**MONGOLIA**
**MINISTRY OF ROAD, TRANSPORT, CONSTRUCTION AND URBAN DEVELOPMENT**

No.

# BASIC DESIGN STUDY REPORT
# ON
# THE PROJECT FOR
# CONSTRUCTION OF RAILWAY FLY-OVER
# IN ULAANBAATAR CITY
# IN
# MONGOLIA

December 2008

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**CTI ENGINEERING INTERNATIONAL CO. LTD.**

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# PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a basic design study on the Project for Construction of Railway Fly-Over in Ulaanbaatar City in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from March 20 to May 6, 2008.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Mongolia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the teams.

December 2008

Eiji HASHIMOTO
Vice-President
Japan International Cooperation Agency

# LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Construction of Railway Fly-Over in Ulaanbaatar City in Mongolia.

This study was conducted by CTI Engineering International Co., Ltd, under a contract to JICA, during the period from March 2008 to December 2008. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kenji MARUOKA
Chief Consultant
Basic Design Study Team on the Project for Construction of Railway Fly-Over in Ulaanbaatar City
CTI Engineering International Co., Ltd.

# SUMMARY

## 1. BACKGROUND AND BASIC CONCEPT OF THE PROJECT

"The Master Plan Study on Improvement and Rehabilitation of Road Network in Ulaanbaatar" was conducted by Japan International Cooperation Agency (JICA) in 1999 to formulate the master plan to improve the road network and traffic situation. The JICA study concluded that, in addition to the two (2) existing flyovers, a new railway flyover is required, as a part of the Middle Ring Road, to form an efficient road network and sustain the socio-economic activities in the area. However, the Mongolian side recognized certain difficulties in constructing a new railway flyover especially from the technical and financial viewpoints using their own funds. Under such circumstances, the Government of Mongolia (hereinafter referred to as "the GOM"), in June 2005, requested the Government of Japan (hereinafter referred to as "the GOJ") to implement the construction of the railway flyover project (hereinafter referred to as "the Project") under the Japanese Grant Aid Program.

In response to the application for Japanese Grant Aid, JICA dispatched the Preliminary Design Study Team to Mongolia three times, between February 2007 and November 2007, to conduct site surveys and hold discussions with the Mongolian side. Accordingly, the following points have been confirmed:

1. The Project, which will connect the northern and southern areas of Ulaanbaatar City, is urgently required to secure safe and reliable traffic.
2. The through-traveled lane of the new railway flyover will be 4-lane to accommodate the traffic demand which is presently large enough to justify the construction of a 4-lane road.
3. The request of the Mongolian side to procure equipment for construction and maintenance of the Project is set aside because necessity remains low.
4. The proposed location of the flyover is justified through the comparison of alternatives.
5. No involuntary relocation of project-affected-persons is found, while it is necessary to acquire land for the Project.

On the basis of the preliminary design study results, JICA decided to conduct the Basic Design Study for the construction of a flyover above the railway and Narny Zam, i.e., a grade separation structure connecting with Ikh Toyruu/Narny Zam and Engels Street. Accordingly, JICA dispatched the Basic Design Study Team to conduct the Study in Mongolia from March 20, 2008 to May 6, 2008.

## 2. STUDY RESULTS AND CONTENTS OF THE PROJECT

The Basic Design Study Team held discussions with the officials concerned of the GOM to confirm the contents of the request for Japanese assistance, and it also conducted a field study involving natural conditions, traffic situation, and procurement condition of construction materials and equipment.

After deliberations in Japan on the basic design and the results of the field study in Mongolia, JICA dispatched the Basic Design Study Team again to Mongolia, which discussed and explained the contents of the Draft Report from October 30, 2008 to November 6, 2008, including the engineering design, project implementation plan, project cost estimates and so on. The Mongolian side had consented to the contents of the Draft Report, including the undertakings that should be done without reservation by and under the responsibility of the GOM. The concepts of conclusive planning of the Project are as described below.

### (1) Extent of Work under Japanese Assistance

The Project consists of the construction of a railway flyover having the total length of 895 meters, including the construction of approach roads from Narny Zam, as well as from Ikh-Toyruu and Engels Street, to link the northern and southern areas of Ulaanbaatar City.

### (2) Road Planning

Traffic demand on the project road has been forecasted to be 45,500 PCU/day in 2017 and thus, a 4-lane flyover is justified from the viewpoint of traffic capacity. On/off ramps, which induce efficient dispersion of prospective traffic in the north–south direction, are to be installed to ensure smooth access from/to Narny Zam Street. The maximum grade of approach roads has been set at less than 5% to ensure climbing performance on slippery frozen surface as well as to mitigate accidents on the steep slope in winter season, as evidenced by the result of site survey on several road sections with steep gradient.

### (3) Bridge Planning

Since there are many underground utilities at the project site including main hot-water pipes (ϕ500 x 2), the horizontal alignment as well as location of respective abutments and piers has to be set to minimize effects to the existing underground facilities.

As for the superstructure, steel I-girder (4-beam) type has been adopted from the viewpoint of economic and traffic safety, especially because of lower girder height and gentler gradient of the approach road.

Steel multi-pillar type piers have been adopted from the economical aspect and driver's visibility at intersections. Based on the geotechnical investigation result, cast-in-place concrete pile is deemed appropriate for foundations, in principle, except for the limited application of rotary penetration steel pile for P4 near the railway.

### (4) Construction Schedule

The appropriate period for concrete-placing and asphalt paving is deemed to be from mid-May to mid-September based on the annual temperature records. Full utilization of such weather-free construction materials as structural steel and pre-cast concrete products has to be duly taken into consideration to pursue the shortest construction period, and the construction schedule has to be formulated based on the condition that manufacturing/pre-fabrication and construction/installation work can be done during winter and summer seasons, respectively.

**Summary of Scope of Construction Work**

| Section | Item | Description |
|---|---|---|
| **1. Railway Flyover** | | |
| | Bridge Length | 262 m (Span arrangement: 30+47+50+55+50+30 m) |
| | Type of Superstructure | 6-span Continues Steel I-Girder |
| | Erection Methods | Crane with Bent and Launching Method |
| | Type of Substructure | Abutment: RC Inverted-T type (A1/A2)<br>Pier: Steel Multi-Pillar Type (φ=1.5 m)<br>Foundation: Cast-in-Place Concrete Pile (φ=2.5 m): A1, A2, P1, P2, P3, P5<br>Rotary Penetration Steel Pile (φ=1.5 m): P4 |
| | Other Facilities | Street Lighting, Drainage |
| **2. North Approach Road** | | |
| | Road Length | 280 m |
| | Channelization Length | 428 m (East Side: 223 m; West Side: 205 m) |
| | Other Facilities | Drainage, Guardrail, Road Marking, Street Lighting, Skid-Resistant Pavement,Delineator |
| **3. South Approach Road** | | |
| | Road Length | 353 m |
| | U-Turn Road Length | 560 m |
| | Other Facilities | Drainage, Guardrail, Road Marking, Street Lighting,Delineator |
| **4. Intersection** | | |
| | Number of Intersections | 2 locations at the crossing point with Narrny Zam |
| | Other Facilities | Drainage, Guard-pipe, Road Marking, Street Lighting, Traffic Signal, Road Signboard |

## 3. SCHEDULE AND COST OF THE PROJECT

In case the Project is implemented with Japanese Grant Aid, the detailed design and tendering, including the preparation of tender documents and assistance in tender evaluation will take around nine (9) months, while the construction period will be around 37 months. Total cost to be borne by the Government of Mongolia required for the complete implementation of the Project has been estimated at 6,800 million Tg.

## 4. VERIFICATION OF PROJECT EFFECTS

The direct recipients of benefit and/or utilization of the Project are the 1.031 million residents in Ulaanbaatar City. The direct and indirect effects expected to be derived from the implementation of the Project are as follows:

### (1) Direct Effects (Effect Index)

- Construction of a safe and reliable flyover in Ulaanbaatar City (0→1)
- Shortening of travel distance between Peace Avenue and Chinggis Avenue (4.7km→1.8km)
- Alleviation of control to heavy vehicles in the north-south traffic (15-ton→40-ton)

### (2) Indirect Effects

- Improvement of vehicular traffic movement and promotion of cargo movement.
- Enhancement of convenience for residential/industrial estates and new international airport in the southern part of Ulaanbaatar City.
- Sustenance of socio-economic activities in metropolitan area and improvement of access to public facilities such as hospitals and schools.
- Reduction of car exhausts due to shorter vehicular travel time and alleviation of environmental burden.

The Project will contribute to: i) effective improvement of road network, as well as ii) improvement of quality of social life in Ulaanbaatar City. Accordingly, it is deemed justifiable to avail assistance through the Japanese Grant Aid Program for the implementation of construction of the Project. The Mongolian side has sufficient institutional capacity in terms of manpower and budget and thus, can sustain the maintenance work for the Project.

To assure the smooth implementation of the Project as well as realize the direct/indirect effects mentioned above, the GOM shall carry out its obligations without delay and reservation, as follows:

Prior to Commencement of Construction Work

- To acquire the necessary land for the Right-of-Way of the Project.
- To relocate existing utilities that will obstruct the construction of the Project.

Prior to Completion of the Project

- To improve the existing roads that will connect to the Project section implemented under Japanese Grant Aid, namely Ikh-Toyruu and Engels Street, into 4-lane arterial roads.

# Тойм

**1. Төслийг хэрэгжүүлэх үндэслэл**

ÆÀÉÊÀ 1999 îíä Óëààíáààòàð õîòûí àâòîçàìûí ñ¿ëæýýã ñàéæðóóëàõ åðºíõèé òºëºâëºãººã ñóäàëãààíû ¿íäñýí äýýð áîëîâñðóóëñàí áëýý. Ýíýõ¿¿ òºëºâëºãºº ¸ñîîð Äóíä òîéðóó çàìûã á¿ðýëä¿¿ëýõýä òºìºð çàì äýýã¿¿ð Èõ òîéðóó áà Ýíãåëüíèéí ãóäàìæóóäûã õîëáîõ ã¿¿ðýí ãàðö íü õîòûí àâòîçàìûí ñ¿ëæýýíä áîëîí íèéãìì, ýäèéí çàñãèéí òîãòîâðòîé ¿éë àæèëëàãààã õàíãàõäà ºíäºð à÷õîëáîãäîëòîé áîëîõ íü òîãîðõîé áîëíî.

2005 îíä Ìîíãîë óëñûí çàñãèéí ãàçàð Óëàáíààòàð õîòîä òºìºð çàì äýýã¿¿ðõ ã¿¿ðýí ãàðö áàðèõ òºñëèéã (öààøèä òºñºë ãýõ) áóöàëòã¿é òóñëàìæààð õýðýãæ¿¿ëýõ õ¿ñýëòèéã ßïîí óëñûí çàñãèéí ãàçàðò ãàðãàñàí þì. Òºñëèéã áóöàëòã¿é òóñëàìæààð õýðýãæ¿¿ëýõ ýíýõ¿¿ õ¿ñýëòèéã õàðãàëçàí ¿çýæ, ÆÀÉÊÀ óã òºñëèéí ñóäàëãààã ã¿éöýòãýõ çîðèëãîîð 2007 îíû 2-ð ñàðààñ 11-ð ñàðûí õîîðîíä Ìîíãîë óëñàä õýä õýäэн ñóäàëãààíû áàã àæèëëóóëñàí.

i) Төмөр замыг алгасан хотын урд хойд хэсгийг холбох гүүр нь хотын хөдөлгөөнийг аюулгүй найдвартай болгох үүднээс зайлшгүй шаардлагатай.

ii) Одоогийн замын хөдөлгөөний эрчмийг харгалзан зорчих хэсгийн эгнээний тоог 4 болгосноор илүү ач холбогдолтой.

iii) Монгол талын хүсэлтэнд орсон барилга ба засвар арчиллагааны тоног төхөөрөмжийн нийлүүлэлтийн хэрэгцээ бага тул тус төлөвлөгөөнд оруулахгуй.

iv) Гүүр барихаар товлосон газар нь байршиллын хувьд нэн тохиромжтой.

v) Нэг хэсэг газрын асуудал байгаа ч, олныг хамарсан нүүлгэн шилжүүлэлт гарахгуй.

Урьдчилсан судалгааны үр дүнг үндэслэж Японы засгийн газар баруун дөрвөн зам ба Хан-Уул дүүргийн Энгельсийн гудамжтай холбох гүүрэн гарцын үндсэн зураг төслийн судалгааг эхлүүлэн 2008 оны 3 сарын 20 -ооc 5 сарын 6 хүртэл үнсэн зураг төслийн судалгааг гүйцэтгэх багийг томилсон болно.

**2. Судалгааны үр дүн ба төслийн агуулга**

Судалгааны үеэр Монгол талын холбогдох байгууллагуудтай зөвшилцөж, хүсэлтийн агуулгыг дахин нягталж, байгаль орчны нөхцөл байдал (газар зүй, хөрс г.м.), хөдөлгөөний байдал (хөдөлнөөний эрчим, тэнхлэгийн даац, аялалын хурд), барилгын материал тоног төхөөрөмж нийлүүлэх нөхцөл зэрэг асуудлуудыг судалсан. ЖАЙКА тус судалгааны үр дүнг

үндэслэн Япондоо гүйцэтгэсэн үндсэн зураг төслийн тайланг 2008 оны 10-р сарын 30-ны өдрөөс 11 сарын 6-ны хоолонд танилцуулах багийг томилж, үндсэн зураг төслийн агуулга, Монгол талын хариуцах ажлын талаар зөвшилцөж, санал нэгдсэн болно. Төслийн ажил доорхи байдлаар явагдана.

- Төслийн хүрээ

  Буцалтгүй тусламжийн хамрах хүрээ нь, төмөр зам ба Нарны замыг давах гүүр ба холбох зам орсон хоёр түвшинд огтолцох гүүрэн гарц бөгөөд, холбох замууд нь одоо байгаа замуудтай нэг түвшинд нийлж Япон талын хийх ажлын нийт урт нь 895 м болно.

- Зам төлөвлөлт

  Гүүрэн гарцын зорчих хэсгийн эгнээний тоог, зам гүүрний ирээдүйн хөдөлгөөний хэрэгцээг өдөрт 45,500 PCU（2017он）гэж тооцон 4 эгнээгээр хийхээр шийдвэрлэсэн болно. Мөн гүүрнээс Нарны зам руу орох, гарах гарц хийснээр хөдөлгөөний урсгалын үр ашигтай хуваарилалт бий болно. Автозамын дагуу огтлолтын налууг, хотын нийт налуу замуудыг хэмжсэний үндсэн дээр, өвлийн улиралд өгсөх үеийн хальтиргаа үүсэхээс сэргийлэн 5% аас доош байхаар төлөвлөж байгаа.

- Гүүр төлөвлөлт

  Барилгын ажил явагдах талбай дотор дулааны шугамаас авахуулаад олон төрлийн инженерийн шугам сүлжээ газар доор байгаа тул эдгээр шугамуудад барилгын ажил хамгийн бага нөлөө үзүүлэхээр төлөвлөж байна. Гүүрний дээд бүтээц нь I хэлбэрийн төмөр ган нуруу бөгөөд, шийдэл нь эдийн засгийн хувьд хамгийн оновчтой. Гүүрний тулгуур нь суурилуулахад хялбар, эдийн засгийн хувьд оновчтой, замын уулзвар дахь үзэгдэх орчинг бүрдүүлсэн олон баганат ган тулгуур байна. Талбай дээр өрөмдлөгө хийж судалсаны үр дүнд, гадсан суурь хийхээр болсон боловч, төмөр замын рельсийн дэргэд суурилулах P4 тулгуур дээр эргэлтээр нэвтрэх ган хоолойн шон хэрэглэнэ.

- Гүйцэтгэлийн төлөвлөлт

  Хүйтний улирлын гаднах температурыг харгалзан, газар дээр бетон цутгах, замын хучилт зэрэг ажлуудыг 5-аас 9 сарын хооронд гүйцэтгэхээр төлөвлөсөн. Барилгын ажлыг богиносгох үүднээс урьдчилан цутгасан бүтээцүүдийг өргөнөөр хэрэглэж өвөлдөө цутгаж, зундаа угсрах ажлыг гүйцэтгэхээр төлөвлөгөөгөө боловсруулж байна..

**＜Нийт ажлын тойм＞**

| Хэсэг | Төрөл | Ажлын агуулга |
|---|---|---|
| **1.Гүүрэн гарц** | | |
| | Гүүрэн гарцын урт | 262 м【Алгасал：30+47+50+55+50+30 м】 |
| | Гүүрний төрөл: | 6 алгаслалтай I хэлбэрийн үргэлжилсэн ган дам нуруун гүүр |
| | Угсрах арга | Гинжит кран＋конвеерэн өргөлт |
| | Гүүрний доод бүтээцийн төрөл: | Захын тулгуур：Төмөр бетонон урвуу Т хэлбэрийн захын тулгуур（A1・A2）<br>Тулгуур：Олон баганат 4 ган тулгуур（φ=1.5 м）;<br>Суурь：A1, A2, P1～P3, P5 ;Цутгамал шон（φ=2.5 m）<br>P4；Эргэлтээр нэвтрэх ган хоолойн шон（φ=1.5 m）、 |
| | Дагалдах байгууламж: | Гэрэлтүүлэг, борооны ус зайлуулах байгууламж |
| **2.Хойд талын дөхөх зам** | | |
| | Замын урт: | 280 м【Далантай хэсэг：110 м, далангүй хэсэг：170 м】 |
| | Зангилаа замын урт: | 428 м【Зүүн чиг：223 м、баруун чиг：205 м】 |
| | Дагалдах байгууламж: | борооны ус зайлуулах байгууламж, хамгаалтын хашлага, замын тэмдэг, замын гэрэлтүүлэг, шарвалтыг эсэргүүцэх хучилт, замын тэмдэглэгээ |
| **3.Урд талын дөхөх зам** | | |
| | Замын урт: | 353 м【Далантай хэсэг：208 м, далангүй хэсэг：145 м】 |
| | Буцаж эргэх хэсгийн урт: | 560 м |
| | Дагалдах байгууламж: | борооны ус зайлуулах байгууламж, хамгаалтын хашлага, замын тэмдэг, замын гэрэлтүүлэг, шарвалтыг эсэргүүцэх хучилт, замын тэмдэглэгээ |
| **4.Замын уулзвар** | | |
| | Уулзварын тоо: | 2 уулзвартай: Зангилааны хэсэг ба Нарны замын уулзвар |
| | Дагалдах байгууламж: | борооны ус зайлуулах байгууламж, хамгаалтын хашлага, замын тэмдэг, замын гэрэлтүүлэг, гэрлэн дохио, замын тэмдэглэгээ |

**3. Төслийн хугацаа ба зардал**

Тус төслийг Япон усын буцалтгүй тусламжийн хүрээнд хэрэгжүүлэхээр болсон тохиолдолд гүйцэтгэлийн зураг төсөл ба тендерийн материал бэлтгэл ба үнэлгээнд 9 сар, барилгын ажилд 37 сарын хугацаа зарцуулахаар төсөөллөж байна. Монгол талын хариуцах ажлын зардал 6,8 тэрбум төгрөг болохоор тооцоолж байна.

