13.2.5 Typical Damage of Bridges

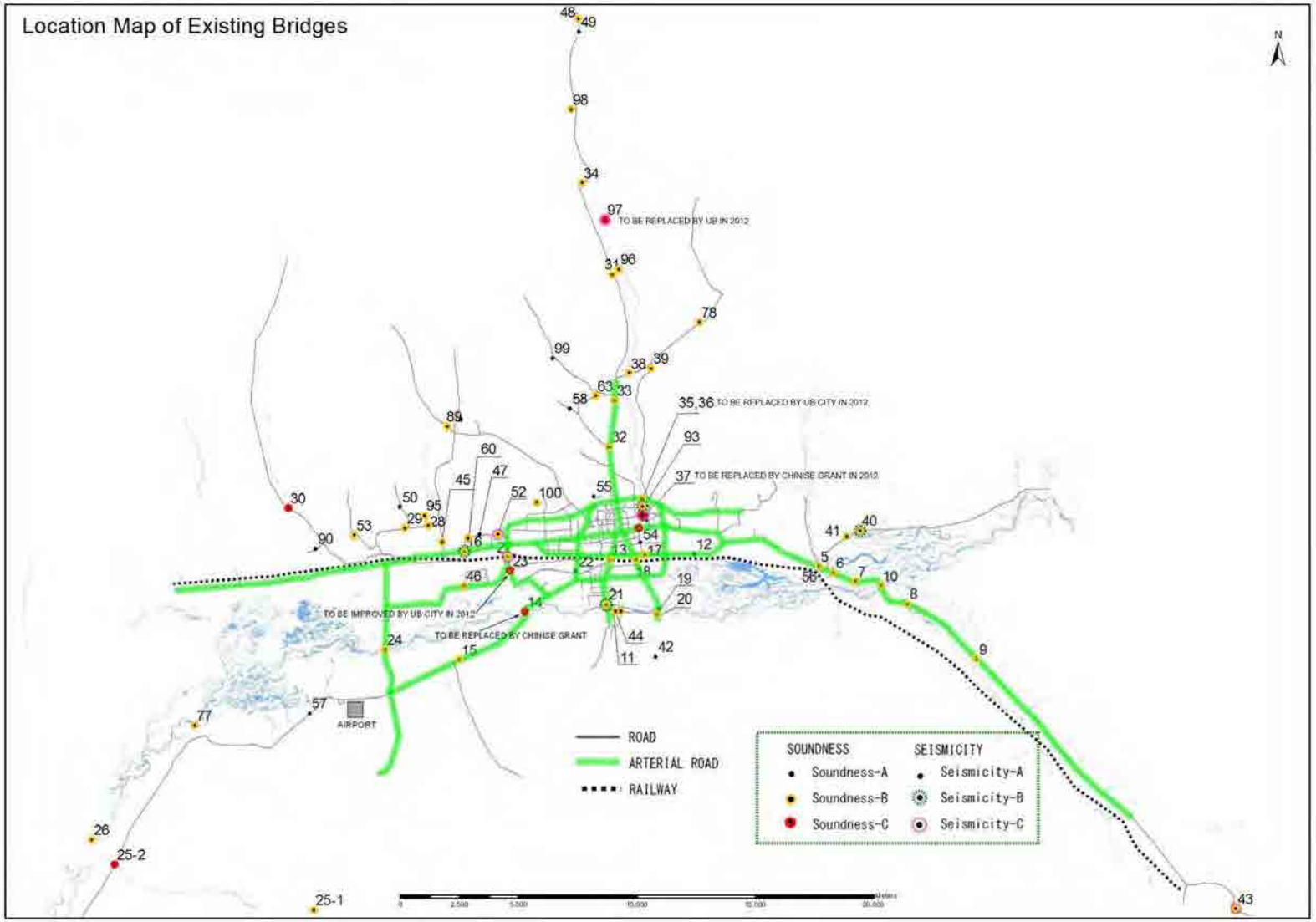


Figure 13.2.6 Result of Existing Bridges Survey

13.3 TECHNICAL ASSISTANCE PROJECT FOR ROAD MAINTENANCE

(1) Road Database Development Using Geographic Information System (TA 7297-MON; ADB 2011–2012)

While the maintenance and management of road facilities has been growing in importance, the Nationwide Road Maintenance and Management Information System was established based on GIS and a New Zealand formulated piece of software for asset management (d TIMS). In addition, the result was prepared in respect of inventory of national roads (11,200 km) as well as condition of paved road surveys (2,600 km). The Intelligent Transport Systemization Strategy for Nationwide Road Network and Planning Manual for Medium-Sized Road Maintenance was also created. On the other hand, there are still some issues remaining with regards to project sustainability including complicated manipulation of software and lack of understanding about the need for asset management.

(2) Road Sector Capacity Development Project (TA-7844 MON; ADB 2012–2014)

With support from the ADB, technology transfer of the following 10 articles has been implemented to MRT (former MRTCUD) and Ulaanbaatar Cityin order to improve their operation and maintenance capacity for the road sector in Mongolia. Along with introducing the maintenance and management software, practical technologies for road pavements including inspection procedures will be transferred. As for pavement construction methods and their technical standards, countermeasures for cold areas that could be taken by introducing Canadian technical specifications have been examined; provided, however, that designing and maintenance and management relating to bridges and structures are not included in theProject.

- Strengthen Road Agencies' Organization and Human Resources
- Restructure the Road Fund and Reestablish the Road Board
- Increase DOR's Project Management and Procurement Capacity
- Set-up an Outsourced Road Supervision System
- Implement a Road Periodic Maintenance Program
- Define a Road Maintenance Strategy and Standards for UB City
- Strengthen MRT's Project Planning and Evaluation Capacity
- Set up Regular Training and Re-training Programs
- Develop Local Capacity for Road Sector Technology Transfer
- Monitoring of Roadmap Implementation and Communicate with the Public

(3) Niigata Prefectural Technical Assistance Project for Implementation of Street Drainage in Ulaanbaatar (JICA, 2009 to 2012)

In order to solve the shortage of road drainage facilities in Ulaanbaatar City, technologies necessary for the development of them have been transferred to the public workers in

Ulaanbaatar City through dispatching specialists and providing training in Japan with technical assistance from the Niigata Construction Technology Center and private companies. Equipment including the steel forms necessary for the manufacture of precast concrete ditches and capacity development of drainage planning, construction and maintenance required for the future development of road drainage facilities was provided.

13.4 ISSUES ON OPERATION AND MAINTENANCE FOR ROAD FACILITIES IN ULAANBAATAR CITY

The nationwide road asset management system has been introduced especially with the assistance of the Asian Development Bank (ADB). It is about to reach the operational stage but its sustainability is not assured. Further, technical assistance with regard to operation and financial issues is currently in progress; for example, fund utilization, enhancement of organizations and entrusted contractor management is taking place as introduced in 13.3(2). As for maintenance technology for road pavements, technical assistance has been continuously provided since the establishment of a database for maintenance in 2011 and the "Road Sector Capacity Development Project" is currently in progress. The following table gives a summary of the technical assistance for road maintenance implemented in the past and currently in progress.

Table 13.4.1 Summary of Technical Assistance on Road Maintenance

		Issue	Required Assistance	Assistance in the Past
Capacity of Staff and Organization		• Insufficient staff number • Insufficient engineering technology	• Outsourcing to road maintenance companies • Establishment of Road Technology Center • Enhancement of existing road material laboratory	• Technical assistance of entrusted contractor management by ADB • It is included in ADB's technical assistance and scheduled to be established in the future. • Equipment was procured in 2009 by ADB.
Budget Allocation		Reestablishment of road budget (increase in budget for road maintenance)	• Budget application based on the medium-term road maintenance plan • Reexamination of road funds and fuel tax	• Technical assistance by ADB is in progress. • Same as the above.
Engineering	Road Pavement	• Construction of database • Technical transfer of inspection procedures • Planning of road maintenance • Technical guidance on rehabilitation work	• Introduction of database software • Technical guidance on inspection procedures • Procurement inspection equipment • Technical guidance to road maintenance companies and staff of UB City	• Implemented by ADB. • Same as the above. • Same as the above. • In progress by ADB.

		Issue	Required Assistance	Assistance in the Past
	Bridge	• Construction of database for maintenance • Technical transfers of inspection procedures for preventive maintenance • Planning of bridge maintenance • Technical Guidance on rehabilitation work	• Construction of sustainable database • Guidance of periodical inspection procedures • Planning of medium-sized bridge maintenance and repair works • Guidance of designing method and construction technology for bridge repairing	**Since no technical assistance for these articles has been implemented in the past, future assistance is required.**

On the other hand, no preventive maintenance technology has been established regarding bridge structures. Maintenance and management work are being implemented in the form of "breakdown maintenance method" where damage is left as it is until it begins extending and measures are taken after a problem arises with the traffic. Accordingly, when deterioration of the existing bridges in the city becomes a serious problem in the future, expenses for large-scale rehabilitation or replacement work will arise. Particularly, the traffic volume in Ulaanbaatar City is increasing significantly, and, on top of that, there are many factors accelerating the deterioration of bridges, such as overloaded vehicles and reinforcement being corroded by application of anti-freezing agents. The important issues are to improve the capacity of maintenance and management for bridge structures and to establish a preventive maintenance system.

