Government of Nepal
Ministry of Physical Infrastructure and Transport
Department of Roads

Federal Democratic Republic of Nepal

Data Collection Survey on Thankot Area Road Improvement in Nepal

Final Report

July 2014

Japan International Cooperation Agency

Tonichi Engineering Consultants, Inc.
CTI Engineering International Co., Ltd

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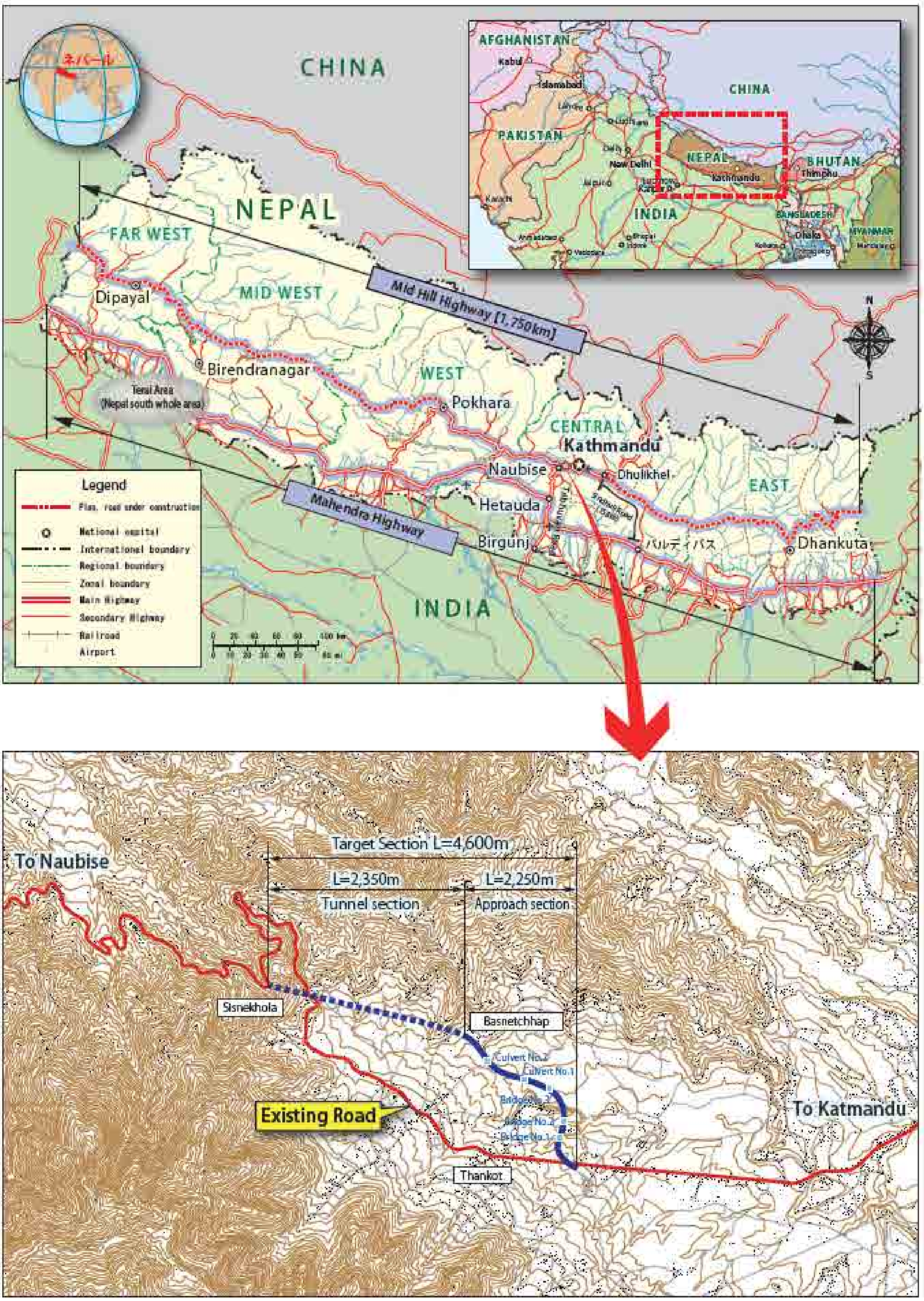