**4. Төслийн үр нөлөө**

Тус төслийн шууд үр ашгийг Улаанбаатар хотын нийт хүн ам хүртэх бөгөөд, доорхи үр нөлөө гарна гэж таамаглаж байна:

(1) Шууд үр ашиг

- Уг төслөөр Улаанбаатар хотод аюулгүй, найдвартай гүүр баригдах тул, төмөр замын гарам ашиглах эрсдэлгүй бөгөөд төвөггүй хотын урд хойд хэсэг рүү зорчих боломж нээгдэж хотын урд хойд хэсэг рүү явах хөдөлгөөн саатах аюул багасна.
- Энх тайваний өргөн чөлөө（Баруун 4 зам）- Чингисийн өргөн чөлөө （Үйлдвэрийн цагаан хаалга）хооронд 4.7 км замыг 1.8 км-ээр богино болно.
- Гүүрэн гарцын даац 15 аас 40 хүртэл тонн тул Гурвалжингийн гүүр ба Энх-Тайваний гүүрүүдийн ачаалалыг бүрэн үүрэх чадвартай.

(2) Шууд бус үр ашиг

- Хот доторхи хөдөлгөөний урсгал сайжирснаар, ачаа тээвэрлэлт нэмэгдэнэ.
- Шинэ орон сууцны хороолол, нисэх онгоцны буудал, үйлдвэрийн район зэрэг газруудын оршин суугч ба ажил эрхлэгчидэд хотын хойд хэсэг рүү аялах нь илүү хялбар болно.
- Нийгэм эдийн засгийн үйл ажиллагаа жигдэрч, эмнэлэг, сургууль зэрэг олон нийтийн үйлчилгээний газар руу хүрэх зам илүү дөхөм болно.
- Аялах зам богино болсноор машины хорт хий багасаж орчинд үзүүлэх агаарын бохирдлын нөлөө буурах найдвар төрж буй.

Уг төсөл нийслэлийн автозамын сүлжээг сайжруулахаас гадна олон нийтийн аж амьдралыг сайжруулахад нөлөө үзүүлнэ. Мөн гүүрний ашиглалт, засвар арчлалтыг хийхэд Монгол талын боловсон хүчин бүрэн чадвартай, төсөв мөнгөний тал дээр асуудалгүй тул, уг төслийг Япон улсын буцалтгүй тусламжийн хүээнд хэрэгжүүлэх нь зөв гэж үзэж байгаа.

Төслийг саад бэрхшээлгүй хэрэгжүүлж, дээр дурьдсан үр ашгүүдийг хүртээл болгохын тулд Монгол талын гүйцэтгэх ажлын хүрээнд газар талбайг бэлдэх, газар доорхи инженерийн шугам сүлжээнүүдийг барилгын ажил эхэлхээс өмнө нүүлгэн шилжүүлэх, мөн барилгын ажил дуусахаас өмнө уг төсөлд хамрах хүрээний урд хэсэгт Энгэльсийн гудамж ба хойд хэсэгт Их тойруугийн замыг 4 эгнээтэй болгох ажил үүргийг биелэх ёстой.

**BASIC DESIGN STUDY**
**ON**
**THE PROJECT**
**FOR**
**CONSTRUCTION OF RAILWAY FLY-OVER**
**IN ULAANBAATAR CITY**
**IN MONGOLIA**

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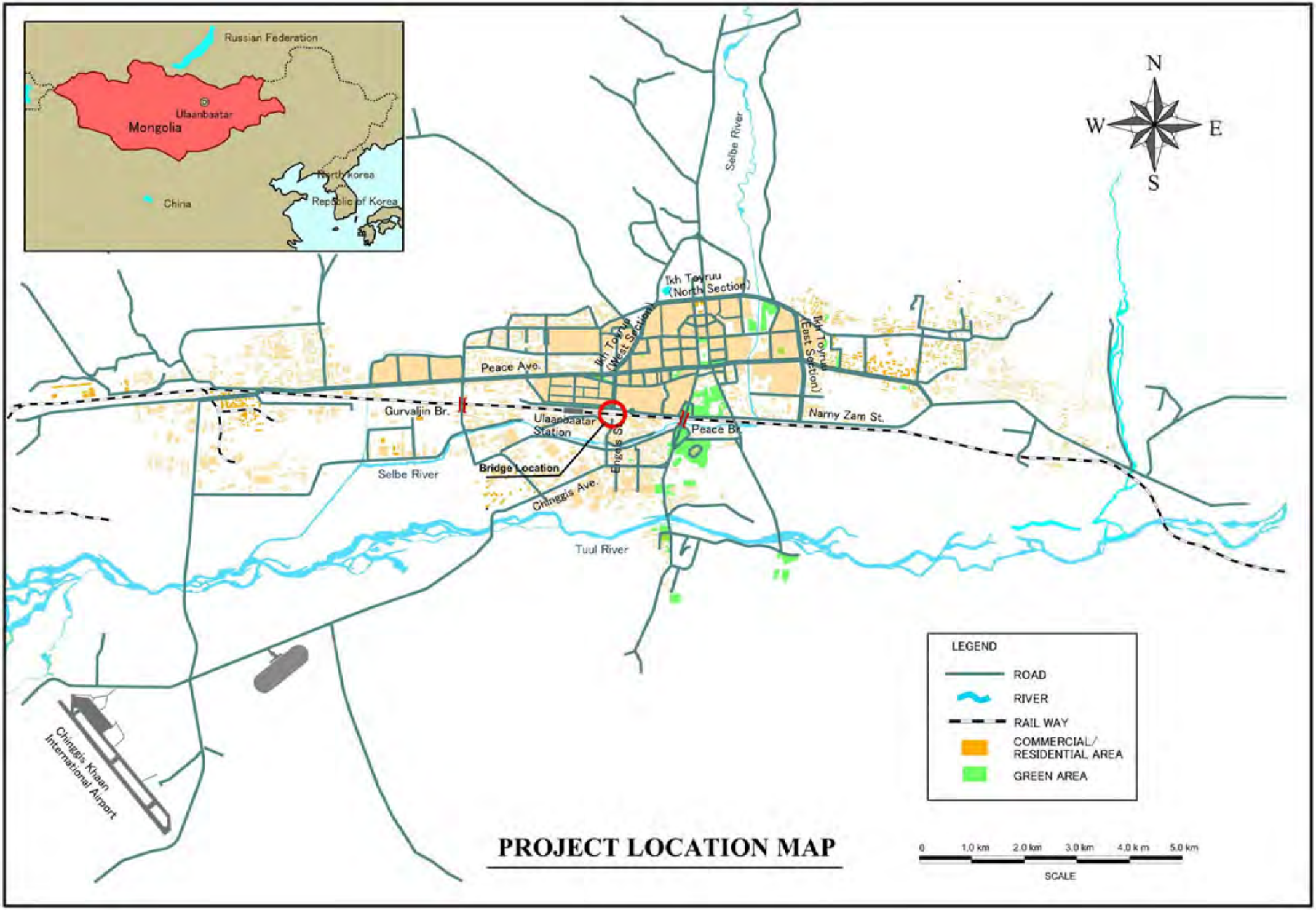
Russian Federation
Ulaanbaatar
Mongolia
China
North Korea
Republic of Korea
N
W
E
S
Selbe River
Ikh Toyruu (North Section)
Ikh Toyruu (West Section)
Ikh Toyruu (East Section)
Peace Ave.
Gurvaljin Br.
Ulaanbaatar Station
Bridge Location
Engels St.
Peace Br.
Narny Zam St.
Selbe River
Chinggis Ave.
Tuul River
Chinggis Khaan International Airport
LEGEND
ROAD
RIVER
RAIL WAY
COMMERCIAL/ RESIDENTIAL AREA
GREEN AREA
PROJECT LOCATION MAP
0
1.0 km
2.0 km
3.0 km
4.0 km
5.0 km
SCALE

**PERSPECTIVE**

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# ABBREVIATIONS

## A. Organization

| | |
|---|---|
| AASHTO | American Association of state Highway and Transportation Officials |
| ADB | Asian Development Bank |
| ASTM | American Society for Testing and Materials |
| DOR | Department Of Roads |
| EOJ | Embassy OF Japan |
| GOJ | Government Of Japan |
| GOM | Government Of Mongolia |
| JGS | Japan Geometrical Society |
| JICA | Japan International Cooperation Agency |
| MOFE | Ministry Of Finance and Economy |
| MRTCUD | Ministry Of Road, Transport, Construction and Urban Development |
| MRTT | Ministry of Road Transport and Truism |
| RIRC | Road Inspection and Research Center |
| UB | Ulaanbaatar |
| WB | World Bank |

## B. Others

| | |
|---|---|
| A/P | Authorization to Payment |
| B/A | Banking Arrangement |
| BC | Box Culvert |
| BH | Borehole |
| BP | Beginning Point |
| Br. | Bridge |
| ℃ | Degree Celsius |
| CBR | California Bearing Ratio |
| CC. | Cubic Capacity |
| cm or CM | Centimeter |
| D/D | Detail Design |
| DEIA | Detailed Environmental Impact Assessment |
| ECC | Environmental Clearance Certification |
| EIA | Environmental Impact Assessment |
| EL | Elevating |
| E/N | Exchange of Notes |

| | |
|---|---|
| EP | End Point |
| F/S | Feasibility Study |
| GDP | Gross Domestic Product |
| GL | Ground Level |
| GNP | Gross Nation Product |
| GVW | Gross Vehicle Weight |
| H | Height |
| Ha | Hectare |
| h , hr | Hour |
| HWL | High Water Level |
| I/C | Inception Report |
| JIS | Japanese Industrial Standard |
| kg or KG | Kilogram |
| Kh | Horizontal Seismic |
| km or KM | Kilometer |
| Kw | Kilowatt |
| ℓ or l | Litter |
| m or M | Meter |
| Mil. | Million |
| mm or MM | Millimeter |
| M/P | Master Plan |
| N | N. Value |
| No. , Nos. | Number |
| ODA | Official Development Assistance |
| PC | Pre-stressed Concrete |
| PCU | Passenger Car Unit |
| RC | Reinforced Concrete |
| S | Scale |
| Sec | Second |
| STA | Station |
| T | Ton |
| Tg | Tugrik |
| TL | Traffic Load |
| UB | Ulaanbaatar |
| US $ | United States Dollar |
| V | Voltage |

| | |
|---|---|
| Veh / day | Vehicle per Day |
| W / F | Weight Factor |
| % | Percent |
| σc | Concrete Compressive Stress |
| σca | Concrete Allowable Comp |
| σck | Concrete Specified Compression Strength |
| σpy | Concrete Yield Point Stress |
| σs | Steel Compressive Stress |
| σsa | Steel Allowable Compressive Stress |
| Φ , φ | Diameter |

# CHAPTER 1 BACK GROUND OF THE PROJECT

The study “the Master Plan Study on Improvement and Rehabilitation of Road Network in Ulaanbaatar” was conducted by JICA in 1999 to formulate the master plan to improve the road network and traffic situation. It was concluded by the JICA study that, in addition to the two (2) existing flyovers, a new railway flyover is required, as a part of the Middle Ring Road in the aspect of forming efficient road network and sustaining socio-economic activities. However the Mongolian side recognized certain difficulties in constructing a new railway flyover, especially, from the technical and financial viewpoints using their own funds. Under such circumstances, the Government of Mongolia (hereinafter referred to as “the GOM”), in June 2005, requested the Government of Japan (hereinafter referred to as “the GOJ”) to implement the construction of the railway flyover project (hereinafter referred to as “the Project”) under the Japanese Grant Aid Program.

In response to the application for Japanese Grant Aid, JICA dispatched a preliminary study team to Mongolia on three occasions between February 2007 through and November 2007, to conduct site surveys and hold discussions with the Mongolian side. Accordingly, the following points have been confirmed:

1. The Project, which will connect the northern and southern areas of Ulaanbaatar City, is urgently required to secure safe and reliable traffic.
2. The through traveled lane of the new railway flyover will be 4 lane to accommodate the traffic demand which is presently large enough to justify the construction of a 4 lane road.
3. The request of the Mongolian side to procure equipment for construction and maintenance of the Project is set aside because necessity remains low.
4. The proposed location of the flyover is justified through the comparison of alternatives.
5. No involuntary relocation of project affected persons is found, while it is necessary to acquire land for the Project.

On the basis of the Preliminary Design Survey results, JICA decided to conduct a Basic Design Study for the Project (hereinafter referred to as "the Study") and dispatched the study team to Mongolia from March 20, 2008 through May 6, 2008. The study team held discussions with the officials concerned of the GOM to confirm the contents of request, and conducted a field study with reference to natural conditions, traffic situation, procurement condition of construction material and equipment.

After deliberations in Japan on the basic design and the results of the field study in Mongolia, JICA dispatched the Basic Design Study Team again to Mongolia, from October 30, 2008 to November 6, 2008 to explain the draft report after conducting studies extended to engineering design, project implementation plan, project cost estimates and so forth. The Mongolian side had consented to the contents of the Draft Report, including the undertakings that should be done without reservation by and under the responsibility of the GOM through a series of discussion.

# CHAPTER 2 CONTENTS OF THE PROJECT

## 2-1 BASIC CONCEPT OF THE PROJECT

### (1) Objective of the Project

The flyover and approach roads to be constructed under the Project will constitute a part of the Middle Ring Road encompassing the central business district of Ulaanbaatar City. The objective of the Project is to ensure safety and smooth vehicular traffic in Ulaanbaatar City by complimenting the two (2) existing and degraded railway flyover bridges located along the arterial road.

### (2) Project Overview

The Project as planned is to construct a flyover above the railway and Narny Zam, i.e., a grade separation structure connecting with Ikh Toyruu / Narny Zam and Engels Street, to achieve the above objective. The end result will be a high security and reliable railway flyover constructed in Ulaanbaatar City to mitigate the restriction on large vehicular traffic and to shorten travel time in the area. Among the Project's scope of work, the portion to be implemented under Japanese Grant Aid will be the construction of the 895 meter long road, including a railway flyover bridge, as shown in Table 2-1-1.

**Table 2-1-1 Requested Items and Study Results**

| | GOM Requested Items | JICA Study Results |
|---|---|---|
| Number of Lanes | 2 | 4 |
| Road Length | 990 m | 895 m |
| Bridge Length | 275 m | 262 m |
| Type of Superstructure | Continuous Steel I-Girder (2-Beam) | Continuous Steel I-Girder (4-Beam) |
| Type of Substructure | N.A. | Steel Multi-pillar Pier |
| Type of Foundation | N.A. | Pile Foundation |
| Erection Method | N.A. | Crane with Bent and Launching Method |
| Procurement of Equipment | Construction Equipment | N.A. |

Note: N.A. means not applicable.

As can be seen in Table 2-1-1, the original request of the GOM was for a 2-lane road. However, during the series of discussions in the preliminary study stage, the Mongolian side strongly requested the Japanese side to revise this into 4-lane in order to ensure traffic safety on the approach roads, as well as at merging/diverging points of access to Narny Zam. The results of the Study summarized in Table 2-1-1, therefore, comprise the scope of work for the portion of the Project that will be undertaken with Japanese Grant Aid based on such major findings as traffic demand forecast, study on practicability and construction economy, and comparison of bridge type alternatives.

## 2-2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

### 2-2-1 Design Policy

#### (1) Basic Policy

Through the comparative study and evaluation of five (5) alternative locations during the Preliminary Design stage, the location of the railway flyover has been selected as the place that will connect with Ikh Toyruu / Narny Zam and Engels Street in conformity with the request of the Mongolian side. The basic policies on the framework and scope of the Project are described below.

**a) Extent of the Work covered by Japanese Assistance**

The portion of the Project that will be covered by Japanese assistance is the grade separation section consisting of the railway flyover bridge and the approach roads which will connect with Ikh Toyruu and Engels Street to link the northern and southern areas of Ulaanbaatar City. The beginning and ending points of each approach road are the places where the elevation and cross-section of the approach road coincide with the existing road.