Table 13.4.2 Breakdown Maintenance Type and Preventive Maintenance Type

Breakdown Maintenance System		**Preventive Maintenance System**	
Initial Damage ↓ Damage Expansion ↓ Problems in Traffic ↓ Budgetary Allocation for Maintenance ↓ Rehabilitation Works	 Service degradation for road users Large rehabilitation	Periodical Monitoring ↓ Medium Term Maintenance Plan ↓ Annual Budget for Maintenance ↓ Scheduled Rehabilitation ↓ Review of Maintenance and Management Plan	Early detection of damage Small rehabilitation
The long-term maintenance budget is increased.		The long-term maintenance budget can be reduced.	

13.5 BRIDGE MAINTENANCE AND MANAGEMENT PLAN IN ULAANBAATAR CITY

(1) Proposal of Bridge Maintenance Plan

Based on the suvey result, the need for replacement, rehabilitation and reinforcement of the existing bridges are summarized in Table 13.5.1 as the Mainteance Plan. The major concerns regarding the maintenance plan are as follows:

(a) Abstract the bridges to be replaced from the bridges scheduled to be replaced under the Medium Term Road Network Plan in Ulaanbaatar City (2011 to 2016).

(b) Bridges located on the routes scheduled to be widened under the Urban Development MP are deemed to be replaced.

(c) Replacement is carried out for the bridges along major arterial roads evaluated as "Soundness-C".

(d) Rehabilitation work is carried out for bridges other than the above.

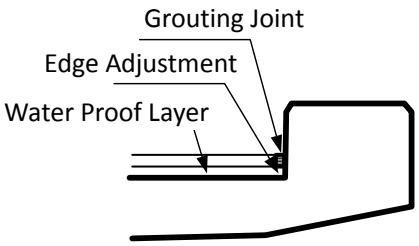
(e) Priority is given to the cost efficiency on the selection of rehabilitation work and reinforcement work; and

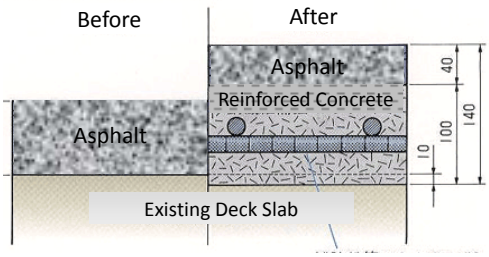
(f) Proposed rehabilitation work and reinforcement work are selected from the following table.

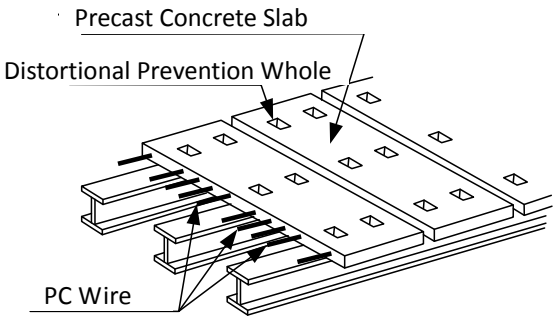
Item	Type of Work	Application
(1) Superstructure	Waterproofing of Deck Slab	A bridge with a lot of free lime from the deck slab.
	Reinforcement of Deck Slab	Deck slab with progressed damage due to insufficient strength.
	Rehabilitation of Main Girder (Restoration of Concrete Section/ Crack Sealing)	A spot where a damaged cross-section, steel bar exposure and wide cracks are observed.
(2) Substructure	Crack repair	A bridge where cracks have developed significantly.
	Scouring Prevention	A bridge having a pier around which scouring has occurred in the river.
(3) Bridge Accessories	Replacement/repair of bearings	A bridge having a significant decline in the strength of bearings.
	Replacement/repair of expansion joint	A bridge without an expansion joint or a bridge whose expansion joint needs to be replaced due to damage.
	Barrier repair work	A bridge where traffic safety is not secured due to a damaged barrier.
(4) Reinforcement of Seismicity	Pier strengthening (Reinforced Concrete Lining)	A bridge of Seismic Resistance C due to insufficient strength of pier.

(2) Outline of Various Rehabilitation Methods

i) Rehabilitation/Reinforcement of Deck Slab

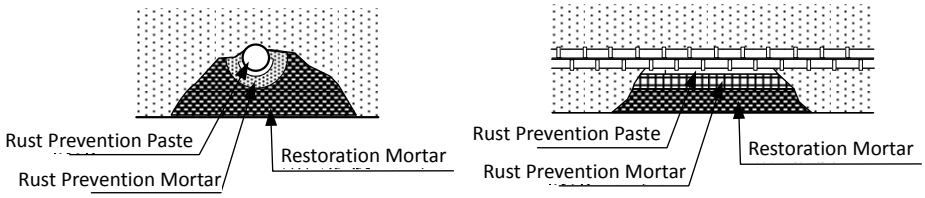
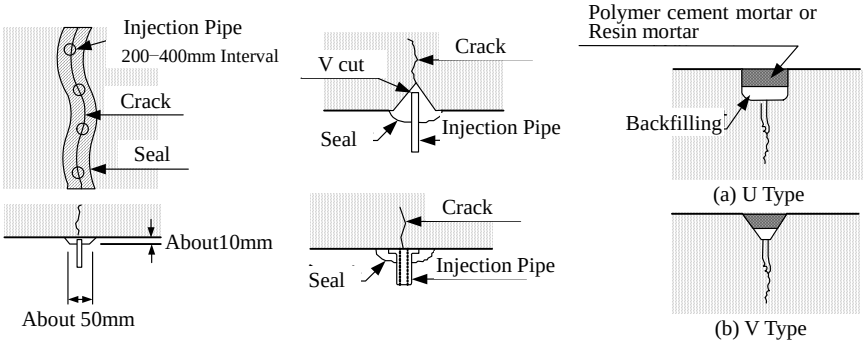
<table>
<tr><th colspan="2">Waterproofing of Deck Slab (Applicable to Concrete Deck Slab)</th></tr>
<tr><td>General Description</td><td>
This method bonds a waterproof sheet or applies waterproofing material to the upper face of a deck slab to prevent rainwater from seeping into the deck slab.



Constructing a Waterproofing of Deck Slab
</td></tr>
<tr><th colspan="2">Deck Slab Reinforcement (Applicable to Concrete Overlaying)</th></tr>
<tr><td>General Description</td><td>
This method is used to reinforce concrete deck slabs that have insufficient strength.
Traffic control is required for concrete overlaying although the construction cost is low.



</td></tr>
<tr><th colspan="2">Deck Slab Replacement (Applicable to Concrete Deck Slabs of Steel Bridge)</th></tr>
<tr><td>General Description</td><td>
Install the precast slab on the main girder, and bind it by pre-stressing in the longitudinal direction.
Reinforcement of the main girder is unnecessary due to weight saving.
It can withstand larger live loads and be widened as required.


</td></tr>
</table>

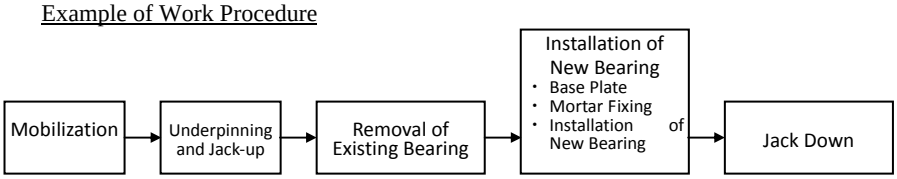
ii) Repair of Main Girder/Crack Repair

Restoration of Concrete Cross-Section (Applicable to Main Girder, Slab, Substructure)	
General Description	• This method repairs cross-section damage by applying several layers of restorative material using a trowel or a spatula after base treatment. • Materials to use are polymer cement mortar, concrete, epoxy resin mortar, non-shrinkage mortar, etc. 
Crack Sealing (Applicable to Main Girders, Slabs, Substructure)	
General Description	• This method pours or fills grouting material such as epoxy resin or polymer cement into a crack to prevent moisture or salt from entering the crack. • When a deteriorated concrete section needs to be removed due to damage, such as neutralization or salt damage, evaluate the possibility of restoring the cross-section together with this method. • Low-viscosity epoxy resin material to be injected at low pressure is suitable for crack repairing of 0.2 to 5.0mm wide. When temperature is 5°C or lower, the material does not harden, so that construction timing is important. • For a 5mm or wider crack, make a U-shaped groove along the crack and fill polymer cement mortar into the groove. 

iii) Scouring Prevention

Measure for Scouring Prevention (Applicable to Substructure in a River with Fast Current Speed)	
General Description	• To prevent scouring around the pier, implement foot protection work. • Gabion mattress is used in foot protection work.  Scouring  Scouring Preventive Measure

iv) Bridge Accessory

<table>
<tr><th colspan="2">Rustproof Work of Steel Bearing (Applicable to Steel Bearing)</th></tr>
<tr><td>General Description</td><td>(1) Zinc Spraying
• Scraping is performed by blasting, so that it can be performed in places where hand scraping is difficult with short bearings.
• Osmotic epoxy resin coating is applied to zinc and zinc aluminum alloy spray film, so that the rustproof effect is superior to ordinary coating. (Cost is high)
• Effective for aging, water leakage from the expansion apparatus, or corrosion caused by accumulated dust.
(2) Refresh Coating
• After scraping the rusted area, apply fresh coating to the external surface of the bearing to prevent bearing corrosion.
• Sufficient space for scraping and coating work is required.
<u>Zinc Spraying Procedure</u>
Before Spraying ⇨ Blasting ⇨ Zinc Spraying ⇨ After Spraying
 
