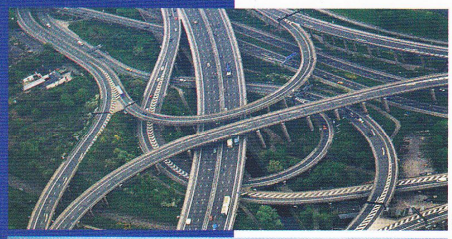
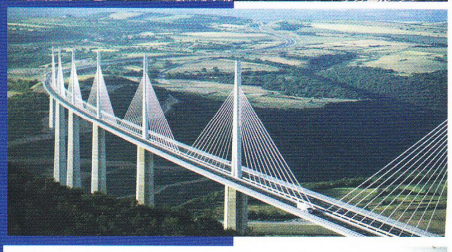
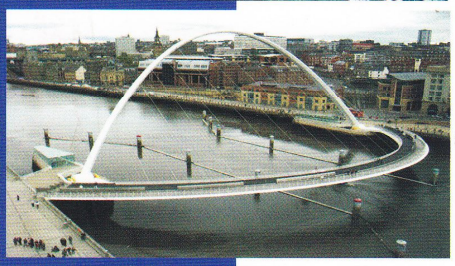


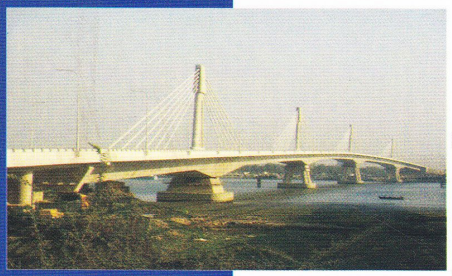




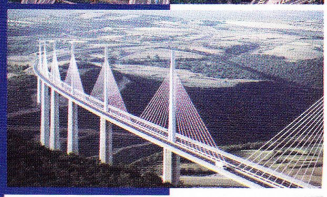
THE PEOPLE'S REPUBLIC OF BANGLADESH
ROADS AND HIGHWAYS DEPARTMENT

Road Master Plan

[Volume I: Main Text]

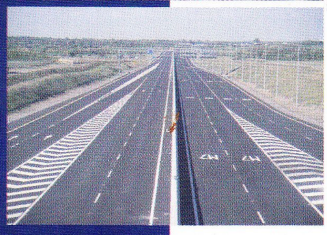


a vision ahead



Road Master Plan

[Volume I: Main Text]



a vision ahead

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
যোগাযোগ মন্ত্রণালয়
সড়ক ও রেলপথ বিভাগ
উন্নয়ন-১ শাখা

নং উন্নয়ন-১/আরএনআইএমপি(২)-১/২০০৪-২৭৮ তারিখঃ ০২ জুন, ২০০৯।

বিষয়ঃ 'Road Master Plan' অনুমোদন সংক্রান্ত।

সূত্রঃ ১। প্রকল্প পরিচালক, আরএনআইএমপি-২ এর স্মারক নং-২১০/২৪৭, তারিখ ঃ ১৫.০২.০৮।
২। প্রধান প্রকৌশলী (সওজ) এর স্মারক নং-সড়ক ২১৫/০২-১৬২-প্রঃ প্রঃ, তারিখ ঃ ১৯/০৩/০৯।

উপর্যুক্ত বিষয়ে সূত্রোস্থ পত্রদ্বয়ের প্রেক্ষিতে নির্দেশক্রমে জানানো যাচ্ছে যে, National Land Transport Policy (NLTP)-তে বর্ণিত নির্দেশনা অনুযায়ী আরএনআইএমপি-২ এর আওতায় পরামর্শক নিয়োগের মাধ্যমে প্রণীত চূড়ান্ত Road Master Plan টি মন্ত্রণালয় কর্তৃক অনুমোদিত হয়েছে।

০২। এ বিষয়ে পরবর্তী প্রয়োজনীয় ব্যবস্থা গ্রহণের জন্য নির্দেশক্রমে অনুরোধ করা হলো।