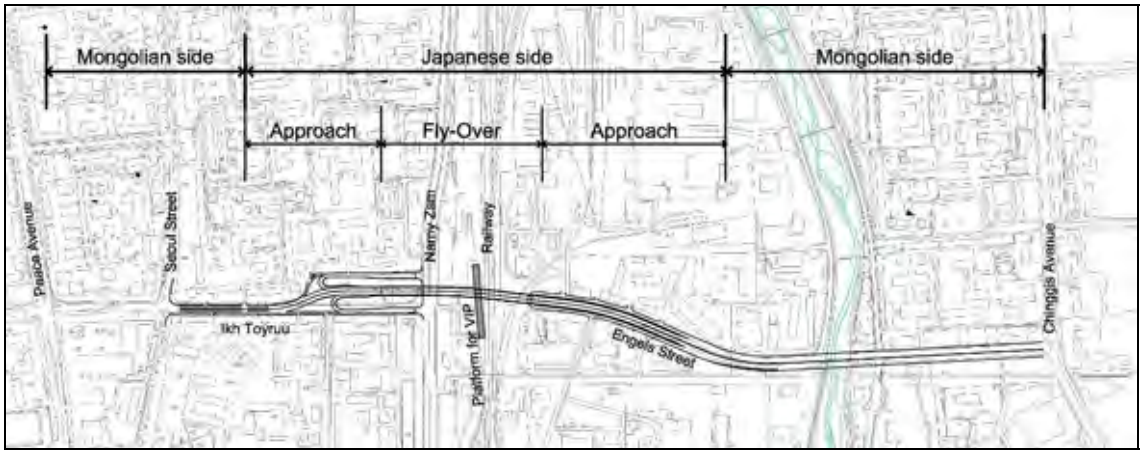



**Figure 2-2-1 Extent of the Project**

**b) Request for Procurement of Construction Equipment**

The request to procure equipment for construction and maintenance of the Project has been set aside from the Project based on the result of discussions held between the Mongolian side and the Preliminary Study Team.

**c) Road Improvement by the Mongolian Side**

The Project is planned to be a 4-lane arterial road as a result of the strong request from the Mongolian side to revise the specification into 4-lane from the 2-lane originally

requested in the preliminary study stage. Accordingly, the necessary widening of Engels Street from 2-lane to 4-lane and the improvement of Ikh Toyruu Street shall be carried out concurrently without reservation by and under the responsibility of the Mongolian side. Therefore, the basic plan of the Project has been formulated based on the condition that the above works will be implemented without delay.

**(2) Natural Condition**

Temperature in Ulaanbaatar City fluctuates in the range of 40°C to +40°C; hence, the project structures have been designed taking the severe variation of weather condition into account. As for the construction schedule, it has been formulated by making full use of weather free works such as manufacturing of steel structures and pre casting of concrete products to minimize the construction period. Furthermore, the latest Mongolian Standard has been applied to the seismic design of the railway flyover to assure safety against earthquake.

**(3) Condition of Construction and Procurement**

Eighty percent (80%) of construction materials in Mongolia are currently being imported from third countries, especially China. Due to the increment of domestic demand for construction materials in China, however, an unstable supply of materials from China might occur which will result in uncertain procurement of construction materials for the Project. Accordingly, it will be necessary to procure construction materials and equipment from reliable suppliers in Japan and/or other third countries.

**(4) Utilization of Local Contractor**

There is only one university in Mongolia having a department of civil engineering under its faculty of engineering, and graduates of this university are either working in government organizations or have become employees of foreign enterprises. Besides, local contractors originally founded as state owned public corporations in Mongolia have privatized as Mongolia shifted to market economy in the 1990's. Approximately 145 local contractors are presently registered with license in road construction work.

Although local contractors have no substantial experience in steel bridge construction work and only a few engineers have the necessary expertise for specialized works, it may be possible to involve a local contactor in the approach road construction work, particularly, the pavement and drainage system.

### (5) Road Operation and Maintenance

UBZZ which is the implementing agency for road maintenance under the Ulaanbaatar City Government has much experience on road pavement work but less experience on systematic bridge maintenance. Hence the type of bridge which requires simple maintenance has been selected while it will be necessary for UBZZ to develop its capacity on bridge maintenance work.

### (6) Road Planning

Traffic demand on the project road has been forecasted to reach 25,600 PCU/day at the 2007 traffic situation on the assumption that the railway flyover is completed to connect with Ikh Toyruu/Narny Zam and Engels Street. In addition, the traffic demand in 2017 has been projected to reach 45,500 PCU/day. Since the 2-lane flyover originally requested by the Mongolian side will not be able to meet the traffic demand forecast, the revision into a 4-lane flyover is justified from the viewpoint of traffic capacity.

**Table 2-2-1 Traffic Demand Forecast at the 2007 Level on Railway Flyover (PCU/day)**

| | A: Traffic Before Flyover | B: Traffic After Flyover | B/A |
|---|---|---|---|
| Gurvaljin Bridge | 21,500 | 20,400 | 95% |
| Peace Bridge | 48,200 | 37,900 | 79% |
| Railway Flyover | 0 | 25,600 | - |
| Ikh Toyruu | 31,100 | 33,900 | 109% |
| Engels Street | 3,000 | 16,800 | 560% |
| Narny Zam, East | 56,300 | 55,100 | 98% |
| Narny Zam, West | 29,100 | 29,600 | 102% |

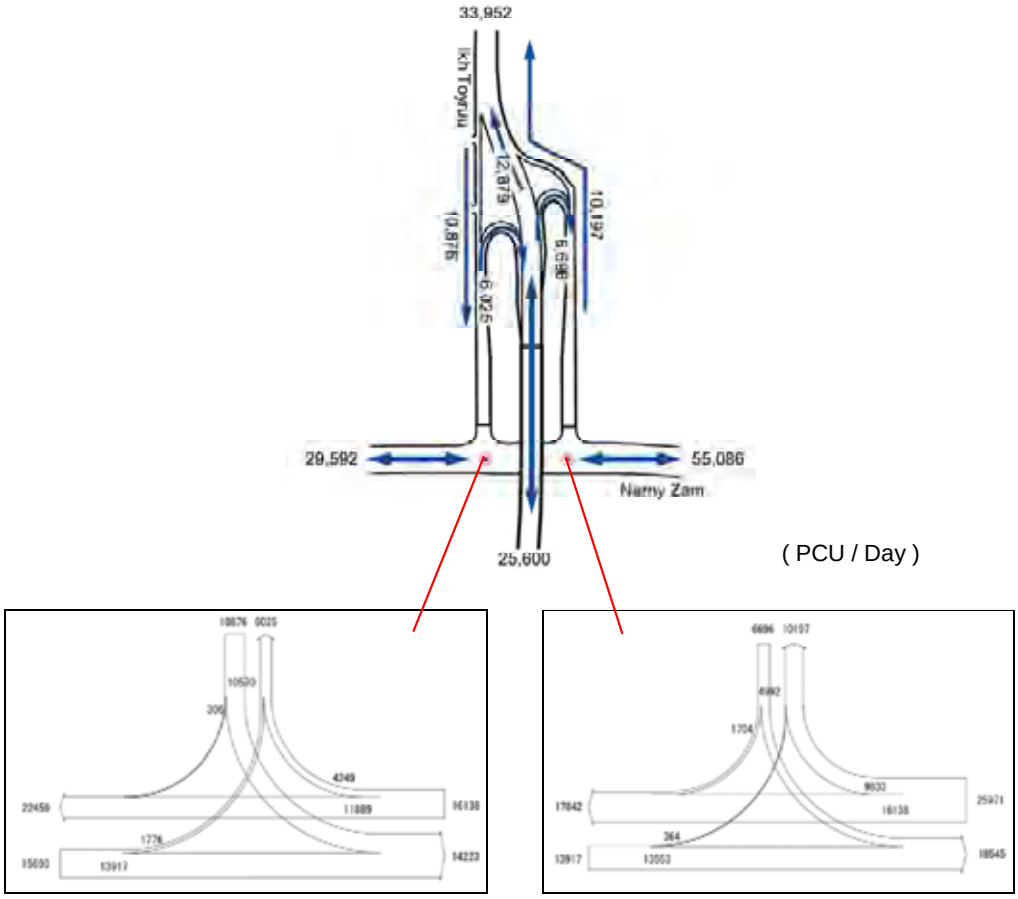



**Figure 2-2-2 Directional Traffic Movement at Intersections on Narny Zam**

## (7) Bridge Planning

### 1) Traffic Safety Aspects

#### a) Maximum Grade

The site survey has revealed that the road sections having problems due to steep slopes are Sansar Tunnel (6.4%) and Chingunjav Street (5.8%), while the roads having lesser problems are Khusgol Street in front of Geser Temple (5.1%), East Cross on Ikh Toyruu (5.0%), Ard Ayush Avenue (4.9%), Amarsanaa Street (4.0%), Gurvaljin Bridge (4.0%), and Peace Bridge (3.7%).

Based on the above, the maximum grade of 5% shall be set for approach roads, considering the risks against climbing performance on slippery road in winter season due to frozen surface and the high accident rate on steep slopes.

**b) High Visibility with Sufficient Sight Distance at Intersection**

The abutment in the vicinity of Narny Zam shall be set 100 meters away from Narny Zam to secure sufficient sight distance, and the multi pillar type shall be adopted for the pier beside Narny Zam to improve visibility.

The former is warranted by the reason that it is necessary to keep sufficient sight distance for traffic safety where roads for channelization run parallel to the railway flyover and approach to the intersection with Narny Zam, while the latter is justified by the fact that predominant directional traffic movement occurs between Ikh Toyruu and Narny Zam (East Side) and the multi pillar pier type will secure high visibility at the intersections.

**2) Underground Utilities**

Hot-water main pipes (ϕ500 x 2) exist 1.0 m deep beneath former bus terminal running north-southward along Ikh Toyruu. The pipes are covered with heating insulator of asbestos and splash prevention of asbestos is rather difficult in Mongolia provided that relocation of pipe requires dismantle and/or removal of heating insulator.

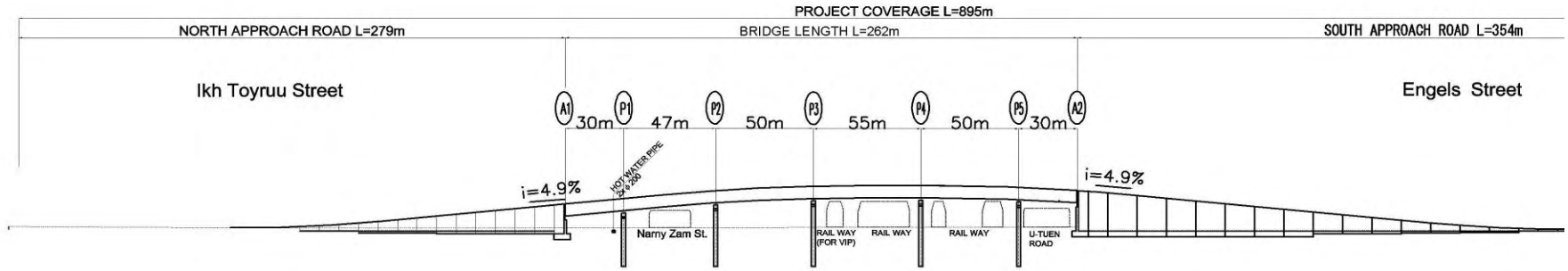
Horizontal alignment is set to avert the hot water pipes, and location of pier and abutment is selected taking into account that pipe relocation requires another budget allocation and takes time to adversely affect the project implementation schedule.

It was confirmed that the affected utilities would be relocated under the responsibility of the Mongolian side prior to the commencement of flyover construction work.

**3) Location of Pier and Erection Method of Girder**

The railway flyover will be 262 meters long, comprising six (6) spans with two (2) abutments and five (5) piers. As shown in Table 2-2-2, the girder erection method without traffic disturbance has been selected depending on the condition of the site.

**Table 2-2-2 Location of Pier and Erection Method**




| Span | | Site Condition and Design Policy | Erection Method |
|---|---|---|---|
| A1 – P1 | 30 m | - Setting of horizontal alignment to avoid underground pipes.<br>- Adoption of multi-pillar type to improve visibility.<br>- Setting of abutment to secure sufficient sight distance. | Crane with Bent |
| P1 - P2 | 47 m | - Setting of pier location outside the sidewalk for the flyover at Narny Zam .<br>- Maintenance of existing traffic on Narny Zam in the range of 30,000 to 50,000 vehicles.<br>- Providing P2 with staircase for the access of pedestrians. | Crane with Bent |
| P2 - P3 | 50 m | - Setting of foundation of P2 so as not to affect underground drainage and cables.<br>- Setting of location of P3 within the premises of VIP Platform. | Crane with Bent |
| P3 - P4 | 55 m | - Construction of flyover at main lines and branch lines of railway.<br>- Maintenance of existing traffic of 34 daily railway operations.<br>- Maintenance of existing traffic in shunting yard.<br>- Control of railway operation for neighboring construction work. | Launching Method |
| P4 - P5 | 50 m | - Construction of flyover at branch lines of railway.<br>- Maintenance of existing railway traffic to private factory. | Crane with Bent |
| P5 - A2 | 30 m | - Provision of frontage road for access to adjacent areas.<br>- Setting of abutment to secure sufficient space for the U-turn of container vehicles on Engels Street | Crane with Bent |

**4) Bridge Design Approach**

Bridge planning has been made by referring to the results of the survey on structural soundness of existing bridges and the lessons learned from actual practices.

**i) Construction Economy**

Since the railway flyover consists of six (6) spans and the joints are apt to suffer damage, the continuous steel bridge type has been selected to minimize not only the construction cost due to the shorter construction period but also the maintenance cost by eliminating the weak points vulnerable to structural damage

**ii) Practicability**

Frigid weather conditions with daily average temperature below 0°C last for five months from November through March at the project site. It is, therefore, important to increase work efficiency by applying the appropriate construction method that would enable full performance of weather-free works, e.g., manufacturing of steel structures and pre-casting of concrete products. However, bridge surfacing and asphalt paving works for which site works are indispensable and sound quality control must be employed should be finished by the middle of September.

**iii) Traffic Safety**

Traffic safety measures on both road and railway shall be taken appropriately, especially for the railway connecting Russia and China which need to be secured definitely from accidents caused by the erection of girders. Since the current traffic arises from the 34 daily railway traffic operations with additional operation at the shunting yard, the time that could be secured for construction work involving the control of railway operations (called “window time”) will only be four (4) hours in nighttime at the project site. Taking the above circumstances into consideration, the safest and most reliable construction method that could complete girder erection on the railway in one night shall be employed.

**iv) Ease of Maintenance**

High durability shall be given high priority on the selection of bridge materials to ease the burden imposed on maintenance work under severe weather condition with temperatures fluctuating between -40°C and +40°C

causing frost damage, since the project site is located in the central business district with heavy traffic.

**v) Durability**

The Steel-Concrete Composite Deck Slab Type is proposed to secure high durability. High durability and performance could be secured by i) arranging proper girder position against wheel track, ii) selecting an expansion joint that would minimize sliding displacement, and iii) adopting quality paint to optimize life-cycle cost.

**vi) Bridge Design against Seismic Force**

The continuous girder is proposed to lessen the risk of bridge collapse in the central business district of Ulaanbaatar, where it is necessary to abate traffic disturbance by bridge collapse caused by excessive seismic force beyond the seismic design standard in Mongolia.

### (8) Construction Planning

**a) Reliable Transportation**

Construction planning shall be made considering i) importance of maintaining the existing traffic at both railway and road and ii) practicability of a reliable construction method. In case construction materials and equipment are transported by railway through China, it will be necessary to transship them at the Zamin Uud Station in Mongolia due to the difference in railway gauges (Mongolia: 1,520mm; China: 1,435 mm). Through the study, it has been confirmed that all necessary materials and equipment could be transported without delay. The Steel I Girder (4 Beam) could be selected on condition that neither problem nor risk has been confirmed regarding transportation and transshipment.

**b) Optimum Construction Period**

Full utilization of weather free works such as manufacturing of steel structures and pre casting of concrete products shall be taken into account in the construction planning to minimize the construction period under the premise that no major site work is expected during winter season.

Cement concrete placing shall be done at site within four (4) months, from the middle of May to the middle of September. Therefore, construction planning has to be made on condition that cement concrete placing is not in the critical path by setting the optimum number of formworks together with their appropriate recycle to meet volume requirements.

Furthermore, it is necessary that bridge surfacing and asphalt paving works shall be completed by the middle of September in case the actual project implementation plan is made.

**c) Optimization of Project Cost**

Project cost has been estimated with high rationality and relevance based on optimized construction period stemmed from practicability with a reliable construction method. It is concluded that, as far as practicability is secured, a shorter construction period will contribute to the optimization of project cost, considering the salient features such as importing almost all materials and equipment, idling of imported equipment in winter, and price escalation of steel and oil products as a worldwide tendency.

### (9) Environmental and Social Considerations

In the scoping of IEE conducted in preliminary study stage, several environmental elements were classified to Rank B (potential adverse environmental impact to some extent) or most serious category, Rank A. Through sound review of the said scoping, comprehensive measures against potential adverse environmental impact are proposed as listed in Table 2-2-3 corresponding to planning and implementation stages. The same Table 2-2-3 also contains the proposed timing and methodology of necessary monitoring on the measures for minimization and reduction of anticipated environmental impact during construction.