NETIS No.HR-100013-A</td></tr>
<tr><th colspan="2">Replacement of Bearing (Applicable to Bearing)</th></tr>
<tr><td>General Description</td><td>(1) Replacement with the same type
• When damage was not caused by the bearing type and structural problems were not caused by the existing bearing type, replace with a new bearing of the same type.
(2) Replacement with other type of bearing
• When damage was caused by the bearing type and the damage cause cannot be removed by the existing bearing type, replace it with a bearing of another type.
<u>Example of Work Procedure</u>
 
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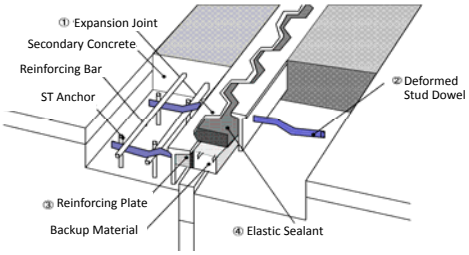
</table>

Replacement of Expansion Joint (Applicable to Expansion Joint)	
General Description	• Remove the existing expansion joint and install a new one. • Select a type by considering the current expansion gap, expansion or deflection value of the target joint, and traffic volume.  
Barrier Repair	
General Description	• Replace and repair the damaged barrier. • An aesthetic design that suits the town needs to be selected for urban areas.  

v) Reinforcement of Seismic Resistance Method

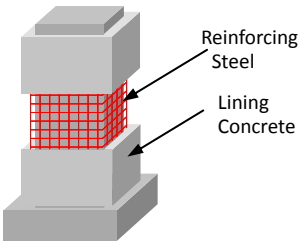
Reinforced Concrete Lining Method	
General Description	• This method is to place reinforced concrete around the existing concrete to improve its ductility and loading capacity. • Lining thickness is 25cm at the minimum.  Reinforced Concrete Lining  Constructing Reinforced Concrete Lining

Table 13.5.1 Bridge Rebuilding/Maintenance Plan

ID	Name of bridge	Arterial Road	Dimensions		Constructed Year	Type of Bridge	Number of Span	Height of Pier or Abut (m)	Girder Support length (cm)	Span length (m)	Soundness Assessment	Seismic Assessment	Replacement Plan	Widening Plan	Replacement Cost (1000JPY)	Maintenance Cost (1000JPY)	(1) Super Structure			(2) Sub Structure		(3) Accessory			(4) Reinforcement of Seismic Resistance	(5) Others
			L (m)	W (m)													Water Proofing	Concrete Overlaying	Rehabilitation of Girders	Crack Sealing	Scouring Prevention	Bearing Replacement/ Rehabilitation	Expansion Joint Replacement/	Barrier Repair	Concrete Lining	
4	Arslantai Bridge	Peace Avenue	34.2	24.7	1962	RC	3	2.40	45	11.4	C	A			132,000		O		O	O						
5	Uliastai tsaad Bridge /Left/	Police Academy St.	96.2	10.0	1967	RC	4	1.80	71	24.1	B	A				8,709	O		O							
6	Uliastai tsaad Bridge	Police Academy St.	6.0	9.0	1985	RC	1	2.45	42	6.0	B	A				225				O				O		
7	Uliastai tsaad Bridge	Police Academy St.	17.5	9.0	1963	RC	3	2.70	46	5.8	B	A				629				O				O		
8	Bridge over the Hol river	Police Academy St.	20.4	11.0	1963	RC	3	2.17	47	6.8	B	A				9,432	O	O		O				O		
9	Chuluut am Bridge	Police Academy St.	11.0	11.0	1963	RC	1	2.70	46	11.0	B	A				5,031	O	O	O	O						
10	Bayanzurkh Bridge	Police Academy St.	252.6	11.8	1967	RC	15	4.20	57	16.8	B	A				122,801	O	O	O							Urgent measur was applied
11	Zaisan West am Bridge		18.0	8.4	1971	RC	1	1.55	100	18.0	B	A				6,179	O	O	O							
12	Bridge in front of the 14th khoroo	Narny Road	2.6	24.6	1963	RC	1	2.00	–	2.6	A	A														
13	Enkhtaivan Bridge	Chingis Avenue	339.5	16.8	1961	RC	27	7.50	42	12.6	B	A		2-lane by ADB	2,673,000				O	O						
14	Yarmag Bridge	Naadamchid	259.4	12.4	1,961	RC	11	6.20	63	23.6	C	A	by UB	2 to 6	1,070,000		O	O		O				O		
15	Yarmag Bridge to Airport	Naadamchid	9.6	11.0	1961	RC	2	1.60	–	4.8	B	A	by UB	2 to 6	38,000			O	O	O				O		
16	Tolgoit Parallel Bridge	Peace Avenue	36.0	*17.2×2*	1987	RC	2	3.00	64	18.0	B	B				53,484	O	O	O	O	O					
17	Selbe dund Bridge	Narny Road	51.0	24.1	2002	RC	3	3.00	92	17.0	B	A				9,964	O							O		
18	Dund gol Deed Bridge	Olympic Street	50.2	12.8	1975	RC	3	3.50	61	16.7	B	A				5,952	O		O							
19	Ikh Tenger Bridge	Ikh Mongol St.	258.0	15.5	1994	RC	12	6.90	89	21.5	A	A				18,125							O	O		
20	Ikh Tenger dwon stream Bridge		12.0	8.1	1979	RC	1	3.00	56	12.0	B	A				4,383	O	O	O	O				O		
21	Zaisan Bridge	Zaisan Road	224.0	12.3	1971	RC	13	5.50	51	17.2	B	B		2 to 4	676,000		O		O	O	O	O		O		
23	Dund gol Dood Bridge	Ajilchin Street	67.0	12.9	1975	RC	3	3.60	54	22.3	C	A	by UB			61,888	O	O	O	O	O	O				
24	Sonsgolon Bridge	Son sgolon road	289.4	10.4	1971	RC	13	5.70	71	22.3	B	A		2 to 4	787,000		O		O	O	O	O		O		
25-1	Turgen river Bridge-1		40.0	13.5	1987	RC	2	3.30	62	20.0	B	A				23,803	O	O	O		O					
25-2	Turgen river Bridge-2		36.0	13.3		RC	2	3.10	53	18.0	C	A	by UB		75,000		O	O	O							
26	Poultry farm Bridge		256.0	10.7	1989	RC	14	2.70	55	18.3	B	A				185,485	O	O	O			O		O		
27	Gurvaljin Bridge	Ajilchin Street	108.0	28.5	1989	RC	6	8.10	103	18.0	B	C				31,854				O			O		O	
28	Naran Bridge		36.3	13.5	1986	RC	2	2.90	64	18.2	B	A			77,000		O		O	O				O		
29	Bridge behind of Meat Factory		54.0	13.5	1986	RC	3	3.60	51	18.0	B	A				34,809	O	O	O		O		O			
30	Nairamdal Bridge		16.6	8.0	1986	RC	2	2.10	65	8.3	C	A				5,461	O	O	O	O						
31	Rashaant Bridge		12.0	10.0	1991	RC	1	2.15	45	12.0	B	A				442								O		O
32	Khailaast Bridge		18.1	25.3	1987	RC	1	2.00	95	18.1	B	A				4,411	O		O							
33	Chingeltei Bridge		18.0	24.0	1987	RC	1	1.90	95	18.0	B	A				4,806	O		O	O				O		
34	Sharga Morit Bridge		50.4	9.2	1982	RC	3	3.50	57	16.8	B	A				6,110	O		O	O			O			
35	Selbe gol Deed Parallel Bridge -1	Ikh Toiruu	45.5	10.5	1963	RC	4	3.85	59	11.4	B	A	by UB		75,000		O	O	O			O		O		
36	Selbe gol Deed Parallel Bridge -2	Ikh Toiruu	45.5	10.5	1982	RC	4	3.55	54	11.4	B	A	by UB		75,000				O	O						
37	Bridge for behind of Chinggis hotel	Beijing Street	34.2	16.0	1990	RC	3	2.65	53	11.4	C	C	by China		86,000		O			O				O		
38	Dambadarjaa Bridge		60.0	11.0	1995	RC	3	2.70	64	20.0	B	A				29,024	O	O	O					O		
39	Dambadarjaa naad Bridge		24.0	13.8	1990	RC	2	2.25	59	12.0	B	A				13,684	O	O	O							
40	Gachuurt Bridge		30.0	9.0	1984	RC	2	3.30	50	15.0	B	B				12,632	O	O	O	O	O					
41	Gachuurt Bridge		18.0	10.3	1984	RC	1	1.55	78	18.0	B	A				8,178	O	O	O					O		
43	Nalaikh Bridge		27.0	9.6		RC	3	5.20	42	9.0	B	C			41,000				O	O			O	O	
44	Zaisan East Bridge		12.0	8.2	1973	RC	1	3.00	37	12.0	B	A				4,880	O	O	O	O			O			
45	Milk factory Bridge		15.8	23.8	1996	multi box	5	1.35	–	3.2	B	A				1,739			O	O				O		
46	Baruun-uul Dithc Bridge	Power Plant Road	27.7	25.2	1986	multi box	7	2.20	–	4.0	B	A				2,417			O	O						
47	Bridge over the ditch west behind the 1st khoroolol		9.2	10.7	2007	RC	1	2.90	43	9.2	A	A				227			O							
48	Bridge to Khandgait-Sanzai		9.0	11.0	2004	RC	1	1.30	32	9.0	B	A				26				O						
49	South Bridge to Khandgait-Sanzai		9.0	11.0	2004	RC	1	1.30	32	9.0	A	A				26				O						
50	Tolgoit ger area road Bridge		18.0	6.0	2004	RC	3	2.00	30	6.0	A	A				208			O	O						
52	Bridge behind the 1st district		17.9	9.9	2006	Steel	2	2.90	56	9.0	B	C				6,264									O	
53	Naran river Bridge		27.7	11.1	2009	RC	3	1.60	45	9.2	B	A				64				O						
54	Damdinsuren street Bridge over the Selbe river		67.8	19.5	2009	RC	5	5.00	90	13.6	A	A				9,584	O			O						
55	Bridge over the ditch west of the 39-th secondary school		10.0	10.5	2010	RC	1	2.00	–	10.0	A	A				1,050							O			
56	New right side Bridge of the Uliastai river Bridge to become parallel		96.2	10.0	2010	RC	4	1.40	62	24.1	B	A				8,709	O		O							
57	Morin/Horse/Hill Bridge		27.0	11.8	2009	RC	2	3.25	50	13.5	A	A				105				O						
58	Khailaast 1.1 km length road Bridge-1		9.0	9.0	2011	RC	1	1.45	35	9.0	A	A				900							O			
60	Bridge behind 1st khoroolol over drainage ditch		24.0	12.0	2000	RC	2	1.75	50	12.0	B	A				1,440			O					O		
63	Bridge on Chingeltei – Khailaast Road		24.0	9.2	2003	RC	1	2.90	83	24.0	B	A				9,173	O					O		O		
77	Wooden bridge rehabilitation work for front side of the Songino's nursing station		206.0	6.2	2005	Wooden	14	–	–	14.7	B	A				13,927					O			O		
78	Belkh river's RC bridge direction to Dambadarjaa-Belkh road		18.0	10.1	1995	RC	2	2.90	56	9.0	B	A				14,118				O				O		
89	Bridge for Bayanhoshuu ger area		24.8	11.5	2004	RC	3	2.60	50	8.3	B	A				109				O						
90	RC bridge Direction to the Orbit-Takhilt		27.0	11.0	2007	RC	3	2.40	45	9.0	A	A				95				O						
93	Golden park bridge of selbe river RC bridge		45.0	11.6	2008	RC	4	2.90	52	11.3	B	B				26,197	O	O	O						O	
95	Songino khairkhan district ,4th and 5th khoroo's borderline road		36.0	12.4	2011	RC	2	2.70	87	18.0	B	A				4,124	O		O							
96	Shadivlan, for Selbe bridge		54.1	13.3	2011	RC	3	2.75	80	18.0	B	A				4,902	O									
97	Goodoin bridge		36.0	6.4		RC	2	1.90	36	18.0	C	C	by UB		36,000				O	O				O		
98	Upper bridge of Sharga morit		27.0	7.0		RC	2	2.95	45	13.5	B	A				7,403	O	O								O
99	Upper bridge of Chingeltein am		9.0	7.3	2004	RC	1	1.70	31	9.0	A	A				1,000					O					
100	behind the 4th khoroolol flood channel's bridge		13.4	6.7	2004	RC	3	0.95	–	4.5	B	A				13,956	O	O		O				O		
103	Bridge for Bayanhoshuu ger area (north) under construction		17.3	11.6	2011	RC	2	2.40	45	8.7	A	A														

