Department of Roads
Ministry of Physical Planning & Works
Nepal

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE IMPROVEMENT OF KATHMANDU-BHAKTAPUR ROAD
IN
NEPAL

July 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of Nepal, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Kathmandu-Bhaktapur Road in Nepal and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Nepal a study team from November 24, 2006 to December 21, 2006.

The team held discussions with the officials concerned of the Government of Nepal, 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 Nepal 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 Nepal for their close cooperation extended to the teams.

July 2007

Masafumi Kuroki

Vice-President

Japan International Cooperation Agency

July 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for the Improvement of Kathmandu-Bhaktapur Road in Nepal.

This study was conducted by Nippon Koei Co., Ltd., Ltd, under a contract to JICA, during the period from November, 2006 to July, 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Nepal 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,

Katsufumi Matsuzawa
Chief Consultant
Basic design study team on
the project for the Improvement of
Kathmandu-Bhaktapur Road in
Nepal
Nippon Koei Co., Ltd.

Summary

SUMMARY

1. Outline of the Country

Nepal with an area of approximately 147,000 square kilometres is a landlocked Himalayan country in South Asia. It is bordered by China in the north and by India on the remaining three sides. The capital of Nepal is Kathmandu located in the Kathmandu Valley, the size of which is about 25km from east to west and about 20km from south to north. The total population of Nepal is about 25.3 million as of July 2004/05 according to the Central Bureau of Statistics (CBS), out of which the Kathmandu Valley has about 1.76 million.

According to the latest data from the Ministry of Finance (MOF), Nepal's nominal GDP for the year 2005/06 is around US$7.0 billion and per-capita nominal GDP is around US$318. Primary industry including agriculture is about 40% of the GDP and sustains about 80% of Nepal's population. Secondary industry including manufacturing accounts for about 20% of the GDP, and tertiary industry including the tourist business and services comprises about 40% of the GDP.

The national roads with a total length of 15,905km are classified into five classes; national highways, feeder roads, urban roads, district roads and village roads. The Department of Roads (DOR) under the Ministry of Physical Planning and Works (MOPPW) of the Government of Nepal (GON) is responsible for developing and maintaining the national highways, feeder roads and urban roads. The total road length under jurisdiction by DOR is only about 1,820km, an extremely low share of the national total, and the road network system in Nepal is still immature.

2. Background and Outline of the Project

In December 2005, DOR, the responsible authority of GON, prepared a Master Plan for a Strategic Road Network (the Master Plan) covering the next 20 years based on the current Eleventh National Development Plan (from July 16, 2007 to July 15, 2012) and future targets of macro economic indicators of the country. The project for improvement of the Kathmandu-Bhaktapur Road is listed as one of the highest priority projects in the Master Plan.

In Nepal, population concentration towards the Katmandu Valley, which is the national center of politics, economy and administration, has been remarkable in recent years. In the Kathmandu Valley, offices related to politics, industries and governments are mostly located inside the Kathmandu Ring Road while new residential areas and factories are expanding towards the east, e.g. Madhyapur Thimi municipality and Bhakutapur municipality where terrain is relatively flat.

The Kathmandu-Bhaktapur Road (the Road) connects Kathmandu and Bhaktapur, a tourism oriented city renowned as a world heritage, and forms a part of the Arniko Highway (Asian Highway No. 42) connecting Nepal and China. In recent years, registration of car ownership in Nepal has been continuously increasing at a rapid rate. Most of the roads are saturated in and around Kathmandu City, which is causing a number of traffic congestion problems on the roads, especially in morning and evening peak hours. Accordingly, as one of the most congested roads, DOR has listed the Project for the

Improvement of Kathmandu-Bhakutapur Road (the Project) in the Master Plan.

Traffic volume on the Road is the highest among the national highways in Nepal, and the traffic congestion is very serious. Moreover, it is anticipated that incoming traffic from Sindhuli Road, for which construction is underway with Japan's Grant Aid, will add more traffic once the Sindhuli Road project is completed.

As a result of this situation, GON requested the Government of Japan (GOJ) in July 2004 to extend Japan's Grant Aid for the Project. In the request, GON intended mainly to widen the existing 2-lane road to a 4-lane road from Kathmandu (Tinkune Intersection) to Bhaktapur (Suryabinayak Intersection) and to rehabilitate the measures for preventing the scour around the foundation of Manohara Bridge on the Road.

In response to the request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Study Team to Nepal in December 2005 to clarify the components of the Project and to discuss the scope of work for an Initial Environmental Examination (IEE) study, which should be conducted by DOR. In the Preliminary Study, DOR made three additional requests: about 1.0km extension of the road ending point from Suryabinayak Intersection to Jagati Intersection, widening of Manohara and Hanumante bridges to 4 lanes to be compatible with the widening of the Road, and provision of service roads which would be used as community roads for inhabitants along the Road including loading/unloading of truck cargos and embarkation/disembarkation of bus passengers. After the Preliminary Study Team had technically examined the requests from DOR and exchanged views with the Nepalese side, it was concluded that, as components of the Japan's Grant Aid, the road ending point would be at Suryabinayak Intersection just as in the original request, additional new 2-lane Manohara and Hanumante bridges would be built, and improvement of protection measures against scour and check dams would be undertaken.

DOR completed the IEE study for the Project in April 2006 and this was approved by MOPPW in July 2006.

3. Outline of Basic Design and Main Feature of Project Facilities

The necessity and urgency of the Project were confirmed by the results of the Preliminary Study and the DOR's IEE. GOJ decided to conduct a Basic Design Study on the Project for the Improvement of Kathmandu-Bhaktapur Road in Nepal (the Study), and then JICA dispatched a Basic Design Study Team (the Study Team) to Nepal from November 24 to December 21, 2006 to discuss the scope of the Project and conduct a site survey and collect necessary data for basic design. After the Study Team returned to Japan, further studies and basic design were conducted and a draft final report was prepared. Then JICA sent a Basic Design Explanation Team to Nepal from May 13 to 19, 2007 and the Minutes of Discussion, which mainly covered the results of the basic design and the recipient country's obligation, were agreed by both sides.

As a result of the Study, it was found that traffic volumes on the Road had already exceeded the traffic capacity of a 2-lane road; the maximum, counted near Koteswore on the Kathmandu side, was about 50,000 vehicles/day, and the minimum was counted near Suryabinayak on the Bhakutapur side at about 15,000 vehicles/day. Accordingly, the necessity and urgency of the Project to augment the traffic capacity

by widening the Road from 2 lanes to 4 lanes were confirmed. The geometry and typical cross section of the Road were designed on the basis of the Asian Highway Standards that the Master Plan designated for the design of all the road sections of the Asian Highway in Nepal.

Two 2-lane bridges exist on the Road, Manohara Bridge and Hanumante Bridge. The widths of these bridges are too narrow to allow a large volume of pedestrians, who are obliged to walk on the edge of the carriageway. Such pedestrians very often disturb the traffic movements on the bridges resulting in traffic bottlenecks on the Road. Accordingly, additional 2-lane bridges with sufficient sidewalk capacity were designed for these two locations in the Study to augment the traffic capacity, in addition to minor repair and surface restoration work on the existing 2-lane bridges that would continue to be used. Existing pier foundation protective measures against scour and check dams, both of which are of gabion structures, had already deteriorated, and hence restoration and rehabilitation of the protective measures for the foundations and check dams were included in the Study.

The existing five intersections along the Road have insufficient facilities, viz. no pedestrian crossings, no traffic safety measures and no appropriately designed connecting roads. Moreover, the mixture of traffic condition and pedestrians is causing severe traffic congestion. Despite the existence of bus stops, neither buses nor passengers use them properly. Most of the buses stay within the intersections during embarkation and disembarkation of passengers. Such indiscriminant movement of bus passengers worsens the traffic flows in the intersections. In order to rectify this intersection situation, five intersections and fourteen bus stops were designed in the Study.

The facilities designed in the Study are summarized below.

Items		Feature of Facilities
Road	Widening	9.142km (Tinkune Intersection to Suryabinayak Intersection)
	Width	Carriageway: (2 x 3.5m = 7.0m) x 2 directions = 14.0m Median: 3.0m for normal section except 0.6m New Jersey within Ring Road Side allowance of median: 2 x 0.5m = 1.0m Shoulder: 3.0 m (including traffic barrier)
	Pavement	Surface (Asphalt Concrete): 5cm Carriageway & Shoulder Binder (Asphalt Concrete): 6cm Carriageway only
Bridge	Existing	Further use
	New	Manohara Br: Length 84.04m, width12.5m, PC girder Hanumante Br: Length 50.44m, width12.5m, PC girder
Intersection Improvement		5 intersections: Jadibuti, Ghataghar, Thimi, Sallaghari, Suryabinayak 3 signalized: Jadibuti, Ghataghar, Sallaghari
Median Strip		3m wide median (from Koteswore to Suryabinayak) 60cm wide New Jersey (from Tinkune to Koteswore)
Access Roads		11 access roads to be connected to the Road other than intersections
Bus stops		14 locations
Road Lighting		At intersections, bridges and bus stops
Drainage	Cross	22 (including 6 involving major drainage)
	S. ditch	Both sides along the Road
Traffic Barrier		Guardrail type: embankment height of 3m or more Guard-pipe type: embankment height of less than 3m

4. Construction Period and Estimated Project Cost

The detailed design including tender document preparation will take about 7 months. The construction period will be about 30 months.

The cost to be borne by the Nepalese side, separate from Japan's Grant Aid, is estimated at about NRs 210.9 million, which includes the construction related cost of about NRs 167.7 million and the future operation and maintenance cost (for 20 years) of about NRs 43.2 million.

5. Project Evaluation and Recommendations

The areas directly benefited by the Project cover Kathmandu, Lalitpur, Madhyapur Thimi and Bhaktapur districts in the Kathmandu Valley with a population of about 176 million. The following benefits are expected.

Direct Impacts and Effects

- Existing traffic volume on the road at Jadibuti for both directions is about 40,000 vehicles per day and that has already reached the capacity of the 2-lane road. The future traffic volume in 10 years after completion of the Project is expected to be approximately 80,000 vehicles per day (Jadibuti), nearly twice the present, with a growth rate of 3.9% to 16.3% per annum

according to the study on the North-South Transport Corridor in the Central Region by DOR. In the do-nothing scenario of the Project, severe traffic congestion on the Road will take place much more often than at present. In this regard, the augmentation of traffic volume by the Project will facilitate smooth traffic flow on the Road.

- At present, travel time by car along a stretch of about 9 km from Tinkune to Suryabinayak is a maximum of 48 minutes in peak hours. Once the road is widened from 2 to 4 lanes, travel time is expected to reduce to nearly half.
- 340 vehicles were recorded in traffic accidents along the Road in one year from November 2005 to October 2006 with a total casualty count of 149 persons (fatalities 11, serious 39 and injured 99). Since there are many traffic accidents which originate in the mixed traffic of slow-moving motorized tricycles, heavy vehicles, high speed sedans, etc., reduction of future traffic accidents is expected by widening of the carriageway of the road and bridges, improvement of intersections, provision of bus stops and installation of traffic safety facilities by the Project.
- Reduction of transportation costs, both for passengers and commodities, is expected as the results of travel time savings and improved driving conditions introduced by the Project.

Indirect Impacts and Effects

- The commerce, fabrication and housing industries along the road would be developed as a result of the Project. New business opportunities would be activated by the investment effects accompanying promotion of urbanized land use.
- Although public buses are generally used by local people in the Kathmandu valley, augmentation of traffic capacity and improvement of bus stops by the Project would facilitate improved public transportation services. As many residents, both inside and outside the Katmandu valley, use the public bus service, the social impact would be very significant and wide ranging.
- By enlarging the traffic capacity of the Road, the travel time to Kathmandu by way of the Arniko Highway from other roads, including the Sindhuli Road, will reduce.

In addition to the above impacts, the implementation of the Project will contribute to the socio-economic activities not only in the Kathmandu Valley but also throughout Nepal since the Road forms a part of Asian Highway No. 42 towards China as well as providing links to the Terai Region through Sindhuli Road.

If the Service Roads as the community roads of the inhabitants (including loading and unloading of truck cargos and embarkation and disembarkation of bus passengers) are developed by the Nepalese immediately after the completion of the facilities under Japan's Grant Aid, the effects of the Project will increase much more. In this regard, it is strongly recommended to maintain close collaboration among the concerned entities of both the Nepalese and Japanese sides.

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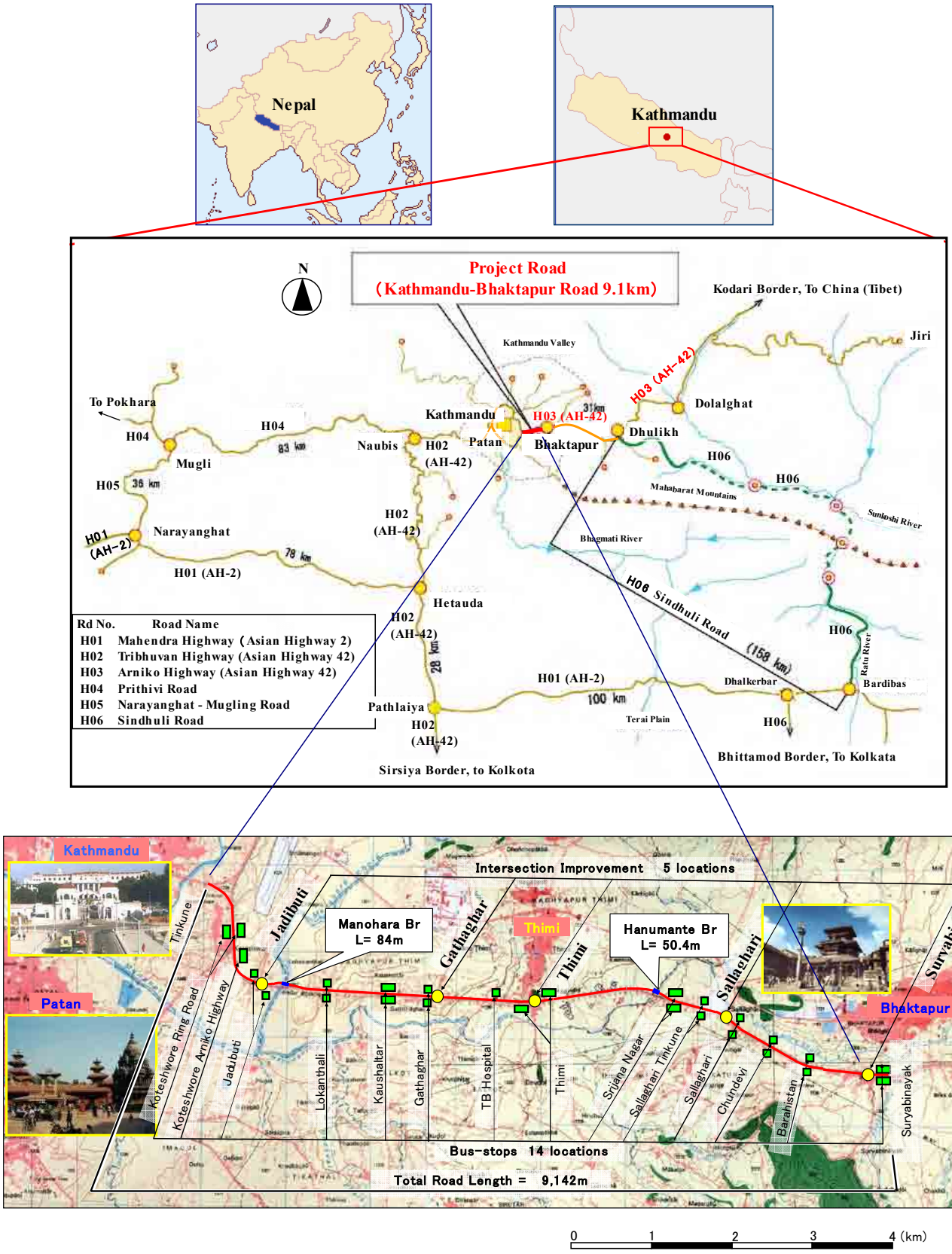
Abbreviation

AASHTO	:	American Association of State Highways and Transportation Officials
ADB	:	The Asian Development Bank
CBR	:	California Bearing Ratio
CBS	:	Central Bureau of Statistics
cd	:	Unit of luminous intensity, candela
CDC	:	Compensation Determination Committee, GON (Government of Nepal)
DBST	:	Double Bituminous Surface Treatment
DDC	:	District Development Committee, GON
DFID	:	Department for International Development, United Kingdom
DHM	:	Department of Hydrology and Meteorology, GON
DOR	:	Department of Roads, GON
EIA	:	Environmental Impact Assessment
E/N	:	Exchange of Notes
EPA	:	Environmental Protection Act, Nepal
EPR	:	Environmental Protection Rules, Nepal
FGD	:	Focus Group Discussion
FWD	:	Light - Falling Weight Deflectometer
GDP	:	Gross Domestic Product
GEU	:	Geo-environment Unit, DOR, GON
GOJ	:	Government of Japan
GON	:	Government of Nepal
GTZ	:	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Cooperation), Germany
GW	:	Unit of power, gigawatt = 1,000 MW
h or hr	:	Unit of time, hour
IEE	:	Initial Environmental Examination
IRC	:	Indian Road Congress
JICA	:	Japan International Cooperation Agency
km	:	Unit of length, kilometer
km^2	:	Square kilometer
Ldn	:	Unit of sound, Ldn (Day-Night Average Sound Level)
LED	:	Light emitting diode
Leq	:	Unit of sound, Leq (Sound Level Equivalent)
lx	:	Unit of illuminance, lux
m	:	Unit of length, meter
MOPPW	:	Ministry of Physical Planning & Works, GON
MW	:	Unit of power, megawatt = 1,000 KW
NEA	:	Nepal Electricity Authority
NRs	:	Currency unit, Nepalese Rupee
PC	:	Pre-stressed Concrete in bridge engineering, and passenger car in traffic engineering
PDSP	:	Planning and Design Strengthening Project, GON
PMO	:	Project Management Office, DOR, GON
PPV	:	Unit of particle peak velocity and frequency, kine (= cm/sec)
RC	:	Reinforced Concrete
RMDP	:	Road Maintenance Development Project financed by the World Bank, Nepal
ROW	:	Right of Way
SDC	:	Swiss Agency for Development and Cooperation
SN	:	Structural Number stipulated by AASHTO pavement design
TFV	:	Ten Percent Fines Value for aggregate test
US$	:	US Dollar
WECS	:	Water Energy Commission Secretariat, GON



Location Map of the Project for the Improvement of Kathmandu-Bhaktapur Road in Nepal

Perspective View of the Project for the Improvement of Kathmandu Bhaktapur Road

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

In recent years, registration of car ownership in Nepal has been continuously increasing at a rapid rate. Most of the roads are saturated in and around Kathmandu City, and this is causing a lot of traffic congestion on the roads, especially in morning and evening peak hours.

The Kathmandu-Bhaktapur Road (hereinafter referred to as "the Road") connects Kathmandu city and Bhaktapur city, a tourism city renowned as a world heritage, and forms a part of the Arniko Highway (Asian Highway No. 42) connecting Nepal and China. The road is connected to the Sindhuli Road, on which construction is now underway with Japanese grant assistance, and it is anticipated that inflow traffic from the Sindhuli Road will increase the future traffic volumes on the Road once the construction project on the Sindhuli Road is entirely completed.

The Road was first completed in January 1973 with Chinese assistance. There are two bridges on the Road, Manohara Bridge and Hanumante Bridge, both of which were built as part of the road project with Chinese assistance. These two bridges have only one lane for each direction and have insufficient width, especially for the footpath which compels pedestrians to walk along the carriageway creating traffic bottlenecks along the Road.

Under this situation, the Government of Nepal (hereinafter referred to as "GON") requested the Government of Japan (hereinafter referred to as "GOJ") in July 2004 to extend Japan's Grant Aid for the Project for Improvement of the Kathmandu-Bhaktapur Road in Nepal (hereinafter referred to as "the Project").

In response to the request from GON, GOJ decided to conduct a preliminary study on the Project for the Improvement of Kathmandu-Bhakthapur Road and entrusted the preliminary study to JICA. In December 2005, JICA sent a Preliminary Study Team to Nepal so as to clarify the requested components from GON as well as to confirm the contents of the Initial Environmental Examination (hereinafter referred to as "IEE") conducted by DOR, MOPPW of GON. The DOR's IEE was approved by GON on July 3, 2006.

GOJ decided to conduct a basic design study on the Project (the Study) and entrusted the Study to JICA. JICA sent a Basic Design Study Team (the Study Team) to Nepal in November 2006. As a result of the first deployment of the Study Team, the following were confirmed as the finally requested components of the Project from GON.

- Widening of the existing road between Kathmandu (Tinkune Intersection) and Bhaktapur (Suryabinayak Intersection)
- Construction of a new Manohara Bridge and a new Hanumante Bridge
- Improvement of intersections at Jadibuti, Ghataghar, Thimi, Sallaghari and Suryabinayak
- Provision of lay-bys for bus stops.

Note: Necessity of signalized intersections in the above was examined in the course of the studies in Japan by the Study Team from the traffic engineering view-points. Finally, Jadibuti, Gathaghar and Sallaghari intersections were selected for signalization.

After the Study Team returned to Japan, further study and basic design were conducted and a draft report was prepared. Then JICA sent a Basic Design Explanation Team to Nepal from May 14 to 18, 2007 and the Minutes of Discussions, which mainly covered the results of the basic design and the recipient country's obligations, were agreed by both sides.

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Purpose

The Government of Nepal prepared its 1st Five-Year Plan in 1956, and subsequently 9 periodic plans have been completed. The 10th Five-Year Plan (August 2002 to July 2007) has come into effect since then. The target of the 10th Plan is to achieve 7% per annum GDP growth rate, population below the poverty line 23% or below, and unemployment 3.6% or below. The successive 11th and 12th Plans are targeting 7.5% and 8.3% for annual GDP growth, below 15% and 10% for poverty line, and below 3.3% and 3.0% for unemployment respectively.