**Table 2-2-3 Measures for Minimization of Adverse Environmental Impact**

| | Items | Specific Issues | Measures to be taken | Monitoring Method | | |
|---|---|---|---|---|---|---|
| | | | | Before Construction | During Construction | After Construction |
| 1 | Business Activity/ Livelihood | Effect on Commercial Establishment at the Construction Site | • Secure the entrance to keep the way for guest who is going to the building.<br>• Cleaning of site in front of the commercial building.<br>• Adjustment of the vertical interval between side walk and entrance of the buildings. | Checking of Construction Plan | Supervision of Implementation | Final Inspection |
| 2 | Traffic/ Lifeline | Effect on traffic control of existing road and railway during construction | • To select a construction method to shorten the construction period.<br>• Detour and security guard for Narny Zam shall be provided during the erection of girder over the road.<br>• Launching Method will be selected to complete the girder erection within 4-hour that has been agreed by Railway Authority as the Window Time | Checking of Construction Plan | Supervision of Implementation | — |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Landownership/ Water Concession/ Commonage | Consideration on commercial building near the intersection of Narny Zam | • Secure the entrance to keep the way for guest who is going to the building.<br>• Cleaning of site in front of the commercial building. | Checking of Construction Plan | Supervision of Implementation | — |
| 4 | Casualty/ Infection | • Accident on the railway during construction<br>• damage at underground utilities<br>• Increasing of infections in works for the construction | • Pre-meeting with Railwa Authority and placing strict security control shall be undertaken.<br>• Confirmation of relocation plan of under ground utilities.<br>• To ensure the health and security control by the Contractor<br>• Instruction and education regarding the infection to workers | Checking of Construction Plan | Supervision of Implementation | — |
| 5 | Beings/ Biogeocenosis | Trimming of existing tees due to construction of pier. | • Multi pillar type pier has been selected to minimize occupied space by structure.<br>• To hold the meeting with Ulaanbaatar City to induce new tree plant. | Checking of Construction Plan | — | — |
| 6 | Landscape | Change of landscape due to new bridge | • Securing high visibility in urban area by adopting Steel Multi-pile Pier<br>• Lessening oppression stemmed from high embankment by adopting lower abutment<br>• Selecting optimum color of superstructure to harmonize with urban landscape | Discussion with Ulaanbaatar city | — | — |
| 7 | Atmospheric Contamination | Air contamination by exhausted gas from construction machine | • Proper operation of vehicles for construction works<br>• Maintenance and inspection of vehicles for construction works<br>• Alleviating adverse impacts brought by fugitive dust by operation of water sprinkler trucks | Checking of Construction Plan | Supervision of Implementation | — |
| 8 | Water Contamination | Waste water arising from construction site. | • Discharge waste water into existing drainage after proper treatment<br>• To construct a retention facility for oil and fuel for exclusive use. | Checking of Construction Plan | Supervision of Implementation | — |
| 9 | Soil Contamination | Infiltrate of waste water arising from construction site | | | | |
| 10 | Waste | • Disposal of construction waste<br>• Human waste arise from workers. | • Disposing construction wastes to designated places<br>• Setting of toilet and management of waste dumping. | Checking of Construction Plan | Supervision of Implementation | — |
| 11 | Noise and Vibration | Noise and Vibration arising from construction equipment | • Restricting working hours at night<br>• Utilizing oil pressure equipment or non-vibration glove-hammer for excavation of cast-in-place piles | Checking of Construction Plan | Supervision of Implementation | — |
| 12 | Smell | Exhausted gas from Construction Equipment | • Proper operation of vehicles for construction works<br>• Periodic maintenance and inspection of vehicles for construction works | Checking of Construction Plan | Supervision of Implementation | — |
| 13 | Traffic Accident | • Accident risk on heavy vehicle for construction<br>• Accident risk on girder erection | • Prior consultation with railway authority and traffic police<br>• Proper arrangement of guard position<br>• Prior notice to road and railway users by public relations | Checking of Construction Plan | Supervision of Implementation | — |

## 2-2-2 Basic Plan

### (1) General

#### a) Extent of Project Section under Japanese Grant Aid

The extent of the Project section will be 895 meters, consisting of i) railway flyover of 262 m and ii) approach roads totaling 633 m (North side: 280 meters; South side: 353 meters).

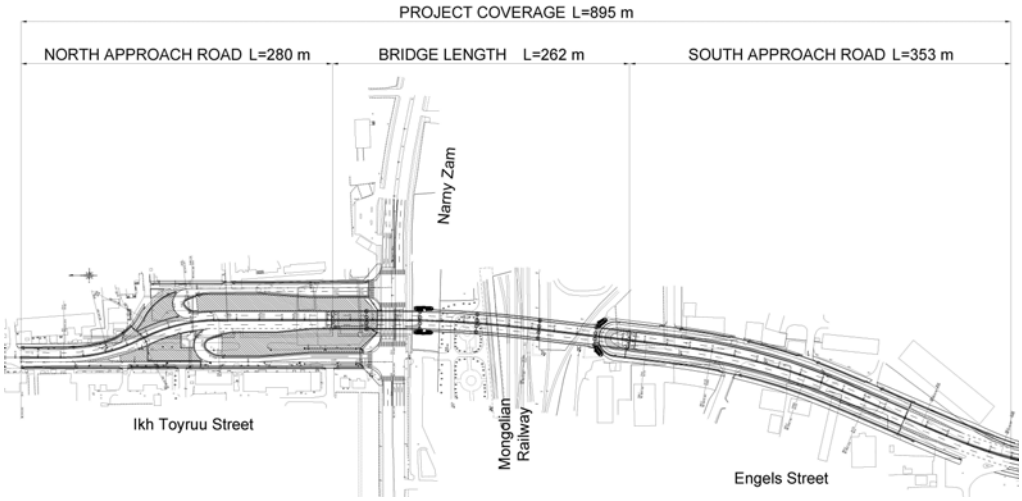



**Figure 2-2-3 Extent of Project Section**

#### b) Geometric Design

Road planning shall comply with the applicable Mongolian standard, with supplementary application of Japanese standard on aspects that the Mongolian standard does not refer or deemed to be insufficient.

**Table 2-2-4 Summary of Geometric Criteria**

| Item | Unit | Design Criteria |
|---|---|---|
| 1. Design Speed | km/h | 60 |
| 2. Traveled Land Width | m | 3.25 |
| 3. Outer Shoulder Width | m | 0.5 |
| 4. Median including Marginal Strip | m | 1.5 |
| 5. Cross fall of Traveled Way | % | 2 |
| 6. Maximum Super elevation | % | 6 |
| 7. Minimum Horizontal Curve Radius | m | 150 |
| 8. Minimum Horizontal Curve Length | m | 100 |
| 9. Minimum Transition Curve Length | m | 50 |
| 10. Maximum Grade | % | 5 |
| 11. Minimum Vertical Curve Length | m | 50 |
| 12. Min. Horizontal Curve Radius for Channelization | m | 13.0 |

Note: The geometric design criteria for at-grade intersection refer to the Japanese standard.

**c) Design Standard for Bridges**

The following standards are deemed applicable for the Project:

- Specification for Highway Bridges, Japan Road Association
- Designing of Road Bridges and Culverts (BNbD 32.02.03), Ministry of Infrastructure, Mongolia, 2005

**i) Design Load**

- Live Load: Type-B (Specification for Highway Bridges, Japan Road Association)
- Temperature Variation: +40~-40°C
- Seismic horizontal coefficient: Kh=0.1 for allowable stress analysis
- Earth Pressure: Coulomb Theory

**ii) Materials**

**Table 2-2-5 Specification of Materials**

| Material | Applicable Location | Specification |
|---|---|---|
| Concrete | Abutment, Pile, Concrete Barrier | σck=24kN/mm2 |
| | Deck Slab | σck=30kN/mm2 |
| Reinforcing Bar | | SD345(JIS) |
| Structural Steel | Super Structure, Multi-pillar Pier | SM520, SM490Y, SM400, SS400 (JIS) |
| Steel Pipe | Steel Pipe Foundation (P4) | STK400, STK 490 (JIS) |

**(2) Bridge Planning**

Bridge planning for the railway flyover has been conducted through the study on comparative modules, as graphically shown in Figure 2-2-4.

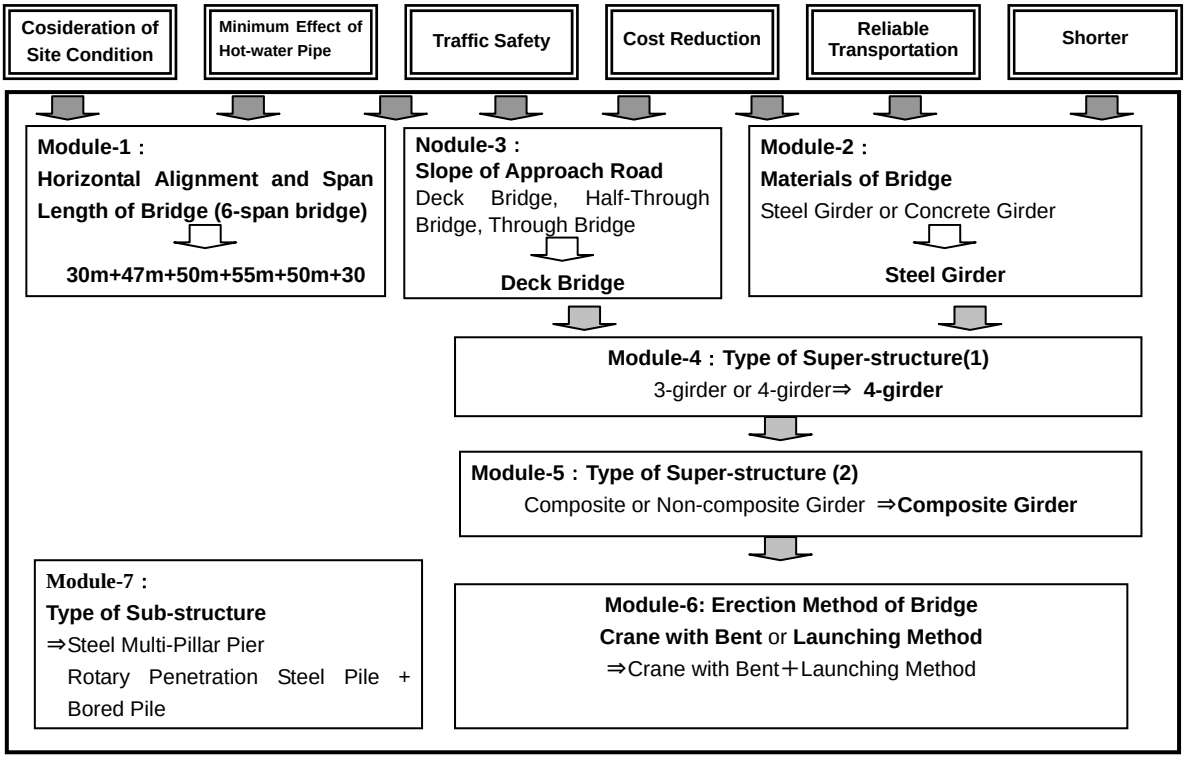



**Figure 2-2-4 Flow Chart of Bridge Planning**

### 1) Horizontal Alignment and Span Arrangement of Bridge

Horizontal alignment of bridge has been set to meet the requirements, namely:

- To minimize the relocation of hot-water pipe.
- To properly align the channel at the junction with Ikh Toyruu for the turning of semi-trailers at the minimum radius of 13m.

Span arrangement of bridge is decided to be "30m +47m +50m +55m +50m +30m = 262m" in consideration of optimum span balance under the condition of abutment location based on examination, as shown in Table 2-2-6.

**Table 2-2-6 Requirement for Location of A1/A2 Abutments**

| | A1 Abutment | A2 Abutment |
|---|---|---|
| Traffic Aspect | To secure driver's visibility at the intersection with Narny Zam. | To secure the U-turn space for cargo trailers. |
| Condition of Underground Utilities | To minimize the influence to hot-water pipes. | No constraint:<br>(Electric cable exists but it will be relocated.) |
| Structural Aspects | • To keep span balance for structural stability<br>• To avoid uplift reaction at A1. | • To keep span balance for structural stability<br>• To avoid uplift reaction at A2. |
| Location of Abutment | No. 32+4.345 | No. 45+6.345 |

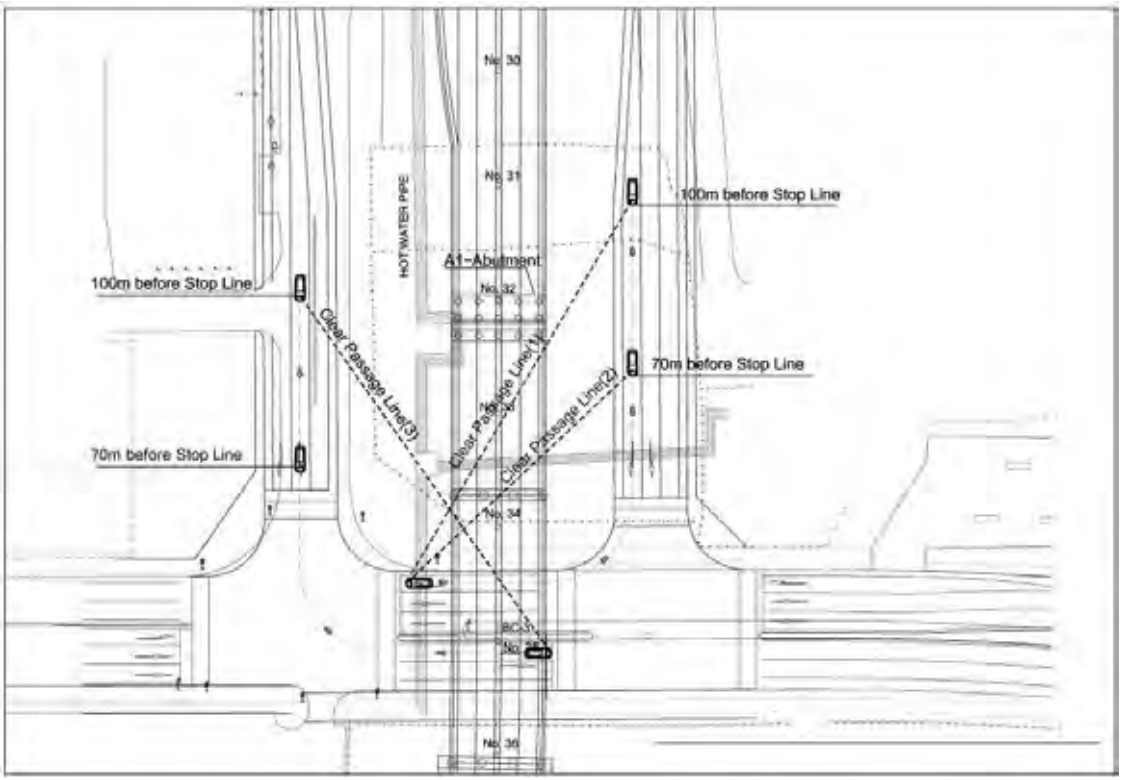



**Figure 2-2-5 Location of A1 Abutment and Driver's Visibility at Intersection**

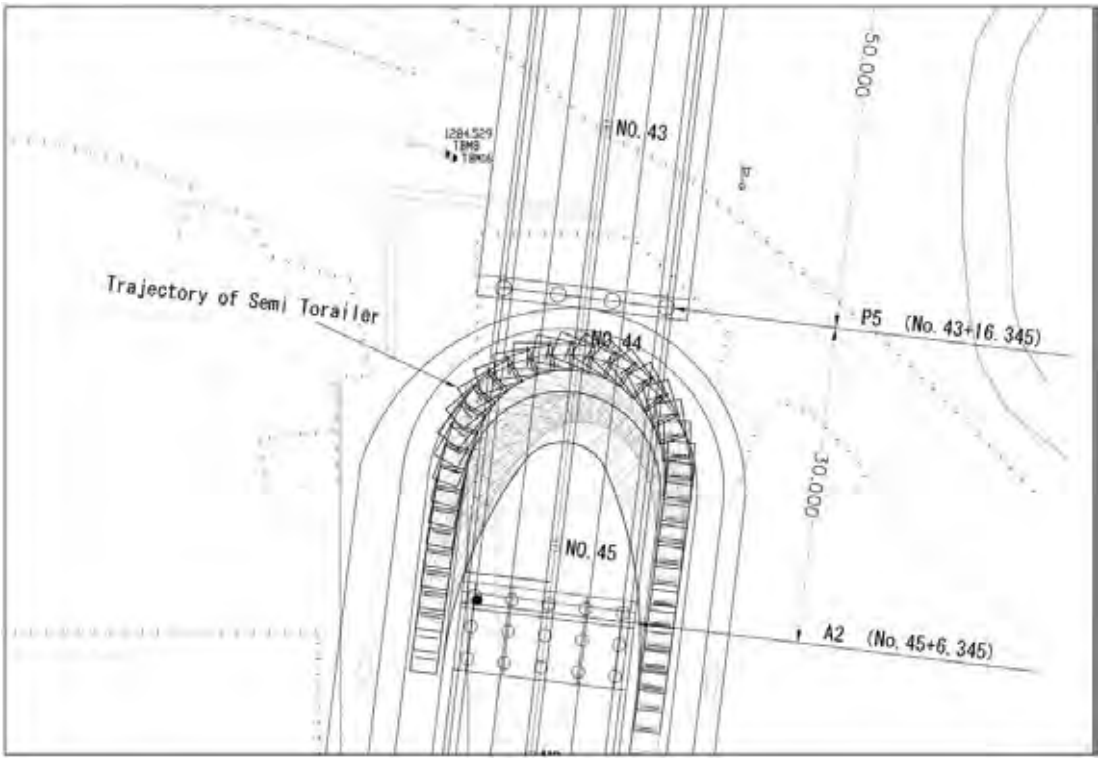
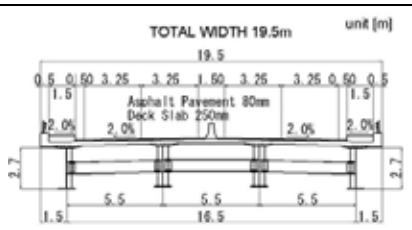
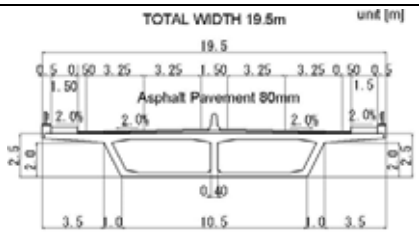



**Figure 2-2-6 Location of A2 Abutment and Trajectory of Semi-Trailers**

### 2) Materials of Bridge

Two types of materials; namely steel and concrete, have been examined as summarized in Table 2-2-7. It is concluded that the steel structure has certain advantages in the practicability and construction economy aspects.