(3) Bridges to be Replaced

Bridges that need to be replaced were selected based on the following three (3) points of view: (a) Soundness and earthquake resistance are remarkably low; (b) Road widening is requried in association with future road improvement plan; and (c) Bridges on an arterial road with traffic control for heavy trucks. Detailed investigations are recommended for the following bridges on the assumption of their reconstruction.

Table 13.5.2 Proposed Reconstruction Project for Major Bridges in the City

No.	Bridge Name	Reasons for Rebuilding	Construction Cost	Remarks
4	Arslantai Bridge	Along the arterial road (Peace Avenue) and soundness is low.	130 million JPY	
28	Naran Bridge	Concrete strength is low and deterioration is progressing quickly.	80 million JPY	
43	Nalaikha Bridge	Concrete strength and earthquake resistance are low. This bridge spans the Nalaikha Railway.	40 million JPY	
21	Zaisan Bridge	Two-lane road will be expanded to four-lane road in the future.	680 million JPY	
24	Sonsgolon Bridge	Two-lane road will be expanded to four-lane road in the future.	790 million JPY	
13	Enkhtaivan Bridge	Traffic control for heavy trucks on the arterial road shall be eliminated.	2.7 billion JPY	
		Total Construction Cost	4.4 billion JPY	

Note: Currency Exchange Rate: 1.0 JPY = 16.67 MNT

Table 13.5.3 Bridges to Reconstruct due to Soundness and Seismic Resistance

No.	Bridge Name	Bridge Data	Damage Condition and Reasons for Reconstruction	Photos of Present Status	
4	Arslantai Bridge	Built in 1962 Bridge Length: L=34m Width: W=24.7m (6 lanes) Type: 3 spans RC simple beam Soundness: C Seismic Resistance: A	This bridge is located on Peace Avenue which has the heaviest traffic volume and 50 years have passed since its construction. A large crack caused by uneven settlement has occurred on the pier, and most likely the problems lies in the bearing capacity of the pier. Also, the superstructure has heavy free lime, and damage expansion of the slab is expected. It is desirable to adopt **rapid construction using precast products** in order to minimize social impact by traffic closure during reconstruction. **Approximate construction cost: 130 million JPY**		
28	Naran Bridge	Built in 1986 Bridge Length: L=36.3 Width: W=13.5 m (2 lanes) Type: 2 spans RC simple beam Soundness: B Seismic Resistance: A	It was constructed 26 years ago. Estimated concrete strength is 19.9 MPa at superstructure and 15.9 MPa at substructure, and these are extremely low figures. Most likely there are problems with durability. Free lime under the deck slab and cracks on the pavement are observed. It is assumed that deterioration of soundness will accelerate as the traffic volume increases. **It is possible to use PC girders that are not common locally,** which will also result in the transfer of technology. **Approximate construction cost: 80 million JPY**		
43	Nalaikha Bridge	Built year: unknown Bridge Length: L=27 Width: W=9.6m (2 lanes) Type: 2 spans RC simple beam Soundness: B Seismic Resistance: C	Located in Nalaikha, a coal-mining town that supplies coal to Ulaanbaatar City. The bridge spans the railway. Estimated concrete strength of the superstructure is as small as 15.1 MPa. Seismic resistance of the pier is low (C rank) as well. Safety measures shall be urgently carried out for this bridge because it is a railway flyover. **Estimated construction cost: 40 million JPY**		

Table 13.5.4 Bridges to Reconstruct due to Future Road Plan

No.	Bridge Name	Bridge Data	Damage Condition and Reasons for Reconstruction	Photos of Present Status	
13	Enkhtaivan Bridge (Peace Bridge)	Built in 1963 Bridge Length: L=340 m Width: W=16.8 m (4 lanes + sidewalk) Type: RC simple slab structure + RC simple beam Soundness: B Seismic Resistance: A	This bridge was built 50 years ago with help from China. Passage of heavy vehicles is prohibited due to small design live load. Since the flyover has the heaviest traffic, the importance of this bridge is high as a major arterial road. Construction of additional bridges for bus lanes beside the existing bridge has been planned under the BRT Project by ADB. Large impact will be expected if highly reliable railway flyover that can accommodate load of heavy vehicle traffic is constructed. With this plan, the development effect will be heightened. **Approximate construction cost: 2.7 billion JPY**		
21	Zaisan Bridge	Built in 1971 Bridge Length: L=224 m Width: W=12.3 m (2 lanes + sidewalk) Type: Simple RC structure Soundness: B Seismic Resistance: B	This bridge was built 41 years ago. Damage on the superstructure and substructure are serious. Scouring of the foundation was confirmed in the area crossing the Tuul River, and countermeasures need to be taken. Development of the Zaisan region is advanced, so traffic volume has significantly increased. There is demand to **expand the current two lanes to four lanes**. In JICA MP2030, this route is considered as a part of the north-south main road. **Approximate construction cost: 680 million JPY**		
24	Sonsgolon Bridge	Built in 1971 Bridge Length: L=289 m Width: W=10.4 m (2 lanes) Type: Simple RC beam structure Soundness: B Seismic Resistance: A	This bridge was built 41 years ago, and scouring of the foundation and damage to the post base are serious. This route is planned to be a main road connecting south and north in association with development in the south-west area. It is necessary to expand this road to **four lanes** including sections prior to and after the access road (approximately 5.5 km). This route passes the Tuul River flood district, so a bridge plan considering the characteristics of the river basin needs to be made. **Approximate construction cost: 790 million JPY**		

CHAPTER 14

PROJECT IMPLEMENTATION PLAN

14.1 PROCUREMENT PLAN

(1) Condition of Procurement for Civil Works and Consultancy Services

The conditions of Procurement for Civil Works and Consultancy Services in Mongolia are stipulated in the following two (2) laws.

i) Law of Mongolia on Procurement of Goods, Works and Services with State and Local Funds (#48 2005)

The following are stipulated in the captioned law.