(সেলিম আবেদ)
সিনিয়র সহকারী সচিব
ফোনঃ ৭১৬৮৭২৩
ই-মেইলঃ sasdev1@moc.gov.bd

প্রধান প্রকৌশলী
সড়ক ও জনপথ অধিদপ্তর
সড়ক ভবন, রমনা, ঢাকা।

অনুলিপিঃ

১। সদস্য, ভৌত অবকাঠামো বিভাগ, পরিকল্পনা কমিশন, শেরেবাংলা নগর, ঢাকা।
২। প্রকল্প পরিচালক, আরএনআইএমপি-২, সড়ক ও জনপথ অধিদপ্তর, সড়ক ভবন, রমনা, ঢাকা
৩। মাননীয় মন্ত্রীর একান্ত সচিব, যোগাযোগ মন্ত্রণালয়, ঢাকা।
৪। সচিব মহোদয়ের একান্ত সচিব, সড়ক ও রেলপথ বিভাগ, ঢাকা।

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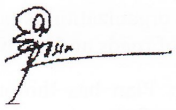
Foreword

I am pleased to learn that the Roads and Highways Department (RHD) has finalized the Road Master Plan which is expected to guide the development and maintenance of RHD's road network over the next 20 years. In fact it could be treated as one of the important milestones in the implementation of the National Land Transport Policy (NLTP).

I understand that the preparation of the Master Plan involved nine months of extensive work by a group of international and local experts, and that there was a detailed consultation process undertaken with all relevant stakeholders, whose views were duly taken into account. The road sector policy developed to further elaborate some of the major elements of NLTP was an important step forward.

The identification of major problems faced by RHD as contained in the Master Plan, and ways and means of addressing them, I hope will go a long way in resolving some of their inherent problems.

Finally, the Road Master Plan, I hope, will be useful to the policy makers, planners, highway engineers, researchers, professionals, administrators and development partners in formulating their strategies, programmes and in taking major decisions for the overall development of the country, and in particular for the development and management of the roads and highways network.



Dhaka
March, 2009

Syed Abul Hossain, MP
Hon'ble Minister
Ministry of Communication

Preface

The Road Master Plan has been developed in response to a long felt need for a systematic and planned development of the highway network which carries nearly 70% of all road based traffic in the country. The policy support for the Plan came from the National Land Transport Policy (NLTP) which was approved by the Cabinet in April 2004, where the need to develop a long-term (20 year) Road Master Plan was emphasized. It is in pursuance of NLTP that a Road Master Plan has been prepared by the Roads and Highways Department (RHD) under the guidance of the Ministry of Communications (MOC).

The Road Master Plan will serve as a guiding document for road sector investment priority programme. It provides a physical plan for new road construction, rehabilitation and maintenance over the next 20 years. During the preparation of the draft plan, several consultations were held with all stakeholders and their views were duly taken into account. A detailed road sector policy was also developed to elaborate on some of the key elements of NLTP. The road sector policy, together with some indication as to how the various elements of the policy could be implemented has been incorporated in the Road Master Plan after its approval by the Ministry of Communications.

In preparing the Road Master Plan, one of the first tasks was to assess the present state of the RHD road network and the problems being faced in their effective development and maintenance. It was observed that large sections of the network have inadequate structural strength, there is wide scale deterioration of the network due to lack of proper maintenance, many of the damaged and narrow Bridges and Culverts need immediate replacement, road pavements continue to get severely damaged by vehicle overloading, lack of adequate road safety has already reached an alarming level, faster and smooth movement along the highways is not possible due to the presence of large number of hats and bazaars right on the edge of the roads.

Traffic growth is also expected to be quite high, at nearly 4 times over the next twenty years, giving rise to the need for mobilization of sizeable resources. Assistance will be required to reform the institutional set-up of RHD to make it more efficient so that it can fully spend the resources allocated to it. RHD as an organization is not fully geared as yet to involve private sector in the development and maintenance of roads and highways.

The Road Master Plan has thoroughly analyzed the above mentioned problems and issues, and recommended specific measures involving short and long term investment programmes for a period of twenty years. The recommendations include concrete actions and affordable solutions to adequately address each of the problem areas indicated above.