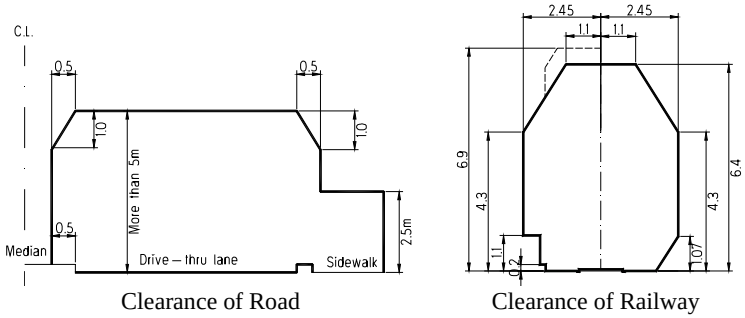
**Table 2-2-7 Comparison between Steel and Concrete Bridges**

| Material | Steel | Concrete |
|---|---|---|
| Bridge Type | Steel I-Girder | PC Box Girder |
| Cross Section |  |  |
| Safety | Less risk due to shorter construction period. Ease of neighboring construction because of smaller foundation | More risk due to longer construction period. Difficulty of neighboring construction because of bigger foundation |
| Practicability | Manufacturing steel structures on weather-free condition | Stop of concrete placing work at site in 8 months from October to May |
| Construction Period | 13 months by Crane with Bent + Launching Method | 27 months by Balanced Cantilever Method |
| Cost Scale | 1.0 | 1.5 |
| Evaluation | Good | Not Eligible |

### 3) Slope of Approach Road by Bridge Type

Road slopes in Ulaanbaatar City are practically planned to be less than 5%. Considering the limited space of urban land use, three (3) bridge types; namely, upper deck bridge, half through bridge and through bridge, may be nominated since the predicted gradient of the approach road for all of these three types could be less than 4.9%, as shown in Table 2-2-8. However, the upper deck bridge has advantages especially in the economical and practicability aspects.

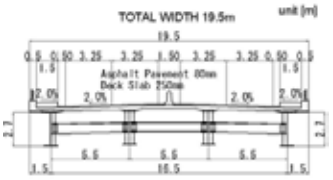
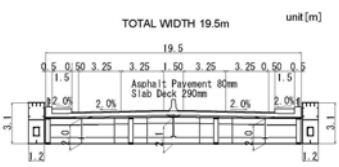
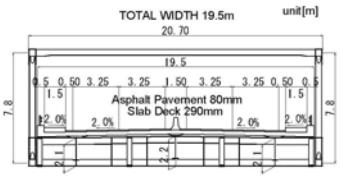
In this connection, the clearance for roads and railways must be duly set in compliance with the Mongolia Standard, as shown in Figure 2-2-7.




Clearance of Road　　Clearance of Railway

**Figure 2-2-7 Required Clearance of Road and Railway under Flyover Bridge in Mongolia**

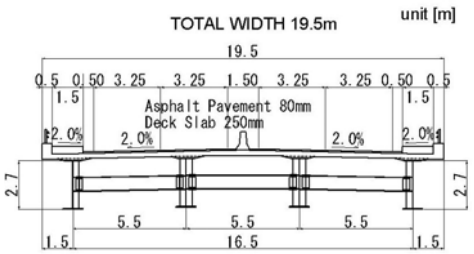
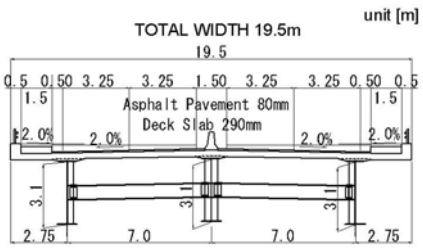
**Table 2-2-8 Comparison of Superstructure Types**

| | (1) Upper Deck Bridge<br>[Steel Plate Girder] | (2) Half Through Bridge<br>[Steel Box Girder] | (3) Through Bridge,<br>[Steel Truss Girder] |
|---|---|---|---|
| Cross Section |  |  |  |
| Girder Height | 2.7m | 2.0~2.1m | 2.1~2.2m |
| Slope | 4.9% | 4.0% | 4.0% |
| Cost Scale | 1.0 | 1.2 | 1.4 |
| Construction Period | 13 months | 14 months | 16 months |
| Mainte-nance | Easy | Easier | Not easy |
| Evaluation | Good | Faire | Bad |

### 4) Type of Superstructure - Number of Girders

A comparative study on the number of girders (3-girder vs. 4-girder) has been made for the steel plate girder, as summarized in Table 2-2-9. The 4-girder type has been adopted from the viewpoint of economy and traffic safety, especially because of lower girder height and gentler gradient of approach road.

**Table 2-2-9 Comparison of Number of Girders**

| | 4-Girder | 3-Girder |
|---|---|---|
| Cross Section |  |  |
| Thickness of Deck Slab | 240mm | 290mm |
| Height of Girder | 2,700m | 3,000mm |
| Slope | 4.9% | 5.1% |
| Cost | 1.00 | 1.01 |
| Evaluation | Eligible | Not Eligible |

**5) Type of Superstructure - Composite Girder or Non-Composite Girder**

The composite girder with a steel-concrete composite slab is adopted because of lower cost of around 10% less than the non-composite girder. Besides, the steel-concrete composite slab has the following features:

i) The steel-concrete composite slab is composed of bottom steel plate and reinforced concrete (RC) slab rigidly connected with the steel plate girder by stud dowel. The bottom steel plate can function as form for placing RC slab.

ii) The steel-concrete composite slab has higher durability compared to the conventional RC slab.

iii) The steel-concrete composite slab is available to place slab concrete without form as well as supporting and scaffolding works, resulting in safer construction work over the railway and the road.

**6) Erection Method of Bridge**

Crane with Bent Method for the side-span and Launching Method for the center span over the railway shall be employed for the election of girders on account of the following:

- The Launching Method for girder installation could be applied to level parts for security reasons. The Japan Construction Mechanization Association recommends that the applicable gradient for the Launching Method shall be less than 4.0%. However, the Launching Method is often avoided to avert accidents during construction, particularly, in the down slope.
- Cost of Crane with Bent Method is generally lower than that of the Launching Method.
- The Launching Method could not be employed for side spans because of the 4.9% slope gradient, while the Launching Method could be applied to the center span over the railway because the span is almost level.
- Crane with Bent Method could not be used for the center span, because it is difficult to operate a large crane for girder installation at the center span over the railway.

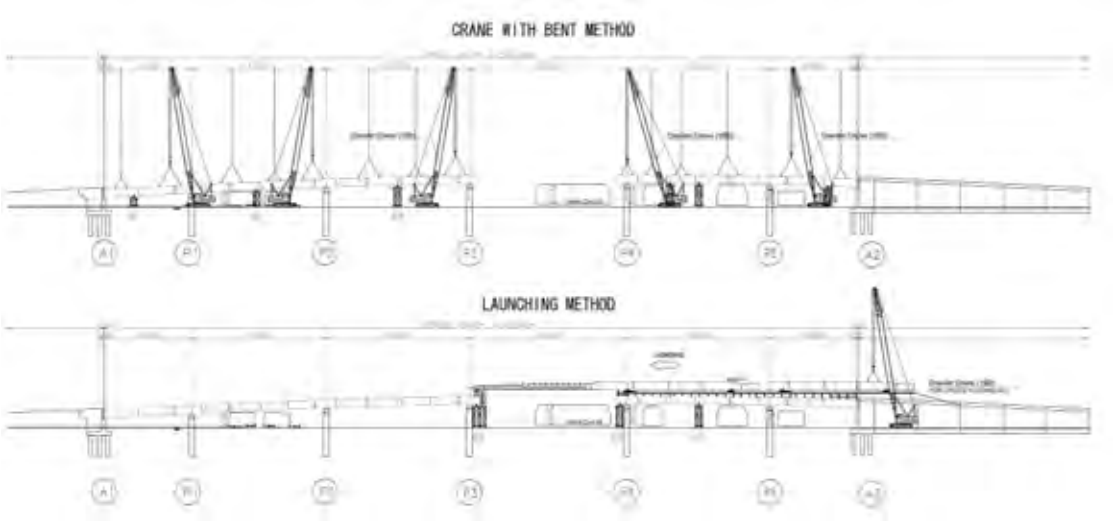



**Figure 2-2-8 Erection Methods for Bridge**

### 7) Type of Substructure

As summarized in Table 2-2-12, the foundation type shall be Bored Pile, in principle, while the Rotary Penetration Steel Pile shall be used near the railway with frequent operation from the viewpoint of geotechnical, safety, practicability and environmental conservation. The soil stratum below 7 to 10m is hard sand and gravel layer mingled with clay, which is suitable to install the pile firmly as shown in Tables 2-2-10 and 2-2-11. On the other hand, the soil stratum of around 6 to 9 m is sand and gravel layer with boulders, which may cause the over-estimation of N-value for the stratum. Therefore, during the detailed design stage, the possibility of shorter pile length is to be studied in consideration of adequate estimation of N-value for the sand and gravel layer with boulder, as well as the structural stability and economic aspects of the superstructure and substructure.

**Table 2-2-10 Conditions for Selection of Foundation**

| | |
|---|---|
| Geotechnical Condition | The soil stratum below 7 to 10m is hard sand and gravel layer mingled with clay, while the soil stratum of around 6 to 9m is composed of gravel with sand and boulders (15 to 20 cm in diameter). |
| Practicability | Construction spaces near the arterial road and railway are very small and narrow. |
| Environmental Consideration | Since the construction site is in commercial and business areas of the capital city, countermeasures for mitigation of vibration, noise and mud-water should be considered from the environmental conservation aspect. |

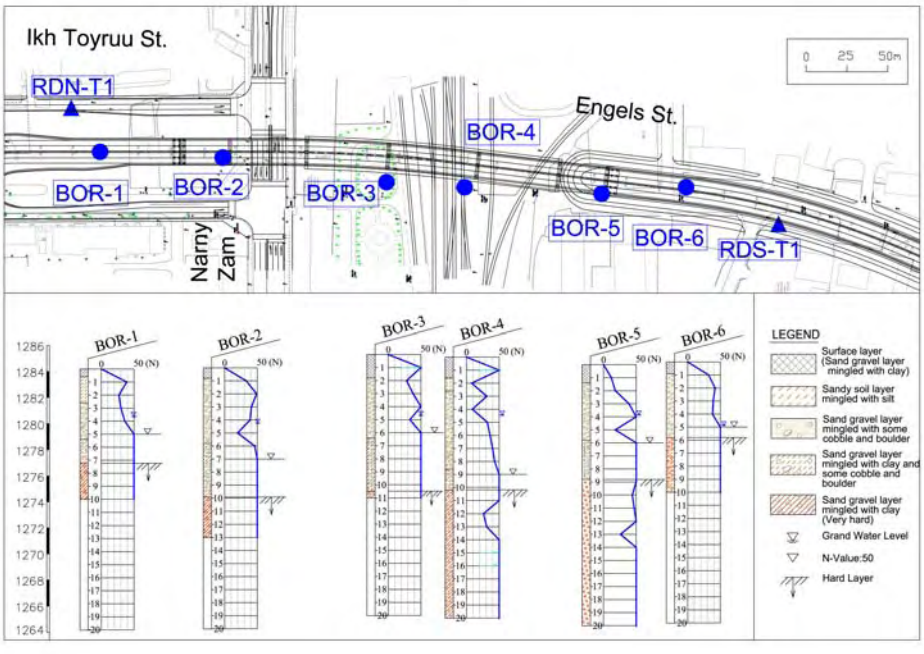


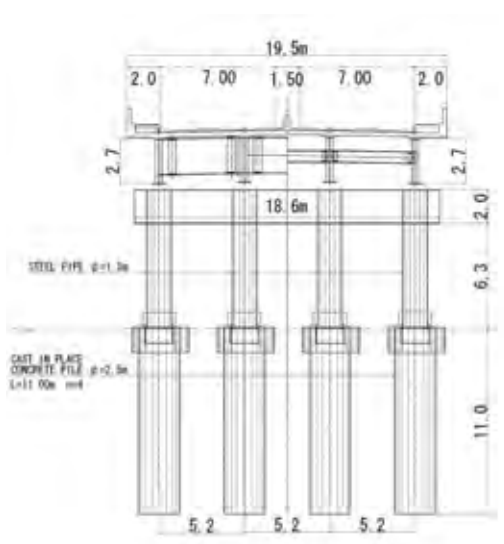
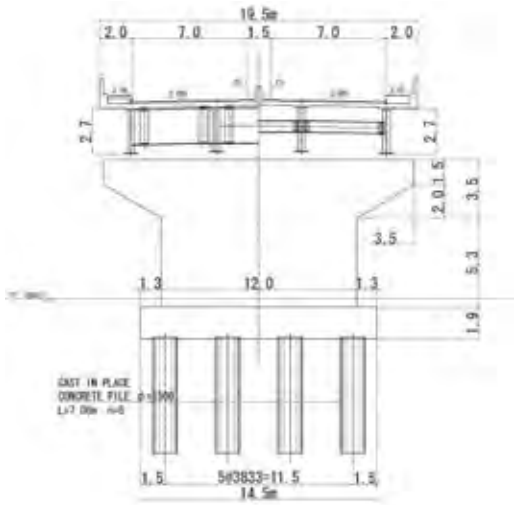

**Figure 2-2-9 Geotechnical Conditions near the Bridge**

**Table 2-2-11 Comparison of Bridge Foundation Types**

| Type of Foundation | Adoptability of Foundation | |
|---|---|---|
| Spread Foundation | Excavation scale is too big and thus it is risky to be carried out near the arterial road and railway. | N.A. |
| Driven Pile | It is difficult to drive the pile into gravel layer. | N.A. |
| Pile Installed by Inner excavation | It is difficult to drive the pile into gravel layer with bolder. | N.A. |
| Bored Pile | Bored pile with casing could be installed into dense layer consisting of sand, gravel and bolder. | Adoptable for A1~A2, P1, P2, P 3 & P5 |
| Rotary Penetration Steel Pile | This file could be driven safely into gravel layer with sand and bolder near the railway. | Adaptable for P4 |
| Open Caisson | There is a high risk to drive it near the alternate road and railway because of loose soil layer vulnerable to deformation. | N.A. |
| Steel Pipe Foundation | It is difficult to drive the pile into gravel layer with bolder. | N.A. |
| Cast-in-Site Diaphragm Wall Foundation | It is very costly to conduct because of the special type of excavation machine. | N.A. |

Note: N.A. means Not Applicable.

**Table 2-2-12 Comparison of Bridge Piers**

| Type | Steel Multi-Pillar Type | RC Wall Pier Type |
|---|---|---|
| Section |  |  |
| Construction Period | 6 months for all substructures:<br>-Piling Works : 3.5 months<br>-Piers and Abutment : 2.5 months | 2 years for all substructures, causing a delay of one (1) year for the completion of construction work. |
| Cost | 49 million yen per Pier | 68 million yen per Pier |
| Others: | Traffic safety advantage due to driver's visibility at intersection with Narny Zam. | Traffic safety disadvantage due to driver's non-visibility at intersection with Narny Zam |
| Evaluation | Advantageous from the economic, construction period and traffic safety considerations. (**Good**) | Not economical due to long construction period and it is inadequate for traffic safety. (**Not Eligible**) |

Based on the comparison of pier types as summarized in Table 2-2-12, the steel multi pillar pier is adopted from the economical and driver's visibility aspects at the intersections. With respect to abutment type, the inverted T type of abutment is the most typical and economical structure to be adopted.

### (3) Bridge Accessories

#### a) Heat-Insulating Plate

Heat-insulating plate shall be placed under the steel girder for protection against waste heat of 500°C emitted by the diesel operated trains passing under the bridge and frequently stopping near the shunting yard (34 trains on the main railway trunk in a day). The heat insulating plate could be used also as inspection way for maintenance work on the railway flyover bridge.

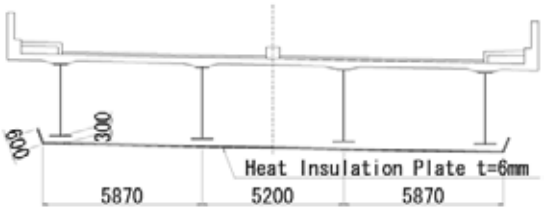



**Figure 2-2-10 Installation of Heat-Insulating Plate**

#### b) Extent of Sidewalk on Railway Flyover

The Railway Flyover is planned to have a 1.5 m wide sidewalk at both sides. The sidewalk extends from the pier located at the southern side of Narny Zam to the pier located at the southern side of the U Turn road, as shown in Figure 2 2 13. Pedestrian bridges 1.5 m in width and provided with four (4) staircases are placed accordingly at the north end of Engels Street and at the south end of Narny Zam.

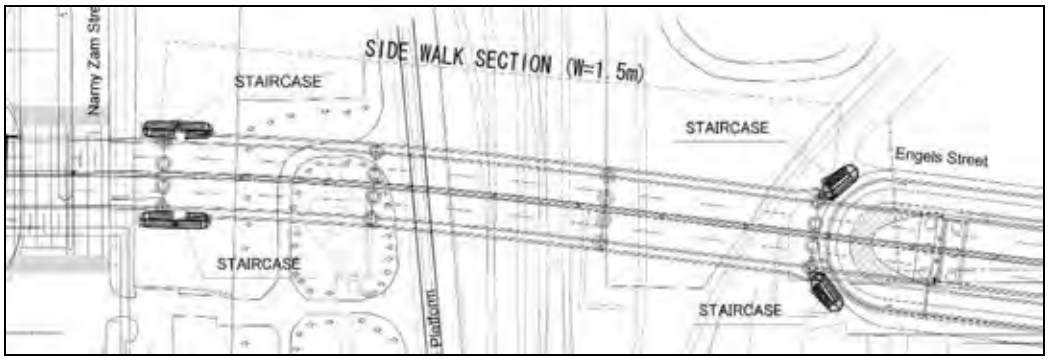



**Figure 2-2-11 Extent of Sidewalk and Pedestrian Bridge**

**c) Expansion Joint**

Finger-type expansion joints, which are simply assembled with finger-type steel plates and angle bars, are adopted for the Project in consideration of i) tolerable expansion of 210 mm, ii) higher durability, and iii) easier maintenance and repair work..