The Department of Roads (DOR) of the Ministry of Physical Planning & Works (MOPPW) prepared the Master Plan for the Strategic Road Network in December 2005 in order to achieve the abovementioned Five-Year Plans. The Master Plan for the Strategic Road Network (SRN) has identified the following development priorities:

i) To maintain the road network effectively and efficiently (Asset Preservation);
ii) To provide access to all District Headquarters to strengthen social, economic, administrative linkages;
iii) To improve existing access to District Headquarters for safe, reliable and cost effective travel;
iv) To develop roads to supplement the Poverty Reduction Program and to improve accessibility in Mid-hills and Terai;
v) To develop and expand the existing SRN to facilitate effective and efficient movement of goods and services and to foster economic growth;
vi) To develop and adopt cost effective measures by initiating innovation in road pavement and bridge design;
vii) To develop roads to support other infrastructure development and to link areas of significant social and economic importance; and
viii) To encourage private sector participation in the development, maintenance and management of roads.

The Project for the Improvement of Kathmandu-Bhaktapur Road (the Road) relates to i), v), vi) and vii) of the above. Further, the Master Plan for SRN stipulates to improve the Road (a part of Asian Highway 42, Arniko Highway) on the basis of Asian Highway Standards. In addition, the Road is included in the priority project list of the Master Plan for SRN.

The Road is the Kathmandu side's first section of the above-mentioned Arniko Highway. The Road has the highest traffic volumes among other roads in SRN, over 50,000 vehicles/day at the busiest place between Tinkune and Koteshwore intersections in Kathmandu City, and over 15,000 vehicles/day, even in the lowest traffic volume section between Sallaghari and Suryabinayak intersections in Bhaktapur City. Traffic congestion occurs very often in the bottlenecks especially at intersections and bridges. Mixed traffic of slow-moving vehicles like motorized tricycles, as well as pedestrians and bicycles are likely to worsen the traffic congestion. The Road is the only trunk road to connect Kathmandu City, the national capital, and Bhaktapur City, the tourism spot as a world cultural heritage. Insufficient traffic capacity on the Road not only hampers socio-economic activities in Kathmandu Valley but also has a negative impact on the whole of the country. Moreover, the traffic congestion of the Road will be more severe after completion of all sections of Sindhuli Road, on which construction is underway using Japan's grant aid scheme.

The Government of Nepal expects the improvement of the Road to improve traffic safety and to contribute to public welfare stability by widening and unplugging the traffic bottlenecks of the Road. Further, the Government of Nepal expects that reduction of traveling time between Kathmandu City and Bhaktapur City would facilitate new industrial development and activate the regional economy by saving on transportation costs and maintaining stable commodity movement.

2.1.2 Outline of the Project

Kathmandu-Bhaktapur Road (the Road), which connects the national capital Kathmandu City and the tourism oriented Bhaktapur City, was constructed with Chinese grant assistance and inaugurated in January 1972. In recent years, registration of car ownership in Nepal has been rapidly increasing, and present traffic in Kathmandu City and in its surroundings is causing a number of incidents of traffic congestion on the road, especially in morning and evening peak hours. The Road forms a part of Arniko Highway (Asian Highway 42), running towards the Chinese border, and has one of the highest traffic volumes among the trunk roads in Nepal. Moreover, it is anticipated that incoming traffic from Sindhuli Road, on which construction is underway, will make the road much more congested than at present once the Sindhuli Road project is completed. Two bridges exist on the road, Manohara and Hanumante, built in the abovementioned road project with Chinese grant assistance. These two bridges have only one lane for each direction of traffic and have caused bottle-necks on the road due to insufficient carriageway width.

Under these circumstances, the Government of Nepal (GON) intended to improve the Road through foreign grant assistance and made a request to the Government of Japan (GOJ) in July 2004 regarding the Project for the Improvement of the Kathmandu-Bhaktapur Road in Nepal. In response to the request from GON, GOJ decided to conduct a preliminary study on the Project for Improvement of Kathmandu-Bhaktapur Road and entrusted the preliminary study to JICA. In December 2005, JICA sent a Preliminary Study Team to Nepal so as to clarify the requested components from GON as well as to confirm the contents of the IEE conducted by DOR, MOPPW of GON. DOR's IEE was approved by GON on July 3, 2006.

GOJ decided to conduct a basic design study on the Project (the Study) and entrusted the Study to JICA. JICA started the Study with the first deployment of the Basic Design Study Team (the Study Team) to Nepal in November 2006. As a result of the first deployment of the Study Team, the following were confirmed as the finally requested components of the Project by GON.

- Widening of the existing road between Kathmandu (Tinkune Intersection) and Bhaktapur (Suryabinayak Intersection)
- Construction of a new Manohara Bridge and a new Hanumante Bridge
- Improvement of intersections at Jadibuti, Gathaghar, Thimi, Sallaghari and Suryabinayak including signalization at Thimi and Suryabinayak
- Provision of lay-bys for bus stops.

Note: The necessity for signalized intersections in the above was examined in the course of the studies in Japan by the Study Team from the traffic engineering view points. Finally, Jadibuti, Gathaghar and Sallaghari intersections were selected for signalization.

The Project aims to achieve the abovementioned project objectives through widening of the road, improvement of intersections and development of road related facilities as summarized in Table 2-1. As such, the following direct and indirect benefits are expected.

(1) Direct Benefits

- Augmentation of Traffic Capacity
  The existing traffic volume on the road at Jadibuti for both directions is about 40,000 vehicles per day and that has already reached the capacity of a 2-lane road. The future traffic volume 10 years after completion of the Project is expected to be approximately 80,000 vehicles per day (Jadibuti), nearly twice the present, with a growth rate of 11% per annum.
- Reduction of Traffic Congestion
  At present, traveling time by car over about 9 km from Tinkune to Suryabinayak is a maximum of 48 minutes in peak hours. Once the road is widened from 2 to 4 lanes, this maximum traveling time of 48 minutes would reduce to nearly half.
- Reduction of Traffic Accidents
  340 vehicles were recorded in traffic accidents along the road in one year from November 2005 to October 2006, with total casualties of 149 persons (fatalities 11, serious 39 and

injured 99). Since there are many traffic accidents which originate in the mixed traffic of slow-moving motorized tricycles, heavy vehicles, high speed sedans, etc., reduction of future traffic accidents is expected by widening of the carriageway as well as the improvement of intersections and traffic safety facilities with the Project.

(2) Indirect Benefits

- Enhancement of Land Use and Activation of Urban Economy
  The commerce, fabrication and housing industries along the road would be developed as a result of the Project. New business opportunities would be activated by the investment effects accompanying promotion of urbanized land use.
- Demonstration Effect of Road Improvement between Katmandu and Bhaktapur of World's Cultural Heritage
  Although the existing road connects two cities of the world's cultural heritage, environmental degradation is remarkable along the road from illegal dumping of waste, etc. By improving the road between the 2 cities representing Nepal, based on the Asian Highway Standards, the consciousness of the living environment by the residents along the road is expected to improve.
- Improvement of Public Transportation Services
  Public buses are generally used by local people in the Kathmandu valley. Augmentation of traffic capacity and improvement of bus stops by the Project would facilitate improved public transport services. Since many residents inside and outside the Katmandu valley use public buses, the social impact would be very significant.
- Improvement in Development Effects of Other Roads linked to Arniko Highway
  By enlarging the traffic capacity of the road, the flow on effect from the Project to other road development linked to Arniko Highway, including Sindhuli Road, can be improved more.

(3) Scale of Benefit

i) Area to benefit from the Project — Kathmandu Valley
ii) Population to benefit from the Project — 1.760 Million

Table 2-1 Project for Assistance

Items	Contents/Scale
Widening of existing road	Widen 2 lanes to 4 lanes for the road between Tinkune in Kathmandu City and Suryabinayak in Bhaktapur City for a total distance of 9.1 km. Composition of typical cross section is as follows: - Carriageway width: 2 x 3.5m = 7.0m in each direction - Median width: 3.0m - Shoulder width: 3.0 m on each side (including traffic barrier)
Intersections to be improved	5 specific intersections at Jadibuti, Gathaghar, Thimi, Sallaghari and Suryabinayak. 3 intersections where traffic volumes are high viz. Jadibuti (Kathmandu Municipality), Gathaghar (Madyapur Thimi Municipality) and Sallaghari (Bhaktapur Municipality) will be signalized. Note) Although DOR initially expected to signalize Thimi (Madyapur Thimi) and Suryabinayak (Bhaktapur), the Study Team identified the abovementioned 3 intersections from the view-point of traffic engineering. Tinkune and Koteshwore intersections, for which improvement was already completed in February 2003, would be excluded in this intersection improvement except for relocation of road lighting poles and signals.
Access roads to be connected	In addition to the feeder/community roads related to the 5 intersections in the above, selected access roads for which connection is essential for social and economic activities would be connected to the road. Improvement works on such selected access roads by the Project are limited to within the ROW. The selected access roads are as follows: East bank of the Manohara River at Km1 + 900 (right side) Lokanthali at Km2 + 340 (left & right) Kaushaltar at Km2 + 800 (left & right) TB Hospital at Km4 + 225 (left & right) Thimi East at Km5 + 175 (left & right) West bank of the Hanumante River at Km6 + 000 (left & right)

Items		Contents/Scale
		Srijana Nagar at Km6 + 775 (left & right) Sallaghari West at Km7 + 500 (left & right) Chundevi at Km7 + 900 (left & right) Suryabinayak West at Km8 + 725 (left & right) The access road improvement by the Project for assistance is limited to within the ROW.
Pavement		The old pavement with penetration macadam that was constructed about 35 years ago has been overlaid by thin asphalt concrete pavement. The surface shows excessive alligator cracks as well as cracks in transverse directions. The new pavement structure is designed for 10-year traffic volumes. Existing subgrade where CBR is very low (<5 %) will be excavated and replaced by new subgrade materials. The bus lay-bys will be paved with cement concrete pavement in order to reduce the adverse effects from frequent localized acceleration and deceleration.
Shoulder		Hard shoulder of 5 cm thick surface course would be provided for protecting the carriageway structure as well as for use of slow moving vehicles (motorcycle, motorized tricycle and bicycle). Total width of shoulder is 3.0 m including 0.5 m space for guard rail/pipe.
Bridges	Existing Bridges	Both existing 2-lane bridges, being 84 m long Manohara and 50 m long Hanumante, were built about 40 years ago, and the main structural elements, other than the bridge surface, seem visually still sound for further use with some repairs/ornament works of railing, expansion joints, pavement, etc. by the Project.
	New Bridges	New 2-lane bridges would be built the same lengths as the existing. Width composition includes 2 of 3.5 m lanes, 2.5 m clear shoulder and 1.5 m sidewalk for each direction. PC concrete T-shaped girder has been selected as the structural type for the new bridges from the view-points of economy and easier maintenance.
Embankment and Retaining Walls		Road embankment is constructed with 1:1.5 slopes. In cases where the 1:1.5 slope embankment requires more space than the ROW, a retaining wall will be provided to construct an embankment within the ROW. Mortar riprap slope protection, the most economic structure, among others, will be applied as the general type of retaining wall where the wall height is 4 m or less. Mechanized reinforced earth wall will be used for the rest.
Cutting of Slope and Retaining Walls		Cutting slope will be in the range of 1:1.0 to 1:1.5. In cases where such slope is impossible within the ROW, a retaining wall with mortar riprap will be constructed.
Side Ditches		Side ditches will be provided by considering the 3-year probable discharges of the road surface water and surrounding water. U shaped RC side ditches with cover and without cover and V shaped mortar riprap side ditches will be applied to drain the discharges.
Cross Drainage		Cross drainage will be provided by considering the 25-year probable discharges of the concerned basin. Types of drainage are box culvert and pipe culvert, and the former is based on JRA standard drawings and the latter based on DOR standard drawings.
Traffic Barriers		The main purpose to provide guard pipe is to safeguard against indiscriminant entry/exit of vehicles and pedestrians from/to the road side other than access roads. Guardrails, for which materials are imported items from Japan or other foreign countries, should be installed in the places where the embankment height is 3 m or more for traffic safety reasons.
Median strip		As a traffic safety measure, a 3.0 m wide median will be provided based on Asian Highway standards. The space of the median can be effectively utilized for the right-turn lane at intersections. In the case of the Ring Road, a 60 cm wide concrete block barrier (New Jersey type) will be applied since the ROW is very limited. Planting work is not included in the Project for assistance.
Road Lighting		Road lighting will be partially provided at and in the vicinity of intersections, bridges and in conjunction with access roads for the purpose of traffic safety. Lighting poles will be installed at 35 m intervals.
Traffic Signals		Specific intersections to be signalized are Jadibuti, Thimi and Sallaghari. The signal system should consist of the following basic devices: LED type traffic signal lights with poles LED type pedestrian signal lights with poles Control and distribution boxes, cabling, etc.
Bus Stops		Bus stops along with bus lay-bys would be provided based on IRC codes. Lay-bys will be in cement concrete pavement and arranged in the following manner: Bus stops are generally 75 m away from intersections. The width of bus stop lay-bys is 3.5 m for N=1, 3.5 m for N=2. Length of lay-bys is 15 m for N=1 and 30 m for N=2. Taper for acceleration and deceleration should be provided based on IRC codes.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policy

The facility plan to widen the Kathmandu-Bhaktapur road (the Road) from the existing 2 lanes to 4 lanes (2-lane dual carriageway) and to construct new 2-lane Manohara and Hanumante bridges should be made within ROW already acquired by DOR taking into consideration the study results from transportation engineering, highway engineering and bridge engineering based on the outcomes of traffic and topographic surveys, geotechnical investigation and hydrological study.

The Master Plan for the Strategic Road Network prepared by DOR (the Master Plan) is intended to guide the future road infrastructure development in Nepal. The Master Plan has decided to concentrate on upgrading the National Highway, which falls under the category of Asian Highways, to the adopted technical standard of Asian Highways. Since the Road forms part of Asian Highway 42, it is a pre-condition to design the Road on the basis of Asian Highway standards.

There exist a number of public utilities viz. trolley-bus poles and electric poles supporting overhead cables within the ROW. In addition, the water main along with water distribution pipes, armored electric cables and armored telecom cables are embedded in the ground. It was mutually agreed between the Study Team and DOR that the Nepalese side would have to relocate such public utilities to the buffer zone (6 m wide space outside the ROW).

The Nepalese side intends to develop service roads (loading and unloading for truck cargos and embarkation/disembarkation for bus passengers as well as the community usage) and sidewalks close to the edge of the ROW in the future, and accordingly the required area of road facility layout for the Project should be reduced as much as possible.

The basic design of the Project should take into consideration the organization capacity, operation and maintenance system and budget allocation of DOR.

Specifically, the basic design of the respective facilities was conducted based on the following design policies.

1) Present ROW

The basic design was conducted taking into consideration the following ROW already owned by DOR.

- From Tinkune Intersection to Koteshwore Intersection: 15 m on each side from the existing road centerline according to the Kathmandu Valley Town Development Committee Standard, Nepalese year 2033 (AD 1977) revised Nepalese year 2050 (AD 1994).
- From Koteshwore Intersection to Suryabinayak Intersection: 22.86 m (75 ft) on each side from the existing road center.

2) Widening Sides from Existing Road Centerline

Generally widening works are on both sides from the existing road centerline, except the following road segments.

- The road segment already built-up from Tinkune Intersection to Koteshwore Intersection, where shops, factories and houses are densely lining the roadside, should be widened northward (left side) from the ROW limitation.
- Civil aviation lights exist near Km1 + 200 after Koteshwore Intersection, which cannot be relocated for aircraft safety reasons. This road segment should be widened southward (right side).
- As new bridges (Manohara and Hanumante) are to be built on the upstream side of the respective rivers (left side), road widening at and near the bridges should be on the left side accordingly.

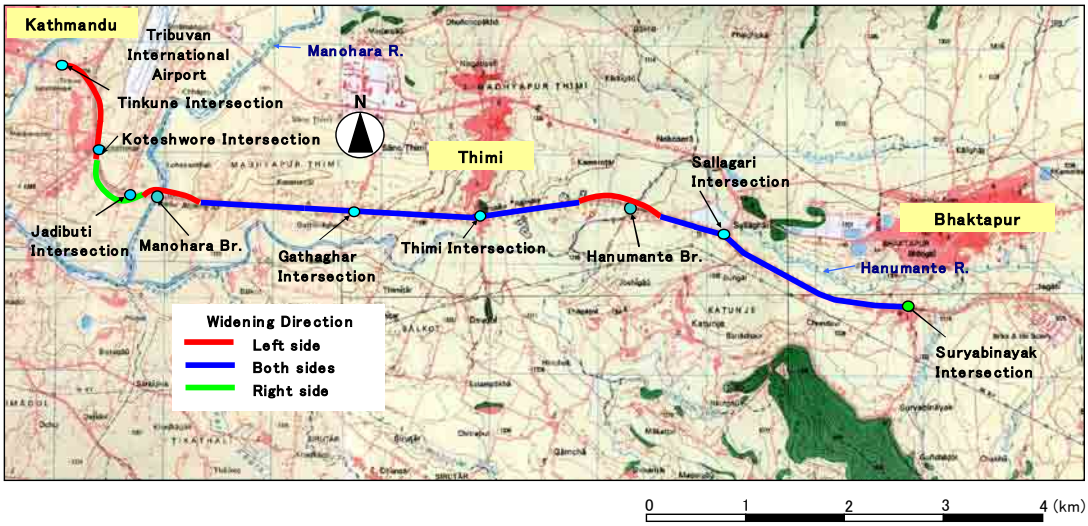


Figure 2-1 Guide Map of Widening Sides

3) Implication of Future Development of Service Road and Sidewalks

In principle, a layout plan should be prepared all the road facilities within the ROW.

Separately from the Project, the Nepalese side intends, in the future, to develop service roads and sidewalks outside the facilities of the Project. The layout plan of the basic design of the Study should be prepared to keep at least 3.0 m space close to the ROW edge so as to enable future development of service roads and sidewalks by the Nepalese side.

4) Possible Methods to Utilize Existing Pavement

As the widening works will be on both sides from the existing road centerline, and the narrowest existing pavement is 6.0 m or less, the pavement able to remain for carriageway is limited to a small portion only. The Study Team will have to determine a favored method by examining the possible methods viz. leaving the existing pavement in place or stripping it out.

5) Design Standard for Bus Stop Lay-bys

Bus lay-bys will be designed based on the IRC codes taking into consideration the similar characteristics of Nepalese users. Specific locations and the number of bus stops should be determined through screening the existing bus stops using technical considerations based on IRC codes.

6) Measures for Inundated Road Segments during Heavy Rainfall

Road segments in the vicinity of Kaushaltar at Km 2 + 950 and Gathaghar Km4 + 000 are likely to be inundated. In such road segments, road elevations are too low to maintain appropriate freeboard above the flood levels. It should be noted that longitudinal alignment of such road segments are relatively steep.

Appropriate sizes of cross drainage should be provided according to hydrological study. In addition, road elevation should be increased and longitudinal alignment should be improved to satisfy the Asian Highway standards.

7) Further Use of Existing Manohara and Hanumante Bridges

Both existing Manohara and Hanumante bridges seem visually still sound for further use even though they were built about 40 years ago. It is not recommended that the dead weight of superstructures be increased by widening or reinforcing the existing structures, which would result in decreased structural stability and increased engineering liability. Accordingly, only repair and ornamental works on railing, expansion joints and pavement should be considered for the further use of existing bridges, without any additional loads on the existing structures.

8) Plan of New Manohara and New Hanumante Bridges

The type of new bridges should be determined from the viewpoint of cost effective and favorable maintenance taking into consideration topographical, geotechnical and hydrological engineering factors.

9) Cross Drainage Plan

Although there are 22 existing cases of cross drainage in the Road, some of them have no drainage function since the sections have been closed by neighboring residents. Locations and required drainage sections should be decided not only by the results of hydrological and hydraulic studies but also by the requirements from the present socioeconomic activities such as irrigation, residential drainage, etc.

Existing drains should be replaced by new ones.

Outlets from the cross drainage towards the Manohara River and Hanumante River should be secured by the Nepalese side.

10) Traffic Safety Measures

i) Median

As a traffic safety measure, a 3.0 m wide median will be provided based on Asian Highway standards. Space from the median can be effectively utilized for right-turn lanes at intersections. In the case of the Ring Road, a 60 cm wide concrete block barrier (New Jersey type) will be applied since the ROW is very limited.

Structures of the 3.0 m wide median should be an ordinal type consisting of concrete curbstone and a green/flower strip that is widely used around the world.

ii) Improvement of Intersections and Signalization

As traffic signal systems were deployed in Tinkune Intersection and Koteshwore Intersection in February 2003, poles and control boxes along with wiring can be relocated during construction of the Project to meet the new alignment.

DOR intends to install signals at Thimi Intersection (Madyapur Thimi Municipality) and Suryabinayak (Bhaktapur Municipality). The necessity for signalization should be examined, not only for the two intersections, but also for other intersections which have higher traffic volumes than Thimi and Suryabinayak.

iii) Road Lighting

Road lighting facilities should be provided at and in the vicinity of the abovementioned intersections and bridges for traffic safety purposes at night. In the road segment from Tinkune to Koteshwore intersections there are four road lighting poles, which can be re-used by relocating them according to the new road alignment.

iv) Traffic and Pedestrian Barriers

Guard-posts should be installed along the 3.0 m wide shoulder edges in order to prevent indiscriminant entry and exit of vehicles and pedestrians. Guard-posts, cost effective barriers which can be fabricated in Nepal and are advantageous for future maintenance, should be considered except for the places where imported items of guardrails will be required for traffic safety in cases where the embankment height is 3 m or more.

v) Safety Measure for Motorcycles

Traffic characteristics on the Road are extremely indiscriminant, especially at intersections, and one cause of the traffic congestion is due to U-turns and interrupting motorcades of motorcycles. In order to improve the present traffic flows, two measures would be considered; 1) a stopping line providing a motorcycle stopping space should be provided in front of the stopping line for other vehicles at specific signalized intersections, and 2) U-turns should be controlled to be allowed only at U-turn median openings.

vi) Safety Measure for Pedestrians

Walkways should be provided at and in the vicinity of 5 intersections and 2 bridges for pedestrian safety. At the end of walkways, stairs will be provided towards service road/sidewalks to be developed in the future. Detail discussion will not be included in the Study since further studies including Detailed Design generally deal with such miscellaneous matters.