Dhaka
March, 2009

Munshi Mustafizur Rahman
Chief Engineer
Roads and Highways Department

Table of Contents

LIST OF MAPS AND DIAGRAMS

Abbreviations

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ACE	Additional Chief Engineer
ADB	Asian Development Bank
ADP	Annual Development Programme
ADT	Annual Daily Traffic
AH	Asian Highway
AIT	Advance Income Tax
ALTID	Asian Land Transport Infrastructure Development
ARB	Annual Rehabilitation Budget
ARC	Accident Research Centre
ATVAT	Advance Trade VAT
BBD	Benkelman Beam Deflection
BCR	Benefit to Cost Ratio
BCS	Bridge Condition Survey
BDR	Bangladesh Rifles
BIDS	Bangladesh Institute for Development Studies
BMMS	Bridge Maintenance Management System
BOT	Build Operate Transfer
BPC	Bangladesh Petroleum Corporation
BR	Bangladesh Railway
BRP	Bridge Replacement Project
BRTA	Bangladesh Road Transport Authority
BTM	Bangladesh Traffic Model
BUET	Bangladesh University of Engineering and Technology
CBR	California Bearing Ratio
CD	Customs Duty
CIDC	Consolidation of the Institutional Development Component
CIF	Cost Insurance Freight
CMS	Central Monitoring System
COBA	Cost Benefit Analysis
CSA	Cumulative Standard Axles
CW	Carriageway
DFID	Department for International Development
DMRB	Design Manual for Roads and Bridges
EIRR	Economic Internal Rate of Return
ESAL	Equivalent Standard Axle load
GDP	Gross Domestic Product
GIS	Geographical Information System
GOB	Government of Bangladesh
HDM	Highway Development and Management System
HFL	Highest Flood Level
IDAP	Institutional Development Action Plan
IDSC	Infrastructure Development Surcharge
ILO	International Labour Organisation
IRC	Indian Road Congress
IRI	International Roughness Index
JBIC	Japan Bank for International Cooperation
JDCF	Japan Debt Cancellation Fund
JMBA	Jamuna Multi-purpose Bridge Authority

LGED	Local Government Engineering Department
LOS	Level of Service
LPF	Landing Permit Fee
LRP	Location Reference Point
MAV	Multi Axle Vehicle
MoC	Ministry of Communications
MoF	Ministry of Finance
MT	Motorised Transport
MV	Motorised Vehicle
NGO	Non-Government Organisation
NHAI	National Highway Authority of India
NLTP	National Land Transport Policy
NMT	Non Motorised Transport
NMV	Non Motorised Vehicle
NPV	Net Present Value
NRSC	National Road Safety Council
ORA	Operational Risk Assessment
PAF	Project Appraisal Framework
PCU	Passenger Car Unit
PI	Plasticity Index
PICOM	Private Infrastructure Committee
PMP	Periodic Maintenance Programme
PNHA	Pakistan National Highway Authority
PPP	Public-Private-Partnership
PRC	People's Republic of China
PSB	Portable Steel Bridge
PSI	Pre-Shipping Inspection Fee
PSIG	Private Sector Infrastructure Guidelines
RAFU	Road Agency Formation Unit
RAMS	Road Asset Management System
RHD	Roads and Highways Department
RMIP	Road Maintenance and Improvement Project
RMMS	Road Maintenance Management System
RMP	Road Masterplan
RNIMP	Road Network Improvement and Maintenance Project
ROB	Road Over Bridge
RSRP	Road Sector Reform Project
SAARC	South Asian Association for Regional Cooperation
SD	Supplementary Duty
SN	Structural Number
STFA	Sub Regional Transport Facilitation Agreement
TFR	Total Fertility Rate
TSMR	Transport Sector Management Reform
TTC	Travel Time Cost
TV	Tariff Value
TVU	Train Vehicle Unit
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
V/C	Volume/Capacity
VAT	Value Added Tax
VOC	Vehicle Operating Cost
WB	World Bank

EXECUTIVE SUMMARY

Ministry of Communications
Roads and Highways Department

Road Network Improvement and Maintenance Project – II
Road Master Plan – Executive Summary

1. Introduction

This plan has been developed in response to the direction provided by the National Land Transport Policy[1], which committed the Government to 'develop a long term (20 year) Road Master Plan[2].