**d) Bearing**

Steel-type bearings are adopted in consideration of i) the frigid climate, ii) higher durability, and iii) seismic design force to be applied for the Project.

**e) Wall of Approach Road**

South End of Flyover (Engels Street): The reinforced earth method is adopted for the wall of approach road, for the following reasons:

i) The proposed road height is more than 10 meters above the existing ground elevation in excess of the ceiling height of the RC retaining wall.
ii) There is not enough space for the construction of embankment.

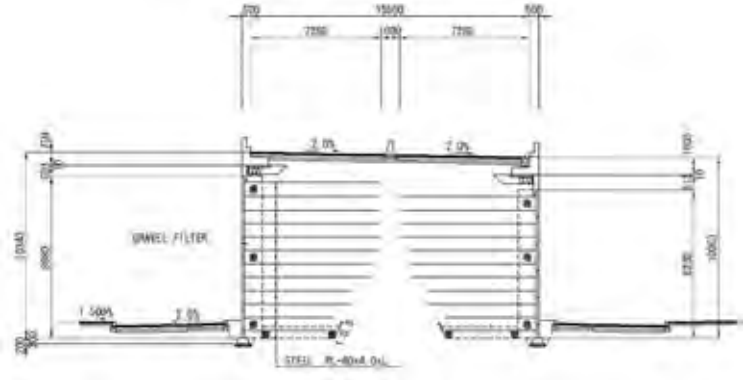


**Figure 2-2-12 Cross Section of Reinforced Earth Wall of Approach Road (Engels Street)**

North End of Flyover (Ikh Toyruu): The reinforced earth method is adopted for the wall of approach road at and near the north end of the flyover in consideration of the following:

i) Traffic safety due to driver's visibility at the intersection.
ii) Location is in the commercial/business center of the capital city with high potential for productivity.
iii) High risk of dust and/or erosion because of earth embankment.
iv) Relocation of hot water pipe is not required

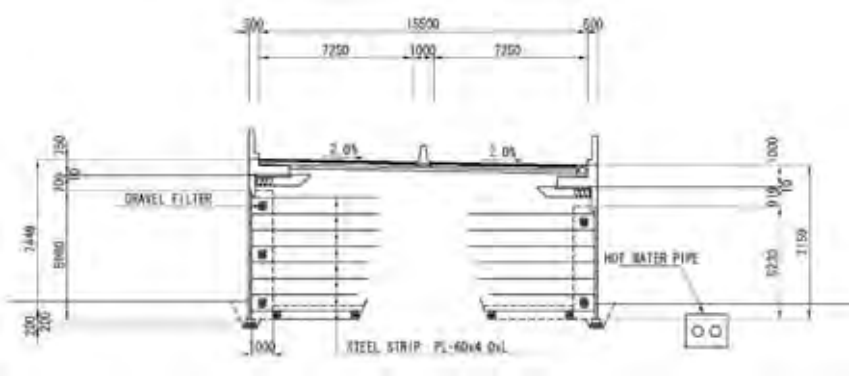



**Figure 2-2-13 Cross Section of Reinforced Earth Wall of Approach Road (Ikh Toyruu Street)**

### (4) Road Planning

#### a) Pavement Design

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

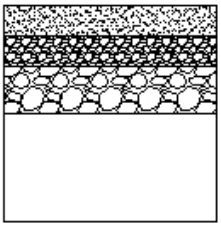
The summary of the required structure number (SN) is given in Table 2-2-13, and the proposed configuration of pavement is illustrated in Figure 2-2-14.

**Table 2-2-13 Summary of Required Structure Number by Road**

| | Design CBR[1)] | Projected Traffic [2)] | Required SN ($T_A$) |
|---|---|---|---|
| Ikh Toyruu | 12 | Less than 1,000 heavy vehicles | 17.0 cm |
| Engels Street | 12 | Less than 1,000 heavy vehicles | 17.0 cm |
| Approach Road | 12 | Less than 1,000 heavy vehicles | 17.0 cm |

1) Design CBR refers to the results of laboratory test and CBR test at site.

2) The number of heavy vehicles in 2017 is projected subject to the annual growth rate of 5%.



Asphalt (100 mm)
Base Course (100 mm)
Sub Base Course (150 mm)
Sub Grade

**Figure 2-2-14 Configuration of Pavement for Approach Road**

#### b) Traffic Safety Facilities

Traffic safety facilities consisting of traffic barrier, road marking, street lighting, traffic signal and skid resistant pavement are required to ensure the vital function of the arterial road in Ulaanbaatar City.

### i) Traffic Barrier

Traffic barriers consisting of guardrail, guard-pipe and concrete barrier must fulfill the function required for traffic safety measures in terms of prevention of vehicles from leaving the traveled way, protection of roadside pedestrians and control of improper road crossing. Therefore, traffic barriers shall be installed at the following locations according to the expected function of the respective barrier types.

**Table 2-2-14 Location and Type of Traffic Barriers**

| No. | Location | Expected Function | Type |
|---|---|---|---|
| 1 | Median on through-traveled way | - To prevent vehicles from leaving the road. | Concrete barrier |
| 2 | Diverging point | - To guide the driver's behavior.<br>- To prevent vehicles from leaving the road. | Guardrail |
| 3 | Intersection | - To protect roadside pedestrians.<br>- To avert illegal road crossing. | Guard-pipe |
| 4 | Sharp curve | - To guide driver's behavior.<br>- To prevent vehicles from leaving the road. | Guardrail |
| 5 | High embankment | - To prevent the falling of vehicles | Concrete barrier |

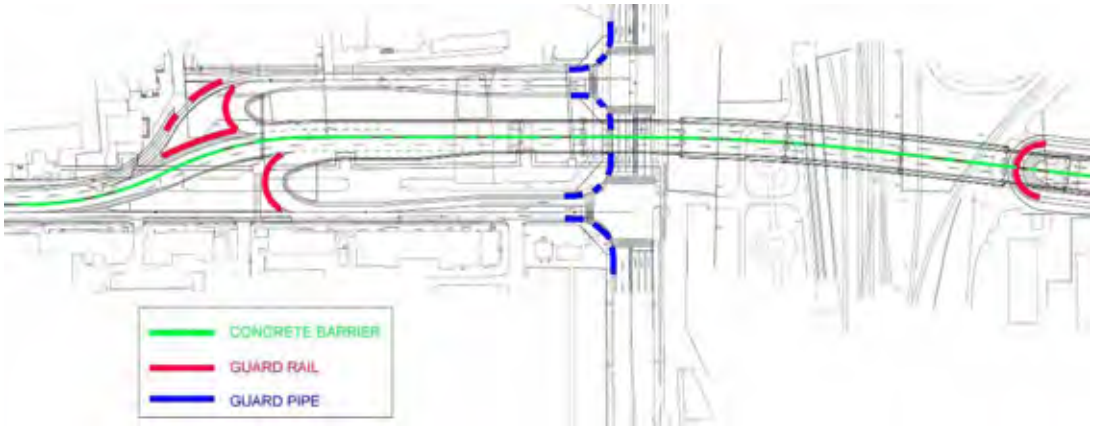



**Figure 2-2-15 Layout of Traffic Barrier**

### ii) Road Marking and Traffic Signboard

Road marking consisting of solid line, broken line, arrow, zebra and pedestrian crossing shall be installed at road surfaces. In addition, delineators such as chatter bars and reflectors shall be installed at center lines, merging and diverging sections, and sharp bends to lead the driver's attention.

On the other hand, since there are two (2) intersections with Narny Zam which may confuse drivers, a traffic signboard shall be installed within 30m of each intersection to lead drivers who are going to pass over the bridge.

**iii) Street Lighting**

Street lighting shall be installed at bridge sections, and at merging/diverging areas and intersections from the viewpoint of driver's comfort and traffic accident prevention at nighttime. The layout of street lighting poles shall be designed in compliance with the Japanese standard pertinent to illumination intensity, as summarized in Table 2-2-15.

**Table 2-2-15 Street Lighting Specification**

| Item | Specification |
|---|---|
| Average Road Surface Luminance | >1.0 candela/$m^2$ |
| Height of Lighting Pole | H = 10m |
| Interval of Lighting Pole | S = 30m (at continuous lighting) |
| Type of Lamp | High-pressure Sodium Lamp (Light Flux F>15,000 lux) |

**iv) Traffic Signal**

Two (2) sets of traffic signal equipment shall be installed by the Project at the new intersections on Narny Zam. The Point Control System having 4 phases at most shall be employed, as illustrated in Figure 2-2-16.

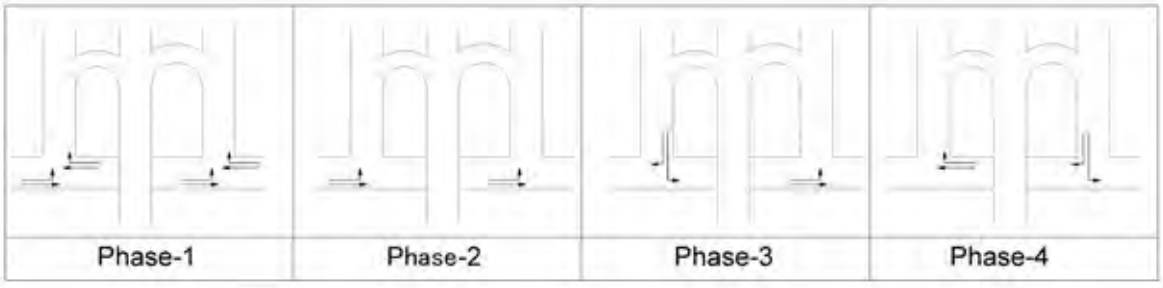



**Figure 2-2-16 Sequence of Traffic Signal**

**v) Skid-Resistant Pavement**

Skid-resistant pavement shall be installed at the section of down slope on the north bound railway flyover to make vehicles decelerate significantly and thus allow drivers to identify and choose their directions before diverging and right turning their vehicles to enter the sharp curve at 13m turning radius.

**e) Drainage**

Since the project road is planned to be linked with the existing roads, the new drainage system shall be able to induce storm water from the project road to the drainage facility of the existing roads. The existing drainage systems in the

northbound and southbound railways are as shown in Figure 2-2-17, where storm water falls into the U ditch and drain towards the outlet of the drainage system.

The existing drainage system on Engels Street shall be improved by the Mongolian side simultaneously with the widening and improvement of the existing roads, which is an indispensable element for the ultimate completion of the Project. Rainfall intensity for the design of drainage system has been calculated by the following formula:

Formula for 12-year Rainfall Intensity based on Mongolian Rainfall Data

$$r = 1{,}221 / (t + 9)$$

r: Rainfall Intensity (mm/hour)

t: Duration of Rainfall (minutes)

**Table 2-2-16 Period-Rainfall Intensity**

| Duration of Rainfall (t) | Rainfall Intensity (r) | | |
|---|---|---|---|
| | 12-year | 5-year | 3-year |
| 5 minutes | 80 | 56 | 48 |
| 10 minutes | 59 | 41 | 35 |
| 15 minutes | 47 | 33 | 28 |
| 20 minutes | 39 | 27 | 23 |
| 25 minutes | 33 | 23 | 20 |
| 30 minutes | 29 | 20 | 17 |

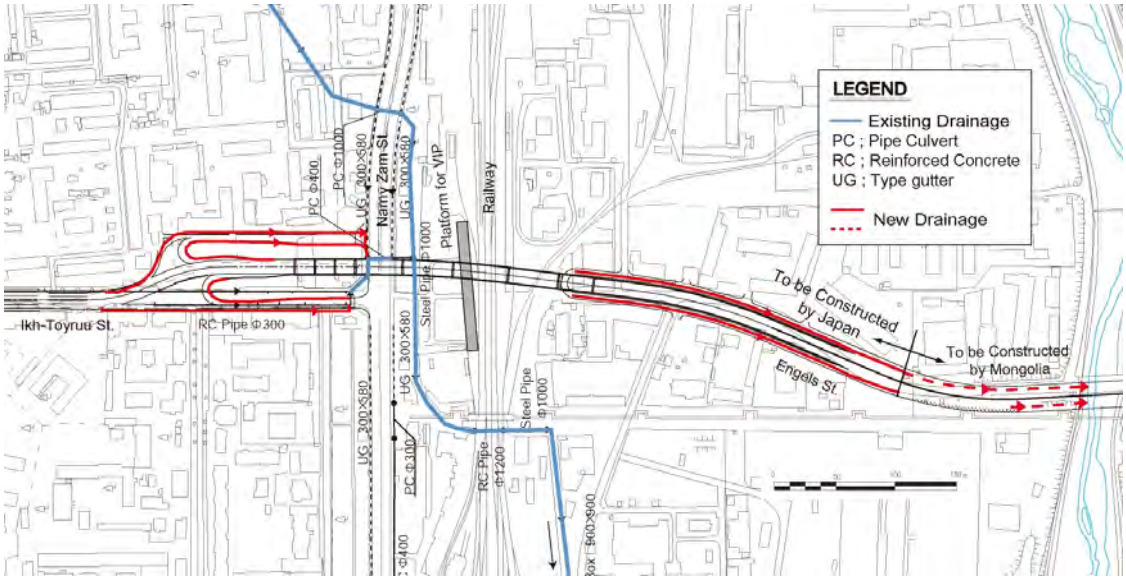



**Figure 2-2-17 Drainage System**

### 2-2-3 Basic Design Drawing

#### (1) Drawing List

The List of Drawings is given in Table 2-2-17.

#### (2) Basic Design Drawing

The Basic Design Drawings are attached to Appendix-8.

**Table 2-2-17 List of Drawings**

| Drawing No. | TITLE | SCALE | NUMBER |
|---|---|---|---|
| BD-1 | GENERAL LAYOUT OF BRIDGE | AS SHOWN | 1 |
| BD-2 | DETAIL OF SUPER STRUCTURE | AS SHOWN | 1 |
| BD-3 | DETAIL OF ABUTMENT (A1) | 1/200 | 1 |
| BD-4 | DETAIL OF PIER (P1) | 1/200 | 1 |
| BD-5 | DETAIL OF PIER (P2) | 1/200 | 1 |
| BD-6 | DETAIL OF PIER (P3) | 1/200 | 1 |
| BD-7 | DETAIL OF PIER (P4) | 1/200 | 1 |
| BD-8 | DETAIL OF PIER (P5) | 1/200 | 1 |
| BD-9 | DETAIL OF ABUTMENT (A2) | 1/200 | 1 |
| BD-10 | DETAIL OF STAIRCASE(1) | 1/80 | 1 |
| BD-11 | DETAIL OF STAIRCASE(2) | 1/80 | 1 |
| BD-12 | ACCESSORY OF BRIDGE | AS SHOWN | 1 |
| BD-13 | PLAN OF APPROACH ROAD(1/3) | 1/1,000 | 1 |
| BD-14 | PLAN OF APPROACH ROAD(2/3) | 1/1,000 | 1 |
| BD-15 | PLAN OF APPROACH ROAD(3/3) | 1/1,000 | 1 |
| BD-16 | PROFILE OF MAIN ROAD(1/3) | H=1/1,000, V=1/200 | 1 |
| BD-17 | PROFILE OF MAIN ROAD(2/3) | H=1/1,000, V=1/200 | 1 |
| BD-18 | PROFILE OF MAIN ROAD(3/3) | H=1/1,000, V=1/200 | 1 |
| BD-19 | PROFILE OF APPROACH ROAD (NORTH) | H=1/2,000, V=1/400 | 1 |
| BD-20 | TYPICAL CROSS SECTION (1/3) | 1/250 | 1 |
| BD-21 | TYPICAL CROSS SECTION (2/3) | 1/250 | 1 |
| BD-22 | TYPICAL CROSS SECTION (3/3) | 1/250 | 1 |
| BD-23 | DETAIL OF REINFORCED EARTH | 1/100,1/40 | 1 |
| BD-24 | DETAIL OF GRAVITY TYPE RETAINING WALL (TYPE-1)(1/2) | AS SHOWN | 1 |
| BD-25 | DETAIL OF GRAVITY TYPE RETAINING WALL (TYPE-1)(2/2) | AS SHOWN | 1 |
| BD-26 | DETAIL OF GRAVITY TYPE RETAINING WALL (TYPE-2) | AS SHOWN | 1 |
| BD-27 | CENTER STRIP | 1/40 | 1 |
| BD-28 | DETAIL OF SHOULDER (1/2) | 1/40 | 1 |
| BD-29 | DETAIL OF SHOULDER (2/2) | 1/40 | 1 |
| BD-30 | DETAIL OF DRAINAGE STRUCTURE(1/2) | 1/20 | 1 |
| BD-31 | DETAIL OF DRAINAGE STRUCTURE(2/2) | 1/20 | 1 |
| BD-32 | DETAIL OF CATCH BASIN | 1/40 | 1 |
| BD-33 | DETAIL OF CURB | 1/20 | 1 |
| BD-34 | DETAIL OF CONCRETE BARRIER FOR MEDIAN STRIP | AS SHOWN | 1 |
| BD-35 | DETAIL OF ROAD SIDE CONCRETE BARRIER | 1/40 | 1 |
| BD-36 | DETAIL OF GUARD RAIL AND GUARD PIPE | 1/40 | 1 |
| BD-37 | TRAFFIC SIGN BOARD | AS SHOWN | 1 |
| BD-38 | DELINEATOR AND CHATTER BAR | AS SHOWN | 1 |
| BD-39 | TRAFFIC SIGNALS | AS SHOWN | 1 |
| BD-40 | STREET LIGHT | AS SHOWN | 1 |

## 2-2-4 Implementation Plan

### 2-2-4-1 Implementation Policy

#### (1) Basic Conditions for the Project

The basic conditions for implementing the Project are as follows:

i) The Project, if approved, shall be implemented in accordance with the guidelines of the Japan's Grant Aid scheme after the signing of the Exchange of Notes by and between the Government of Japan (GOJ) and the Government of Mongolia (GOM).

ii) The responsible ministry for the Project shall be the MRTCUD, and the implementing agency shall be the Ulaanbaatar City Government. Coordination among the relevant agencies on the Mongolian side, including budgetary allocation, shall be the responsibility of the MRTCUD.

iii) The detailed design, assistance in tendering and construction supervision of the Project shall be undertaken by a Japanese consulting firm in accordance with the consulting contract that shall be executed by and between the MRTCUD and the said consulting firm.

iv) The construction work shall be undertaken by the successful Japanese tenderer/contractor after the construction contract has been awarded to him by the MRTCUD.