Pedestrian crosswalk markings should be considered at intersections and junctions with access roads.

(2) Policy on Natural Condition

1) Climate Condition

The climate of the Kathmandu Valley is comparatively moderate, the highest temperature being 23ºC in summer from June to August and the lowest 10ºC in January. It is characterized as a continental climate with a large temperature difference from day to night. The maximum rainfall is about 360mm in a month in the monsoon season from late June to early October.

Pavement works of laying surface course and binder course should be carried out in other seasons than the monsoon season. Piling and substructure works of bridge building should also be carried out in other seasons than the monsoon season.

2) Characteristics of the River Basin

Manohara and Hanumante bridges, side ditches and cross drains should be designed on the basis of flood analysis in the past monsoon periods. Rainfall intensity should be decided by analyzing the data from the rain-gauging stations in the vicinity of the project area. Among rainfall-gauge stations, data from Kathmandu Airport Station, located beside Tinkune Intersection at the beginning point of the Road, and Sankhu Station, located in the north of Bhakhtapur at the end point of the Road, should be referred to.

(3) Policy on Socio-Economic Condition

1) Social, Economic and Urbanization Pattern

According to the national census in 2002, Nepal had 22,150 thousand population, out of which the Kathmandu Valley had 1,760 thousand population. In recent years, concentration of population to the Kathmandu Valley, which is the center of politics, economy and administration in the country, has been remarkable. Many administrative institutions and commercial industries exist, mostly inside the Ring Road, while many residences, including apartments and condominiums and small/medium-sized factories, occupy the outside of the Ring Road. Rapid urbanization is expanding eastward, where relatively flat terrain and small hills alternately continue in Madiapur-Thimi Municipality and Bhakhtapur Municipality.

As the central business district (CBD) is located inside the Ring Road while new residential and industrial areas are located east of the Ring Road, traffic congestion on the Road has been severe, especially in the morning and evening peak hours. Accordingly, the Study on widening of the Road should be appropriately conducted to understand the socio-economic circumstances along the Road.

2) Traffic Condition in the Kathmandu Valley

The transport system in Nepal consist essentially of roads, civil aviation, railways and ropeways. In the Kathmandu Valley, roads are the principal transport mode and this position is unlikely to change in the foreseeable future. Most commodity movements between major cities in Nepal is via the Kathmandu Valley. There are two major gateways in the Kathmandu Valley, Arniko Highway (including the Road) linking the Chinese border and Tribhuvan Highway linking Terai and the Indian border (Asian Highway 42 consists of Arniko Highway and Tribhuvan Highway).

In the Kathmandu Valley there are three major roads of the SRN as shown in Figure 2-2: Arnoko Highway, Tribhuvan Highway and the Ring Road. The highest traffic volumes among the roads of the SRN are at Koteshwore Intersection, over 50,000 vehicles/day.

The widening of the Road should be carried out taking into consideration the above situation.

Figure 2-2 Major Road Network in Kathmandu Valley

(4) Policy on Construction and Procurement

1) Procurement Conditions of Labor Resources

It is relatively easy to procure a common labor force in the Kathmandu Valley. On the other hand, many skilled laborers and heavy equipment operators in Nepal are working in neighboring countries like India as well as in the middle-east where construction is booming, and therefore the number of skilled laborers for road and bridge construction has been limited in recent years.

Laborers' wages in Nepal are rising as are commodity prices.

2) Procurement Conditions of Materials and Equipment

Sand, stone, embankment materials, timber and cement are produced in Nepal, and reinforcing bars that are imported items can be obtained. Fabricated items, such as expansion joints and bearings for bridge building works, which are not available in the country, should be procured from Japan. In addition, items requiring special quality like plaque plates should be procured from Japan.

3) Labor Laws and Construction Regulations

In the case of labor employment, "Rules and Regulations for Workers and Employees in Private Institutions and Factories in Nepal, xxx year" should be followed.

(5) Procurement of Local Contractors

Participation of local construction firms in Nepal should be considered as sub-contractors of the main contractor from Japan for the purpose of cost effective construction as well as smooth conduct of future maintenance for the completed facilities by technology transfer through the Project. Items that are possibly fabricated in Nepal should be adopted as much as possible for the same reasons as above.

1) Application of Local Contractor

Appropriate periods for negotiation between the main contractor and sub-contractors should be considered when preparing the implementation schedule in the Study.

2) Use of Items Possibly Produced and Fabricated in Nepal

Some small and medium-sized enterprises can produce and fabricate items such as pre-cast concrete members, interlocking tiles, steel poles, guard pipes, gabion mesh, signal lights, etc. Items other than these items possibly produced and fabricated in Nepal would be procured from Japan and third countries.

3) Procurement of Equipment

Most common construction machinery is available in Kathmandu. However, special equipment like a pile drilling machine with all casing pipe is not available in Nepal and it is not certain that it would be available from India where construction is booming. Accordingly, a pile drilling machine would be brought from Japan.

(6) Policy on Capability of Implementation Organization as to Management and Maintenance

1) Implementation Organization

The implementation organization for the Project is the Ministry of Physical Planning and Works (MOPPW) and Department of Roads (DOR). MOPPW has jurisdiction over various fields, viz. drinking water and sanitation, foreign cooperation and quality control, building and housing, and transportation facilities along with administration, planning, monitoring and evaluation. The organization chart of MOPPW, a 138 person organization, is shown in Figure 2-3. The Minister's undersecretary and the Assistant Minister are responsible for administering all the branches. Each branch is administered by the respective joint secretary.

The organization chart of DOR, which includes 2,611 staff, is shown in Figure 2-4. DOR headed by the Director General (DG) consists of various branches, viz. maintenance, foreign cooperation, planning and design, and mechanical. Each branch is administered by the respective Deputy Director General (DDG).

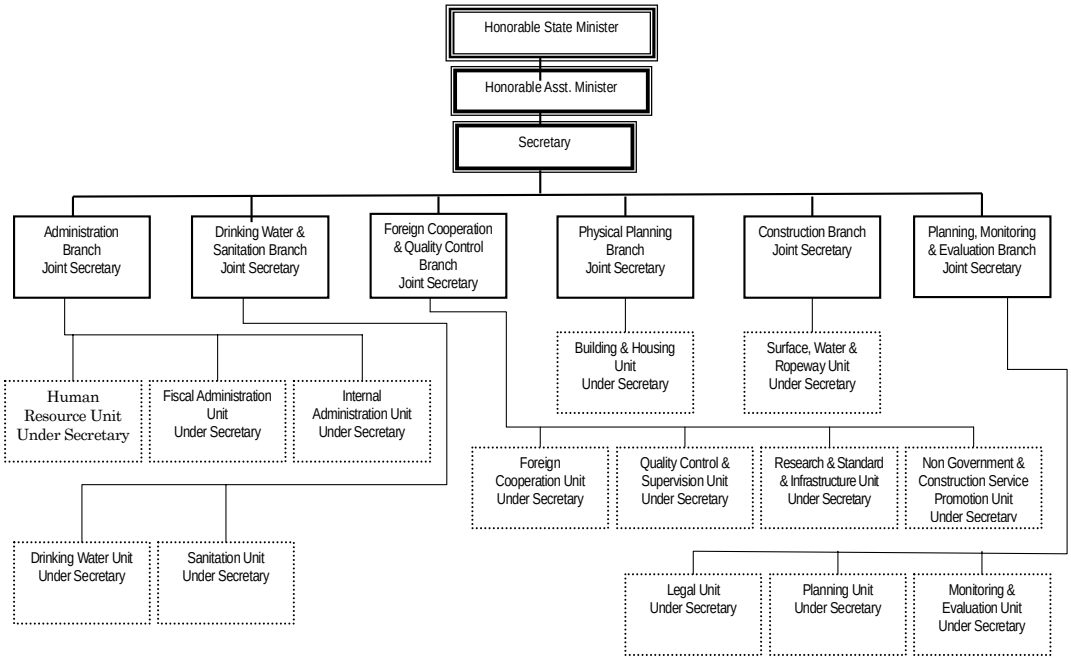


Figure 2-3 Organization Chart of MOPPW

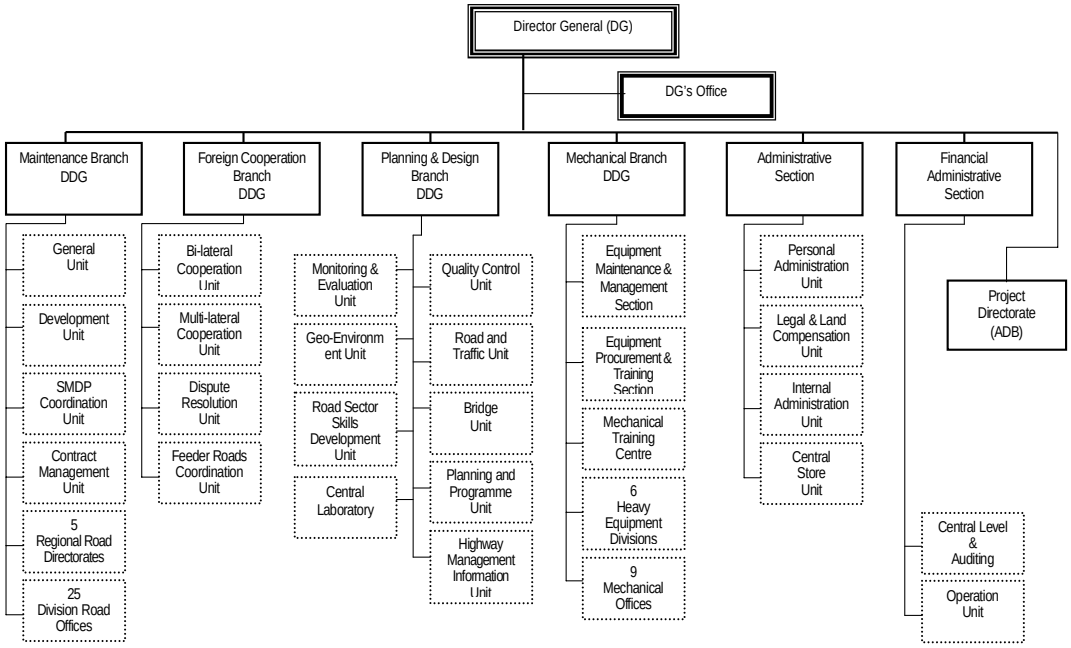


Figure 2-4 Organization Chart of DOR

2) Detailed Design and Construction

DOR is the implementation agency for the Project. Foreign Cooperation Branch along with the Bi-lateral Cooperation Unit would become the Clients of the Project during the construction period. As with the previous and ongoing Japan's grant aided projects of DOR, the Kathmandu-Bhakuthapur Road Improvement Project Office (the Project Office) would be established in or nearby the DOR headquarters.

Since the Road is located in the built-up area, the Project Office has to solve a number of issues related to underground public utilities and so on, even during the construction time. The tentative organization chart of the Project Office is shown in Figure 2-5. The tentative organization of the Project Office headed by a Project Manager would include a civil engineer (highway cum bridge engineering), an electrical cum mechanical engineer (public utilities, road lighting and signal system), an environment expert for environmental monitoring, overseers for daily inspection and office support staff.

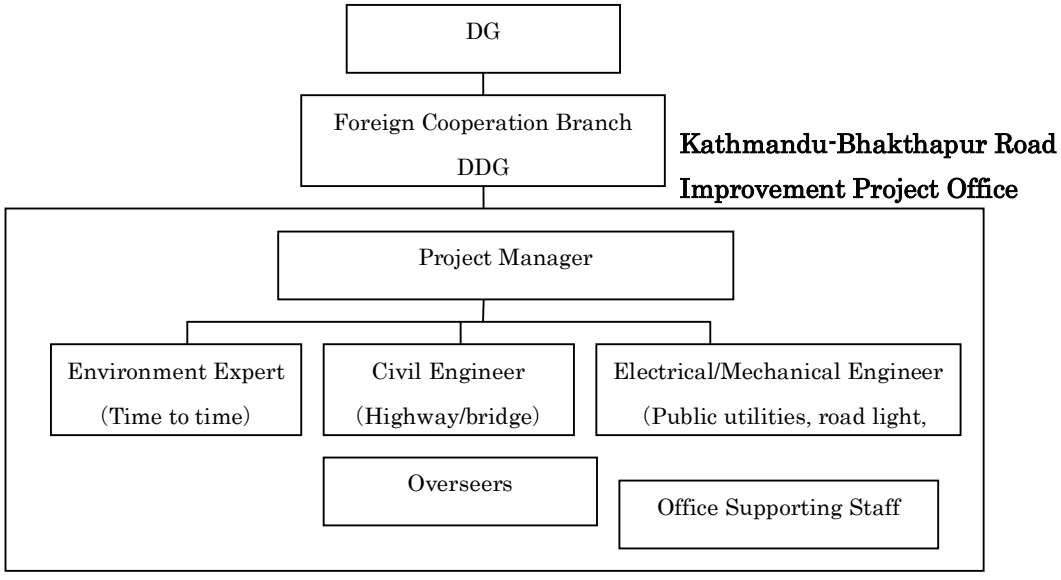


Figure 2-5 Tentative Organization of DOR Project Office

3) Future Operation and Maintenance (OM)

DOR Kathmandu Division and Bhaktapur Division under the jurisdiction of Maintenance Branch would be responsible for the OM activities after completion of the Project. The former covers the road segments up to Manohara Bridge and the latter after Manohara Bridge to Suryabinayak Intersection. The public administrative demarcation, which 3 municipalities (Kathmandu, Madiapur Thimi and Bhaktapur) cover, differs from the DOR maintenance demarcation.

(7) Policy on the Grade of Facilities and Equipment

1) Design Standards to be Adopted

According to the Master Plan for the SRN, geometric design criteria should follow the Asian Highway Standards. As the Asian Highway Standards refer to the AASHTO design loads, the loads for pavement and bridge design should follow AASHTO design parameters. As for bus-stops, layout of bus lay-bys should follow the IRC (India) code taking into consideration the similarity of traffic and passengers in the region. For the rest, Japan Road Association (JRA) standards and DOR standards should be used.

2) Improvement Policy of Road Facilities

Since the Road forms a part of Asian Highway 42, the improvement policy should follow at least the minimum requirements stipulated in the Asian Highway standards as well as satisfying the need to provide smooth maintenance of the completed road facilities.

In principle, the following grades of road facilities are to be taken into consideration.

- Traffic capacity of the carriageway, traffic capacity of intersections and pavement design should be based on the future traffic volumes after completion of the Project.
- Design discharges of bridges should be for the return periods of 50 years, those of cross drains 25 years and side ditches 3 years.
- For facilitating smooth conduct of future maintenance work, the following are to be taken into consideration:
- Median strip, traffic barrier, road lighting and signal system should be provided taking traffic safety into consideration. So as to facilitate easier and smoother maintenance, items produced or fabricated in Nepal should be installed as much as possible.
- Planting work (trees and flowers) in the median strip should be conducted by the Nepalese side.

(8) Policy on Construction Method and Construction Period

Since the Road is located in the built-up area in the Kathmandu Valley where traffic volume is extremely high in the daytime, various works will continue even during the night-time. In addition, temporary roads should be provided along the ROW ends for public traffic diversion.

Roadwork (ranging from earth works to pavement works) would be on the critical path of the Project and requires 27 months.

Construction of the Project would begin in September 2008 and end in February 2011 with a total construction period of 30 months.

2.2.2 Basic Plan

2.2.2.1 Overall Plan

(1) Design Criteria and Standards

Table 2-2 Summary of Design Parameters and Standards for Road Design

Items		Design Parameters	Applied Standards, etc.
Highway Classification		Class I （4 lanes）	Asian Highway Standards
Terrain Classification		Rolling	According to site condition
Design Speed		80 km/h	Asian Highway Standards
Width	ROW	22.75 m (15 m) from existing road center	（ ） shows Ring Road. Actual status.
	Lane	3.5 m	Asian Highway Standards
	Shoulder	3.0 m	DOR Standards and Asian Highway Standards
	Median Strip	3.0 m	Asian Highway Standards
Min. Radius of Horizontal C.		210 m	Asian Highway Standards
Pavement Slope (Cross-fall)		2 %	Asian Highway Standards
Shoulder Slope		3 – 6 %	Asian Highway Standards
Type of Pavement	Carriageway	Asphalt Concrete	According to site condition and Asian Highway Standards
	Bus-stop Lay-by	Cement Concrete	According to site condition and Asian Highway Standards
Max. Super-elevation		10 %	Asian Highway Standards
Max. Vertical Grade		5 %	Asian Highway Standards
Min. Distance between Bus Stop Lay-by and Intersection		75 m	IRC Codes (Indian Standards)
Return Period of Design Discharge for Cross Drainage		25 years	JRA Standards (Japan)
Standard Drawings to be applied	Box Culvert	Standard Design by Ministry of Land, Infrastructure and Transport, Japan	JRA Standards (Japan)
	Pipe Culvert	DOR Standard Design	DOR Standards
Return Period of Design Discharge for Side Ditch		3 years	JRA Standards (Japan)
Standard Drawings to be applied		DOR Standard Design	DOR Design Standards
Pavement Design Method		Flexible Pavement	AASHTO Guide for Design of Pavement Structure （USA）
Target Year of Pavement Design		10 years after completion	
Target Year for Intersection Design		10 years after completion	JRA Standards (Japan)

Table 2-3 Design Parameters and Standards to be adopted for Bridge Design

Items		Design Parameters		Applied Standards, etc.
Design Standards		AASHTO LRFD Bridge Design Specifications 2004 and IRC (Indian Roads Congress) Standard Specifications and Code of Practice for Road Bridges		
Live Loads		HL-93 (AASHTO HS20-44 equivalent)		As a result of discussion with DOR
Seismic Force		Horizontal equivalent force $\alpha = 0.08$		As a result of discussion with DOR
Meteorological Effects	Wind Speed	Hourly mean Max. 10.1 m/sec		According to site condition
	Thermal Change	-2 ～ +35 ℃		Tribhuvan Airport
	Humidity	Annual average 70 %		Tribhuvan Airport
River Characteristics	Return Period of Design Discharge	50 years		As a result of discussion with DOR
		Manohara Br	Hanumante Br	
	Velocity of Water	2.28 m/sec	1.84 m/sec	According to site condition
	Flood Level	EL + 1293.35 m	EL + 1301.60 m	According to site condition
	Scour Depth	3.0 m	4.2 m	According to site condition
Subsoil Characteristic	Bearing strata	SPT N-value > 30, Silt to clay layer	SPT N-value > 50, Silt to clay layer	According to site condition
	Depth of pile tip	17 ～ 26 m	18 ～ 20 m	According to site condition

(2) Width Composition

A typical cross section of the Road is shown in Figure 2-6 determined for a 2-lane road based on the Asian Highway Standards.

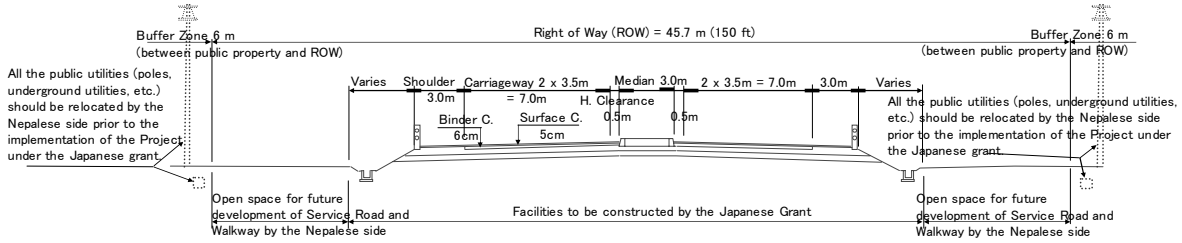


Figure 2-6 Typical Cross Section

(3) Location of Bridges, Intersections and Bus-stops

Figure 2-7 shows the conceptual location map including bridges, intersections and bus-stops.

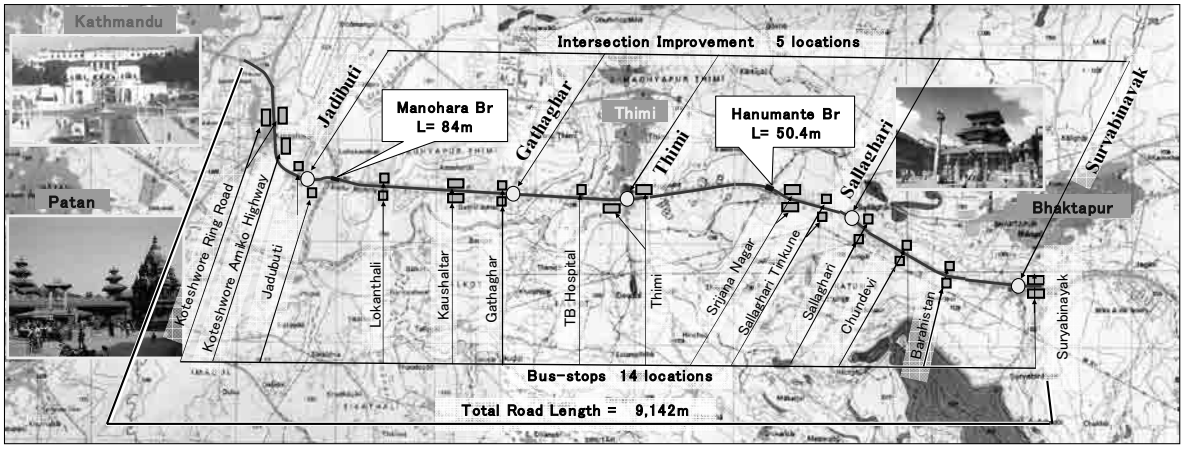


Figure 2-7 Locations of Bridges, Intersections and Bus-stops

2.2.2.2 Facility Plan

(1) Road

1) Asphalt Concrete Pavement

Subgrade Strength: Evaluation of the existing subgrade strength by using portable Falling Weight Deflectometer along the project road is shown in Table 2-4.