The Road Master Plan for Bangladesh is intended to be the guiding document for investment in the road sector over the next twenty years. It has been compiled following a thorough diagnosis of the existing problems of the RHD road network, and the future challenges to be faced. These can be summarised as:

- Roads and bridges are continuously damaged from a lack of adequate maintenance and vehicle overloading;
- Continuing traffic growth that will exceed the capacity of many National Highways in the next 20 years;
- A mix of motorised and non-motorised traffic, and encroachment onto roads, leading to high accident rates
- The country's rural centres are not fully connected with the main road network; and
- The large number of rivers that are still crossed by ferries hampers smooth movement of traffic

The objectives of the Master Plan are to set out a comprehensive investment programme that will :

- Protect the value of RHD's road and bridge assets;
- Improve the connectivity of the road network;
- Enhance and develop the strategic road network to meet economic and traffic growth targets;
- Improve the Zila Road network to enhance connectivity to the country's growth centres;
- Improve road safety and reduce road accidents;
- Provide environmental and social protection; and
- Outline the institutional improvements required for RHD to deliver the above.

The key components of the plan, along with references to the main report, are set out overleaf.

Section

[1] Approved by Cabinet in April 2004
[2] Paragraph 5.3.1

	Reference
2. Condition of the National Highways and Regional Roads	
The surface condition of National Highways has been maintained at a reasonable level over the last three years, but the underlying strength of many of the pavements, particularly those with an IRI[3] of greater than 5 is relatively poor and deteriorating. The surface condition of Regional Roads has got worse over the last five years, and the underlying pavement strength of the majority of these roads is low. This is due to a historical lack of maintenance, leading what has been termed 'the backlog'. Unless this backlog is addressed soon, many of these roads will require costly rebuilding.	3.1
Routine maintenance is not carried out properly on these roads, and insufficient funds are allocated for this. Unless routine maintenance is treated as a priority, the value of any rebuilding and periodic maintenance interventions will be severely eroded.	3.1.10
Over the next 5 years 4,780 km of National Highways and Regional Roads that are not under maintenance and/or improvement projects[4] will require major interventions to increase pavement strength, mainly in the form of structural overlays, at a cost of Tk. 5,407 Crore. Only 138 km will not require any intervention. The economic benefits of this programme are immense, with net present values (NPV) divided by capital cost ranging from 1.1 on lightly trafficked Regional Roads, to 26 on the heavily trafficked National Highways.	8.7
The introduction of HDM has played a great part in identifying and prioritising roads for maintenance and rehabilitation. This facility needs to be sustained over the Master Plan period and beyond.	
3. Zila Roads	
Over a quarter of Zila Roads, by length, are in poor condition, with an IRI of greater than 8. The approved Road Sector Policy states that the Zila road network will be rehabilitated over the next ten years in order to achieve a minimum accessibility level on all Zila roads. The criteria for taking up Zila Roads projects are based on roads which serve the highest concentrations of poverty have been treated as priorities for rehabilitation. The priorities for Zila road improvements will be based on analysis of socio-economic indicators.	3.2
There are still 16 Upazilla headquarters not connected to District headquarters by Zila roads. There are nearly 10,000 km of paved Zila roads, and a further 3,600 km of unpaved roads. The required interventions on these roads presents a major challenge for RHD over the next twenty years, given the importance of Zila Roads in providing the connectivity that can lead to poverty reduction.	11.6.1 11.7

[3] International Roughness Index
[4] 2,684 km under RMIP, RNIMP-I, RNIMP-II, RSRP, and Periodic Maintenance Programmes.