Table 14.1.1 Summary of the Law on Procurement of Civil Works and Consultancy Services in Mongolia

Item	Description
Application	Applicable for projects financed with budget from state and local governments, as well as projects financed by foreign donor or grant without any procurement agreement. It is not applicable for procurement by state-owned companies for road maintenance.
Methodology	In principle, General Competitive Bidding is applied. Direct Procurement and Designated Competitive Bidding can be applicable as needed.
Participation of Foreign Entities	Foreign entity can participate in tenders exceeding 10 billion MNT for Civil Works and 1 billion for Consulting Services.
Local Preference	Advantages such as 7.5% to 10% abstraction from bid price provided for Mongolian domestic products and entities or Joint Venture when Mongolian nationals own 50% of the assets.
Pre-Qualification	Pre-Qualification is required, but specific criteria for qualification are not mentioned.
Bidding Procedure	Two-envelope method is principally applied for General Competitive Bidding.
Advertisement	Procurement equivalent to, or more than 1,000,000 MNT shall be announced on the Web and/or media in foreign language commonly used.
Period of Preparation	At least 30 days are required for the preparation of bidding after announcement in case of general competitive bidding and 15 days for designated competitive bidding. Within 5 days after award, the Contract shall be concluded.
Procurement of Consultancy Services	Three (3) or more consultants shall be shortlisted for the selection. Preparation of bidding shall be 30 to 60 days. Based on condition of the Project, Quality Evaluation or Quality and Cost Based Evaluation are to be applied, in general.

ii) Law of Mongolia on Coordination of Foreign Loans and Grant Aid (June 12, 2003)

The basic condition of institutional arrangement for Loan and Grant projects financed by international agencies and donors is stipulated in the Law. It is also stipulated that the Project Executing Agency[1] shall be selected by the Ministry in charge. If agreed by and between the Mongolian Government and the International Agency, the "Law of Mongolia on Procurement of Goods, Works and Services with State and Local Fund" can be applied according to this law. The following are the responsibilities of the concerned person/organization for Loan and Grant projects financed by international agencies and donors.

Table14.1.2 Responsibility of State Authorities on Foreign Loans and Grant Aid

Authorities	Responsibilities
Authorities of State Ikh Khural	• Approve the Loan Agreement (L/A) and supervise the project implementation • Approve the project components to be undertaken by the Mongolian Government
Authorities of State Central Administration Organization[2]	• Conduct due diligence on justification, cost and benefit analysis, estimates and research of proposed programs, projects and activities related to foreign loans and grant aid; • Reflect domestic resource funding required for programs, projects and other activities in the annual state budget; develop proposal on concession and exemptions from taxes and other payables; • Develop and submit to the Government the proposal for foreign loans and the needs on annually required foreign loans in line with the guidelines for social and economic development; • Conclude loan agreements with the project implementing agency on the repayable terms; • Open income account at the Bank of Mongolia for payments; • Develop a detailed schedule of outstanding payments of loans for each program, project and activity; estimate the possible adverse consequences and implications on the state budget; maintain integrated registry and track of foreign loans, grant aid and debt management; • Demand necessary documentation on foreign loans and grant aid from relevant entities; approve related procedures and rules; and • Monitor the fulfillment of agreement and contractual obligations of projects and activities within the framework of bilateral and multilateral cooperation; take adequate measures to ensure the

[1] Project Executing Agency is defined as "Business entity or organization that has been authorized by the Government of Mongolia to implement specific projects financed by foreign loans and grant aid."

[2] The name is not specified. The Ministry of Economic Development and Ministry of Finance will be in charge.

	fulfillment of such contractual obligations.
Government Authorities	• Work out and approve medium-term program on foreign aid in compliance with the State policy; • Review and approve project proposals to be funded by foreign loans and grant aid and present the proposals to international organizations and donor countries; • Review progress and performance reports of projects and activities implemented; • Conduct audit on activities, related to foreign loans and grant aid, of project implementing and executing agencies, and of utilization of loan and grant aid and take corrective follow up measures; • Administer funds received as foreign loan and grant aid; • Organize the Project Implementing Unit.
Authorities of Ministry of Foreign Affairs	• Make official requests on loans and grant aid to international organizations and donor countries on behalf of the Government; exchange official notes to such effect; • Research foreign aid policy of international organizations and donor countries and provide information to relevant organizations and officials; • Administer funds received as foreign loan and grant aid.
Authorities of Line Ministries and Government Agencies	• Develop project proposals and submit requests for projects, and provide information to interested parties; • Participate in the conclusion of contracts and other agreements; provide required information and reports; • Facilitate implementation of programs, projects and activities; ensure internal monitoring; • Register assets and property supplied as foreign loan and grant aid in the accounting books.
Authorities of Capital City Mayor	• Develop and submit through relevant line ministries to the Government project proposals and activities to be implemented in their respective locations; • Ensure the implementation of projects funded by foreign loan and grant aid and monitoring of the activities of project implementing and executing agencies of projects.

(2) Basic Policy on Bid Conditions for Yen Loan Project

In the case of a Japanese Yen Loan Project Scheme, the "STANDARD BIDDING DOCUMENTS UNDER JAPANESE ODA LOANS, October 2012" shall be applied to formulate the bid conditions.

(3) Selection of the Consultant

The Consultant shall be selected by the Shortlisting System. Practical methdology of the selection shall be based on the "Guidelines for the Employment of Consultants under Japanese ODA Loans (JICA 2012)" and the Quality Based Selection (QBS) shall be applied for the evaluation considering the particular nature of the Project, which includes Construction Supervision with a particular safety measure for complicated and large-scale civil works. It is stipulated in the Domestic Law that three (3) or more consultants qualified in areas of general aspects, financial status and technical capability shall be shortlisted and invited to the selection. Shortlisted consultants shall submit their technical and financial proposals for evaluation by the Evaluation Committee organized by the MRT as stipulated in the Domestic Law. A contract shall be awarded to the winning bidder by the Project Executing Agency.

(4) Selection of the Contractor

Pre-Qualification and Bidding is implemented in a stepped manner for the selection of the Contractor. Practical methodology of the selection shall be based on the "Guidelines for the Employment of Consultants under Japanese ODA Loans (JICA 2012)." Conditions of Pre-Qualification shall be based on the "STANDARD BIDDING DOCUMENTS UNDER JAPANESE ODA LOANS, JICA, October 2012." Specific requirments for the technical qualification to be described in the Bid Documents would be sufficient experience in steel bridge cosntruction, particular girder erection method, installation of rotary penetration steel pipe pile and construction of steel and concrete composit deck slab.

The Consultant, which is selected through the process stipulated in item (3) above, shall prepare the Draft Bid Documents with the agreement of PIU, and submit it to the Bid Evaluation Committee for approval. In addition, Bid Drawings and Technical Specifications shall be examined and approved by the experts designated by MRT. Furthermore, Bid Drawings shall be examined and approved by the administrative agency of utilites such as sewage and water supply, heating pipes, electricity, communication and railways.

The Contract can be divided into four (4) packages as shown below; however, it is crucial to minimize the construction period in congested urban areas. Accordingly, a one (1) package contract which enables efficient schedule control is highly recommended.

Table14.1.3 Possible Contract Packages of Civil Works

Contract Packages	Work Components	Construction Costs (JPY)
Package 1	Substructure and Superstructure of Bridges (L=828m)	6.4 Billion
Package 2	East side access road (L=515 m) and frontage road (L=1210 m)	0.4 Billion
Package 3	West Side Access Road (L=1000 m) and Dike of Dund River Improvement. (L=915 m)	0.5 Billion
Package 4	Improvement of Wes Industrial Road (L=1370 m)	0.1 Billion
Total		7.4 Billion

(5) Contract Management

i) Undertakings of the Client and the Contactor

According to past experiences in Japan's Grant Aid projects for the development of road infrastructue, the construction schedule will be affected and can be easily delayed if land acquisition and utility relocation is protracted. It is therefore impotant to define the responsibility of the contractor and the client for every undertaking and schedule so as to avoid conflicts due to delayed undertakings.

ii) Contact Period based on Work Schedule

The construction schedule may also be affected by the weather conditions in Mongolia. A few months delay in the contracting procedures will cause a delay of one (1) year in the completion of construction works because the work schedule at site during the summer time and the shop fabrication and transportation during the winter time should be properly coordinated. Therefore, the conract period of the Project shall be reviewed and adjusted in accordance with the prospective schedule of work commencement.

iii) Provision of Quality Control System

Under Mongolian Law, the State Professional Inspection Agency (SPIA) has the power to intervene in quality control and inspection for any project other than the Client. The responsibility and authority should be clearly stipulated in the conditions of the contract to create an effective quality control system for the Project.