Location Map

Source: JICA Study Team

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LIST OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transport Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
AMGB	Asphalt Mixed with Base
ARMP	Annual Road Maintenance Plan
BCR	Benefit Cost Ratio
CBR	California Bearing Ratio
CDC	Compensation Determination Committee
CRRD	Central Regional Road Directorate
DDC	District Development Committee
DDG	Deputy Director General
DFID	Department for International Development
DG	Director General
DHM	Department of Hydrology and Meteorology
DMG	Department of Mining and Geology
DOLIDAR	Department of Local Infrastructure Development and Agricultural Roads
DOTM	Department of Transport Management
DOR	Department of Roads
DOS	Department of Survey
DPO	District Project Office
DTMP	District Transportation Master Plan
DUDBC	Department of Urban Development and Building Construction
DWIDP	Department of Water Induced Disaster Prevention
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
EPR	Environmental Protection Rule
ESMF	Environmental and Social Management Framework
EWH	East West Highway
FHWA	Federal Highway Administration
FNNTE	Federation of Nepalese National Transport Entrepreneurs
FY	Fiscal Year
GDP	Gross Domestic Product
GESU	Geo Environmental and Social Unit
GIS	Geographic Information System
GON	Government of Nepal
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
HCM	Highway Capacity Manual
HMGN	His Majesty's Government of Nepal
HFL	High Flood Level
IDA	International Development Association
IEE	Initial Environmental Examination
IRC	Indian Road Congress
JICA	Japan International Cooperation Agency
JRA	Japan Road Association
KMC	Kathmandu Metropolitan City
KTM	Kathmandu
KVDA	Kathmandu Valley Development Authority

LRN	Local Road Network
MC	Motor Cycle
MHC	Mid-Hill East-West Corridor
MOA	Ministry of Agriculture
MOE	Ministry of Education
MOFSC	Ministry of Forests and Soil Conservation
MOLE	Ministry of Labor & Employment
MOLD	Ministry of Local Development
MOPIT	Ministry of Physical Infrastructure and Transport
MOSTE	Ministry of Science, Technology and Environment
MOU	Memorandum of Understanding
MOUD	Ministry of Urban Development
MRCU	Maintenance and Rehabilitation Co-ordination Unit
MTP	Metropolitan Traffic Police
NATM	New Austrian Tunneling Method
NEP	Nepal Electricity Authority
NEFIN	National Foundation for Indigenous Nationalities
NGO	Non Governmental Organization
NITTFP	Nepal India Trade and Transport Facilitation Project
NPBCL	Nepal Purwadhar Bikash Company Ltd
NPC	National Planning Commission
NPV	Net Present Value
NRS	Nepal Road Standard
NRs.	Nepal Rupees
NTA	Nepal Tunnel Association
ODA	Official Development Assistance
ORRDP	Outer Ring Road Development Project
PCU	Passenger Car Unit
PPP	Private Public Partnership
PAP	Project affected people/person
PMU	Project Management Unit
RBN	Road Board Nepal
ROW	Right of Way
RSDP	Road Sector Development Project
SDC	Swiss Agency for Development and Cooperation
SRN	Strategic Road Network
STGB	Surface Treatment with Granular Base
TRB	Transportation Research Board
TRP	Tribhuvan Rajpath
URN	Urban Road Network
VDC	Village Development Committee
WB	World Bank
WECS	Water and Energy Commission Secretariat

Summary of the Project

1-1 Project Background

Nepal is a landlocked country between China and India. Kathmandu is located in the valley surrounded by 800~1,500m mountains, only two international corridors are available, namely, one is from India to the western Kathmandu via the Prithvi Highway, and the other is from China to the northeastern Kathmandu via the Arniko Highway. Regarding the latter road, it crosses over Himalaya Mountains and landslides have often happened in a rainy season, therefore the trade amount is not large.

From the above reason, it is advantageous that the route from India to the western Kathmandu via the Prithvi Highway is the most reliable for foreign trade. This route, however, also has the steep gradient and sharp curve and the road alignment is not appropriate for logistics distribution. Especially, those steep gradient and sharp curve sections are located along the road between Thankot and Naubise of Tribhuvan Highway.