The Master Plan recommends a recovery programme for 6,865 km of Zila Roads to connect, at a good paved standard, all Upazilla headquarters. The cost of this programme is estimated to be Tk. 3,188 Crore. The investment is prioritized according to the condition of individual roads, and the level of connectivity that they provide. 11.5.6

Some 356 km of new Zila Roads to connect the remaining Upazilla headquarters are proposed at a cost of Tk. 346 Crore, along with a programme to pave remaining Zila roads (3,603 km), at a cost of Tk. 5,781 Crore. 11.6 11.7

The impact of these programmes will be that ultimately 469 Upazilla headquarters will have paved access to the main road network, serving an additional 32 million people, of whom 18 million are currently classified as poor. 11.10.4

4. Bridges and Structures

The riverine nature of Bangladesh means that the country has to support a relatively large number of bridges and structures in order to maintain connectivity and prevent flooding. There are almost 15,000 structures on the RHD network of which a large number have major structural damage and require full or partial replacement, major elemental damage which needs to be urgently addressed before their conditions becomes worse. The priorities for bridge repair and replacement were based on the Bridge Condition Survey (BCS), and field surveys. 3.3

Major programmes of bridge replacement and repair proposed in order to maintain the integrity of the RHD road network. The priority is the replacement of 22 bridges on National Highways, followed by the replacement of 44 bridges on Regional Roads and 67 bridges on Zila roads, at a total cost of Tk. 477 Crore. In addition, 418 bridges are identified for major repairs at a cost of Taka 590 Crore. The economic case for the bridge repair programme is underlined by an EIRR estimated to be 42%. 12.6.3 12.12

Some 126 narrow bridges are identified for replacement at a cost of Taka 443 Crore. 12.7

Some 262 portable steel bridges (PSB's), of which 23 are on National Highways and 239 on Regional Highways, are identified for replacement by permanent structures at a cost of Taka 755 Crore. 12.8

Some 2,091 structures in condition category B, with a total length of 29.5 km, should be repaired to be in category A, at a cost of Taka 49 Crore. 12.9

New bridges are proposed for construction to replace ferry operations in two programmes. Priority 1 is the construction of 13 new bridges on National and Regional roads, at a cost of Taka 600 Crore. Priority 2 is the construction of 8 new bridges on Zila roads at a cost of Taka 230 Crore. Priority 3 is the construction of new bridges on remaining Zila roads, but these were not found to be economically viable during the Master Plan period. 12.10

Table E1 : Summary of proposed bridge interventions by condition

	A	B	C	D	Total
Maintain	9,279				9,279
Repair		2,091	418		2,509
Reconstruct				133	133
Replace PSB's			200	62	262
Replace Narrow Bridges			101	25	126
Repair/replace culverts			1,427	318	1,745
Repair/replace short structures			481	177	658
	9,279	2,091	2,627	715	14,712

5. Axle Load Control

Overloading of trucks and buses causes excessive damage to pavements particularly on national and regional roads. The degree of overloading is extremely high in Bangladesh, and is estimated to cost the country over Tk. 300 Crore per year in additional maintenance and rehabilitation needs. During the Master Plan study a comprehensive survey of overloading was undertaken which revealed the full extent of the problem, and highlighted the need for urgent measures to control axle weights. 3.4

Without a doubt, axle load control is urgently needed in Bangladesh. Without it, the value of most of the components of the Master Plan will be eroded to such an extent that they will have no economic benefit. The Master Plan proposes that 27 weighbridges be installed across the country, with the immediate operation of 5 weighbridges, and a further 18 to be phased in over the next two years. Later, a further 4 weighbridges will be needed to control overloading on roads connecting new landports. 9.5

Axle load control should involve a combination of punishment through the prevention of further passage, and on the spot tolls or fines related to the amount of overloading. In parallel with axle load control, fully computerised and controlled toll collection needs to be introduced. The total cost of this programme is estimated to be Tk. 320 Crore. 9.8

6. Operational Issues on National Highways

The major National Highways (N1 through N8) are the backbone of the nation's road network, but their efficiency is hampered by traffic congestion at a large number small towns, hats and bazaars. The impedance caused to through traffic at these places outweighs the benefits of the economic activities taking place there. A comprehensive survey carried out, during the preparation of the Master Plan, of all eight Highways revealed 139 places where roadside activities were hampering the operation of these highways, and where some form of low cost physical intervention would deliver benefits and improve safety. 3.5

Small and medium scale traffic management measures on the major national

highways are needed to assist the smooth flow of traffic. A set of interventions have been identified which are required today, but as conditions changes further measures will be necessary in the future. For this reason, it is important that the RHD have the capability and the resources over the longer term to identify, plan and implement traffic management measures. The projects specifically identified in the Master Plan include 15 by-passes on National Highways at an estimated cost of Tk. 291 Crore, and a further 124 interventions including junction improvement, provision of service lanes, and overbridges at a cost of Tk. 235 Crore. 10.2 10.3

Future provision for traffic management on the strategic National Highways has also been made at the same rate as for the first five years, at a cost of Taka 704 Crore. 10.4

RHD will need to ensure that it fully uses its Rights of Way, to maximize road capacity, and minimize further land acquisition.