14.2 IMPLEMENTATION SCHEDULE OF THE PROJECT

The Implementation Schedule of the Project shall be set based on the following assumptions:

(1) Selection of the Consultant

Six (6) months will be expected for the selection of the consultant from delivery of Request for Proposal (RFP) to designated consulting firms up to conclusion of the contract agreement after contract negotiation through preparation, submission and evaluation of the proposal.

(2) Detailed Engineering Design

Twelve (12) months will be expected for detailed engineering design (DD) including preparation and approval of bid documents after the conclusion of a contact agreement. At the stage of the Detailed Engineering Design, a Definitive Plan Formulation based on a review of the topographic conditions and traffic conditions will be completed within five (5) months after the Contract.

(3) Land Acquisition and Relocation of Existing Utilities

Land acquisition will be started immediately after the Definitive Plan Formulation during the DD stage and have to be completed in twelve (12) months before selection of the Contractor. A Detailed Plan for the utility relocation will be prepared by each administration office and the relocation work will be carried out in the next summer season for seven (7) months from April until October.

(4) Selection of the Contractor

The bidding process for the selection of the Contractor is described as below. The procedure on Pre-Qualification will be started immediately after Definitive Plan Formulation during the DD to minimize the period of the bidding.

Pre-Qualification (PQ)

- Preparation of PQ Documents: 1.5 months
- Preparation and Submission: 1.5 months
- Evaluation and Approval: 2.0 months

} 5.0 months in total (During the DD)

Bidding

- Preparation of Bids: 3.0 months
- Bid Evaluation and Approval: 3.0 months
- Contract Negotiation and Approval: 3.0 months
- Opening of Letter of Credit: 1.0 months

} 10.0 months in total

Note: Period for preparation of Bid Documents and its approval are included in the DD period.

(5) Construction Work

As referred to in Chapter 9, 48 months will be required for the construction work in case the contract is concluded in December. However, depending on contract date, it may be required to modify the construction schedule. Accordingly, it is important to finalize the contract process as early as possible.

(6) Implementation Schedule

The above conditions are to be reflected in the Implementation Schedule of the Project, as shown in the following figure. Based on the Implementation Schedule, the Assignment Schedule of the Consultant is to be estimated as shown in succeeding figure.

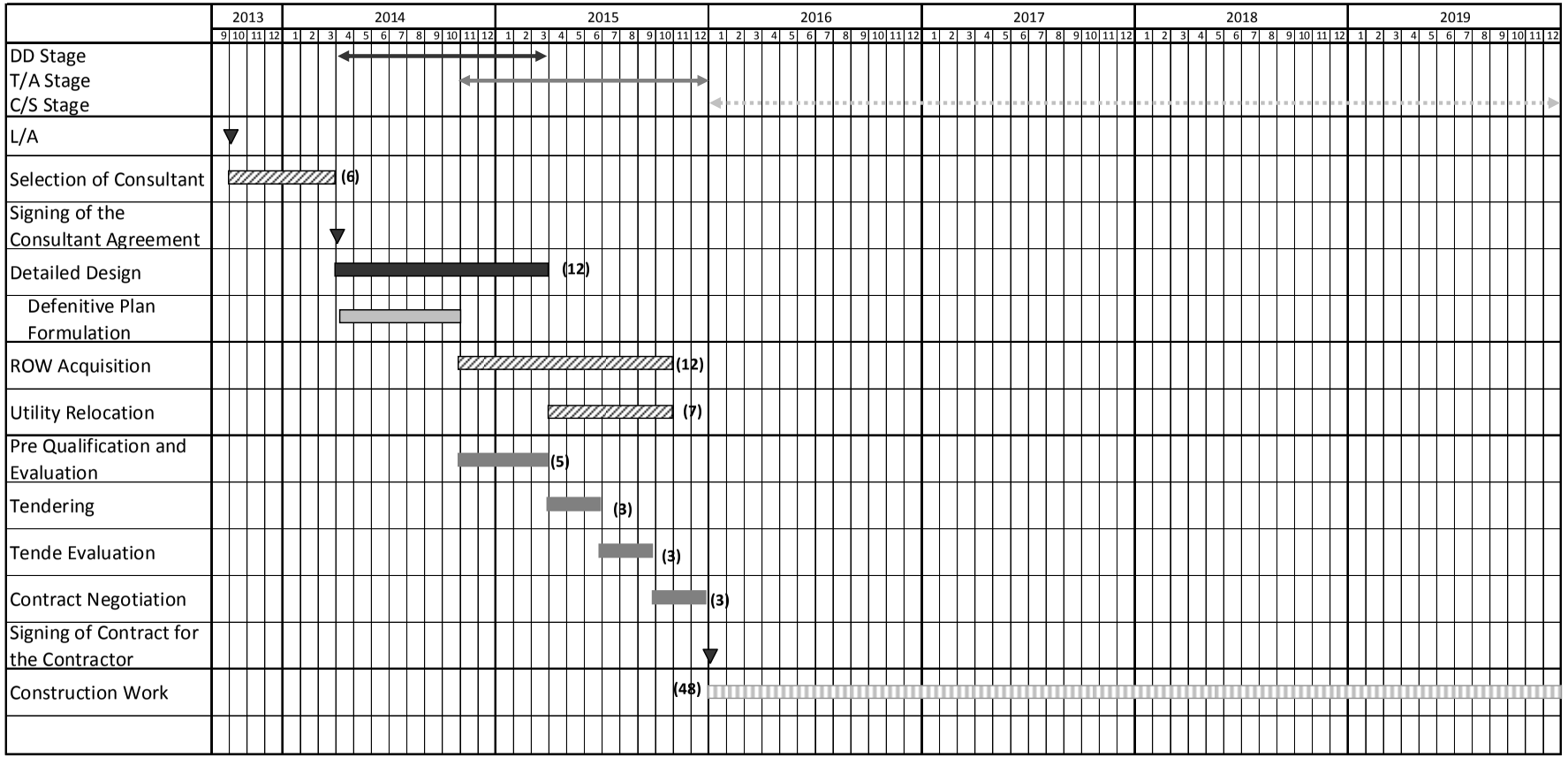
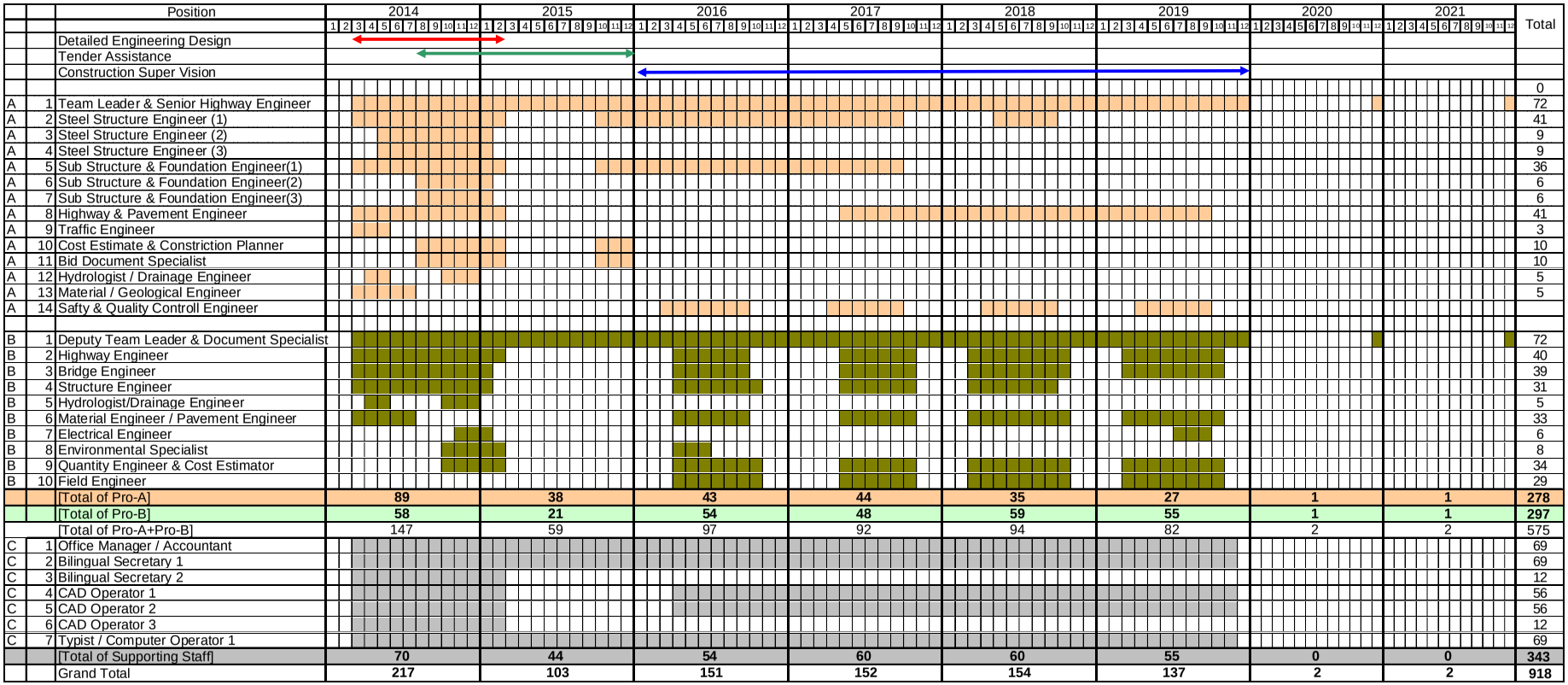