Table 2-4 Summary of Existing Road CBR

No.	Station		Existing Subgrade CBR%
	From	To	
1	0+000	1+800	2
2	1+800	4+000	5
3	4+000	5+600	5
4	5+600	7+000	3
5	7+000	END	3

Based on these results, existing subgrade material where the CBR value is less than 5% is excavated to a depth of 1 m and replaced by new subgrade material.

Traffic volume: Classified volume counts were conducted at different sections of the road, between each major intersection. Results of the volume count, except for three wheelers and motorcycles, are summarized below:

Table 2-5 Traffic Volume after 10 Years from the Project Completion

Average Daily Volume	PC	Bus	Truck 2A	Truck > 2A	Utility
Tinkune - Koteshore	20104	957	622	47	81
Koteshore - Jadibuti	13399	1397	774	33	44
Jadibuti - Gatthaghar	7317	813	582	26	130
Gatthaghar - Thimi	7027	1060	941	120	181
Thimi - Sallaghari	6742	794	591	27	105
Sallaghari - SuryaBinayak	5014	811	618	40	203

The values for traffic growth rates have been used from the published data for the Central Region, North-South corridor and are 16.3, 4.8, 4.5, 8.1, 3.9 for PC, bus, 2-axle trucks, trucks with more than 2 axles and utility vehicles respectively.

Thickness Design: Thickness Design is based on "AASHTO Guide for Design of Pavement Structures, 1993". A design period of 10 years has been considered with the opening to traffic from the year 2011. The AASHTO method of pavement design has been used to design the thickness of pavement structures. The AASHTO method considers 80% to 100% of total traffic volume in each direction in the design lane in cases where the total number of lanes in each direction is two.

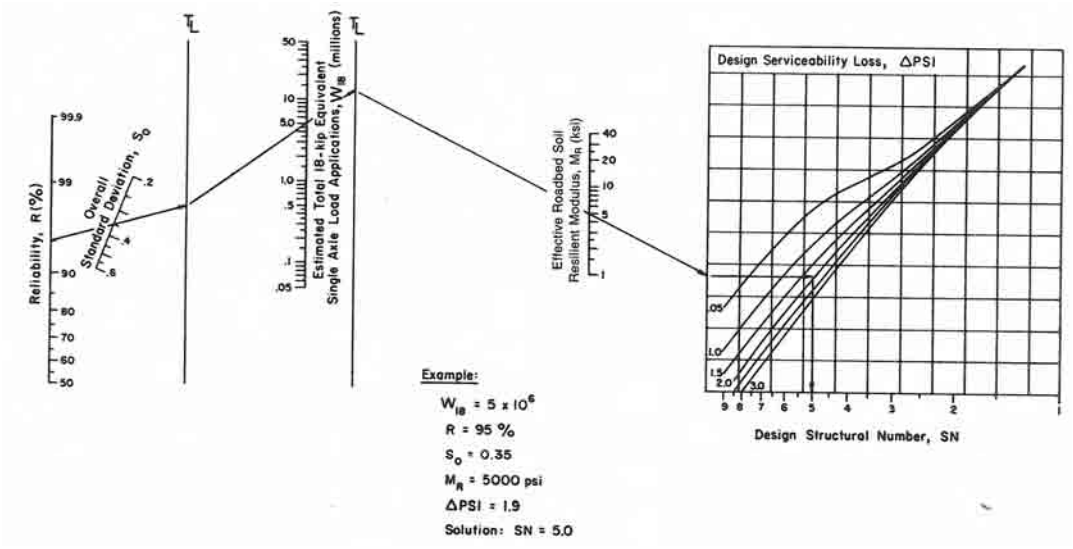
Table 2-6 Summary of Pavement Design Criteria by AASHTO Method

Design Input Requirements			Value
1	Design Variables	Performance Period (years)	10
		Traffic	
		Equivalent Single Axle Load (ton-f)	8.2
		Directional Distribution Factor, D_D	0.5
		Lane Distribution Factor, D_L	0.8-1.0
		Reliability % (Z_R)	85%(-1.037)
		Overall Standard Deviation, S0	0.45
2	Performance Criteria	Initial Serviceability Index, p_0	4.2
		Terminal Serviceability Index, p_t	2.2
		Design Serviceability Loss, ΔPSI	2.0
3	Material Properties	Effective Roadbed Soil Resilient Modulus, M_R (psi)	1500 × CBR
		Layer Coefficient for Asphalt Concrete, a_1 Surface	0.42
		Layer Coefficient for Asphalt Concrete, a_1 Binder	0.37
		Layer Coefficient for Base Course, a_2 (CBR > 80)	0.132
		Layer Coefficient for Sub-base Course, a_3 (CBR > 30)	0.109
4	Pavement Characteristics	Drainage Coefficients for Base Course and Sub-base Course, m_2, m_3	1.0

Design equation and chart applicable: For a set of design variables, performance criteria and effective roadbed soil resilient modulus, the required Structural Number (SN) is estimated from the following equation or the AASHTO Monogram. Here, the calculated SN is indicated in inches and it is necessary to multiply by 2.54 to convert to cm units, when it is used to determine each layer thickness in the next step.

$$Log_{10}W_{18} = Z_R S_0 + 9.36 LOG_{10}(SN+1) - 0.20 + \frac{LOG_{10}(\Delta PSI/(4.2-1.5))}{0.40 + 1094/(SN+1)^{5.19}} + 2.32 LOG_{10} M_R - 8.07$$

where:
W_{18} = Number of 18,000 pound (8.2 ton-f) ESAL (Equivalent Single Axle Load)



Source: AASHTO Guide for Design of Pavement Structures

Figure 2-8 Determination of Design Structural Number, SN: AASHTO

A set of the pavement layer thicknesses is then identified which, when combined, will provide the load-carrying capacity corresponding to the design SN.

$$SN = a_1 D_1 + a_2 D_2 m_2 + a_3 D_3 m_3$$

where:

a_1, a_2, a_3 = layer coefficients representative of surface, base, and sub-base courses, respectively

D_1, D_2, D_3 = actual thicknesses of surface, base, and sub-base courses, respectively

m_2, m_3 = drainage coefficients for base and sub-base layers, respectively

The results of design pavement thickness for various sections of road are summarized below.

Table 2-7 Designed Pavement Thickness for Various Sections of Road

Station		Design	ESAL (million) for		SN (cm) for		Calculated Thickness (cm) for 80% ESAL				Calculated Thickness (cm) For 100% ESAL				Designed Thickness (cm)			
From	To	CBR	80 %	100 %	80 %	100 %	Asphalt Surf.	Asphalt Bind.	Base	Sub base	Asphalt Surf.	Asphalt Bind.	Base	Sub base	Asphalt Surf.	Asphalt Bind.	Base	Sub base
0	1000	6	3.6	4.5	9.4	9.7	5	6	20	25	5	6	20	25	5	6	20	25
1000	1500	6	4.1	5.1	9.6	9.9	5	6	20	25	5	6	25	25	5	6	25	25
1500	1800	6	3	3.8	9.1	9.5	5	6	20	20	5	6	20	25				
1800	3600	5	3	3.8	9.7	10.1	5	6	25	25	5	6	25	25				
3600	4800	5	5.9	7.3	10.8	11.1	5	6	25	30	5	6	25	35	5	6	25	30
4800	5600	5	3	3.8	9.7	10.1	5	6	25	25	5	6	25	25	5	6	25	25
5600	7100	6	3	3.8	9.1	9.5	5	6	20	20	5	6	20	25				
7100	9000	6	3.4	4.3	9.3	9.7	5	6	20	25	5	6	20	25	5	6	20	25

Design Concept: The widening of existing road is generally done on both sides of the existing embankment. Existing pavement consists of penetration macadam, constructed about 35 years ago, which has been overlaid by thin asphalt concrete surfaces. Base and sub-base courses are not clearly identifiable, but consist of granular material of varying thickness.

For economical profile grade, the new profile is normally set at the bottom of new base course, although the finished level changes considerably where the profile is improved for other geometric reasons. Along the section where the existing sub-grade CBR is greater than 5%, existing pavement surface is proposed to be scarified lightly and compacted along with laying of new sub-base course on a widened portion as shown below.

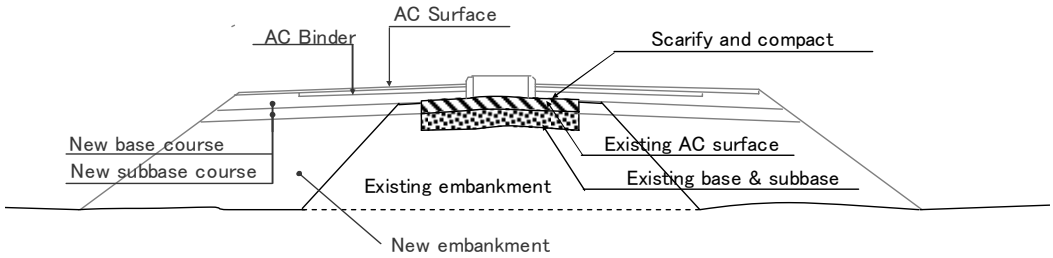


Figure 2-9 Pavement Structure, CBR > 5%

Where the existing sub-grade CBR is very low (<5%), the existing sub-grade is proposed to be excavated and replaced by new sub-grade material to a depth of 1 m from the bottom of the new sub-base layer, as shown below.

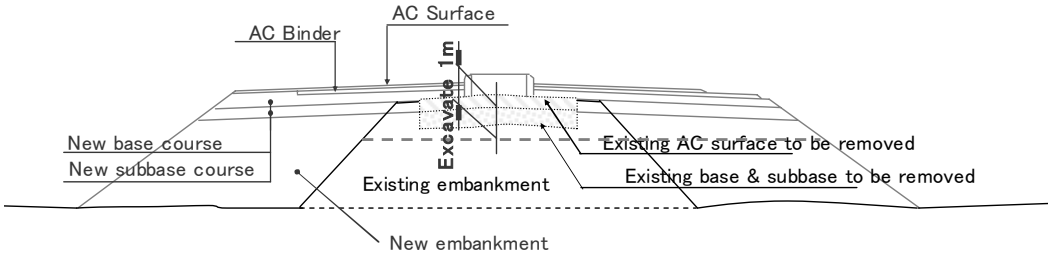


Figure 2-10 Pavement Structure, CBR < 5%

2) Cement Concrete Pavement

The design of rigid pavement is based on the AASHTO method of design and the design criteria are the same as that of Flexible Pavement Design, except the overall standard deviation. Results are summarized in Table 2-8.

Table 2-8 Summary of Rigid Pavement Thickness Design

Mat. CBR		Rd.bed	S.base	S.base	Comp.	LoadTr.	LS	SubRk n	Conc	ModR up	Drain.	Traffic mill.		Thick.
SG	SB	MR	cm	Esb	k	J		k pci	Ec	psi	Coef.	100 %	50%	D cm
5	30	7500	36	15000	475	3.8	2	42	4200000	600	1.00	3.8	1.90	24.0
5	30	7500	41	15000	500	3.8	2	45	4200000	600	1.00	7.3	3.65	25.0
6	30	9000	31	15000	500	3.8	2	45	4200000	600	1.00	3.8	1.9	24.0
6	30	9000	36	15000	500	3.8	2	45	4200000	600	1.00	4.5	2.25	24.0
6	30	9000	36	15000	500	3.8	2	45	4200000	600	1.00	5.1	2.55	25.0

Note: Sub-base thickness is 11 cm thicker than in asphalt pavement section due to the removal of base course and addition of 25 cm of concrete pavement.

From the above calculations the thickness of the rigid pavement is proposed to be 25 cm in all bus lay-bys for continuity.

(2) Bridges

1) Further Use of Existing Bridges and Check Dams

Along with the preliminary survey, this time the inspection also came to the same conclusion that the bridges could be reused, but their remaining service lifetime is not expected to be so long considering the current increase of traffic volume and the structural cracks found on girders.

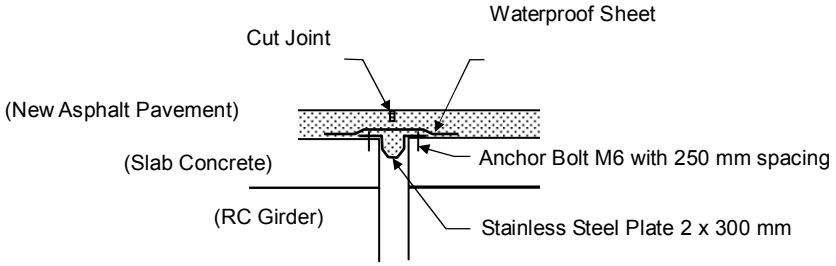
i) Repair of Existing Bridges

Neither structural strengthening nor widening is recommended this time because the bridges have aged, so that when the time comes, total replacement is recommended as discussed above.

It is, therefore, recommended for the existing bridges to limit work to minor repair work but

not to involve structural alteration concerning safety of the bridges. From the field survey, repair work on the bridge deck, such as for pavement, joint gaps and railings, is recommended to improve the user's comfort. The repair work will include the following:

a. Pavement: be replaced with new on entire bridge spans. The new pavement shall not be heavier than the existing.
b. Joint Gaps: be covered up using the method shown below concurrently with replacing the pavement.



Repair of Deck Joint

Figure 2-11 Repair of Deck Joint

c. Railing: be repaired essentially by mortar plastering and color painting. The railings after repair shall not be heavier than that before repair. Major repair work will include the following:
   - Many rail posts need mending at their feet where they are damaged because of fixing of telecommunication cables.
   - A missing top rail on Hanumante Bridge needs to be compensated for by manufacturing a new member.
   - The entire railing surfaces are to be painted with color paint.

ii) Repair of Check Dams

The layout of check dams and the riverbed conditions around them at both the Manohara and Hanumante Bridge sites shows irregularities as reported above. Therefore, a river training work to repair the river course and check dams is recommended to control the riverbed degradation as well as to make floods flow smoothly for safety of the bridges. However, the river training work shall be limited to the extent of immediate upstream and downstream of the check dams required to protect the bridges but shall not take responsibility for any river improvement works beyond the said extent.

2) New Bridges Proposed

i) Bridge Widths

New bridges are proposed, in parallel with the existing bridges, to widen the bridge roadway from the existing two to the designed four lanes. The design roadway for the new bridges follows the design road cross-section, but the existing bridges are required to tolerate the present roadway width less than the width of the new bridge.

The typical cross-section of the new bridge proposed and the positional relation with the existing bridge is given below and the technical sources for bridge design will be briefed in the next paragraphs.

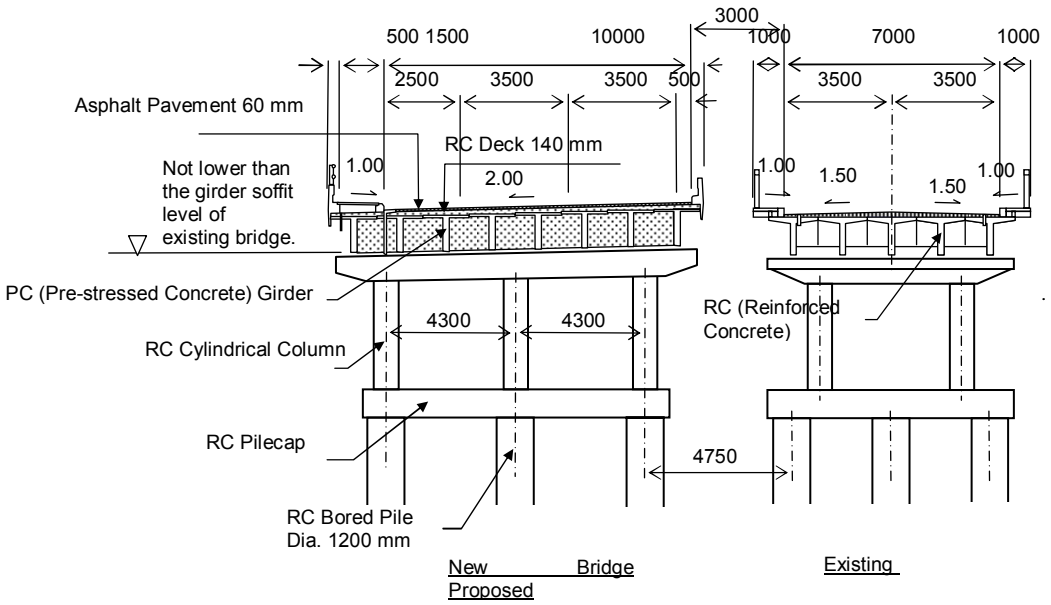


Figure 2-12 Composition of Bridge Widths

ii) Location and Layout Plan of New Bridges

Bridge Location: At both the Manohara and Hanumante Bridges, the new bridges are recommended to be on the up-stream side of the existing bridges, because the space between the existing bridge and the check dam is not sufficient to accommodate the new bridges safely on the downstream side. The relative location between the bridges and check dams along with the river profile are illustrated below.

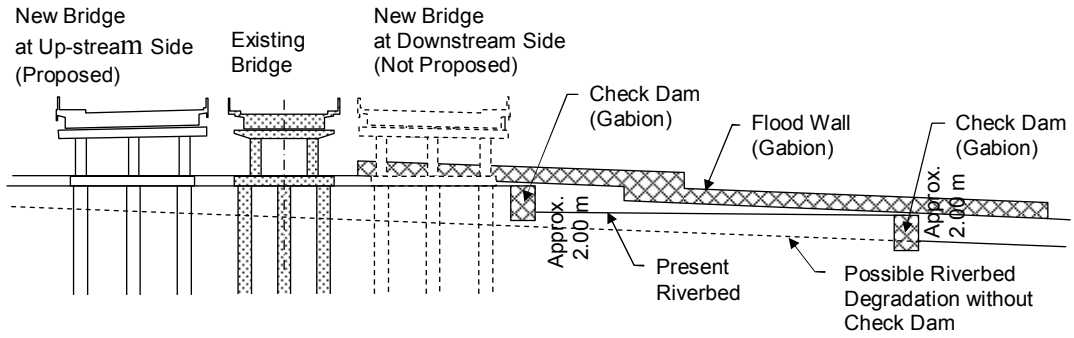


Figure 2-13 Location of Manohara Bridge & Check Dam

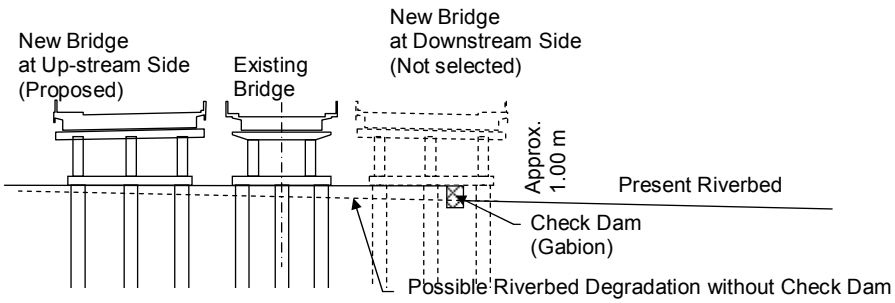


Figure 2-14 Location of Hanumante Bridge & Check Dam

Bridge Layout Planning: To minimize the blockage effect against river flow due to the existence of bridge piers in the waterway, the new bridge piers are to be aligned with those of the existing bridge along the flow line. New bridge girders are to be positioned higher than those of the existing bridges.

Based on this flow-aligning rule on pier location mentioned above, the new Manohara Bridge is planned at the position and with the span length the same as the existing bridge because the bridge crosses the river almost at right angles.

Concerning the Hanumante Bridge, for it crosses the river on a skew, the new bridge is planned to shift some 4.5 m from the existing bridge along the road centerline so as to orient the direction of piers between the existing and the new bridges to the flow direction. The span length is to be the same as that of the existing bridge.

The bridge layout plans of the Manohara and Hanumante bridges are shown in Figure 2-165 and Figure 2-16 respectively.

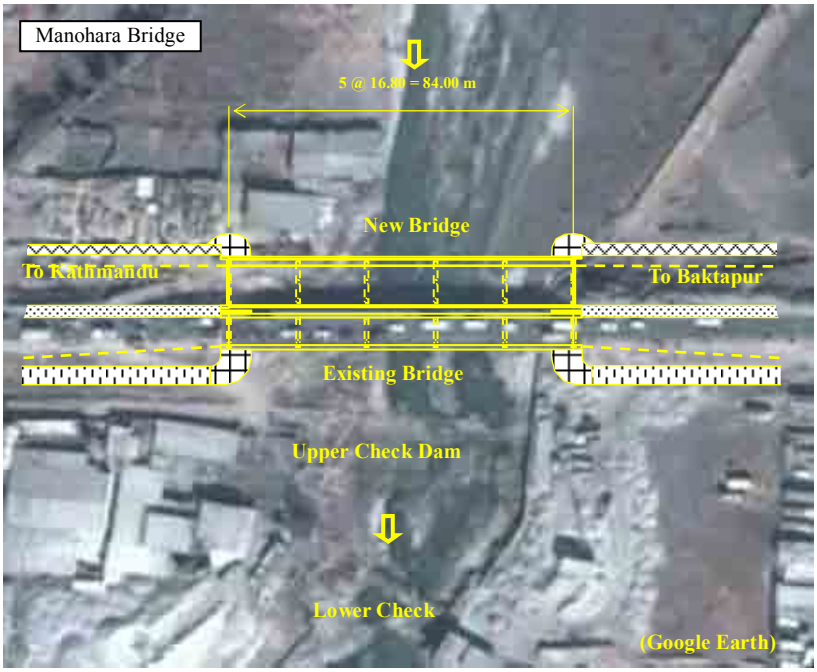


Figure 2-15 Layout Plan of Manohara Bridge

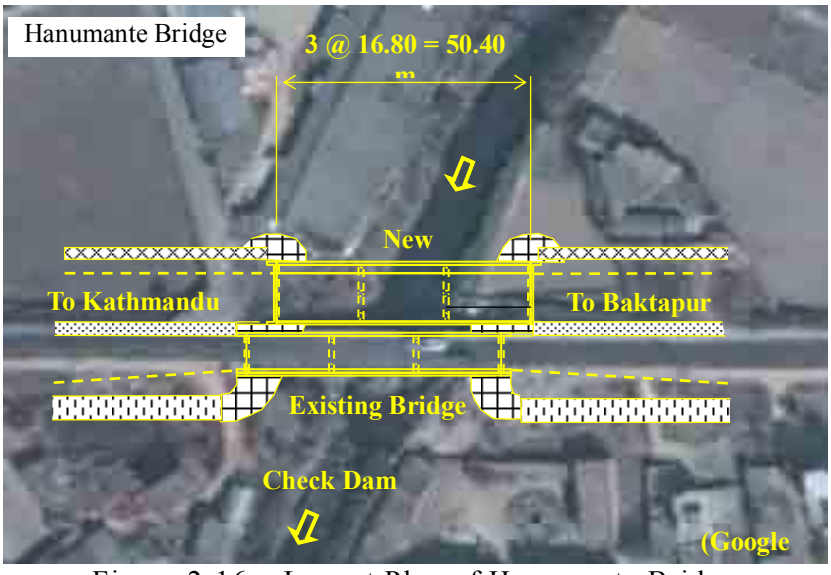


Figure 2-16 Layout Plan of Hanumante Bridge

Span Length and Girder Depth: Based on the span length of the existing bridges, which is 16.8 m measured from pier to pier, and applying the flow-aligning rule on pier location mentioned above, the design span length of the new bridges must be either 16.8 m, the same as that of the existing bridge, or doubled to 33.6 m. The required girder depth for the 33.6 m long girder is estimated at about 1.9 m by applying a girder depth-to-length ratio of 1/18, which comes to 0.8 m higher than the girder depth of the existing bridges.