Improvement of this steep and sharp curving road to be appropriate alignment enables large-sized vehicles to run smoothly and reduces the traffic accident and traffic congestion. It will make trade between Nepal and India more active and contribute the economic growth of Nepal.

1.2 Objectives of the Study

The objectives of the study are to gather information on existing road conditions, and environmental and social consideration for the section between Kalanki intersection and Naubise as the intersection along the Tribhuvan Highway. And also the study should reveal the future policy for the new road improvement in this section from viewpoints of necessity and validity.

1.3 Location of the Project Road

Location of the Project Road is approximately 22km between Kalanki intersection located on a ring road in the Kathmandu Valley and Naubise, however, the road improvement is 15km between Thankot and Naubise where the most steep slopes and sharp curves are located along Tribhuvan Highway. Figure S-1 shows the road improvement project section along Tribhuvan Highway.

2.1 Procedure of Route Location Selection

The flow of the process for route location selection for the improvement of the existing road within Kalanki to Naubise section is illustrated in Figure S-2 and explained below

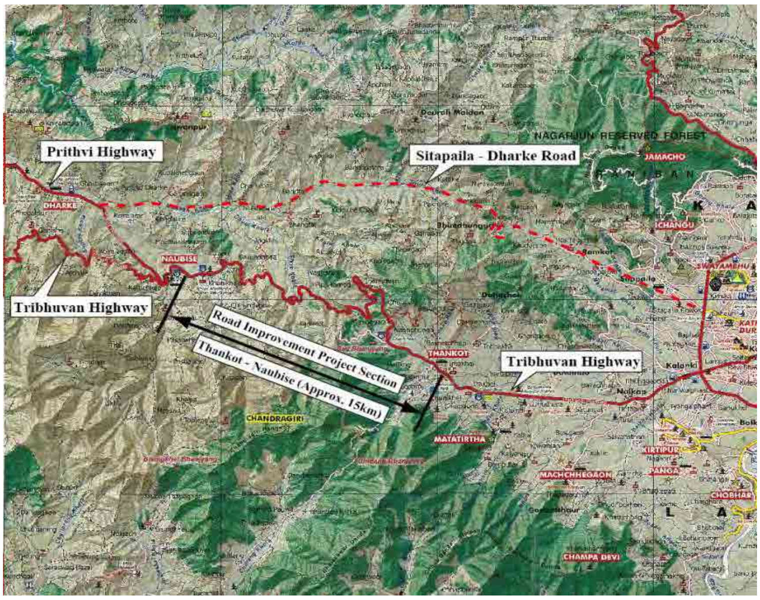
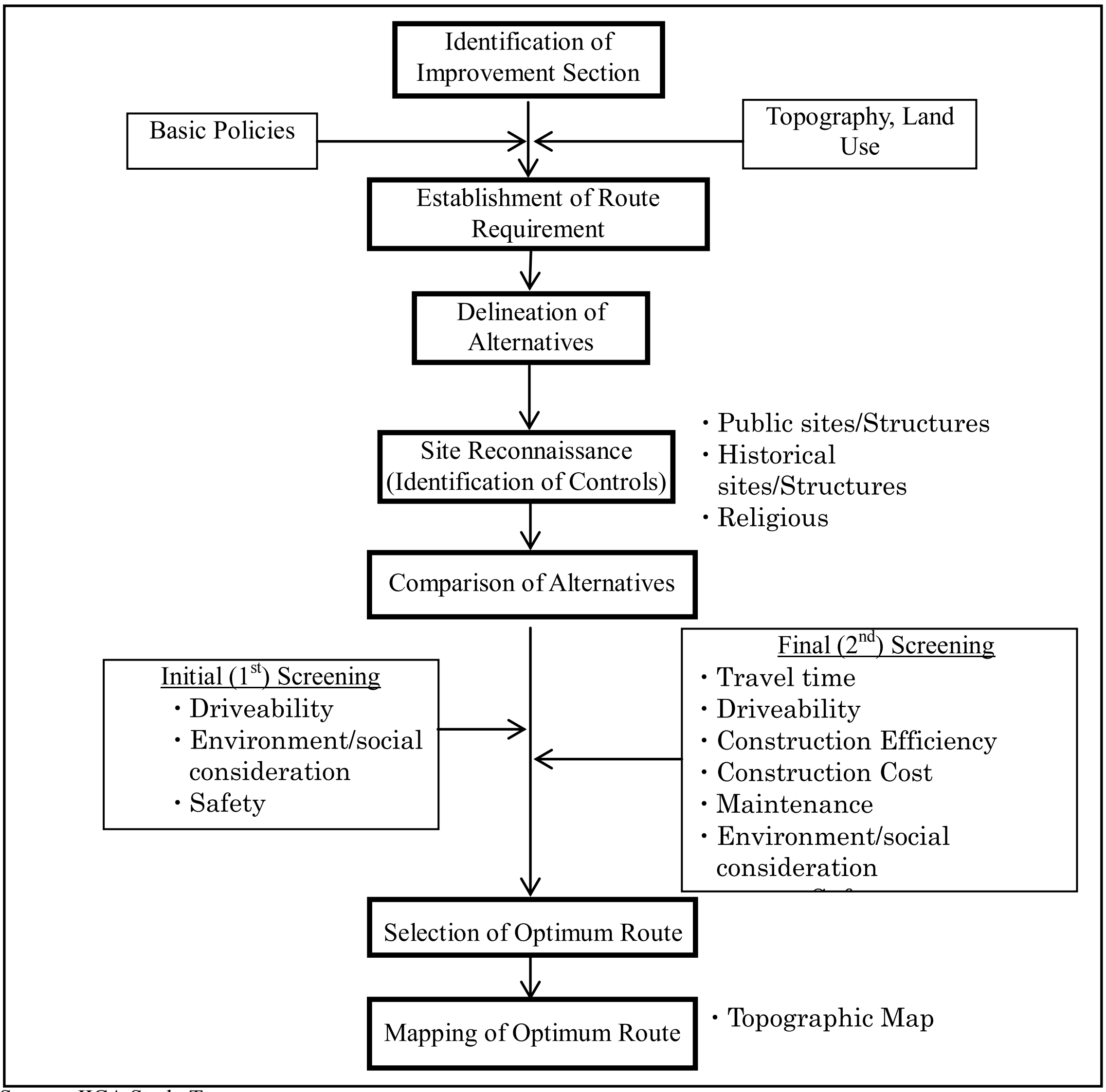