7. Road Safety

A perennial problem on Bangladesh's roads is the lack of safety. 328 km on National Highways have been identified as having accident black spots on them. Although road accidents are recognised as a severe issue, they have not been properly addressed, particularly at the institutional level. Without active measures to improve safety there is a severe danger that many of the proposals in the Master Plan will cause vehicle speeds to rise, with the consequence of more, and more fatal, accidents on the RHD network. This problem needs to be addressed as a national priority. 3.6

The primary fault with the current approach to safety is the lack of enforcement of existing laws. This can be addressed by combination of political will and leadership at relatively low cost. Proposals for institutional change to achieve this, including the establishment under law of an autonomous National Road Safety Agency are included in the Master Plan. 13.2

An integrated pilot project on road safety is proposed on the N5 Dhaka-Aricha Highway. Following its results, it is recommended that 2% of the annual budget for roads and bridges be devoted to road safety projects, at an estimated cost of Taka 1,039 Crore over the plan period 13.3

In addition, a priority programme of level crossing replacement by grade separation at 15 locations is recommended at a cost of Tk. 150 Crore, on National and Regional Highways. 13.5.4

8. Traffic Growth

Truck traffic will grow by between 2.5 to 4 times over the next twenty years. Car traffic will grow at an even faster rate, between 4 and 7 times, depending on the state of the economy. Bus traffic will grow at a slightly lower rate, reflecting the expected improvement in railway infrastructure and services over the Master Plan period. The road network will need to respond to these challenges. Over the next twenty years, many of the major National Highways will require to be widened to accommodate this extra traffic, and this major programme of works needs careful phasing in the plan. 4.3.4

The following projects have been identified as necessary and feasible to cope with traffic growth during the Master Plan period, at a cost of Tk. 14,341 Crore 14.10

- N1 Dhaka-Chittagong 4 Lane
- N3 Dhaka-Mymensingh 4 Lane (to Mawna)
- N102 Mynamati-Brahmanbaria
- R260 Sylhet-Sunamganj
- Dhaka Eastern Bypass
- Dhaka Western Bypass
- Dhaka Outer Orbital Road
- Upgrading of R750/Z5703 Bhatiapara-Narial -Jessore
- Deep Sea Port to N1
- N1 Chakaria-Chittagong 4 lane
- N8 Dhaka – Mawa 4 lane
- N4 Dhaka – Tangail 4 lane
- N6 Baneshwar – Belephur 4 lane
- N5 Dhaka- Baniajuri 4 lane
- N2 Bhairab – Moulvibazar 4 lane
- N2 Dhaka – Bhariab 4 lane
- N2 Habiganj – Sylhet 4 lane
- N8 Jessore – Benapole 4 lane
- Chittagong By-pass
- N1 - Hatazari Link Road
- N1 2nd Meghna Bridge
- N1 2nd Meghna Gumati Bridge
- N8 Padma Bridge

The capacity increase required for the N1 Dhaka-Chittagong can be most efficiently provided by a tolled expressway along the existing alignment, with significant private sector involvement. It is recommended that a detailed feasibility of this be carried out urgently. 14.12

New connections to land ports to National Highway standard are proposed at a cost of Taka 383 Crore. 14.13

Further improvements to the network to meet Asian Highway standards are recommended at a cost of Taka 536 Crore. 14.14

Paving remaining National and Regional Highways is proposed at a cost of Taka 1,916 Crore. 14.16

9. Maintenance

15.1

One consequence of the investment in new infrastructure will be an increased requirement for road and bridge maintenance. In particular, routine maintenance needs to be introduced across the whole RHD network, on the basis of performance contracts, at a current estimated cost of Tk. 60 Crore per year, although this cost will increase slightly over time.