The girder soffit level of the new bridges is required to not be lower than that of the existing bridge in order to maintain the present discharge capacity.

If the 33.6 m span is adopted, it will make a big difference of about 1.0 m on the bridge deck level between the existing and the new bridges including the difference of road surface level due to cross slope, and this must make the profile and the cross-section design of the approach road very difficult.

It is, therefore, concluded that the new bridge should be designed modeled on the existing bridge with the same span length and consequently girder depth in order to maintain the existing road surface level as near as possible.

iii) Superstructure Design

Girder Type: Concrete and steel girders have been compared for their advantages and disadvantages as summarized in Table 2-9 from the view-points of ease of construction, cost efficiency and maintenance. As a result, it is concluded that concrete girder construction is better than the steel girder construction, mainly for cost effectiveness and easier maintenance.

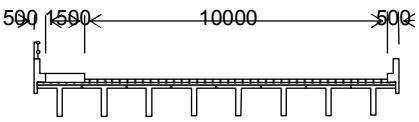
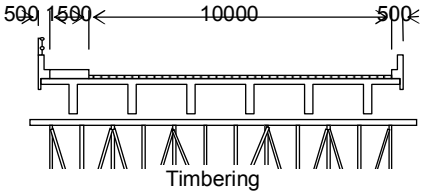
Table 2-9 Comparison of Girder Types

Girder Type	Steel Girder	Concrete Girder (Selected)
Ease of Construction	- Easier in erection work for light girder weight of approx. 3.5 t/girder. - Long distance transportation to the site from the fabricating place maybe from neighboring country. OK	- A girder pre-casting yard is required near the site. - Erection equipment of larger size is required for heavier girder weight of approx. 13.8 t/girder. OK
Economic Efficiency	- Domestic fabrication of girders is not available, so import is required from a neighboring country with high fabrication and transportation costs. NG	- Domestic materials and equipment for girder work are available and girder casting is at site, so that makes it less costly for fabrication and transportation. OK
Future Maintenance	- Periodic painting of steel surfaces is required other than bridge surface cleaning. NG	- Bridge surface cleaning is required. OK

Girder Casting Method: The casting method of concrete girders is broadly divided into the cast-in-situ (girders are to be cast on timbering at construction site) and the pre-cast (girders are to be cast at yard and be transported to erection site) methods.

For the project bridges, it is recommended to adopt the latter, because the cast-in-situ method needs to maintain scaffolding on the riverbed for periods of approximately 4 to 6 months and consequently increases the risk of flood. For this reason, the existing bridges had been constructed 40 years ago using the pre-casting method. Comparison of the two methods is summarized in the following Table 2-10.

Table 2-10 Comparison of Girder Casting Method

	Pre-casting and Erection Method (Selected)	Cast-in-Situ Method
Casting Method		
Ease of Construction and Safety	- Easier in construction work and shorter in construction period at site for no timbering required in river, and - That reduces flood risk during construction in river. However, - Heavy equipment for girder erection is required.	- Complication in construction work and longish in construction period at site for timbering required in river, and - That increases flood risk during construction in river. However, - No heavy equipment for girder erection is required.
Cost Efficiency	- Girder pre-casting, transportation and erection will be cost increase factors against saving factors of no timbering in river. - In conclusion, this method is estimated to be approx. 5 % less costly than the cast-in-situ method.	- Timbering in river and so longish construction period will be cost increase factors against saving factors of girder pre-casting, transportation and erection. - In conclusion, this method is estimated to be approx. 5 % more costly than the pre-casting method.

Shape and Sizes of Girders: The pre-cast concrete girders adopt a T shape as with the existing bridge girders. After girder erection, deck slab concrete will be cast on the pre-cast girders to form a composite structure, and the T-girders can avoid the bottom form and timbering for the deck slab concreting to save field-work and time periods.

Reinforcement of Girders: Many cracks have been found in the existing bridge girders. Those are probably because the girders are only reinforced but not pre-stressed. It is, therefore, recommended that the new bridge girders be pre-stressed to avoid cracks. It is also recommended that the pre-tensioning method be adopted for the girders considering the girder length (16.76 m), which is suitable for a straight-line layout of pre-stressing steel and the economic efficiency for a good number of production girders (64 girders scheduled). Considering the difficulty in avoiding cracks for such concrete girders that are reinforced only with ordinary reinforcement, although over 15 m in span length, pre-stressing is deemed necessary though a little costlier.

The typical cross-section of a pre-tensioned PC (Pre-stressed Concrete) girder under design is shown in Figure 2-17.

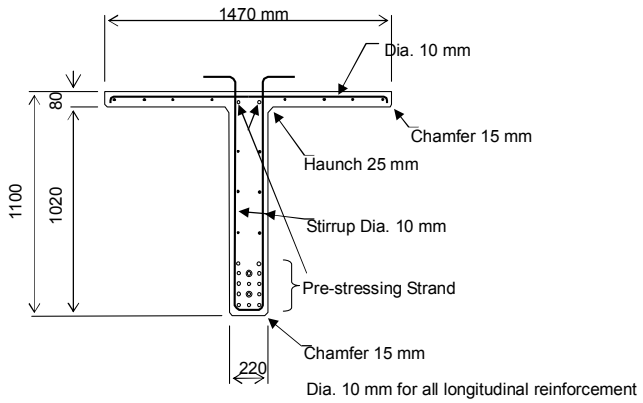


Figure 2-17 Prestressed Concrete T-girder

Joint Filler on Deck Slab: If the bridge is designed based on a frame structural model as discussed below in paragraph (4), the deck expansion joints between the girder spans become useless. Therefore, no large expansion clearance is required on the deck slab and instead, a small

joint filler (10 mm in thickness designed) is sufficient to cut off negative moment and to allow rotation movement caused by loading deflection. However, between the girders, some clearance (40 mm designed) is required as an allowance for the girder erection work and rotation behavior. The filler joint is designed as shown below.

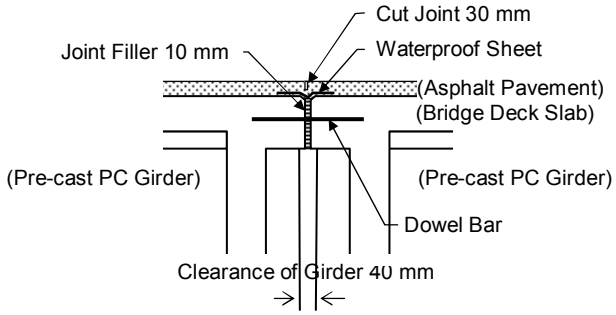


Figure 2-18 Filler Joint on Deck Slab

iv) Substructure Design

Geometry of Piers: To minimize resistance to river flow as well as to share a common appearance with the existing bridge piers, the new bridge piers are to be designed with cylindrical columns.

Pile-Bent Structure based on Frame Model: The bridge span is considered rather short and that requires a number of piers. For such short span bridges, the portion of substructure in construction cost is comparatively high, so that a compact and accordingly cost effective design is essential for economy of construction in balance with the scale of superstructure.

In accordance with the above thought, the stability of the bridge against horizontal load such as earthquake in a longitudinal direction is designed with a frame structural model assuming that all piers and abutments are connected through superstructure to work integrally, but not dependent on the conventional fixed piers and abutments which need a large amount of rigidity to resist horizontal load independently. In a frame model, each pier or abutment does not need to have a large degree of rigidity, and therefore the pile-bent structure with single-row piles is applicable for economical design just as in the case of the existing bridge. A frame model in consideration is shown below.

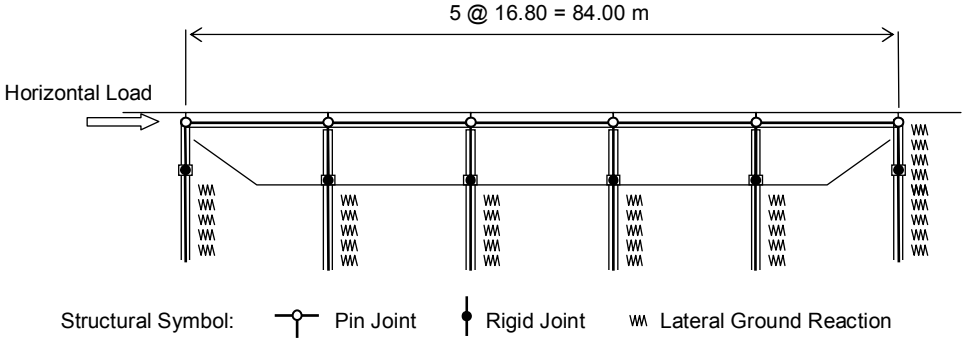


Figure 2-19 Frame Structural Model (in the case of Manohara Bridge)

As regards the stability in the perpendicular direction, each pier as well as its abutment can be designed by frame modeling with more than one column and piles.

Pile Foundation: According to the soil boring investigation on the bridge sites, the riverbed consists of laminated deposits being classified into fine sand, silt and clay layers from surface with depth. As regards density of the deposits, the surface layer shows as loose with SPT (Standard Penetration Test) value of around 10, but as depth increases, density improves quickly to show SPT 30 to 40 in the Manohara Bridge site and over 50 in the Hanumante Bridge site.

It is considered difficult to drive piles into such densely deposited silt to sandy ground because of high driving resistance. For this reason, bored cast-in-situ concrete piles have been employed in many bridges in the Kathmandu basin, and 40 years ago also, the existing Manohara and Hanumante Bridges were constructed with bored piles (1.2 m in diameter). Therefore, we recommend that the new bridges employ bored piles, too. In addition, bored piles are generally credited with the most harmless piling method for neighboring construction.

(3) Road Drainage

1) Cross Drainage

Catchment Characteristics: The catchment is located in a middle mountain range. The catchments related to the Road are mostly cultivated land. All drainage falls in the Bagmati watershed via the Manohara and Hanumante rivers. The catchment characteristics of 6 major cross drains required hydrographically, other than the Manohara and Hanumante rivers are summarized in Table 2-11.

Table 2-11 Summary of Catchment Characteristics of 6 Major Cross Drains

Name of Drain	Catchment Area (km^2)	Stream Length (km)	Highest Point (+m)	Lowest Point (+m)	Height Difference (m)	Catchment Slope	Concent-ration Time (hrs)
CD3 at Lokanthali	0.92	1.5	1,315	1,295	20	0.0133	0.48
CD4 at Kaushaltar	0.188	0.5	1,320	1,310	10	0.02	0.18
CD8 at Thimi West	1.359	2.75	1,375	1,299	76	0.0276	0.58
CD11 at Thimi East	0.943	1.1	1,332	1,298	34	0.0309	0.27
CD14 at Bhimsen	1.489	2.6	1,332	1,298	34	0.0131	0.74
CD16 at Chundevi	2.285	0.75	1,550	1,335	215	0.2867	0.09

Design Discharge: Design discharges of the 6 drains for 25 year probability were estimated by using 6 different methods: rational equation, PCJ method (Prem Chandra Jha method, Nepal), PDSP (Planning and Design Strengthening Project) manual, probability analyses of the past floods, probability analyses of the Bagmati river basin and WECS (Water Energy Commission Secretariat) method. The results are shown in the third column of Table 2-12.

Drainage Capacity: Capacity of the respective drains was estimated based on the Manning's formula as shown in Table 2-12. It should be noted that outlets from the major drains (CD3, CD4, CD8, CD11, CD14, CD16) towards the Hanumante river should be secured by the Nepalese side.

Table 2-12 Summary of Design Discharge and Discharge Capacity

Location		D. Discharge Q_{25} (m^3/s)	Discharge Capacity					
			Section	Roughness Coeff. n	Grade i	Hydraulic Depth R (m)	Area A (m^2)	Capacity Qcap (m^3/s)
CD1	Km0+540	-	2.0m x 2.0m	-	-	-	-	-
CD2	Km0+780	-	0.6m dia	-	-	-	-	-
CD3	Km2+400	5.0	1.5m x 1.5m	0.015	0.02	0.462	1.800	10.1
CD4	Km2+950	3.2	1.2m dia	0.013	0.06	0.320	0.904	7.9
CD5	Km3+420	-	0.6m dia	-	-	-	-	-
CD6	Km4+020	-	0.9m dia	-	-	-	-	-
CD7	Km4+310	-	0.6m dia	-	-	-	-	-
CD8	Km4+360	16.0	2.0m x 2.0m	0.015	0.04	0.615	3.200	30.9
CD9	Km4+760	-	0.6m dia	-	-	-	-	-
CD10	Km4+990	-	0.9m dia	-	-	-	-	-
CD11	Km5+575	13.0	2.5m x 2.5m	0.015	0.003	0.769	5.000	16.1
CD12	Km5+690	-	0.9m dia	-	-	-	-	-
CD13	Km5+860	-	0.9m dia	-	-	-	-	-
CD14	Km5+975	14.0	2.0m x 2.0m	0.015	0.02	0.615	3.200	21.8
CD15*	Km6+495	-	0.6m dia	-	-	-	-	-
CD16	Km7+020	20.0	2.5m x 2.5m	0.015	0.01	0.769	5.000	28.0
CD17	Km7+090	-	0.6m dia	-	-	-	-	-
CD18	Km7+420	-	1.2m dia	-	-	-	-	-
CD19	Km7+595	-	0.9m dia	-	-	-	-	-
CD20	Km7+750	-	0.9m dia	-	-	-	-	-
CD21	Km8+235	-	0.9m dia	-	-	-	-	-
CD22	Km8+980	-	0.6m dia	-	-	-	-	-

Notes:
1) Blanks in the table show the existing cross drains that are used for irrigation and other social environmental requirements.
2) 80% of drainage sections are considered for capacity calculation.
3) Figure marked with * is the pipe culvert required from a sagging point of the new longitudinal alignment.

2) Side Ditches

Design Discharge: Design discharge to drain the road surface water along with water from neighboring areas was estimated and summarized in Table 2-13 for the return period of 3 years by using the rational equation.

Table 2-13 Summary of Roadside Discharge

Location				Length (km)	Width (Km)	Catchment Area (m^2)			Discharge (m^3/s)
ID	From	To	Connected to			Road	Others	Total	
LS1	Km0+400	Km1+000	Bagmati R	0.400	0.025	0.010	0.100	0.110	0.587
LS2	Km1+000	Km2+220	Manohara R	1.220	0.025	0.031	0.294	0.325	1.732
LS3	Km2+220	Km2+700	CD3	0.480	0.025	0.012	0.010	0.022	0.118
LS4	Km2+700	Km3+650	CD4	0.950	0.025	0.024	0.033	0.057	0.303
LS5	Km3+650	Km4+500	CD8	0.850	0.025	0.021	0.030	0.051	0.274
LS6	Km4+500	Km6+000	CD11	1.500	0.025	0.038	0.200	0.238	1.268
LS7	Km6+250	Km7+975	Hanumante R	1.725	0.025	0.043	0.000	0.043	0.230
LS8	Km7+975	Km8+975	CD16	1.000	0.025	0.025	0.000	0.025	0.134
RS1	Km0+000	Km1+000	Bagmati R	1.000	0.025	0.025	0.025	0.050	0.267
RS2	Km1+000	Km2+220	Manohara R	1.220	0.025	0.031	0.020	0.051	0.270
RS3	Km2+220	Km2+700	CD3	0.480	0.025	0.012	0.010	0.022	0.118
RS4	Km2+700	Km3+650	CD4	0.950	0.025	0.024	0.000	0.024	0.127
RS5	Km3+650	Km4+500	CD8	0.950	0.025	0.024	0.000	0.024	0.127
RS6	Km4+500	Km6+000	CD11	1.500	0.025	0.038	0.000	0.038	0.200
RS7	Km6+250	Km7+975	Hanumante R	1.725	0.025	0.043	0.100	0.143	0.764
RS8	Km7+975	Km8+975	CD16	1.000	0.025	0.025	0.155	0.180	0.961

Notes: - Rainfall intensity of the rational equation = 30 mm/hr
- Runoff coefficient of the same: $f = 0.6401 - 0.0012 A$, where, A: catchment area (km^2)

Drainage capacity: Manning's formula was employed to estimate sizes of side ditches along with capacities. Results are summarized in Table 2-14. Drains should be covered by considering present and possible future expansion of settlement, in addition to intersections, access road locations and existing built-up areas, as a safety consideration while designing side ditches.

Table 2-14 Summary of Side Ditches

Location				Discharge	Capacity Calculation (Manning's Formula)				
	From	To	Connecting to	$Q_3(m^3/s)$	Sect. (mm)	Grade i	Perimeter R (m)	Area A (m^2)	Q_{cap} (m^3/s)
LS1	Km0+400	Km1+000	Bagmati R	0.587	U600	0.015	0.185	0.288	0.762
LS2	Km1+000	Km2+220	Manohara	1.732	U800	0.040	0.246	0.512	2.683
LS3	Km2+220	Km2+700	CD1	0.118	U400	0.010	0.123	0.128	0.211
LS4	Km2+700	Km3+650	CD2	0.303	U500	0.010	0.154	0.200	0.383
LS5	Km3+650	Km4+500	CD3	0.274	U500	0.010	0.154	0.200	0.383
LS6	Km4+500	Km6+000	CD4	1.268	U500	0.010	0.154	0.200	0.383
LS7	Km6+250	Km7+975	Hanumante	0.230	U400	0.015	0.123	0.128	0.259
LS8	Km7+975	Km8+975	CD6	0.134	U400	0.010	0.123	0.128	0.211
RS1	Km0+000	Km1+000	Bagmati	0.267	U500	0.003	0.185	0.288	0.341
RS2	Km1+000	Km2+220	Manohara	0.270	U500	0.010	0.154	0.200	0.382
RS3	Km2+220	Km2+700	CD1	0.118	U400	0.010	0.123	0.128	0.211
RS4	Km2+700	Km3+650	CD2	0.127	U400	0.010	0.123	0.128	0.211
RS5	Km3+650	Km4+500	CD3	0.127	U400	0.010	0.123	0.128	0.211
RS6	Km4+500	Km6+000	CD4	0.200	U400	0.010	0.123	0.128	0.211
RS7	Km6+250	Km7+975	Hanumante	0.764	U600	0.015	0.185	0.288	0.762
RS8	Km7+975	Km8+975	CD6	0.961	U800	0.010	0.246	0.512	1.341

Note: - 80% of sectional area is regarded as effective for estimating the discharge capacity.
-Discharge capacities of U-shaped concrete ditch are used in the table. The same sizes of V-shaped mortar-riprap ditches have bigger capacity than those of U-shaped concrete ditches. V-shaped ditches can be applied to the places where topography and land-use pattern allow use of the latter from the aspect of cost effectiveness.

(4) Intersections

The required number of lanes at intersections has been examined by way of analyzing the present traffic volumes according to the JRA Geometric Design Standard. Table 2-15 summarizes the analysis.

Table 2-15 Required Lane Numbers for the Present Traffic Volumes

Intersection Name	Connecting Road Name (Inflow)	Inflow Traffic Volume (cars/hr)				Lane Nos. (2 directions)		Storage Length for L & R-Turn Lane (m)	
		Morning Peak		Evening Peak					
		L.V	H.V	L.V	H.V	Present	Plan	Direct.	Length
Tinkune (1)	Baneshwore	1,070	171	1,464	84	5	5	Left	100
	Airport	466	113	491	69	2	2	-	-
	Koteshwore	891	67	759	95	4	5	Right	90
Tinkune (2)	Baneshwore	614	166	833	20	4	4	-	-
	Airport	536	85	613	40	3	3	Left	120
	Koteshwore	1,464	251	1,779	53	4	5	Right	300
	Mahadevistan	7	0	4	0	2	2	-	-
Koteshwore	Tinkune	1,146	47	2,002	53	5	5	Right	-
	Jadibuti	1,405	58	899	87	4	5	Left	80
	Ring Road	1,053	79	1,319	30	4	4	-	-
	Mahadevistan	157	12	75	1	2	2	-	-
Jadibuti	Koteshwore	943	87	1,327	84	2	5	Right	60
	Pepsi Cola	292	20	221	12	2	3	Left	50
	Gathaghar	1,024	55	583	69	2	5	Right	60
	(Access Road)	-	-	-	-	0	2	-	-
Gathaghar	Jadibuti	420	343	877	151	2	4	-	-
	Old Thimi	63	6	162	8	2	3	Left	40
	Thimi	578	127	469	64	2	5	Light	75
Thimi	Gathaghar	393	47	458	23	2	5	Right	60
	Old Thimi	23	0	14	0	2	2	-	-
	Sallaghari	592	33	756	45	2	5	Right	60
	Dadikott	80	0	47	0	2	2	-	-
Sallaghari	Thimi	506	68	474	53	2	4	-	-
	Nagharkott	136	9	547	8	3	2	-	-
	Suryabinayak	609	307	447	81	2	5	Right	155
Surya Binayak	Sallaghari	260	35	246	26	2	5	Right	75
	Bhaktapur	86	5	106	14	2	2	-	-
	Jagati	280	25	351	64	2	5	Right	75
	Shrine	45	5	56	8	2	2	-	-

Note: L.V = Light Vehicle, H.V = Heavy Vehicle

Signalization is examined in the cases where each intersection will be improved to the lanes in the above. However, existing signalized intersections, such as Tinkune and Koteshwore intersections, are excluded in the examination. Pre-conditions of the examination are based on West Germany Method and results are summarized in Table 2-16, which shows the necessity of signalization at Jadibuti, Gathaghar and Sallaghari..