Figure S-1 Road Improvement Project Section along Tribhuvan Highway



Source: JICA Study Team

Figure S-2 Route Location Study Procedure

2-2 Initial Screening

The most important task during the first field work was to determine the optimum route within a short period of time. For this, it was necessary to consider all theoretically possible alternatives and conduct screening of them. As shown in Table S-3, the Study Team proposed 3 such alternative routes based on the available maps, documents and information collected thru meetings with JICA and relevant organizations of the GON. These alternatives were checked at the site and screened based on general evaluation factors. The alternative routes that were found inappropriate in the initial screening were dropped out and the remaining alternatives were selected as the potential alternative routes and subjected for a more detailed comparison. The comparison result for the initial screening is summarized in Table S-3.

2.3 Evaluation Factors

The 3 alternatives selected from the initial screening are again examined and compared in detail, based on the following evaluation factors:

Travel Time	:	Shorter routes with smooth alignment contribute to high travel time reduction (high vehicle operating cost),
Driving Comfort (safety)	:	Smooth alignment meeting minimum geometric requirement will be better alternative,
Construction Efficiency	:	Sufficient availability of construction yard and easy to construct (especially tunnels are easy to construct upwards) relates to shorter time and cheaper cost,
Maintenance	:	Metal bridges need regular maintenance,
Environment and social consideration	:	Less number of affected houses will have less impact during implementation, and
Cost	:	The shorter and simple structures used, the less expensive is the route