15.2

The full costs of periodic maintenance for roads need to be provided for and this is estimated to be Tk. 23,000 Crore over the Master Plan period, i.e. over Tk. 1,000 Core per year.

16.7

In addition, a proper programme for bridge maintenance is required, and this is estimated to cost Tk. 682 Crore over the Master Plan period.

10. Environmental and Social Issues

3.7

Road building is still not properly controlled in Bangladesh, to the extent that the social problems of land acquisition and resettlement can, and does, cause financial hardship to the poor and very poor. Land is scarce in Bangladesh. The country cannot afford uncontrolled land use if it is to attain food security. Similarly the adverse environmental impacts of roads are not fully controlled, and flooding is a common result of poorly executed road projects.

18

The Master Plan includes recommendations for RHD to firmly adopt and implement a set of social and environmental codes to ensure that the worst effects of road construction are militated against.

11. Financing the Investment Programme

5.2.2

The 2006/07 ADP contained 144 projects – far too many for RHD to implement efficiently with its limited capacity. Of these projects, 9 are vaguely titled and poorly defined 'clusters' of sub-projects with questionable priority, that are unable to be implemented transparently or professionally. The amount of unspent allocation in these projects will inevitably deny space in the ADP to more worthy Master Plan projects unless they are removed. The Master Plan has to take the starting position that the remaining commitments in the ADP can be completed in the next 4 years. This then defines the spending commitments until 2011/12

17.4.5

The total cost of the investment programme is estimated to be Taka 66,768 Crore (USD 9.6 Billion), over 20 years. The sources of fund identified for the programmes and projects are :

Recurrent expenditure (maintenance, safety, traffic management), funded by Road Fund (41%), Private Sector (14%), Development Partners (16%), and Government of Bangladesh (29%).

12. Prioritisation of the Master Plan

17.3

- Recurrent (maintenance) expenditure should have the first priority, and full needs should be planned for on an annual basis;
- The rehabilitation of National Highways, Regional Roads and Zila Roads must be considered a priority, as delay will increase the costs of recovery;
- Road and bridge projects that are related to traffic growth should be programmed according to dates that they are needed;
- Bridge replacement and repair programmes are a priority, but have to be phased in order to respect human capacity constraints in RHD; and
- Axle load control is of the utmost priority

13. Institutional Issues

19.1

RHD can deliver the proposed spending programme contained in the Road Master Plan, with enhanced authority, increased capacity, and better accountability. Continued training of officers and engineers is required, and the RHD's training centre and road research laboratory need to be sustained over the Master Plan period and beyond.

19.2

Much greater use can be made of the private sector in financing the capital costs of road development than has hitherto been the case.

19.3

In many countries, both developed and developing, a new relationship is emerging between Government and the agency responsible for developing and managing the government's road assets. New road agencies are being created with a different relationship between themselves and their respective Government Ministries. In particular, greater levels of authority are being granted, with a parallel deal of responsibility to meet targets, standards and deadlines.

1. INTRODUCTION

1.1. Background

The transport system of Bangladesh changed quite a bit over the past thirty-six years. Prior to Independence in 1971, there were no national or regional highways, but only a few roads connecting Dhaka with the rest of the country. The extensive network of natural waterways provided the alternative mode of inland water transport (IWT) which served almost the entire country, along with a railway network of around 2900 km. that linked 17 former districts out of the then 19 districts.

Transport demand in Bangladesh has grown faster than the GDP growth of the country. It grew to 72 billion passenger-kms (pkms) in 1996 and reached 110 billion pkms in 2005. Freight traffic also increased at a similar rate and reached 10 billion ton-kms in 1996 and 18.6 billion ton-kms in 2005. However, the share of different transport modes did not increase in the same proportion. The road sector carried the majority of the passenger traffic, around 73% in 1996, mainly at the expense of railway. In the freight sector, where IWT had been playing a dominant role, its share also eroded slightly from 37% in 1974 to 30% in 1996 and in 2005. In comparison, road transport increased to 63% in 1996 and 72% in 2005, again mainly at the expense of railway. The main reason behind such distortion has been the allocation of the lion share of national resources to road sector over successive 5-year plan periods. This has happened at the cost of development and maintenance in other competing modes such as railway and IWT.