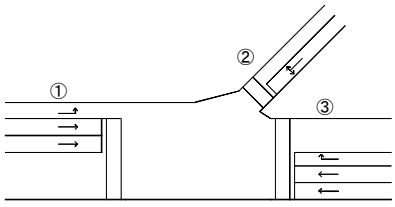
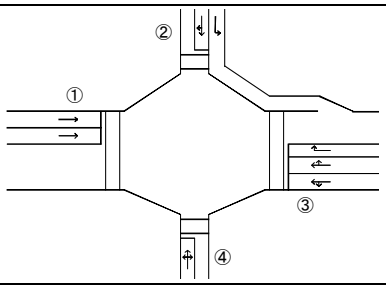
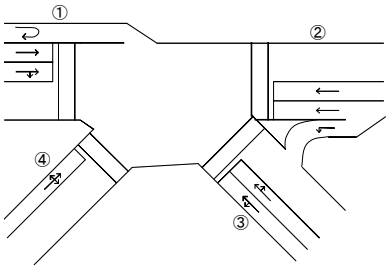
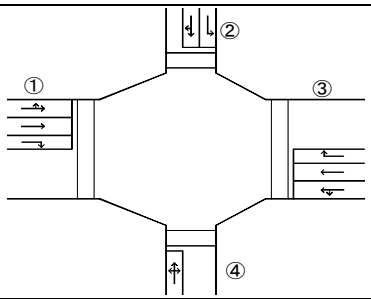
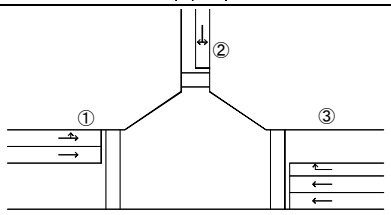
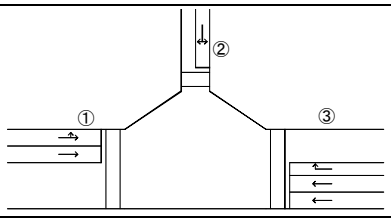
Further, saturation degrees of Tinkune, Koteshwore, Jadibuti, Gathaghar and Sallaghari intersections were estimated and summarized in Table 2-17.

Table 2-16 Examination of Necessity of Signalization

Intersection	Traffic		Classification etc		Traffic Volume (Average Peak Hours)			Evaluation
	From	To	Main / Minor	Direct	Volume	Capacity	Difference	
Jadibuti	Koteshwore	Pepsi Cola	Main	Right	0	283	283	○
	Pepsi Cola	Gathaghar	Minor	Left	283	203	-80	×
		Koteshwore	〃	Right	293	0	-293	×
		Exst. Service Rd	〃	Straight	0	0	0	-
	Gathaghar	Pepsi Cola	Main	Right	11	283	272	○
	Exist. Service Rd	Koteshwore	Minor	Left	50	262	212	○
		Pepsi Cola	〃	Right	50	0	-50	×
		Gathaghar	〃	Straight	50	0	-50	×
	Exist. Congested	Exst. Service Rd	-	-	150	0	-150	×
Gathaghar	Thimi	Old Thimi	Major	Right	17	366	349	○
	Old Thimi	Thimi	Minor	Left	38	279	241	○
		Jadibuti	Minor	Right	81	24	-57	×
Thimi	Gathaghar	Dadikott	Major	Right	19	602	583	○
	Old Thimi	Sallaghari	Minor	Left	8	487	479	○
		Gathaghar	〃	Right	4	34	30	○
		Dadikott	〃	Straight	4	69	65	○
	Sallaghari	Old Thimi	Major	Right	14	602	588	○
	Dadikott	Gathaghar	Minor	Left	46	327	281	○
		Sallaghari	〃	Right	22	42	20	○
		Old Thimi	〃	Straight	12	68	56	○
	Minor Congested	Old Thimi	-	-	15	85	70	○
		Dadikott	-	-	80	95	15	○
Sallaghari	Suryabinayak	Nagarkott	Major	Right	458	602	144	○
	Nagarkott	Suryabinayak	Minor	Left	184	487	303	○
		Thimi	〃	Right	244	24	-220	×
	Minor Congested	Nagarkott	-	-	428	43	-385	×
Surya Binayak	Sallaghari	Shrine	Major	Right	16	750	734	○
	Bhaktapur	Jagati	Minor	Left	69	617	548	○
		Sallaghari	〃	Right	61	154	93	○
		Shrine	〃	Straight	44	214	170	○
	Jagati	Bhaktapur	Major	Right	20	750	730	○
	Shrine	Sallaghari	Minor	Left	31	563	532	○
		Jagati	〃	Right	10	128	118	○
		Bhaktapur	〃	Straight	9	216	207	○
	Minor Congested	Bhaktapur	-	-	174	246	72	○
		Shrine	-	-	50	286	236	○

Note: Traffic volume per lane

Table 2-17 Result of Intersection Analysis (Degree of Saturation & Cycle Length)

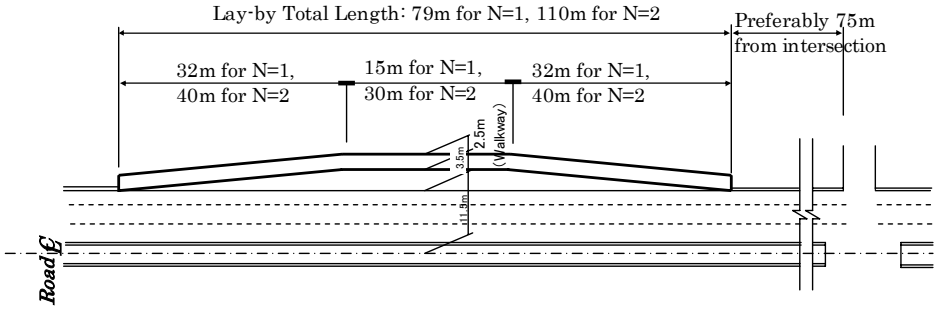
Name of Intersection	Access Road		No. of Lanes		Improvement Plan	Degree of Saturation	Cycle Length(s)
	No.	Name	In	Out		Up:AM Down:PM	Up:AM Down:PM
Tinkune（1）	1	Baneshwore	3	2		0.568	120
	2	Airport	1	1			
	3	Koteshwore	3	2		0.648	120
Tinkune（2）	1	Baneshwore	2	2		0.684	120
	2	Airport	2	1			
	3	Koteshwore	3	2		0.723	120
	4	Mahadevistan	1	1			
Koteshwore	1	Tinkune	3	2		0.689	120
	2	Jadibuti	3	2			
	3	Ring Road	2	2		0.768	180
	4	Mahadevistan	1	1			
Jadibuti	1	Koteshwore	3	2		0.465	90
	2	Pepsi Cola	2	1			
	3	Gathaghar	3	2		0.526	90
	4	（Access Road）	1	1			
Gathaghar	1	Jadibuti	2	2		0.310	60
	2	Old Thimi	1	1			
	3	Thimi	3	2		0.394	60
Sallaghari	1	Thimi	2	2		0.262	60
	2	Nagarkott	1	1			
	3	Suryabinayak	3	2		0.493	90

(5) Bus-stops

Location of bus stops: 13 locations were selected at Koteshwore, Jadibuti, Lokhanthali, Kaushaltar, Ghataghar, T.B. Hospital, Thimi, Srijana Nagar, Sallaghari Tinkune, Sallaghari, Chundevi, Barahisthan and Suryabinayak. It should be noted that the bus stop at T.B. Hospital is to be scheduled only on the left side (toward Bhaktapur) as existing. A summary of bus stops, along with the number of bus parking spaces, is shown in Table 2-18 and a conceptual plan based on the IRC code is in Figure 2-20.

Table 2-18 Location of Bus Stops along with Numbers of Bus Parking Spaces

Name of Bus Stop	Left Side (toward Bhakutapur)		Right Side (toward Kathmandu)	
	Location	No. of Buses: N	Location	No. of Buses: N
Koteshwore Ring Road	Km0+815	2	Km0+840	2
Koteshwore Arniko H.	Km1+145	2	-	-
Jadibuti	Km1+415	1	Km1+660	1
Lokanthali	Km2+240	1	Km2+260	1
Kaushaltar	Km2+690	2	Km2+690	2
Gathaghar	Km3+630	1	Km3+660	1
T. B. Hospital	Km4+410	1	-	-
Thimi	Km4+920	2	Km4+550	2
Srijana Nagar	Km6+610	2	Km6+650	2
Sallaghari Tinkune	Km6+935	1	Km7+20	1
Sallaghari	Km7+280	1	Km7+360	1
Chundevi	Km8+115	1	Km8+080	1
Barahisthan	Km8+630	1	Km8+610	1
Suryabinayak	Km8+850	2	Km8+820	2



Notes: Pavement of bus lay-by should be of cement concrete and that of walkways thereof is of interlocking tiles.

Figure 2-20 Conceptual Plan of Bus Lay-by based on IRC Code

(6) Access Roads

Access roads will be connected to the Road at 10 places as listed in Table 2-19.

Table 2-19 Summary of Access Roads to be Connected

Place Name	Location	Left/Right	Width of Access Road (m)
East bank of Manohara	Km1+900	Right	4.0
Lokanthali	Km2+340	Left & Right	4.5
Kaushaltar	Km2+800	Left & Right	3.5
T.B Hospital	Km4+225	Left & Right	4.0
Thimi East	Km5+175	Left & Right	3.5
West bank of Hanumante	Km6+000	Left & Right	4.0
Srijana Nagar	Km6+775	Left & Right	4.0
Sallaghari West	Km7+500	Left & Right	5.5
Chundevi	Km7+900	Left & Right	5.5
Suryabinayak West	Km8+725	Left & Right	4.0

(7) Retaining Walls

Mortar riprap walls (slope protection), mortar riprap gravity walls and RC inverted T-shaped retaining walls have been widely used in Nepal, and recently reinforced earth walls have been used in the high embankment of the Sindhuli Road project. Further, a combination of reinforced earth wall (so-called mechanized reinforced wall) and gabion is going to be deployed for cost effectiveness reasons. Figure 2-21 shows the relationship between cost per length and retaining wall height for mortar riprap slope protection, mortar riprap gravity wall, RC T-shaped retaining wall and mechanized reinforced wall.

From the figure, mortar riprap slope protection will be used when the wall height is 4 m or less while mechanized reinforced wall will be used when the embankment height is 5 m or more.

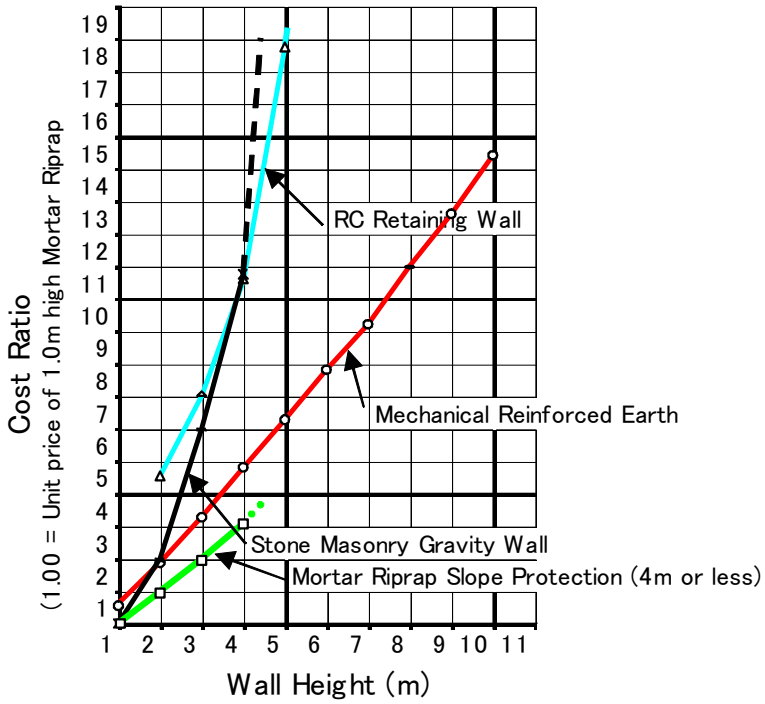


Figure 2-21 Concept of Mechanized Reinforced Earth Wall

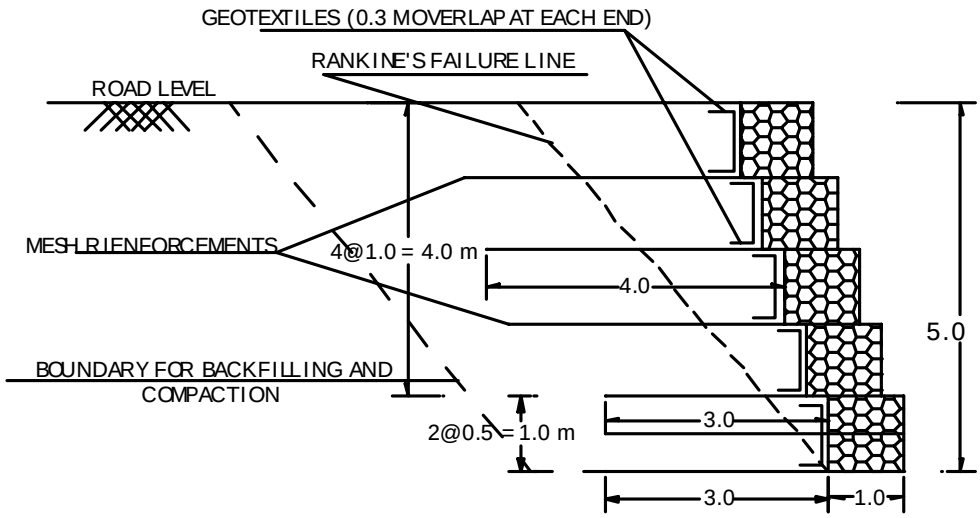


Figure 2-22 Relationship of Wall Types and Cost per Meter

(8) Road Lighting

A partial lighting system will be deployed at the intersections where traffic flows are complicated, i.e. at bridges, major access points and bus stops, viz. Tinkune to the Manohara Bridge, Ghataghar intersection, Thimi intersection, Hanumante Bridge, Sallaghari intersection, Suryabinayak intersection. General requirements of road lighting facilities are shown in Table 2-20.

Table 2-20 Design Criteria for Road Lighting

Items	Requirement, Specification etc.
Standard Luminance	0.7 cd/m^2
Required illuminance for luminance	15 lx/cd/m^2
Height of lighting pole	10 m
Arrangement of lighting pole	Single and Twin bulbs
Spacing of lighting poles	35 m
Applied standards	JRA Standards, 1981 for Road Lighting

(9) Other Road Safety Facilities

As already discussed with signalization, bus-stops, sidewalks at bus-stops and road lighting in the preceding paragraphs, road safety facilities were implicated.

In addition, other traffic safety measures were considered, viz. traffic barriers including guardrails which are installed in cases of high embankments (more than 3m) and guard pipes which can be produced in Nepal, a median strip, lane marking, pedestrian crossings, motorbike stopping lines and traffic sign boards. In particular, a motorbike stopping line will be significant in future based on the traffic characteristics of the Road and the fact that there are a number of motorbikes.

2.2.3 Basic Design Drawing

The basic design drawings are provided in Appendix-5.

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

An Implementation Plan for the Project has been carried out using the guideline of Japan's Grant Aid and considering the site conditions. The policies for implementation of the Project are summarized in the following:

- - To activate regional development and generation of job opportunities, local labor and construction materials should be used to the maximum for the Project.
- - To consider night-time working since the traffic volume is very high and the traffic capacity of detours is insufficient.
- - To prepare a construction method taking into consideration the monsoon period from June to September.

2.2.4.2 Implementation Conditions

1) Labor Law

The contractor should manage labor properly with an adequate safety control plan and should prevent conflict with the local labor force. In all circumstances, he should abide by the labor laws and regulations in force in Nepal.

2) Detours and Temporary Roads for Public Traffic Diversion

The traffic volume on the Road is high, and traffic congestion is becoming chronic. Accordingly, the road segment from Tinkune Intersection to Jadibuti Intersection, where no detour is available and no temporary road for traffic diversion can be provided, will be improved only with night-time working.

The existing Old Thimi Road can be used as a detour from Jadibuti Intersection to Suryabinayak Intersection. The Old Thimi Road has a narrow carriageway, only 3.5m wide near Bhaktapur City, and can carry, at most, 2,000 to 3,000 vehicles/day. Since traffic demand along the Road where a number of houses and shops are being lined-up is extremely high, temporary roads should be accommodated along both the ends of the ROW as a traffic diversion for the use of public traffic during construction. A temporary road on each side would have 4.0m width with a 15cm thick crushed stone layer covered by prime coat to mitigate the generation of dust.

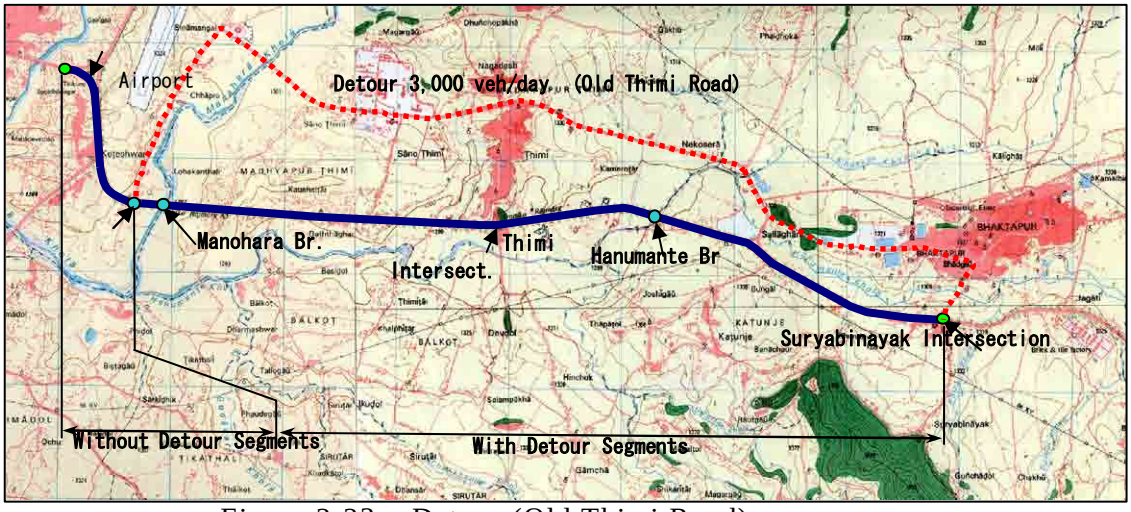


Figure 2-23 Detour (Old Thimi Road)

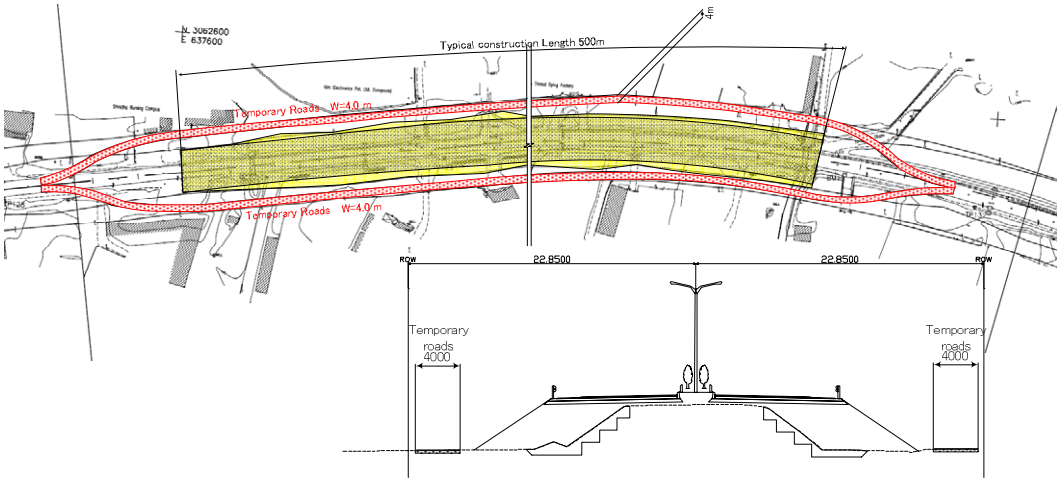


Figure 2-24 Temporary Roads for Traffic Diversion (Typical Segments)

3) Traffic Control and Safety Measure during Construction

The construction for the Project mainly consists of roadwork, being carried out by two parties, and bridge building work. During construction, guards would be deployed at all working sites other than the traffic police for temporary roads. Appropriate sign-boards and signal lights would be provided during construction as a traffic safety measure within the construction sites.

4) Importance of Concrete Quality Control

The quality of concrete has a great influence on the life of concrete structures. Reinforcing bars should be properly protected against corrosion by minimum concrete coverage from the crack width. Concrete material selection such as aggregate, sand, water and cement, low W/C, contained air, calibration of concrete plant, regulation of transporting, placing concrete and curing are given priority to produce high quality concrete.