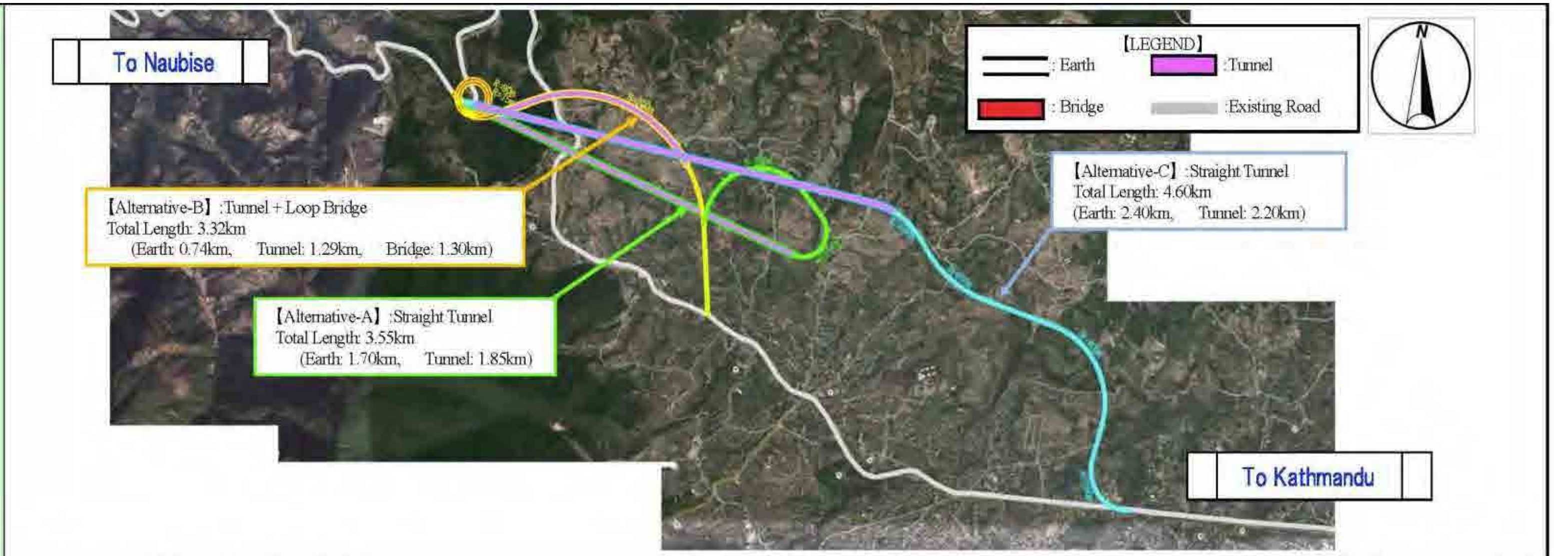
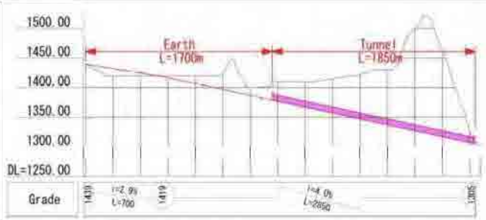
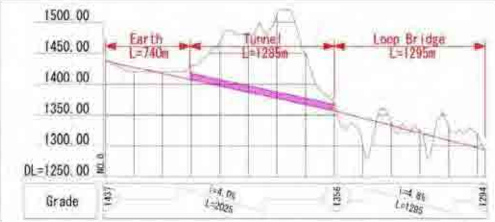
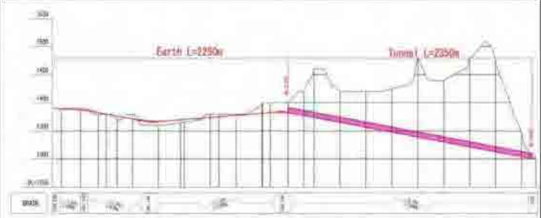
The environmental and social consideration factor in general needs to be given the highest importance as the evaluation factor. However, as there is no significant difference in the number of relocation, other factors such as travel time, driving safety etc. are used for evaluation.

2.4 Conclusion of Route Selection

From the result of the comparative study Alternative-C is recommended as optimum as it is superior than or similar to other alternatives in the following manner:

- Reduction of travel time is highest,
- Both horizontal and vertical alignment are smooth meaning high driving comfort,
- Sufficient construction yard available plus upward excavation is possible,
- Maintenance cost is low (Metal bridge of Alternative-B requires regular maintenance), and Number of houses affected is low.