#### (2) Basic Concepts of Implementation Plan

i) The construction method and schedule shall reflect the local conditions of climate, topography, geology, railway operation and road traffic and so on. Especially, the implementation plan shall not disturb the operation of railway and road traffic during the construction of the railway flyover.

ii) The construction period shall be the shortest through an efficient construction plan with minimal idling adjustment period during winter season.

iii) Materials and equipment necessary for the Project shall be procured in Mongolia as far as available. Items unavailable locally shall be procured in Japan or in third countries on the basis of cost and on condition that the quality and supplying capacity meet the requirements.

iv) The organization for construction management by the Contractor and construction supervision by the Consultant shall be established fulfilling the standardized construction management requirements. Works requiring special

techniques such as pile foundation, long-span railway flyover bridge and the reinforced earth wall for approach roads will require advanced technical expertise from Japan because of the few foreign assisted project experiences of local contractors/engineers in Mongolia.

### 2-2-4-2 Implementation Conditions

The implementation plan of the Project shall duly take into consideration the site condition specifically pertinent to the aspects described below.

#### (1) Construction Period

The available period for concrete placement and asphalt pavement is deemed to be the period from mid May to mid September based on the annual temperature records. The construction plan shall pursue the shortest construction period to complete the Project with steady progress. The construction machinery operation plan shall be established to efficiently utilize machines procured from Japan, eliminating i) non operation period and/or ii) storing them in a warehouse during winter season.

#### (2) Railway Operation

It is not possible to operate a big construction machine near and between the proposed P3 and P4 bridge piers because of the 34 daily railway traffic operations and the frequent replacement of wagons near the shunting yard. The narrow space of six (6) meters between the railway and the foundation will require an adequate type of construction method for pier foundation that will not affect or deform the railway base. Besides, safety measures to avoid contact with trains are required during the construction work.

#### (3) Road Traffic Safety

Countermeasures on traffic safety are required to avoid accidents in and near the Narny Zam and Ikh Toyruu streets which have heavy traffic. Road users should be prevented from entering the project site by clearly defining the construction area with the installation of notices, signs and barricades.

#### (4) Transportation Plan of Equipment and Materials

In general, equipment and materials from Japan and third countries will be transported through the Chinese railway to the Ulaanbaatar Railway Station. Since railway gauges in China and Mongolia are different, cargoes are reloaded at the Zamin-Uud Station in Mongolia located at the boarder with China. It must be noted that cargo handling at Zamin-Uud has drastically increased in these years due to the rapid economic development of Mongolia, which is presently a critical issue often

causing delay in cargo handling and transportation. Hence, a detailed transportation plan including packing methods is necessary to mitigate or avoid the delay in cargo handling and transportation of construction equipment and materials for the Project.

**(5) Procurement of Equipment and Materials**

Prices of construction equipment and materials in Mongolia have drastically increased due to the growth of mining and construction activities in these years. Accordingly, the difference in price of construction equipment and materials between Mongolia and Japan is very small, and market prices of several materials may even be higher in Mongolia.

Moreover, it might be difficult to procure some of the necessary equipment and materials from China, since China also intends to concentrate on its own economic development and to support reconstruction after the devastating earthquake in Sichuan in May 2008. Thus a stable supply of equipment and materials with reliable quality will fully depend on the procurement plan with sound consideration on the economical aspect.

### 2-2-4-3 Scope of Work

The undertakings of both the governments of Japan and Mongolia are listed in Table 2-2-18.

**Table 2-2-18 Undertakings of the Government of Japan and Mongolia**

| Item | Contents | Undertaken by | | Remarks |
|---|---|---|---|---|
| | | Japan | Mongolia | |
| Procurement of Materials and Equipment | Procurement and delivery | O | - | |
| | Tax exemption and Customs clearance | - | O | |
| Preparatory Works | Acquisition of land for the construction work | - | O | Site office, stockyard, plant yard, working area, detour road at construction sites, etc. |
| | Other preparatory works | O | - | |
| Removal / Relocation of Obstructions | Removal of surface/air obstructions | - | O | Electric posts and cables, telephone cables, street lighting, traffic signals, trolleybus cable, etc. |
| | Removal of underground obstructions | - | O | Water pipes, drainage pipe, electric cable pipe, telephone cable pipe, etc. |
| Construction Works | Bridge construction | O | - | |
| | Approach road construction | O | - | Including intersection |
| | Accessory works | O | - | Traffic Signal, Street Lighting |

### 2-2-4-4 Consultant's Supervision

A Japanese engineering consultant shall carry out the detailed design services and provide assistance to the implementing agency of the Mongolian Government in the tendering and contracting work. The Consultant shall also provide construction supervision services for the Project in accordance with the consulting services contract which shall be executed by and between the Consultant and GOM.

**(1) Detailed Design**

The major work activities in the detailed design services to be provided by the Consultant shall be as follows:

i) Consultation meeting at the commencement of consulting services between the Mongolian Government and the Consultant, as well as site survey for the detailed design.

ii) Detailed design of bridges including approach roads, and preparation of drawings.

iii) Preparation of cost estimate.

**(2) Assistance in Tendering**

The major items of services in the assistance related to tendering shall be as follows:

i) Preparation of tender documents (conducted under the detailed design services)

ii) Tender announcement

iii) Pre-qualification of tenderers

iv) Assistance in tendering

v) Tender evaluation

vi) Contract facilitation

**(3) Construction Supervision**

The Consultant shall carry out the supervision of construction works to be executed by the Contractor. The major items of the construction supervision services shall be as follows:

i) Evaluation and approval of construction plans, schedules and construction drawings submitted by the contactor.

ii) Quality control

iii) Progress control

iv) Measurement of work

v) Inspection of safety aspect

vi) Coordination with agencies concerned

vii) Final inspection and turnover

The above construction supervision services shall be managed at the project site by the Japanese Consultant's resident supervisor/engineer, with assistance and support from the local consultant to be engaged in the project.

### 2-2-4-5 Quality Control Plan

Quality control plans for construction works such as bridge accessories, pile foundations, concrete works, earthworks and pavement works are as summarized in Table 2-2-19 to Table 2-2-23.

**Table 2-2-19 Quality Control Plan for Bridge**

| Item | Items of Inspection | Contents of Inspection |
|---|---|---|
| Quality Inspection of Materials | Quality of structural steel | Mill sheet and inspection reports for approval. |
| | Quality of painting specification | Approval of public agency. |
| | Sampling inspection of painting | Approval of public agency. |
| Fabrication of Structural Steel | Welding test | Submittal of welding test report for approval: material test, fillet weld test, groove weld test, weld quality and soundness requirement. |
| | Shop painting test | Submittal of shop painting report and coats thickness for approval. |
| | Trial shop assembly | Check of camber, level, alignment, dimensions, etc. for approval |
| Field Erection of Girders | Inspection of members assembly | Accurate assembling of steel members: camber, splices, bearing, etc. for approval. |
| | Inspection of bolted connections | Submittal of inspection results for approval. |
| | Inspection of completed erection | After assembly, bolted connections and removal of staging, camber, alignment, bearing, etc. should be inspected for approval. |
| Field Painting | Record of painting works | Submittal of painting records for approval |
| | Surface cleaning before painting | Inspection of damage, cleaning surface, foreign substances. |
| | Surface preparation | Inspection of clearing of rust at splices, damages, etc. |
| | Coat thickness | Submittal of coating records for approval. |

**Table 2-2-20 Quality Control Plan of Bridge Accessories**

| Item | Item of Inspection | Contents of Inspection |
|---|---|---|
| Bearing | Acceptance inspection of product | Submittal of inspection results before shipping |
| | Inspection of installation | Inspection of alignment of bearing for approval of Consultant before fixing by anchor bolt. |
| Expansion Joint | Acceptance inspection of product | Submittal of inspection results before shipping |
| | Inspection of installation | Inspection of alignment of expansion joint for approval of Consultant before fixing |
| Drainage | Acceptance inspection of drainage materials | Submittal of inspection results before shipping |
| | Inspection of installation | Inspection of alignment of drainage for approval of Consultant before fixing |

**Table 2-2-21 Quality Control Plan for Foundation**

| Item | Item of Inspection | Contents of Inspection |
|---|---|---|
| Bored Pile | Loading test | Loading test to verify the vertical bearing capacity of bored pile, which will be estimated by dynamic loading analysis of free fall weight. The test shall be carried out at the location of two abutments, A1 and A2, the typical locations of north and south bridges. |
| | Inspection of vertical alignment | Accuracy of vertical alignment of drilled hole. |
| | Inspection of filling rate with concrete | Quality or filling rate of completed concrete work is inspected by sonic test. |
| | Countermeasures against boiling | Control of casing installation and excavation to the proposed depth considering countermeasures against boiling. |
| | Others | De-sliming required at the bottom of pile to ensure quality. |
| Rotary Penetration Steel Pile | Control of pile driving to ensure quality of pile | Driving of pile shall be measured and controlled to decide the adequate torque and driving speed to ensure quality. |
| | Control of pile driving so as not to affect railway base structure | Base structure of railway shall not be affected by controlling pile driving together with the measurement of horizontal and vertical movements of ground near the base. |

**Table 2-2-22 Quality Control Plan for Concrete Works**

| Item | Item of Test | Frequency of Test |
|---|---|---|
| Cement | Physical property test | Once before trial mix. Thereafter, once every 500m$^3$ placing or when the material brand is changed. |
| Aggregate | Physical property test for fine aggregate | Once before trial mix. Thereafter, once every 500m$^3$ placing or when the quarry site is changed. |
| | Physical property test for coarse | Once before trial mix. Thereafter, once |

| | | |
|---|---|---|
| | aggregate | every 500m$^3$ placing or when the quarry site is changed. |
| | Alkali-silica reaction test | Once before trial mix. Thereafter, when the quarry site is changed. |
| | Mineralogical composition | Once before trial mix. Thereafter, when the quarry site is changed. |
| Water | Quality test | Once before trial mix. Thereafter, according to need. |
| Admixtures | Quality test | Once before trial mix. Thereafter, according to need. |
| Concrete | Slump test | One per 75m$^3$ or one placement |
| | Air test | One per 75m$^3$ or one placement |
| | Compressive strength test | 6 specimens per placement or 6 specimens per 75m$^3$ when concrete volume in one placement is large (3 specimens for 7 days strength test and 3 specimens for 28 days strength) |
| | Temperature measurement | One per 75m$^3$ or one placement |

**Table 2-2-23 Quality Control Plan for Earthworks and Pavement Works**

| Item | Item of Test | Frequency of Test |
|---|---|---|
| Embankment | Moisture density relation | Once before placement and when the material source is changed. |
| | Density in-situ | Once every 500m$^2$ |
| Sub-Base Course | Sieve analysis | Once before placement and when the material source is changed. |
| | Moisture - Density relation | Once before placement and when the material source is changed. |
| | CBR | Once before placement. Thereafter, once every 1,500m$^3$ placing or when the material source is changed. |
| | Density in-situ | Once every 500m$^2$ |
| Base Course | Sieve analysis | Once before placement. Thereafter, once every 1,500m$^3$ placing or when the material source is changed. |
| | Moisture - Density relation | Once before placement and when the material source is changed. |
| | CBR | Once before placement. Thereafter, once every 1,500m$^3$ placing or when the material source is changed. |
| | Density in-situ | Once every 500m$^2$ |
| Asphalt Pavement | Sieve analysis | Once before placement and when the material source is changed. |
| | Physical property test of asphalt emulsion | Once before placement and when the material source is changed. |
| | Physical property test of asphalt | Once before placement and when the material source is changed. |
| | Physical property test of cutback asphalt | Once before placement and when the material source is changed. |

### 2-2-4-6 Procurement Plan

#### (1) Construction Material

The procurement plan for major materials is as shown in Table 2-2-24. It must be noted that most construction materials in Mongolia are currently being imported from China and neighboring Russia, because locally available materials are very limited. However, the growth of Mongolia's construction industry in these years had induced the drastic price increase of construction equipment and materials, as well as difficulty in procuring the required materials in Mongolia.

**Table 2-2-24 Materials Procurement Plan**

| Item | Country of Procurement | | | Remarks |
|---|---|---|---|---|
| | Mongolia | Japan | Third Country | |
| Ready Mixed Concrete | O | | | |
| Asphalt Mixture | O | | | |
| Bitumen | O | | | |
| Embankment Materials | O | | | |
| Crushed Stone | O | | | |
| Form Plywood | O | | | |
| Reinforcing Steel Bar | | O | | Deformed bar |
| Structural Steel | | O | | |
| Steel Materials for Bridge Erection | | O | | Bent, Launching Erection materials |
| Street Lighting Apparatus | | O | | |
| Traffic Signal | | O | | |
| Bearing | | O | | |
| Expansion Joint | | O | | |
| Scaffolding Materials | | O | | |
| Paint for Bridge | | O | | |
| Non-skid Surface Treatment Materials | | O | | |
| Concrete Manufacture | O | | | |
| Non-shrinkage Mortar | | O | | |
| Road Marking Materials | | O | | |

With respect to materials to be procured from Japan as listed in Table 2-4-7, special attention shall be paid to the items described below.

**1) Reinforcing Steel Bar**

The capacity of the steel factory in Darhan is limited to the production of reinforcing steel bars for consumption in Mongolia. However, the annual demand for reinforcing steel bars in Mongolia is estimated at 300,000 tons, which is three

times the annual production of 100,000 tons. The shortfall is thus imported from China and other countries.

Furthermore, the factory has the monotonous system of producing the same type of standard product for a certain period and another type of standard product in the following period. This system will surely cause serious delay in providing the Project with a variety of steel products on demand and on time.

Moreover, though China has the potential to supply reinforcing bars for the Project, it may not be able to export reinforcing steel bars on demand and on time because of tight domestic demand and urgent needs for the reconstruction of buildings/facilities in Sichuan which were severely damaged by the devastating earthquake in May 2008. Based on the reasons stated above, reinforcing bars for the Project shall be procured from Japan.

**2）Structural Steel, Steel Materials for Bridge Construction**

The required standard products of structural steel, steel bearing, steel expansion joints and steel materials for bridge construction are not available in Mongolia, and China will not be able to provide the steel products for the Project on demand and on time for the same reason as the reinforcing bars. Besides, the difference in prices of steel products between third countries and Japan is very small due to global inflationary market prices in recent years. In addition, the curve-shaped steel girder for the Project requires a high technique to produce.

In consideration of these issues, it would be appropriate to procure structural steel materials for the Project from Japan.

**3）Street Lighting Apparatus, Traffic Signal**

Most of the street lighting apparatuses and traffic signal equipment in Mongolia have been procured from China and Korea. However, it was gathered that these electrical facilities sometimes encounter operational trouble due to fluctuation of electrical voltage and severe variation of temperature. On the other hand, the Japanese made equipment procured under the Japanese Grant Aid Project in 2003, namely, the Project for Improvement of the Roads in Ulaanbaatar, have not encountered any serious trouble at all.

In this connection, the electric circuit and relay inside the control panel of the street lighting and traffic signal equipment to be procured under the Project shall be able to prevent failure due to condensation caused by temperature variation. In addition, the control panel shall be equipped with automatic regulating system against exceptional fluctuation of electric voltage. In order to credibly fulfill the

above requirements, street lighting apparatuses and traffic signal equipment for the Project are planned to be procured from Japan.

### (2) Construction Machinery

Ordinary construction machinery can be procured in Mongolia. However, large machines which are difficult to procure in Mongolia such as crawler crane, swivel casing excavator for bored pile, hydraulic jack, and big scale deck for launching erection are planned to be procured from Japan.

**Table 2-2-25 Major Machinery Procurement Plan**

| Item No. | Machine | Specification | Country of Procurement | | |
|---|---|---|---|---|---|
| | | | Mongolia | Japan | Third Country |
| 1 | Crawler Crane | 150 ton | | O | |
| 2 | Crawler Crane | 120 ton | | O | |
| 3 | Swivel All Casing Pile Driver | φ3000 | | O | |
| 4 | Excavator | 0.45,0.8$m^3$ | O | | |
| 5 | Wheel Loader | 2.1 $m^3$ | O | | |
| 6 | Bulldozer | 15ton,32ton | O | | |
| 7 | Motorized Grader | 3.1m | O | | |
| 8 | Macadam Roller | 8 – 20 ton | O | | |
| 9 | Tier Roller | 8 – 20 ton | O | | |
| 10 | Vibration Roller | 1 ton | O | | |
| 11 | Rammer、Tamper | Varied | O | | |
| 12 | Asphalt Cutter | φ300 | O | | |
| 13 | Road Sprinkler | 6,000ℓ | O | | |
| 14 | Dump Truck | 10ton | O | | |
| 15 | Truck | 10ton | O | | |
| 16 | Trailer | 32ton | O | | |
| 17 | Truck with Crane | 2.9 ton -4 ton | O | | |
| 18 | Concrete Pumping Vehicle | 90-110$m^3$ | O | | |
| 19 | Bent | Varied | | O | |
| 20 | Launching Equipment | | | O | |
| 21 | Hydraulic Jack for Bridge Erection | Varied | | O | |
| 22 | Roller for Launching Equipment | Varied | | O | |

### (3) Transportation Route

In general, equipment and materials from Japan and third countries will be transported through the Chinese railway to the Ulaanbaatar Railway Station. Since railway gauges in China and Mongolia are not the same, cargoes are to be

transshipped at the Zamin Uud Station in Mongolia, which is located at the boarder with China. Even if there is another route to Ulaanbaatar through Siberia in Russia, fewer forwarders are using this route; besides, reliability is low because transportation period could not be estimated due to the rapidly increased domestic demand caused by the economic boom in Russia.