2.2.4.3 Scope of Works

The scope of works to be undertaken by the Japanese Government as well as the Nepalese side is shown Table 2-21:

Table 2-21 Scope of Works undertaken by the Japanese Government and the Nepalese Side

Works, Facilities and Services to be provided by the Japanese Government	Works, Facilities and Services to be provided by the Nepalese Side
- Consulting services for detailed design, preparation of tender documents, assistance to DOR in tender process, and construction supervision - Widening of Kathmandu-Bhaktapur Road, construction of new 2-lane Manohara and Hanumante bridges, improvement of 5 intersections (including 3 signalized intersections), 14 bus-stops (2 bus-stops only one side), 10 access road junctions as selected by the basic design - Installation and removal of temporary facilities (construction yard) - Construction of temporary roads (traffic diversion) - Protection measures for environmental pollution in execution of construction works - Procurement, import and transport of equipment/materials required for the improvement works and re-export of imported equipment.	- Free provision of site (land), temporary facilities and other construction activities in execution of construction works - Execution of environmental monitoring - Compensation to private houses in ROW and removal of these houses - Removal and relocation of the existing religious facilities, monuments (including statues) and water fountains - Removal and relocation of the existing public utilities (water/sewer pipes, electricity cables, trolley bus cables and telephone cables along with supporting poles) - Payment of bank service charges for banking arrangements (B/A) and authorization to pay (A/P) along with the required formalities - Free provision of land for construction yard and connection for electricity, potable water and telephone - Exemption of consultants and contractors from taxes, customs duties and other levies charged in Nepal for execution of construction works - Arrangement for visas, certification and other privileges to Japanese nationals and third country personnel relating to and required in execution of construction works - Free provision of traffic control and management for detour road and temporary roads - Planting in median strip, development of service roads, development of walkways, assurance of effective outlets from major cross drainage to Hanumante River - Execution of traffic safety awareness training at bus-stops as well as proper operation and maintenance for all the completed facilities.

2.2.4.4 Consultant Supervision

1) Supervision

The engineering services for construction supervision will begin with the acceptance of the construction contract and the issuance of a Notice to Proceed (N/P) to the contractor.

The consultant shall perform his duties in accordance with the criteria and standards applicable to the construction works and shall exercise the powers vested in him as the Engineer under the contract to supervise the field works by the contractor.

The consultant, within his capacity as the Engineer, shall directly report to DOR and JICA Nepal Office about the field activities and shall issue field memos or letters to the contractor regarding various matters, including progress, quality, safety and payment for the works under the Project. In addition, the consultant shall report to the Embassy of Japan in Kathmandu, if required.

After one year from the completion of the construction, the final inspection for defect reliability is conducted as the final task of the consultant.

2) Implementation Organization

The Resident Engineer basically stays at the construction site and conducts both construction supervision and project management. The necessary specialists for each stage are shown as follows:

- Resident Engineer: Coordination and liaison for all the project activities to ensure smooth progress and management of all technical aspects
- Bridge Engineer: Technical and quality control of bridge building work
- Electrical Engineer: Technical and quality control of road lighting and signal system

2.2.4.5 Quality Control Plan

As there is no adequate quality control plan in Nepal, the quality control plan in the Project has been formulated on the design concepts as shown in Table 2-22.

Table 2-22 Quality Control Tests Plan

Item			Test Method	Frequency
Sub-base (crushed stone)	Mixed Materials		Liquid Limit, Plastic Index (<SieveNo.4)	Every mixing
			Sieve Gradation	
			Aggregate Strength (TFV)	
			Aggregate Density	
			Maximum Dry Density (Compaction)	
	Placing		Field Density (Compaction)	Once/day
Prime Coat And Tack Coat	Material	Bitumen	Quality Certificate	Every material lot
			Temperature of Storage and Placing	Every placing
Hot Mix Asphalt	Material	Bitumen	Quality Certificate & Chemical Analyses	Every material lot
		Aggregate	Sieve Gradation (Mixed)	Every mix
			Water Absorption	Every material site
			Aggregate Strength (TFV)	
	Mix Requirement		Marshall Stability	Every mix
			Marshall Flows	
			Air Void	
			Voids in Aggregate Materials	
			Indirect Tensile Strength	
			Immersion Strength Index	
			Bitumen Content	
	Compact		Temperature in Mixing	Every mix
			Temperature in Compaction	Every transport
			Sampling (Marshall Test)	Every day
Concrete	Material	Cement	Quality Guarantee, Chemical & Physical Analysis	Every material lot
		Water	Chemical Analyses	Every source
		Admixture	Quality Certificate, Chemical Analyses	Every lot
		Fine Aggregate	Bulk Specific Dry Gravity	Every material site
			Sieve Gradation, Fineness Modulus	
			Clay and Friable Particles	
		Coarse Aggregate	Bulk Specific Dry Gravity	Every material site
			Flakiness Index	
			Sieve Gradation (Mixed)	
			Sodium Sulfate Soundness	
	Mixing Test		Compressive Strength (Cylinder Mold)	Every mixing test
	Placing		Slump	Every batch
			Temperature	
	Test		Compressive Strength (7 days, 28 days)	Daily
Re-bar/PC cable	Material		Mill Sheet, Tensile Strength, Chemical Composition	Every material lot
PC Cable	Equipment		Calibration of Prestressing Device	Before first prestressing
	Control of Prestressing		Prestressing control diagram	Each prestressing

2.2.4.6 Procurement Plan

Natural construction materials (aggregate, stone, embankment material, timber) and cement are produced in Nepal. Reinforcing bars are available in the markets. Special/qualified items, which are not available in the markets of the country, would be imported from Japan, viz. expansion joints, elastomeric lubber bearings, stainless plaque plate with powder coating paint.

Indicative procurement of construction materials and equipment is summarized in Table 2-23.

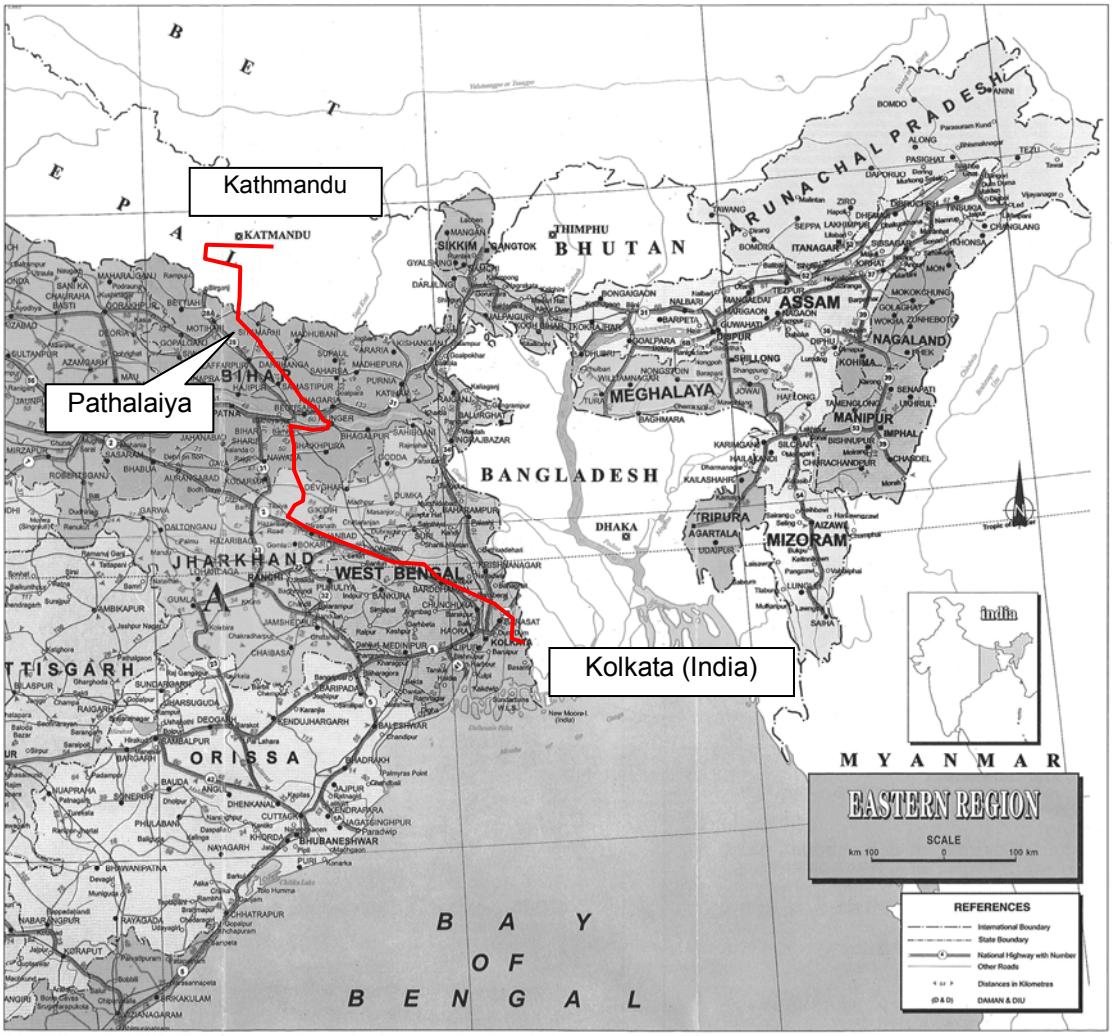
Table 2-23 Indicative Procurement of Construction Materials/Equipment

Items of Materials/Equipment		Nepal	Third Country (India)	Japan	Import Route
Materials					
Cement		○	○		Nepalese/Indian Products available
Aggregate（Coarse, Fine）		○			
Concrete Admixture		○	○		
Re-bars		○	○		Nepalese/Indian Products available
PC Cable		-		○	Quality reasons
Bituminous Materials		○			Imported items available
Wood/Plywood		○			
Fuel (oil, gasoline)		○			Imported items available
Steel Materials (Steel Sheet Pile, H-shaped)		○			Imported items available
Bearing, Expansion Joints, Cast Iron		-		○	Durability and quality reasons
Guardrail			○		Nepalese/Indian Products available
Stainless Plate with Powder Coating Paint		-		○	Durability and quality reasons
Equipment					
Bulldozer	15t	○			
Backhoe	$0.6m^3$	○			
Dump Truck	10t	○			
Vibration Roller	3.0-4.0t	○			
Road Roller	10t	○			
Grader	3.1m	○			
Distributer	2,000lit	○			
Concrete Batching Plant	30m3/h	○			
Asphalt Mixing Plant		○			
Asphalt Finisher	2.5-5.0m	○			
Lane Marker	2.0lit/min	○			
Trailer Truck	20t	○	○		
Truck Crane	25t	○			
Vibro Hammer	60kw	○			
Pile Drilling Machine	1.2m			○	Lease from India is difficult.

2.2.4.7 Operational Guidance Plan

Construction materials and equipment that are procured from Japan, will ship, reach Kolkata Port and transport by land. The distance from Kolkata to the construction site via Pthalaiya (Nepal) is about 750km. The good condition of the road enables the equipment to be transported within 3 days.

Construction materials and equipment that are procured from India will also be transported by land. The distance from Pthalaiya (near the border with India) to the construction site is about 230km. The good condition of the road enables the equipment to be transported within 1 day.



Source : All Indian Map by Indian Tourist Authority

Figure 2-25 Route map of transportation

2.2.4.8 Soft Component (Technical Assistance) Plan

Traffic signal systems with LED type traffic signal lights will be equipped at three intersections: Jadibuti, Thimi and Sallaghari.

The traffic signal systems will be similar to the Japanese ones that were developed and put into practice in Kathmandu city, introduced with Japan's Grant Aid (The Project of Improvement of Kathmandu Intersections) during 2001 to 2003. The equipment supply and operation of these systems will be transferred to a Nepalese construction maker.

2.2.4.9 Implementation Schedule

The construction of the Project will require 30 months considering the inefficiency of construction work in the monsoon seasons. Three budgetary years of the Japanese Government could be applied to the construction work of the Project in accordance with the Japan Grant Aid Guideline.

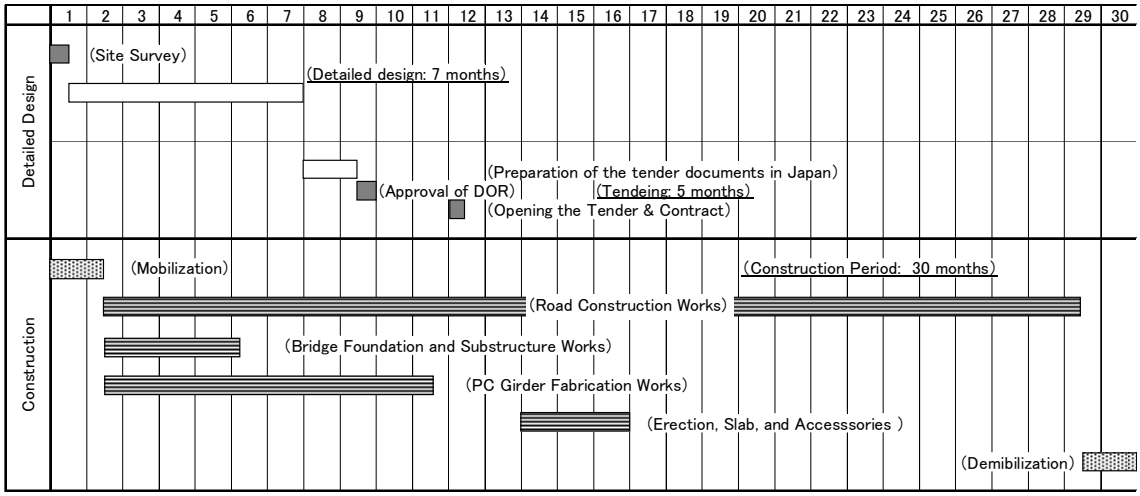
Soon after signing the Exchange of Notes (E/N) between the Government of Nepal and the Government of Japan regarding the detailed design of the Project, the consultant would carry out the detailed engineering design and preparation of the tender documents for construction works under Japan's Grant Aid Scheme. The consulting services of the detailed design would be completed in 7 months: Firstly two-week review surveys on the topography and alignment produced in the basic design will be conducted in Nepal. After that the detailed engineering design, preparation of drawings and preparation of the tender documents will be carried out as desk work in Japan.

Almost at the end of the consulting services for detailed design, another E/N will be signed between the two governments for the construction work and the consulting services for construction supervision. At the outset, the consultant would have to assist DOR for about 5 months in the tender process for construction work, viz. pre-qualification, tender opening and evaluation, and subsequent negotiation to conclude the contract between DOR and the successful tenderer. After signing the above contract, the signed contract will be verified by the Government of Japan.

After receiving the verification of the contract, the consultant is to issue a notice to proceed and then the construction work will begin. As discussed already, the construction will continue for 30 months till the completion of the Project.

The overall timetable mentioned above is shown in Table 2-24.

Table 2-24 Tentative Implementation Schedule



2.3 Obligations of Recipient Country

2.3.1 Common Items of Japan's Aid Scheme

For smooth implementation of the Project, the Government of the recipient country shall fulfill the following undertakings:

- To provide the necessary data and information for implementation of the Project;
- To secure the land necessary for the sites of the Project (for the road, construction yard and storage of materials and equipment);
- To clear, level and reclaim the land prior to commencement of the Project;
- To open a bank account in the name of the Government in a bank in Japan (B/A) and issue the authorization to pay (A/P);
- To ensure all expenses and prompt execution for unloading and customs clearance;
- To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified contracts;
- To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work;
- To accord Japanese nationals the permission and other competence, if required, for the implementation of the Project;
- To ensure proper maintenance, management and preservation of the facilities provided by Japan's Grant Aid;
- To bear all expenses, other than those to be born by the Grant Aid, necessary for the construction of the facilities as well as for the transportation and installation of the equipment.

2.3.2 Special Items of the Project

(1) Before Construction

- To complete the site clearance following compensation to the private houses in the ROW by the end of November, 2007,
- To relocate religious facilities, water fountains and monuments in the ROW by the end of November, 2007,
- To confirm the return of the ROW occupied by the airport authority by the end of November, 2007, and
- To relocate the public utilities on the surface/overhead and underground in the road by the end of March, 2008.

(2) During Construction

- To announce the detour road and traffic diversion in the construction period to the public through mass media,
- To be responsible for traffic control and facility maintenance of the temporary diversion road by the concerned entities,
- The temporary diversion road will be handed over to the Nepalese side soon after the bituminous coat is finished, and then the Valley Traffic Police would have to be responsible for traffic control on the temporary diversion road.
- To assure the drainage outlet from the major cross drains to the Hanumante river; CD3(Km2+400) and CD4 (Km2+950) at Kausalthar, CD8 (Km4+360) near TB hospital, CD11（Km5+575）at Thimi east, CD14 (Km5+975) on the west bank of the Hanumante river and CD16 (Km7+020) at Sallaghari, and
- To conduct environmental monitoring by DOR.

(3) After Provisional Handover

- To plant trees and flowers in the median strip,
- To conduct traffic safety awareness training for bus users and drivers with the Valley Traffic Police and DOR.

- To develop the service roads and walkways.

2.4 Project Operation Plan

2.4.1 Necessary Items before Construction of the Project

DOR, the executing agency of the Government of Nepal for the Project, has already acquired ROW. It was agreed that the Nepalese side should clear the private houses in the ROW and relocate the religious facilities, water fountains and monuments in the ROW as well as the public utilities.

(1) Relocation of Private Houses within ROW

The IEE report by DOR indicates that 18 houses exist within the ROW. DOR should complete the payment for compensation of these houses and clear the site totally or partially by the end of November 2007.

(2) Relocation of Religious Facilities, Water Fountains and Monuments

There are 3 religious facilities (temples, shrines), water fountains and monuments in the ROW. These should be relocated outside the ROW by the end of November 2007.

(3) Relocation of Surface and Overhead Public Utilities

It has been agreed that the Nepalese side would have to relocate trolley bus and electricity poles along with trolley bus cables/wires, electricity cables and telephone cables by March 2008.

(4) Relocation of Underground Public Utilities

It has been agreed that the Nepalese side would have to relocate the underground public utilities, which consist of water and sewage pipes and telephone cables, by March 2008.

2.4.2 Obligations of Nepalese Side During and Soon After Provisional Handover

The construction of the Road will begin at Tinkune Intersection in Kathmandu Municipality, proceeding toward Suryabinayak Intersection in Bhaktapur Municipality, and be scheduled to complete within 30 months. The road segment to be completed each year will be provisionally handed over to DOR.

Old Thimi road, which is only a one-lane road, is regarded as the possible detour road during construction of the Project. In addition to the detour road, temporary diversion roads will be provided at both ends of the ROW. According to the traffic counting surveys in December 2006, traffic volumes are over 50,000 vehicles/day in the highest segment between Tinkune and Koteshwore intersections and over 15,000 vehicles/day in the lowest segment between Sallaghari and Suryabinayak intersections. The traffic management for a detour road and temporary diversion roads, which will be handed over to DOR soon after the bituminous surface treatment is completed, will be very important for public use.

From the above and previous discussions, the Nepalese side would have to be responsible for traffic management for temporary roads during the construction period as well as planting of trees and flowers in the median strip, traffic safety awareness training to public bus users and drivers, and development of service roads and walkways soon after the provisional handover to DOR.

(1) Traffic Control of Public Vehicles during Construction

During construction of the Project, public vehicles should be diversified to the following two roads:

- Detour to Old Thimi Road, which still has a one-lane road section near Bhaktapur.
- Divert to temporary roads, which will be constructed under Japan's grant aid scheme as one-lane roads for each direction along the ROW edges.

(2) Planting of Trees and Flowers in Median Strip

Since the tourism industry is pre-dominant in Nepal, the planting of trees and flowers in the median strip of the Road, which connects two cities of the world cultural heritage, is extremely important work.

Figure 2-26 Example of Planting in Median Strip

In order to carry out the planting work safely and effectively, it should be completed before the road segment is open to public traffic. The road segments as shown in Figure 2-27 will be handed over to DOR provisionally in the following order:

- Provisional handover of Tinkune Intersection～Jadibuti Intersection: by March 2009
- Provisional handover of Jadibuti Intersection～before Hanumante Bridge: by March 2010 (excluding Manohara and Hanumante bridges)
- Provisional handover of Hanumante Bridge～Suryabinayak Intersection: February 2011 (including Manohara and Hanumante bridges)

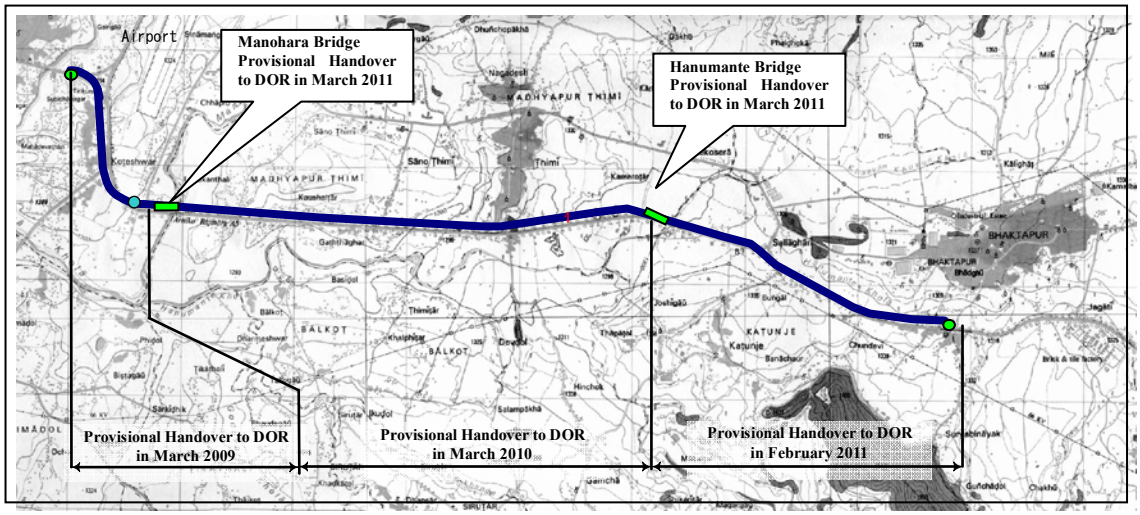


Figure 2-27 Indicative Schedule of Provisional Handover to DOR

(3) Traffic Safety Awareness Training at Bus-stops

Soon after the provisional handover of the respective segments to DOR, DOR should conduct traffic safety awareness training for the bus drivers and passengers in collaboration with the Valley Traffic Police. It is desirable to conduct such training sessions at least twice per segment.

(4) Development of Service Roads and Walkways

As the number of junctions with access roads is minimized from a traffic engineering view-point, development of access roads along with walkways should be completed in the quickest possible manner so as to enable better accessibility to/from the concerned areas. Design standards for the service roads might be different from those of the Road. Probably a cost effective pavement method like DBST would be desirable for the service roads just to prevent dust.