Figure 14.2.1 Project Implementation Schedule



		Position	2014	2015	2016	2017	2018	2019	2020	2021	Total
		Detailed Engineering Design									
		Tender Assistance									
		Construction Super Vision									
											0
A	1	Team Leader & Senior Highway Engineer									72
A	2	Steel Structure Engineer (1)									41
A	3	Steel Structure Engineer (2)									9
A	4	Steel Structure Engineer (3)									9
A	5	Sub Structure & Foundation Engineer(1)									36
A	6	Sub Structure & Foundation Engineer(2)									6
A	7	Sub Structure & Foundation Engineer(3)									6
A	8	Highway & Pavement Engineer									41
A	9	Traffic Engineer									3
A	10	Cost Estimate & Constriction Planner									10
A	11	Bid Document Specialist									10
A	12	Hydrologist / Drainage Engineer									5
A	13	Material / Geological Engineer									5
A	14	Safty & Quality Controll Engineer									
B	1	Deputy Team Leader & Document Specialist									72
B	2	Highway Engineer									40
B	3	Bridge Engineer									39
B	4	Structure Engineer									31
B	5	Hydrologist/Drainage Engineer									5
B	6	Material Engineer / Pavement Engineer									33
B	7	Electrical Engineer									6
B	8	Environmental Specialist									8
B	9	Quantity Engineer & Cost Estimator									34
B	10	Field Engineer									29
		[Total of Pro-A]	**89**	**38**	**43**	**44**	**35**	**27**	**1**	**1**	**278**
		[Total of Pro-B]	**58**	**21**	**54**	**48**	**59**	**55**	**1**	**1**	**297**
		[Total of Pro-A+Pro-B]	147	59	97	92	94	82	2	2	575
C	1	Office Manager / Accountant									69
C	2	Bilingual Secretary 1									69
C	3	Bilingual Secretary 2									12
C	4	CAD Operator 1									56
C	5	CAD Operator 2									56
C	6	CAD Operator 3									12
C	7	Typist / Computer Operator 1									69
		[Total of Supporting Staff]	**70**	**44**	**54**	**60**	**60**	**55**	**0**	**0**	**343**
		Grand Total	**217**	**103**	**151**	**152**	**154**	**137**	**2**	**2**	**918**

Figure 14.2.2 Assignment Schedule of the Consultant

14.3 RISK ANALYSIS FOR THE PROJECT

Prospective risks associated with implementation of the Project and the mitigation measures are as summarized below.

Table14.3.1 Prospective Risks and the Mitigation Measures

Phase	Risks	Mitigation Measures
Detailed Engineering Design (DD)	Delay in initiation of the Project due to late establishment of PIU	• Ensure the establishment of PIU before selecting the Consultant
	Delay in DD	• Procure an experienced consulting firm
	Prolonged procedure for approval of DD	• Hold periodical meetings and discussions with PIU and Experts
	Defect Liability on Engineering Design	• Require the provision of Professional Liability Bond
	Opposition of Stakeholders to the road alignment	• Hold intensive stakeholder meetings and discussion with PAPs
Project Preparation	Delay in ROW acquisition and handing over to the Contractor	• Land entry agreement between the client and the landowners prior to ROW acquisition
	Delay in budget execution for ROW acquisition	• Formulate a budget execution plan with sufficient allowance
	Delay in relocation of utilities and inappropriate execution of relocation work	• Ensure prompt budget execution by PIU and Ulaanbaatar City • Implement strict supervision by the Client of the relocation work with assistance by the Consultant
Construction Work	Change of construction schedule due to delay in commencement of the Work	• Implement strict schedule management starting from the DD stage
	Delay in completion of the work and handing over	• Implement strict schedule control by the Contractor and management by the Consultant • Compensation of Liquidated Damages by the Contractor in conformity with the Contract
	Traffic accident involving the public	• Select a Contractor with sufficient experience in bridge construction work in an urban area • Coordinate with Ulaanbaatar Railway and traffic police authorities on the selection of construction time
	Poor Quality Control (Material and Dimension)	• Select the Contactor by giving priority to quality of experience • Strict inspection by the Consultant

Phase	Risks	Mitigation Measures
	Delay in work due to change of natural conditions	• Priority selection of precast products during the design stage in order to respond to changes
	Early termination of the Construction Work caused by the Contractor	• Provision of definite measures and sanctions to the Contractor in the Contract
	Deviation from Environmental Requirements	• Strict execution of environmental measures by the Contractor and monitoring by PIU
	Traffic accident due to poor traffic management	• Discuss and coordinate with the traffic police authorities • Check and supervise the traffic control plan by the Consultant
Operation and Maintenance	Unexpected deterioration of facility constructed by the Project	• Minimize the deterioration factor by quality control • The Contractor shall address the issue during the Defect Liability Period
Common to All Phases	Force Majeure	• Indemnify losses through All-Risks Insurance
	Economic Risks (Rapid Infuriation, unexpected currency exchange fluctuation, oil crisis and global depression)	• Prompt project implementation so as not to protract the schedule • Price Adjustment according to price escalation

14.4 SAFETY MEASURES DURING CONSTRUCTION

The Contractor shall be obliged to assign personnel responsible for safety management and to carry out periodical safety patrol to educate their workers on safety measures. Practical safety measures for each activity in the construction at the site are as given below.

i) Foundation Work

- Assignment of security personnel and laying of barricades to control entry of people to the site;
- Pre-confirmation of existence of underground and overhead high-voltage power lines;
- Pre-confirmation of railway operation at the site adjacent to railway track; and
- Discussion and coordination with traffic police authorities regarding traffic control

ii) Girder Erection

- Pre-confirmation and coordination with Ulaanbaatar Railway regarding the work schedule for erection work on the railway track;
- Installation of protection net between bents as preventive measure against falling down;
- Installation of safety handrails in high work places to prevent the workers from falling down;

- Stepwise analysis of stress and deformation for main girders during erection work to confirm safety;
- Stepwise analysis of reaction force on support such as roller or launching devices during launching of erection work to check local buckling; and
- Checking of launching progress at each support, jack operation point, and roller passing point if the progress is in accordance with the plan; checking of launching distance and condition of main girders by experts at major points.

iii) Road Construction

- Installation of traffic signs/signage and security guards at critical points;
- Installation of sufficient lighting facilities for night construction work; and
- Confirmation and relocation of dangerous underground utilities such as high-voltage power cables before the construction work.

CHAPTER 15

PROJECT EFFECT

15.1 SETTING OF EVALUATION INDICATOR

(1) Operation Indicator

Daily traffic volume (veh/day) is defined as the indicator to quantitatively measure the operational status of the Project. Sectional traffic volumes to be counted are at the bridge section of 1) Ajilchin Flyover, 2) Narny Bridge, 3) Peace Bridge, and 4) Gulvaljin Bridge as indicated Figure 15.1.1. In addition, the traffic volume of 5) Peace Avenue shall be counted to measure the effect of development of the East-West Arterial Road.

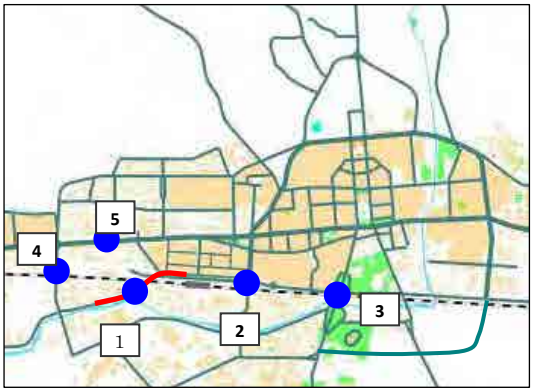


Figure15.1.1 Proposed Sections of Traffic Volume as Operation Indicator

Table15.1.1 Daily Traffic Volume as Operation Indicator for the Project

		Base Line (as of 2012)	2021 (veh/day)		2030 (veh/day)	
			WO/ Case	W/ Case	WO/ Case	W/ Case
1	Ajilchin F.O.	—		29,640	—	57,000
2	Narny Bridge[1)]	24,120	30,760	24,960	50,200	46,200
3	Peace bridge	49,300	49,240	46,900	73,000	70,300
4	Gulvaljin Bridge	48,700	67,640	52,870	115,700	76,000
5	Peace Avenue[2)]	66,900	70,180	55,270	98,800	61,300

1) Traffic volume in November 2012

2) Between Sapporo Intersection and west edge of Narny Road

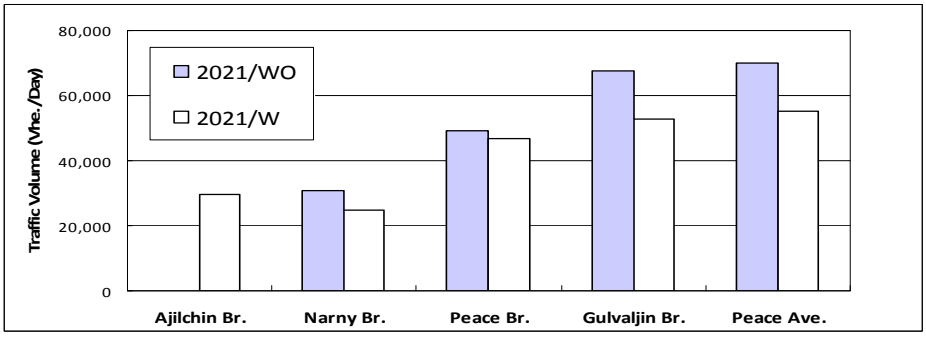


Figure 15.1.2 Daily Traffic Volume in 2021 (Without Case / With Case)