Table S-3 Comparison of Alternative Routes (Final Screening)

		Alternative-A		Alternative-B		Alternative-C	
Route Map							
Alternatives		【Alternative-A】:【Straight Tunnel (i=4.0%)】 Alternative with an emphasis on Constructability and Drivability. (Grade of Tunnel section is 4.0%)		【Alternative-B】:【Tunnel + Loop Bridge】 Alternative which utilizes advanced technologies.		【Alternative-C】:【Straight Tunnel (i=2.5%)】 Alternative with an emphasis on Constructability and Drivability. (Grade of Tunnel section is 3.5%)	
Longitudinal Section							
Evaluation Factors	Time Reduction	■Travel time is reduced by about 14 minutes compared to the existing road use. (Existing Road: about 26 minutes, Alternative Route: about 12 minutes)	△	■Travel time is reduced by about 14 minutes compared to the existing road use. (Existing Road: about 26 minutes, Alternative Route: about 12 minutes)	△	■Travel time is reduced by about 19 minutes compared to the existing road use. (Existing Road: about 26 minutes, Alternative Route: about 7 minutes)	○
	Distance Shortened	■Approx. 1.4km (Existing road 4.95km)		■Approx. 1.6km (Existing road 4.95km)		■Approx. 3.0km (Existing road 7.55km)	
	Drivability	■Drivability(vertical alignment and horizontal alignment) is good.	△	■Loop bridge radius is small. Drivability is inferior.	△	■Drivability is best among the alternatives.	○
	Constructability	■Tunnel excavation from the west portal is possible. Here, construction yard can be easily secured. Transport of excavation soil and drainage discharge is also easy because excavation can be done from the lower side. ■The overburden (surcharge) at the east portal of the tunnel is low ■Effect of groundwater is high as the alignment runs in a valley	○	■Excavation from tunnel exit portal is difficult as it is on high slope. Excavated from the entry portal needs digging in the lower (downward) direction casing difficulty in transporting the excavated soil and drainage discharge. ■Securing construction yard for construction of loop bridge is difficult. ■Effects of groundwater is lowest.	△	■Space for construction yard is readily available at the tunnel entrance side and also at the exit portal. Transport of excavation soil and drainage discharge is also not a big issue as the excavation in the higher (upward) direction is possible. ■The overburden (surcharge) at the starting point of the tunnel is low. ■Effect of groundwater is lowt.	○
	Maintenance	■Maintenance cost is lowest among the alternatives.	○	■Maintenance cost is higher than other alternatives because the metal bridge requires regular painting to avoid rusting.	△	■Maintenance cost is lower than alternative-B.	○
	Environmental and Social Consideration	■Land acquisition area required is about 85,000 m^2. ■Maximum number of house to be relocated is estimated to 20. ■As the tunnel passes along a valley, possibility of lowering of groundwater level of the surrounding area is anticipated.	△	■Land acquisition area required is about 85,000 m^2. ■Maximum number of houses to be relocated is about 15	○	■Site acquisition area is about 120,000 m^2. ■Maximum number of houses to be relocated is about 27. ■Possibility of lowering groundwater level of the surrounding area is anticipated.	△
	Cost (Ratio)	About $ 80 million (1.00)	○	About $ 180 million (2.25)	△	About $ 100 million(1.25)	△
Ranking Evaluation		Construction and maintenance cost is the cheapest, but drivability and time reduction are inferior than alternative-C.	2	Construction cost is the highest. Superior in terms of environmental and social consideration, but constructability and maintenance are inferior than other alternatives.	3	Drivability, constructability and maintenance are better than other alternatives. The construction cost is higher than alternative-A, but there is no large difference.	1

Source: JICA Study Team

3.1 Japanese Technology for the Project

Although there are some hydro-tunnels in Nepal, road tunnel has never been constructed in Nepal before. Therefore, no local consultants and contractors have any experience of road tunnel. As a mountainous country, needs for tunnels to ensure faster and safer transportation of people and goods is expected to increase in the future. Implementation of this project can provide an opportunity to enhance the capacity of local contractors in this field through technical transfer on application of tunnel technologies such as excavation methods, quality management, safety control including deformation check during tunnel excavation, etc. from Japanese contractors.