(5) Outlets from Major Cross Drains

The Nepalese side would have to assure the function of the existing outlets from the major cross drains to the Hanumante river: CD3 at Lokanthali, CD4 at Kaushaltar, CD8 Thimi West (near TB hospital), CD11 at Thimi East, CD14 at Bhimsen and CD6 at Chundevi.

(6) Environmental Monitoring

According to the IEE report, DOR will have to conduct environmental monitoring throughout the construction period. The DOR project office may cover this task since highway construction projects generally include such items as indicated in an IEE Report.

i) Contents of investigation

Negative environmental and social impacts and their mitigation measures that the IEE report identified are shown in Table 2-25.

Table 2-25 Environmental and Social Impacts and their Mitigation Measures

No.	Environmental and Social Impacts	Mitigation Measures
1	Air, water, noise and vibration	Periodical water spraying. Undertake construction activities in daytime. Locate bitumen plant and fuel filling stations away from water sources and settlement areas. Educate contractor for maintenance of construction machines. Plant trees in green belt area within ROW, etc.
2	Soil erosion	Slope stabilization work (including tree planting).
3	Use of quarries and stockpiling of materials	Proper operation of quarries, reclaiming the quarries and stockpiling yards after use. Avoiding leakage and stockpiling of hazardous materials near settlements, etc.
4	Drainage and cross drainage work	Provide sufficient cross drainage structures and check dams. Protection of natural gullies with vegetation structures.
5	Establishment of labor camps and workforce	Contractor to use standard occupational health and safety standards.
6	Acquisition of private land and houses	Provide appropriate compensation to affected people.
7	Relocation of temples and shrines	Consultation with local people on how and where the relocation can be done.
8	Relocation of public water stands	Provide alternative public water stands and washing spaces through consultation with local people.
9	Relocate of power lines	Consultation with participants with well-planned relocation.
10	Use of outside workforce	Ensure maximum use of local workforce and give priority to local unskilled labor resouce. Contractor only allowed to use outside workforce if required skills are not available locally.
11	Ribbon resettlement and urbanization along the Road	Regulate settlement along road and compliance to ROW. Regulate management of solid waste disposal and wastewater disposal, and incorporate proper traffic safety standards.
12	Economic activities	Provide alternative business opportunities for economic activities.
13	Health, sanitation and social service facilities	Use signs to warn traffic of school and hospital areas. Provide additional drinking water facilities for the labor force.

ii) Monitoring plan

Referring to the National EIA Guidelines (1993), the JICA Study Team prepared the draft of "The Environmental Monitoring Plan" for the Project. It consists of a "Compliance Monitoring

Plan" which mainly focuses on the environmental impacts during the construction phase, and an "Ambient Monitoring Plan" which focuses on the impacts of air, noise and vibration during construction activities.

The "Compliance Monitoring Plan" and the "Ambient Monitoring Plan" are shown in Table 2-26 and 2-27 respectively.

Table 2-26 Compliance Monitoring Plan

No.	Monitoring Parameters	Location	Frequency	Responsi-bility
	Bio-physical Environment			
	<Air, water, noise and vibration>			
1	Water spraying during sub-grade preparation and gravelling	Project site	Once a week	DOR (PMO)
2	Undertake construction activities in daytime	Project site	Once a month	DOR (GEU)
3	Avoid heavy vibrating compaction near settlement	Project site	Once a month	DOR (GEU)
4	Locate bitumen plant and fuel filling station away from water source and settlement areas	Project site	1 in 3 month	DOR (GEU)
5	Enforce regulations to allow only vehicles meeting emission standards and restrict speeds	Project site	1 in 6 month	MOPPW
	<Slope Stability/Landscape>			
6	Slope protection measures	Cutting & embankment slope	1 in 3 month	DOR (EU)
	<Use of Quarries and Stockpiling of Materials>			
7	Proper operation of quarries	Quarry site	Twice a year	MOPPW
8	Reclaiming the quarries and stockpiling yards after use	Quarry site	1 in 6 month	MOPPW
9	Avoid leakage and dispose of hazardous materials	Disposal site	1 in 3 month	DOR (GEU)
10	Avoid stockpiling of hazardous materials near settlement	Project site	1 in 3 month	DOR (GEU)
	<Drainage and Cross Drainage Work>			
11	Provide sufficient cross drainage structures, check dams	Project site	During design period	DOR (PMO)
12	Protection of natural gullies with vegetation structures	Project site	During design period	DOR (PMO)
	Socio-Cultural Environment			
	<Establishment of Labor Camps and Workforce>			
13	Proper occupational health and safety standards	Labor Camps	Once a year	MOPPW
14	Safe disposal of wastes and alternative fuel for cooking	Labor Camps	1 in 3 month	DOR (GEU)
15	Use of local manpower as far as possible	Project site	1 in 3 month	DOR (GEU)
	<Acquisition of Private Land and Houses>			
16	Provide reasonable compensation to affected people	Project site	Before construction	DOR (PMO)
	<Acquisition of Temples and Shrines>			
17	Consultation with local people on how and where the relocation can be done	Project site	Before construction	DOR (PMO)
	<Relocation of Public Water stands>			
18	Provide alternative public water stands and washing spaces in consultation with local people	Project site	Before construction	DOR (PMO)
	<Use of Outside Workforce>			
19	Ensure maximum use of local workforce	Project site	1 in 3 month	DOR (GEU)
	<Ribbon Resettlement and Urbanization along Road>			
20	Encourage planned settlement and provide access to it	Project site	Once a year	MOPPW
21	Discourage settlement along the road	Project site	Once a year	MOPPW
22	Regulate settlement along road and compliance to ROW	Project site	Once a year	MOPPW
23	Regulate management of solid waste disposal	Project site	Once a year	MOPPW
24	Regulate wastewater disposal	Project site	Once a year	MOPPW
25	Incorporate proper traffic safety standards	Project site	Once a year	MOPPW
	<Economic Activities>			
26	Provide alternative opportunities for economic activities	Project site	Once a year	MOPPW
	<Health, Sanitation and Social Service Facilities>			
27	Discourage concentration of people	Project site	Once a year	MOPPW
28	Use signs to warn traffic of school and hospital areas	Project site	Once a year	MOPPW
29	Provide additional drinking water facilities for labor force	Project site	Once a year	MOPPW

Table 2-27 Ambient Monitoring Plan

	Monitoring Parameters	Frequency	Place
Air Pollution	TSP (Total Suspended Particulate), PM10, SO_2, NO_2, CO, lead and benzene	Twice a year	Nepal Tuberculosis Hospital
Noise	Sound level equivalent (Leq 24hr) and Ldn	Twice a year	Nepal Tuberculosis Hospital
Vibration	Particle peak velocity and frequency	Twice a year	Nepal Tuberculosis Hospital

2.4.3 Annual Operation and Maintenance

The Operation and Maintenance (OM) program requires every year, at least, provision to clean the surface of road facilities and to operate/maintain the road lighting and signals.

(1) Cleaning of Road Facilities

1) Cleaning of Surface

Cleaning of the road surface is one of the significant items in the OM program, and from these activities some defects of facilities are often identified. Two different cleaning ranges are shown in Figure 2-28.

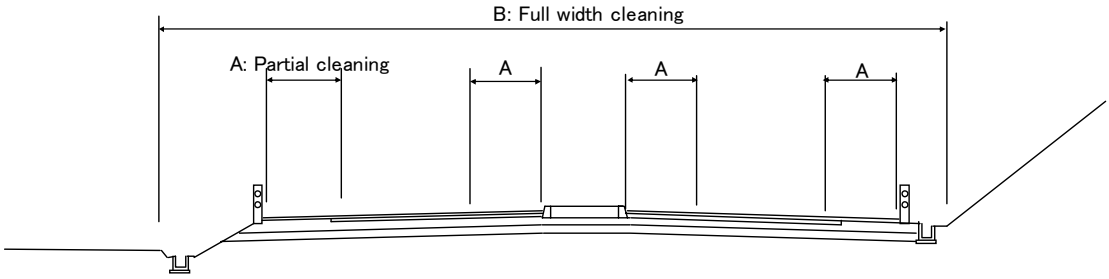


Figure 2-28 Road Surface Cleaning

The range "A" shows the partial cleaning of the road surface, limited to the passing lane and shoulder. The partial cleaning A should be carried out at least once a week by using a water sprinkler truck.

The range "B" shows the full width cleaning of the road surface, slope and side ditch. The full width cleaning B should be carried out at least once a month by manpower.

2) Cleaning of Intersections and Bus-stops

Cleaning of sidewalks and shoulders at intersections, as well as sidewalks, sheds and lay-bys of bus stops, should be carried out every 2 days by manpower and at least once a month by using a water sprinkler truck.

3) Cleaning of Cross Drains

Box culverts and pipe culverts should be cleaned at least once a year.

(2) OM for Road Lighting and Signal Systems

Electricity should be supplied to the road lighting and signal system throughout the year. Replacement of bulbs for road lighting and maintenance of signal systems are required from time to time.

(3) Maintenance of Planting in Median Strip

The Road connects two cities having world cultural heritage status. As tourism is a very important industry among others in Nepal, the planting of trees and flowers should be well maintained throughout the year, desirably four times replanting/trimming each year.

(4) Patching Work on Asphalt Pavement

After expiry of the defects liability period of the Project, patching work will be required for the surface course.

2.4.4 Periodic Operation and Maintenance

(1) Pavement Overlay

Although the pavement design is targeted at a 10-year life in the Project, overlay of surface course seems applicable after 10 years from completion of the Project as a result of experience with past similar road projects.

(2) Bridge Maintenance

- Painting of railing: every 10 years,
- Repair of gabions for bank protection and check dam: every 10 years.

(3) Bus-stop Maintenance

- Repair of interlocking tiles: every 10 years,
- Painting of poles supporting the roof of sheds: every 5 years.

(4) Maintenance of Traffic Safety Facilities

- Painting of lane marking: every 3 years,
- Painting of traffic barrier (guardrail/guard posts): every 5 years,
- Cleaning and replacement of traffic sign boards: every 5 years,
- Painting of poles supporting the road lighting and signals: every 10 years.

2.5 Project Cost Estimate

Costs to be borne by the Nepalese side are discussed in this sub-section.

2.5.1 Cost of Obligations of Nepalese Side

The Nepalese side would have to be responsible for acquisition and compensation of private houses, relocation of monuments/temples/water fountains, relocation of public utilities, traffic management for detour and temporary roads, planting in the median strip, traffic safety awareness training, development of service roads and walkways, outlets from cross drainage to the river, and environmental monitoring before construction as well as during and soon after the Project.

The above requires an indicative amount of NRs 210,862,000 over 7 years from 2007 to December 2014, at an annual average of NRs 30,123,000. Out of the indicative amount, the work for relocation of public utilities (trolleybus & electricity poles along with trolley bus, electricity and telephone cables) requires about NRs 43,200,000, which will be borne by four other Nepalese entities (NEA, water and sewerage, trolley bus, Nepal Telecom) than DOR.

On the other hand, DOR would have to bear the costs for acquisition and compensation of private houses, relocation of monuments/temples/water fountains, traffic management for detour and temporary roads, planting in the median strip, traffic safety awareness training, development of service roads and walkways, outlets from cross drainage to the river, and environmental monitoring. The total indicative amount for such work and services by DOR is about NRs 167,662,000, which will be disbursed over 7 years. The annual average disbursement by DOR is about NRs 23,952,000, which corresponds to about 0.7% of the DOR's development budget for the fiscal year 2006/2007. As the Road is one of the top priority projects in the country, such annual disbursement would be affordable.

Table 2-28 Project Cost to be Borne by Nepalese Side

Classification	Work Item	Approximate Cost	
		'000NRs	'000 JPY (Equivalent)
1. Work before Japanese grant-aided project (From 2007 to March 2008)			
1) Acquisition & compensation of private houses	Site clearance in ROW	3,600	5,666
2) Relocation of monuments, temples, shrines, water fountains	Relocate from ROW	800	1,259
3) Relocation of surface/overhead public utilities (trolleybus & electricity poles along with trolley bus, electricity & telephone cables, etc.)	Relocate to buffer zone	40,500	63,747
4) Relocation of underground public utilities (drinking/sewerage pipes, telecom lines)	Relocate to buffer zone	2,700	4,250
2. Works during & soon after Japanese grant-aided project from April 2009 to December 2014 (just predicted)			
1) Bank charge (in connection with AP)		1,695	2,668
2) Traffic control & management for detour & temporary roads	Old Thimi road, temporary roads	--	--
3) Planting of trees & flowers in median strip	Planting trees, etc.	3,153	4,964
4) Traffic safety awareness training for bus drivers & passengers	In collaboration with traffic police	1,134	1,785
5) Development of service road	DBST or more	114,287	179,888
6) Development of walkways	Interlocking tile works	42,991	67,669
7) Outlets from major cross drainage	Secure earth ditch to appropriate outlet	N.A	N.A
8) Environmental monitoring	By DOR Project Office	N.A	N.A
Total of 1 & 2 of the above (Annual Average for 7 years from 2007 to 2014)		210,862 (30,123)	331,897 (47,413)

Notes: - Exchange rate NRs 1.0 = JPY 1.574, US 1.0 = JPY 117.55

2.5.2 Operation and Maintenance Cost

Normal OM (operation and maintenance), viz. cleaning of road facility surfaces, OM for road lights and signals, would be about NRs 8,154,000 per annum. Pavement overlay would be required every 10 years. Painting of lane markings would be required every 3 years. Total indicative cost for both normal OM and periodic maintenance/rehabilitation would be about NRs 213,748,000 for 20 years. Annual average of this work would be about NRs 18,841,000, which corresponds to 0.5% of the DOR's maintenance budget for the fiscal year 2006/2007. Such annual disbursement would be affordable by DOR.

Table 2-29 Cost Estimation of Operation and Maintenance

Classification	Frequency	Component	Work Item	Approximate Cost '000 NRs	Approximate Cost '000 JPY
1. Annual Operation and Maintenance					
1) Surface cleaning of road facilities					
i) Road surface, slope & side ditches					
A: By water sprinkler truck	Once a week	Road surface	Passing lane, shoulder	144	226
B: By manpower	Once a month	ROW	Clean road surface, slope, side ditch	627	986
ii) Intersections & bus-stops	Every 2 days	Road surface	Clean sidewalks, etc.	931	1,465
iii) Cross drainage	Once a year	Cross drainage	Clean box culverts & pipe culverts	8	13
2) OM for road lighting & signal systems					
i) Electricity consumption of road lighting	Annually	Road lighting	350,000kW.h/year	3,533	5,561
ii) Replacement of bulbs of road lights	Ad hoc	Road lighting	Replace 25 bulbs or more	367	578
iii) Electricity charge for signal systems	Annually	Signal	90,000 kW.h/year	876	1,379
iv) Repair of signal systems	Ad hoc	Signal	Maintain signal system	760	1,197
3) Maintenance of planting in median strip	4 times/year	Median	Planting & trimming	158	248
4) Patching of pavement	Ad hoc	AC pavement	750 m^2/year or more	749	1,179
2. Periodic Operation and Maintenance					
1) Overlay of asphalt concrete pavement	Every 10 yrs	AC Pavement	150,000 m^2 or more	149,793	235,776
2) Bridge maintenance					
i) Painting of railing	Every 10 yrs	Bridges	Paint area 150 m^2	174	273
ii) Repair of gabions for bank protection & check dam	Every 10 yrs	Gabions	Repair of gabions	434	683
3) Maintenance of bus-stops & intersections					
i) Repair of interlocking tiles	Every 5 yrs	Bus-stops, etc	Replace interlocking tiles	469	739
ii) Painting of poles supporting roof	Every 5 yrs	Bus-stop	Painting about 180m^2	215	338
4) Maintenance of traffic safety facilities					
i) Painting of lane marking	Every 3 yrs	Road surface	Straight line 36,000 m broken line 27,000 m	5,080	7,996
ii) Painting of traffic barriers	Every 3 yrs	Guardrail, etc.	Paint area 8,000m^2	9,646	15,183
iii) Cleaning & replacement of sign boards	Every 5 yrs	Traffic sign bd	Traffic sign board	482	758
iv) Painting of poles for road lights & signals	Every 10 yrs	Poles	Paint area 360m^2	432	680
Total of 3 & 4 of the above, OM cost for 20 years (Annual average of 20 years from April 2011 to March 2031)				376,819 (18,841)	593,113 (29,656)

2.6 Other Relevant Issues

Because the Project site is in the urban area or a developing area, it is important to implement the Project considering environmental impact of operations. Unique environmental operations of the Project are: to work at night from Tinkune to Jaributi intersections as there is no detour route and no space for temporary roads, to take measures against dust from temporary roads, and to transport disposal soil from the construction site to the limited area in "Manohara Land Pooling Project" allowed by DOR. These operations must be mentioned in the CONTRACT.

Earlier traffic opening must be important from the social and environmental points of view, for the Road has a lot of traffic and servicing a temporary road for a long term is not good for safety. Therefore, the Road should be handed over earlier from contractor to DOR after the binder work on the pavement is completed.

Many facilities will be constructed by the Project, so it is also important to develop maintenance manuals for these facilities. They will be developed by the Consultant and be approved by DOR just before the construction work ends.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATION

3.1 PROJECT EFFECTS

According to the results of the socio-economic, traffic and field surveys and the basic design under the Study, the project implementation would generate the following impacts and effects:

(1) Direct Impacts and Effects

Present Status and Issues	Countermeasures taken by the Project	Direct Impacts and Effects
The Kathmandu-Bhaktapur Road (the Road) has the highest traffic volumes, over 50,000 vehicles/day at the busiest place in Kathmandu City and over 15,000 vehicles/day even in the lowest traffic volumes in Bhakthapur City. The Road is the only road connecting Kathmandu and Bhaktapur cities, and the present condition requiring long travel/driving time due to severe traffic congestion has had a bad influence on the socio-economic activities, not only of Kathmandu Valley, but also of the whole country of Nepal since the Road links with China as a part of the Asian Highway.	To improve the Road by widening the existing 2-lane road to a 2-lane dual carriageway (4 lanes) with a median strip.	Improvement of the lifeline road between Kathmandu and Bhaktapur by enlarging the traffic capacity and upgrading the driving condition related to the road surface is to realize a smooth traffic flow and save transportation costs.
Two bridges exist on the Road, Manohara and Hanumante, which worsen the traffic flows since the traffic capacities of the existing 2-lane bridges have been already saturated and moreover the insufficient sidewalk width compels pedestrians to walk along the carriageway as well as on the sidewalks.	To obtain 4-lane bridges by building new 2-lane bridges along with sidewalks in addition to further use of existing 2-lane bridges.	The traffic capacity of Manohara and Hanumane bridges will be enlarged by building new bridges in addition to further use of existing bridges. Pedestrians will be able to walk safely on the sidewalks of new bridges and invasion of pedestrians onto carriageways can be eliminated.
Lane marking, pedestrian crossings and other traffic safety facilities have not been provided at the existing five intersections including Jadibuti Intersection. This inadequacy of traffic safety facilities increases the traffic congestion in view of the mixed traffic conditions of slow moving motorized tricycles, heavy vehicles and passenger cars.	To improve 5 intersections at Jadibuti, Gathagahar, Thimi, Sallaghari and Suryabinayak.	As vehicles can make easy right/left turns and pedestrians can safely move across the road on the pedestrian crossings, reduction of traffic accidents is expected.
Despite there being bus stops, which have not been properly accommodated in the road design, they are rarely used by passengers as most of the buses stay within the intersections for embarkation/disembarkation of passengers. Such indiscriminant movement of bus passengers worsens the traffic flows in the intersections.	To provide 14 locations of bus stops along with lay-bys which are accommodated a sufficient distance from the respective intersections.	As the provision of bus stops can facilitate higher services of public transportation as well as reduce indiscriminant crossing of bus passengers at intersections, the traffic flow of the Road will become smoother.

(2) Indirect Impacts and Effects

i) The commerce, fabrication and housing industries along the road will be developed as a result of the Project. New business opportunities will be activated by the investment effects accompanying promotion of urbanized land use.

ii) Although public buses are generally used by local people in the Kathmandu valley, augmentation of traffic capacity and improvement of bus stops by the Project will facilitate improved services of public transportation. As many residents inside and outside the Katmandu valley use the public bus, the social impact will be very significant over a wide area.

iii) By enlarging the traffic capacity of the Road, the traveling time to Kathmandu by way of Arniko Highway from other roads, including Sindhuli Road, will reduce.

3.2 RECOMMENDATIONS

It is a precondition before the implementation of the Project that surface and overhead public utilities, viz. trolley bus poles along with associated wires as well as electric and telephone overhead wires, and underground utilities, viz. water pipes, sewer pipes and telecom cables, should be relocated to outside the ROW by the Nepalese side. DOR has already taken action with the concerned entities for the relocation of utilities. Follow-up activities by MOPPW and DOR for this purpose are indispensable.

As a result of reclaiming lowlands with housing construction in recent years, there is a road segment where the side ditches have been destroyed and inundation took place at flood time. The Project includes raising of the road surface to the appropriate level and installation of cross drainage to avoid such inundation risks. In such places, the Nepalese side should ensure that the drain outlets from the cross drainage are constructed under Japan's Grant Aid.

The abovementioned effects of the Project largely rely on the application of safe traffic practices by the users of the Road, especially bus passengers at bus stops. Special emphasis should be placed on the preparation of a program by DOR, Kathmandu Valley Traffic Police and the three municipalities regarding training and a traffic safety awareness campaign for the public. Participation of a JICA expert for this purpose is recommended, if possible, as with the previous project in Kathmandu.

The Nepalese side intends to develop the service roads along the Road soon after the completion of the Project for the purpose of the loading/unloading for truck cargos and embarkation/disembarkation for bus passengers as well as the community usage. Proper application of land-use and future development programs should be taken into account to develop the roads. Proper execution of design and construction of the service roads is desired through initiatives of DOR.

The Project includes various facilities, and accordingly the operation and maintenance of the Road covers a wide range of work. It is recommended that appropriate operation and maintenance work is carried out, in all the items listed in Chapter 2.