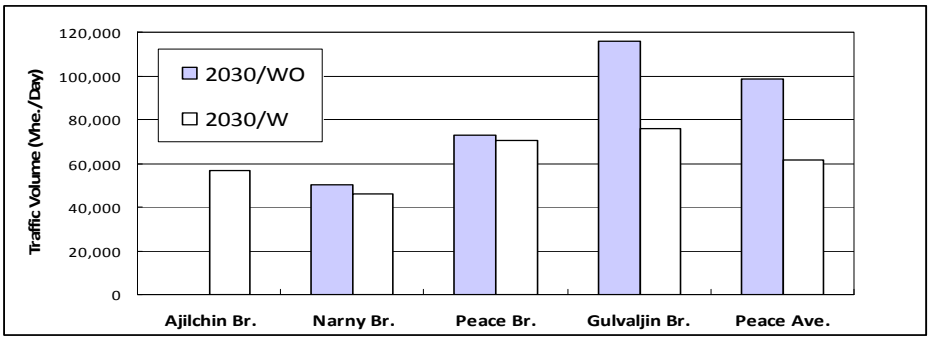


Figure15.1.3 Daily Traffic Volume in 2030 (Without Case / With Case)

(2) Effect Indicator

Indicators to quantitatively measure the effects of the Project are defined as below.

i) Travel Time

Travel time is one of the Effect Indicators for the Project. The average of inbound and outbound travel time from Ulaanbaatar railway station to the intersection of Ajilchin Street and West Industrial Road (L=3.5 km) is the Base Line as of 2012. "With Case" is measured by the Travel Time of Project road including Ajilchin Flyover (L=2.25km).

Table15.1.2 Travel Time Indicator

	2012	2021
	Base Line	**After the Project**
A.M. Peak Hour (8:00-10:00)	17 minutes	-
Mid day (12:00-14:00)	14 minutes	
P.M. Peak Hour (18:00-20:00)	28 minutes	
Daily Average	20 minutes	4 minutes *1

*1: Average Vehicle Speed V_{ave} = 31 km/h (based on JICA STRAD)

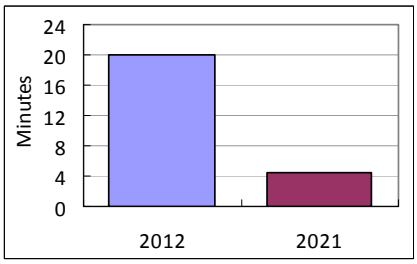


Figure15.1.4 Comparison of Travel Time

Figure 15.1.5 Route of Traveling Time Comparison

ii) Travel Time Saving

Based on the travel time estimated as above, Daily Travel Time Saving will reach 7,736 hours/day in 2021 with the Project as shown in Table 15.1.3. It should be noted that the above travel time saving was estimated for a single road, and a larger time saving can be expected if the Project is effective for road network improvement.

Table 15.1.3 Travel Time Saving

	Daily Traffic Volume	**Travel Time**	**Travel Time (Vehicle-Hour/day)**
1) 2021: Without Case	29,640 (veh./day)	0.33 hour (20 minutes)	9,781
2) 2021: With Case		0.069 hour (4 minutes)	2,045
Travel Time Saving: 1) − 2)			7,736

iii) Vehicle Operation Cost (VOC) Saving

VOC Costs regarding the With Case and Without Case in 2021 are estimated as below. The diference between VOC Saving With and Without is defined as the Effect Indicator. It is expected that 52.0 Million MNT per day will be saved after the Project in 2021.

Table 15.1.4 VOC Saving in 2021

	Daily Traffic Volume	**Distance (km)**	**VOC (MNT-Veh./km)**	**Daily VOC (Million MNT/day)**
1) 2021 Without Case	29,640 (vehicle/day)	3.50 km	699	72.5
2) 2021 With Case		2.25 km	317	20.5
VOC Saving: 1) − 2)				52.0

Note: 1 USD=1379.47 MNT, VOC is estimated based on the assumption of 1) V1 = 10 km/h and 2) V2 = 31 km/h

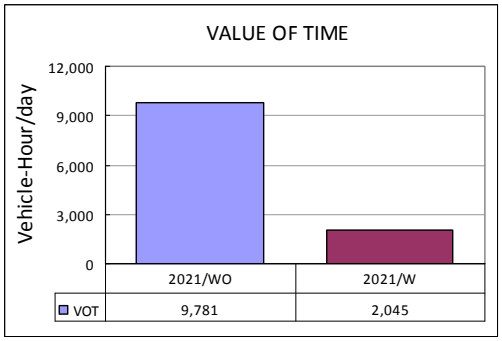


Figure 15.1.6 Comparison of Travel Time

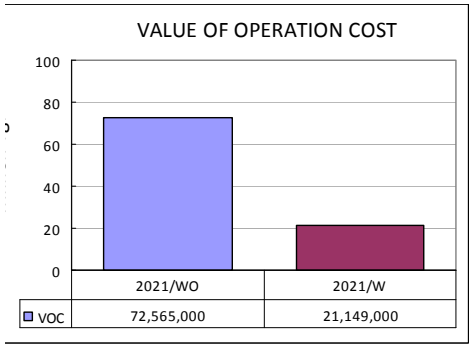


Figure 15.1.7 Comparison of VOC

15.2 QUANTITATIVE AND QUALITATIVE EFFECTS

The quantitative and qualitative effects to be derived from the implementation of the Project are as summarized below. The number of beneficiaries of the Project will be equivalent to the population of Ulaanbaatar City; namely, 1,221,000 people.

Current Status and Issues
• Railway severance of north-south traffic becomes a traffic bottleneck in terms of road network. • Traffic congestion has arisen at the existing railway flyover and its access road since the number of the flyovers is insufficient. • Traffic in the east-west direction suffers from congestion since the East-West Arterial Road is limited to Peace Avenue.

⇩

Input by the Project
Construction of Railway Flyover and its access road to establish new East-West Arterial Road in parallel with Peace Avenue.

⇩

Quantitative Effect	Qualitative Effect
i) Travel Time Saving from Narny Road in front of railway station to intersection of Ajilchin Road and West Industrial Road (reduced to 4 minutes from 20 minutes) ii) Reduction of VOC: 52 million MNT per day	i) Improvement of vehicular traffic movement and promotion of cargo movement. ii) Enhancement of convenience for residential/industrial estates at new development area in Southwest of Ulaanbaatar City and International Airport. iii) Facilitate development of west side of Ulaanbaatar City by means of developing the East-West Arterial Road, which contributes to sustainable development of Ulaanbaatar City. iv) Sustaining socio-economic activities in metropolitan area and improvement of accessibility to public facilities such as hospitals and schools. v) Reduction of car exhaust due to improvement of traffic speed and mitigation of adverse effects on the environment.

CHAPTER 16

CONCLUSION AND RECOMMENDATION

16.1 CONCLUSION OF PREPATORY SURVEY

- The Project is feasible from the viewpoints of technical, environmental and economic aspects. The Project fully complies with the Ulaanbaatar Master Plan and the Ajilchin Flyover will function as a part of an east-west major corridor in the prospective road network of Ulaanbaatar City.
- Realization of the Project will help to alleviate traffic congestion and save travel time in the Project area resulting in a significant economic effect.
- It is quite effective to apply advanced bridge construction technology from Japan pertinent to girder erection above the railway, piling work adjacent to the railway in service, construction of a stable structure with highly durable steel members and so forth.

16.2 RECOMMENDATION FOR IMPLEMENTATION OF THE PROJECT

- The Project Implementation Unit (PIU) shall be established under the Ministry of Roads and Transportation (Implementing Agency of Mongolian Government) when the detailed engineering design work commences to thoroughly manage the implementation of the Project including the construction of an 828 m long bridge.
- It is crucial to completely relocate existing utilities prior to commencement of construction work. To do so, it is necessary to identify the utilities to be relocated and execute actual relocation work at the stage of detailed engineering design. It is also necessary for Ulaanbaatar City to control the Project site so that no additional utilities are installed prior to project implementation.
- It is necessary to review and update a resettlement action plan at the stage of detailed engineering design in accordance with the final Right-of-Way. To thoroughly complete land acquisition prior to commencement of construction work, it is crucial to start resettlement actions along with detailed engineering design work.
- It is recommended to carry out i) widening of the road in front of Power Plant No. 3 to a 4-lane road and ii) grade separation of Ajilchin Road.
- A drainage design in an urbanized area shall be carefully studied in the detailed engineering design.
- After completion of the Project, maintenance will be managed by the Road Department in Ulaanbaatar City. Thus it is important that Ulaanbaatar City accumulates and improves its technologies necessary for steel bridge maintenance through several opportunities such as the Technical Cooperation Scheme implemented by JICA.