3.1.1 Special Construction Equipment

Special equipment used for excavation of tunnel is Rock Drilling Machine, Shotcrete mixing plant, Shotcreting Machine, Side-dump Loader and Ventilation Fan. These equipment are neither available locally nor can be procured from India. Therefore, all these equipment are required to be procured from Japan. The concrete lining equipment such as sliding form is also required to be procured from Japan. In addition, the deficiency of power supply, which is evident from the everyday load shedding in the Kathmandu Valley, necessitates some special engine air compressor also to be procured from Japan.

3.1.2 Lighting

The lighting of the tunnel is very important for securing traffic safety inside the tunnel. The lighting must be planned such that both the initial cost and maintenance cost is economical. Recently, LED lighting is in common use whose overall cost is less than the conventional lighting. Therefore, it is recommended to use LED lightings inside the tunnel as far as possible.

3.1.3 Safety Facilities

The tunnel length of 2.35km and the daily traffic of 7,500 classify the tunnel class B in Japanese road tunnel safety standard. The class B tunnel requires provision of;

- Emergency telephone in the tunnel
- Push button report facility in tunnel
- Emergency alarm at the entrance of tunnel
- Portable fire extinguisher in tunnel
- Evacuation guide panel on tunnel wall

3.1.4 Ventilation

From the tunnel length (L) of 2.35km and the recent traffic volume (N) of 7,500 per day excluding motorbikes, the limit of the natural wind ventilation estimated, in accordance with Japanese Road Tunnel Ventilation Standard, is as follows:

1) Design Hourly Traffic Volume in City/Rural Area and Flat Topography

   $N = 0.090 \times 7{,}500 = 675$ vehicles per hour

2) Two (2) directions Traffic Tunnel

   $L \cdot N = 675 \times 2.35 = 1{,}586$ over 1,000

Hence, Natural Wind Ventilation is not applicable, and provision of ventilation system is required. The typical ventilation by the Jet Fans will be most simple and applicable among various ventilation systems.

3.1.5 Power Supply Facilities

One of the prerequisites in connection to the implementation of this project is assurance of power supply and backup system. Stable and continuous electricity supply will be critically required during operation and maintenance, particularly inside the tunnel section to keep the ventilation and lights adequately functioning.

The total electric power demand of the tunnel will reach to 1,000kw. Supply of this power in a stable and continuous manner can be made available from Nepal Electric Authority (NEA). However, a minute of understanding (MOU) has to be signed between MOPIT and MOE for this provision. This is possible if the project road is enlisted in the National Priority Project List. The power supply line to the tunnel from the transmission line or directly from the nearby substation of NEA needs to be maintained as well as the provision of power supply system inside the tunnel is required.

4.1 Conclusion

Economic and trade activities are flourishing in Kathmandu through the network of roads connecting neighboring India and the Kathmandu Valley. However, the Kathmandu Valley itself is located in the basin within surrounding mountains, therefore, the transportation of goods and commodities from India have to inevitably pass through the steep slopes and sharp curves of the Thankot Pass. With the proposal of building a tunnel at Thankot Pass, this project will bear huge economic benefits as it will greatly relieve traffic congestions, reduce the number of accidents and decrease travel time as follows:

(1) Shortening of travel time
(2) Shortening travel distance
(3) Saving of vehicle running cost
(4) Reduction of traffic accidents
(5) Application as a Model Case

As mentioned above, this tunnel project connecting Kathmandu and India through the Tribhuvan Highway will bring great economic prospects into Nepal. It is strongly believed that with the implementation of this project, the infrastructure development of the country will improve steadily whereby drawing strong foreign investments into the country. Although this proposed tunnel project in Thankot Pass will be the first model case in Nepal, it will be a ’successful’ model case as there are many places in Nepal where tunnel constructions can be implemented in the future.

As mentioned above, there are so many advantages for the country of Nepal to implement the tunnel construction at Thankot. They are not only district development and economics, but also technical transfer to Nepalese engineers of DOR or other related institutions. The tunnel

construction starts from a planning, design, construction and inauguration. These processes contain a various modern civil engineering technologies.
It is a revolutionary project that a tunnel technology is introduced into Nepalese engineers, moreover, the technology transfer by this project will be enhanced the country of Nepal to develop more in the future.