Based on the above, the Chinese route, which is relatively reliable, has been selected as the transportation route in the implementation plan of the Project.

The transportation period in each section from Japan to Mongolia has been estimated at 45 days in total, as follows:

| | | |
|---|---|---|
| 1) Marin Transportation: Japan- Tianjin Port: | 10 days | |
| 2) Inland Transport: Tianjin- Zamin-Uud-Ulaanbaatar | 20-days | 45 days in total |
| 3) Custom Clearances and Road Transportation: | 15 days | |

### 2-2-4-7 Implementation Schedule

After conclusion of the Exchange of Notes (E/N) by the Government of Japan and the Government of Mongolia, the detailed design services will be executed under the consulting contract which shall be made by and between the GOM and the Japanese Consultant.

The detailed design and tendering stage including preparation of tender documents and the assistance in tender evaluation and contracting will take around nine (9) months, while the construction stage including the procurement of machines and materials will be around 37 months, as shown in Figure 2-2-18 and Figure 2-2-19, respectively. In case that the actual schedule is made, the construction schedule shall be formulated in consideration of the midwinter in Mongolia when many construction works are restricted.

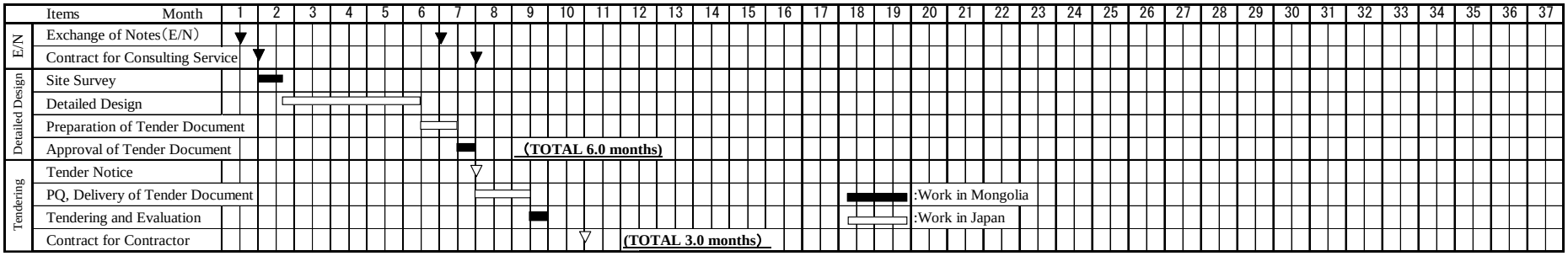



**Figure 2-2-18 Implementation Schedule of Detailed Design and Tendering**

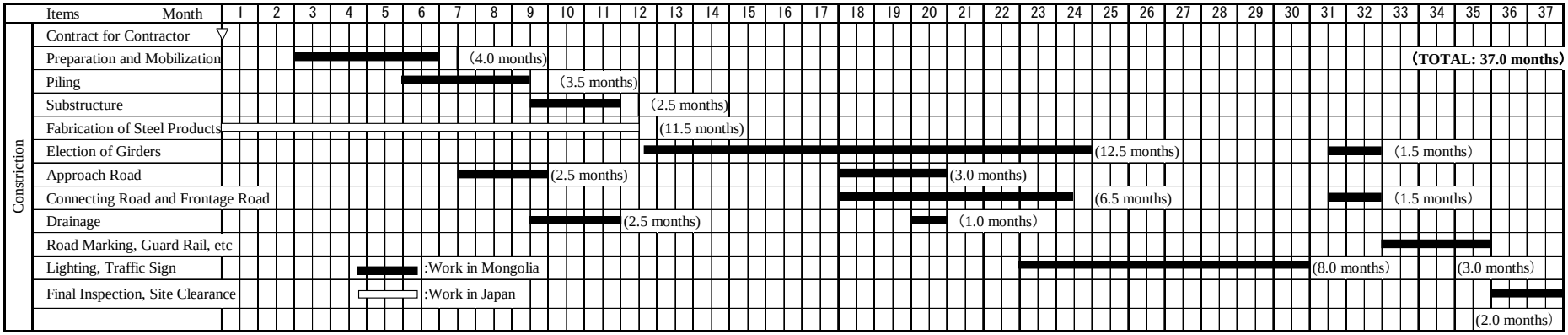



**Figure 2-2-19 Implementation Schedule of Construction Work**

## 2-3 OBLIGATIONS OF THE GOVERNMENT OF MONGOLIA

The Government of Mongolia shall undertake the following obligations for the Project:

1) To acquire the necessary land and establish the Road Right-of-Way for the Project.
2) To relocate, improve and/or repair existing utilities (hot-water pipes, power lines, telecommunication lines, water supply pipes, sewer pipes, power supply catenaries of trolleybus, etc.).
3) To make the necessary arrangements for vehicles' detour or diversion at necessary sections.
4) To secure and clear temporary yards such as land for contractor's facilities.
5) To install water supply, sewerage, electric power and telephone line facilities up to the base camps.
6) To secure the site for disposal of wastes at Ulaan-Chuluut Waste Disposal Site.
7) To clear and grub affected trees as listed.
8) To remove and/or relocate affected facilities and properties.
9) To remove and/or reconstruct the affected roof of the VIP platform.
10) To make necessary arrangements to control railway operation at sites neighboring the construction work (so-called "window time") for at least four (4) hours.
11) To bear the advising commission and payment commission to the Japanese bank where an account related to the Project is opened for banking services, like service charges and disbursement charges.
12) To exempt materials imported for the Project from tax and Customs levies and clearance to ensure smooth inland transportation of such materials.
13) To exempt Japanese nationals engaged in the construction work from Customs duties and other fiscal levies on products and services necessary for the execution of the Project.
14) To exempt Japanese nationals from all legislative measures necessary for entering and staying in Mongolia.
15) To acquire permits and approval documents (approval on environmental issues, permits for the bridge construction, traffic restrictions, relocation of underground utilities and overhead wires) necessary for the execution of the Project.
16) To ensure proper use and maintenance of the constructed flyover road and bridge as well as the approach roads.
17) To cooperate in solving potential troubles with local people or third parties in connection with the execution of the Project.
18) To bear all expenses required for project execution and other than the expenses borne under Japan's Grant Aid.

## 2-4 PROJECT OPERATION PLAN

Operation and maintenance work shall be undertaken by the Ulaanbaatar City Government which is the Implementing Agency for the Project. In addition, inspection and rehabilitation work for the bridge and road shall be carried out by UBZZ, which is publicly-owned agency under the Ulaanbaatar City Government. The structures to be constructed under the Project are designed to necessitate "minimum maintenance" as mentioned below taking into consideration that Ulaanbaatar City and UBZZ have much experience in road pavement, but less experience in systematic maintenance of bridge structures.

### (1) Ordinary Inspection

Ordinary inspection shall include the following:

- Cleaning of bridge surface, drainage and bearings
- Inspection and Maintenance of Traffic Safety Facility such as Guard Rail and Road Marking
- Snow removal
- Inspection of asphalt pavement condition and other defects of structures

### (2) Periodical Inspection

Periodical inspection shall be carried out every three (3) years in principle based on the detailed inspection schedule which shall be prepared by the designated inspector. Items to be inspected are as shown in Table 2-4-1. In case certain defects are observed, rehabilitation shall be considered following further detailed inspection.

**Table 2-4-1 Items of Periodical Inspection**

| Location | Structures | Inspection Items |
|---|---|---|
| Superstructure | Deck Slab | Defect on Road Surface, Water Leakage under the Slab |
| | Girders, Steel Members and Drainage | Corrosion, Crack, Loose-Bolt, Breakage, Deterioration of Painting, Defect on Expansion Joint, Unusual Sound and Vibration, Deformation of Members |
| Substructure | Steel Pier | Corrosion, Crack, Loose-Bolt, Breakage, Deterioration of Painting, Unusual Sound and Vibration, Deformation of Members |
| | Concrete Abutment | Crack, Separation, Deformation, Exposure of Rebars |
| Bearing | Bearing and its Anchor Bolt | Corrosion, Crack, Loose-Bolt, Breakage, Deterioration of Painting, Water Leakage, Clogged Earth, Settlement |
| | Bearing Mortar / Concrete | Crack, Floating, Deformation |
| Approach Road | Reinforced Earth | Damage, Deflection and Falling of Concrete Skin Plate, Defect of Joint, Water Leakage, Corrosion of Strip and Rebars |
| Accessories | Expansion Joint | Corrosion, Crack, Loose-Bolt, Breakage, Clogging, Deterioration of Coating, Flatness |
| | Concrete Barrier | Crack, Floating, Deformation |
| Pavement | Asphalt Pavement | Crack, Floating, Abrasion, Flatness |

Technical personnel to be involved in the periodical inspection are as listed below. The number of personnel shall be adjusted according to the required work volume.

**Table 2-4-2 Personnel Required for Periodical Inspection**

| Designation | Number Required | Period |
|---|---|---|
| 1) Bridge Inspector | 2 | 10 days |
| 2) Supporting Inspector | 4 | |
| 3) Vehicle Operator | 1 | |
| 4) Traffic Control Staff | 4 | |

The bottom of girders and deck slab shall be inspected using scaffold suspended to the hook fixed at the main girder. The portion at railway crossing where trains frequently pass shall be inspected using the Heat Insulating Plate as the scaffold for safely.

### (3) Rehabilitation Work

The lifespan of the bridge can be extended considerably through sound inspection and appropriate maintenance. On the other hand, some replacement or rehabilitation will be required after the lifespan, as exemplified by the list in Table 2-4-3.

**Table 2-4-3 Item of Rehabilitation Work and its Frequency**

| Location | Rehabilitation Work | Frequency (Year) |
|---|---|---|
| Steel- Concrete Composite Slab | Partial Replacement of Concrete | 10 |
| Painting / Coating | Partial Painting | 10 |
| Expansion Joint | Replacement of Bolt and Anchor Bolt<br>Welding of damaged part | 10 |
| Bearing | Anti-rust treatment | 10 |
| Pavement/Marking | Crack Searing, Patching | 3 |
| | Re-pavement of Skid Resistant Pavement | 7 |
| | Re-painting of Road Marking | 5 |
| | Reconstruction of Asphalt Surface | 10 |
| Other Concrete Structures | Repair of Crack | 10 |

It is presumed that large scale maintenance work and complicated regular maintenance will not be required in the meantime, since the bridge as designed is durable and highly weather proofed.

Although Ulaanbaatar City and UBZZ have no previous experience on maintenance of steel bridges, the Mongolian Railway has had experience on maintenance of steel bridges under MRTCUD since the 1960's. It is important that MRTCUD carry out technology transfer to Ulaanbaatar City and UBZZ on the maintenance of steel bridges in cooperation with the Railway Authority.

## 2-5 PROJECT COST ESTIMATION

### 2-5-1 Initial Cost Estimation

The initial cost estimation in this Basic Design Study is based on the expectation that the Mongolian side will fund the costs summarized in Table 2-5-1.

**Table 2-5-1 Project Cost to be borne by the Mongolian Side**

| Item | Cost (in Tg) |
|---|---|
| 1. Relocation of Existing Utilities | 5,404,000,000 |
| 2. Preparation of power supply for new road lighting and traffic signal | 1,351,000,000 |
| 3. Land Acquisition | 30,000,000 |
| 4. Banking Commission | 15,000,000 |
| **Total** | **6,800,000,000** |

### 2-5-2 Operation and Maintenance Cost

It is deemed that operation and maintenance of the Project can be managed by UBZZ under the present condition of budget and organization, since the operation and maintenance cost required is only around 16.5 million Tugrug which is equivalent to 1.6% of the 1,054 million Tugrug, the annual budget of UBZZ for the Year 2006.

The major maintenance items and estimated annual expenses for maintenance and operation are as summarized in Table 2-5-2.

**Table 2-5-2 Major Maintenance Items and its Annual Expenses**

| Type | Work Item | | Frequency | Cost per Work | Yearly Cost |
|---|---|---|---|---|---|
| **1. Ordinary Inspection** | Cleaning of bridge surface, drainage and bearings | | Monthly | 1,260,000 Tg / Year | |
| | Snow Removal | | 20 days/Year | 1,500,000 Tg / Year | 3,320,000 Tg |
| | Inspection of asphalt pavement condition and other defects of structures | | Every 3 Months | 560,000 Tg / Year | |
| **2. Periodical Inspection** | Detailed Inspection of Bridge, Bearings, Approach Road and Accessories | | Every 3 Years | 5,750,000 Tg | 1,917,000 Tg |
| **3. Rehabilitation** | Painting and Coating | Partial Re-painting | Every 10 Years | 10,400,000 Tg | 1,044,000 Tg |
| | Expansion Joint | Partial Rehabilitation | Every 10 Years | 4,200,000 Tg | 420,000 Tg |
| | Bearing | Partial Rehabilitation | Every 10 Years | 7,000,000 Tg | 699,000 Tg |
| | Pavement | Partial Rehabilitation | Every 3 Years | 1,700,000 Tg | 562,000 Tg |
| | Skid Resistant Pavement | Re-pavement | Every 7 Years | 21,500,000 Tg | 3,074,000 Tg |
| | Guardrail | Repair and Painting | Yearly | 140,000 Tg | 140,000 Tg |
| | Marking | Re-marking | Every 5 Years | 16,000,000 Tg | 3,228,000 Tg |
| | Other Concrete Structures | Partial Rehabilitation | Yearly | 2,050,000 Tg | 2,050,000 Tg |
| **Total Cost（/ Year）** | | | | | 16,454,000 Tg |

## 2-6 OTHER RELEVANT ISSUES

Following issues shall be taken into consideration for implementation of the Project.

### (1) Land Acquisition and Removal of Existing Buildings

Procedure for basic agreement on land acquisition has been completed except 1 land possessor who is under negotiation on compensation of existing building while other 10 land possessors had concluded basic agreements with Ulaanbaatar City as of December 2008. Therefore Ulaanbaatar City would be strongly required hereafter to advance the land acquisition and removal of existing buildings according to implementation schedule of the Project.

### (2) Relocation of Existing Utilities

Existing utilities such as underground utilities and overhead wires at the Project site shall be remove or reinforced before commencement of the construction of the Project. Ulaanbaatar City shall carefully discuss with proprietary companies to coordinate the relocation plan and its construction schedule with the Project Implementation. In addition, the relocation and reinforcement plan need to be examined by Japanese consultant who will conduct detailed design of the Project.

### (3) Improvement of Access Road to the Project Site.

Widening of the Engels Street to 4-lane and improvement of Ikh Toyruu Street has been scheduled to complete the design in 2009, and to complete the construction work in 2012 by Ulaanbaatar City. It is important to confirm the design and construction schedule for improvement of the access roads to complete its construction work conformity with the Project.

### (4) Monitoring on measures for minimization of adverse environmental impact

For implementation of flyover construction project in the urbanized area, it is important to take measures for minimization of adverse environmental impact as well as reduction of anticipated influence to passers-by, commercial facilities, residents and so forth near the project site. It is crucial that indispensably necessary measures shall be specified in the tender documents and that sound monitoring shall be executed throughout the construction period. The contractor(s) shall be obliged to certainly execute the following issues;

1) Safety measures to secure railway operation during construction,
2) Safety measures relevant to traffic control of passing vehicles,
3) Management of waste materials disposed from the construction site, and
4) Environmental preservation measures against noise, vibration and dust derived from construction work.

# CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

## 3-1 PROJECT EFFECT

The direct and indirect effects to be derived from the implementation of the Project are summarized in Table 3-1-1.

**Table 3-1-1 Direct and Indirect Effects by the Project Implementation**

| Status quo and Issues | Measures taken by the Project | Direct Effects (Effect Index) | Indirect Effects |
|---|---|---|---|
| 1. Railway severance of north-south traffic becomes traffic bottleneck in terms of road network.<br>2. It is hard to secure safe and reliable north-south traffic. | Construction of railway flyover and approach road | 1. Construction of safe and reliable flyover in Ulaanbaatar City (0→1)<br>2. Shortening travel distance between Peace Avenue and Chinggis Avenue (4.7 km→1.8 km)<br>3. Alleviation of control on heavy vehicles in north-south traffic (15 ton→40 ton) | 1. Improvement of vehicular traffic movement and promotion of cargo movement<br>2. Enhancement of convenience for residential/industrial estates and new international airport in the southern part of Ulaanbaatar City<br>3. Sustaining socio-economic activities in metropolitan area and improvement of accessibility to public facilities such as hospital and school<br>4. Reduction of car exhaust due to vehicular travel saving and alleviation of environmental burden |

## 3-2 RECOMMENDATIONS

The following recommendations are made, which should be undertaken by the Mongolian side, to bring about and sustain the project effects, provided, that the Project is implemented:

1. Timely periodic inspection and maintenance should be carried out. Cleaning of drainage and bearing shoe is important to prevent early deterioration of bridge and prolong its lifespan. Timely removal of snow should be carried out to avoid traffic accidents on the slippery frigid slope.

2. Since incremental traffic volume is projected in the vicinity of merging and diverging points in the northern section of the Project, traffic control and enforcement should be imposed strictly in coordination with the relevant authorities.

3. It is assumed that traffic volume of the Project Road will be saturated after 2017. Therefore, it is important to strengthen the connecting routes of the north-south traffic, including reconstruction of Gurvaljin Bridge, and to improve the road network in terms of accessibility in the north-south traffic to accommodate future traffic demand.

4. It is possible to expand the lifespan of the bridge and structure by keeping proper maintenance. To minimize the life-cycle-cost of the bridge, MRTCUD should be required to share the maintenance technology on steel bridges accumulated in the Railway Authority with Ulaanbaatar City and UBZZ to enable these entities to develop their own capacity on maintenance work.