The Roads and Highways Department (RHD) has developed 21,264 kms of road infrastructure by 2005. However, the sustainability of these roads is threatened due to lack adequate maintenance. Bangladesh can ill afford investing scarce resources for new transport infrastructure development and allow degeneration of existing assets for lack of maintenance. Transport infrastructure development also has social and environmental dimensions, which if not addressed on time will negate the impact on poverty.

In order to revive the lost roles of the competing modes like railway and IWT, in the recent years, both the government and the development partners have started allocating higher percentage of resources to those sectors. In the absence of any institutionalized coordination mechanism, to ensure integrated and well coordinated development of the competing modes through long-term investments, the Integrated Multimodal Transport Policy (IMTP), which is under consideration of the Cabinet/ Council of Advisors has emphasized the need for preparation of transport sub-sectoral Master Plans.

In the case of RHD road network, the National Land Transport Policy (NLTP), approved by the Cabinet in April 2004, had already emphasized the need for development of a long-term (20 year) Road Master Plan. It is in pursuance of the above mandate provided by NLTP that this Road Master Plan has been prepared, within the framework of above mentioned IMTP. This Road Master Plan is expected to guide the development and maintenance of RHD's road infrastructure over the next 20 years.

1.2. Purpose of the Report

This document reports on the results of consulting services for the Preparation of a Road Master Plan under the Road Network Improvement and Maintenance Project-II[5]. The Masterplan is

[5] Funded by the Asian Development Bank, Loan No. 2021BAN-(SF)

underpinned by a sectoral policy to enable the road sector to respond to economic and social needs coherent with the country's macro-economic environment. The road master plan is required to determine investment priorities in the road sector over the next 20 years, paying particular attention to the availability of resources over the next 5 years.

The individual study objectives were to:

- review, in conjunction with Government official counterparts, the road sector policy components of the NLTP;
- undertake a participation process so that all stakeholders' views are taken into account in the review;
- draft a detailed road sector policy for submission to the relevant political level;
- draft, in conjunction with relevant agencies, a road master plan which provides a physical plan for new road and bridge construction, rehabilitation and maintenance over the next 20 years, and sets out a spending program for the sector;
- assist, where necessary, to ensure that the Road Master Plan is approved by Government and becomes the guiding document for road sector investment;
- provide technical assistance, during the process, to staff in the RHD for policy monitoring and implementation, and means of monitoring and updating the Road Master Plan on a regular basis.

1.3. Report Contents

The report deals with an assessment of the current RHD Road network and its traffic characteristics, along with a diagnosis of existing problems (chapters 2 and 3). Chapter 4 sets out the background of growth in traffic that might be expected over the next twenty years. Chapter 5 deals will the road sector policy and the commitments that form the starting point for the masterplan, and Chapter 6 outlines the approach that has been used to develop the plan. Chapters 7 to 16 deal with each programme area of the plan in turn, and Chapter 17 consolidates these into the Road Masterplan.

1.4. Data Sources

All data sources for tables etc. are referenced. Where no reference is given, it means that the data has been generated by the consultants during this study.

2. ASSESSMENT OF CURRENT SITUATION

2.1. Physical Characteristics

The Roads and Highways Department (RHD) in Bangladesh is responsible for over 21,000 km of roads which are classified in Table 2-1. Not all the roads, particularly in the Zila category, are yet paved. As Table 2-2 shows, 9,719 km of the total Zila roads are paved, or just under 72% of the total. Map 2.1 shows the current RHD network.

Table 2-1 : Roads and Highways road network definition and lengths

Road Class	Definition	Length (km)
National Highways	Highways connedting National capital with Divisional HQ's or sea ports or land ports or Asian Highway.	3,570
Regional Highways	Highways connecting District HQ's or main river or land ports or with each other not connected by National Highways.	4,323
Zila Roads	Roads connecting Distrcit HQ's with Upazilla HQ's or connecting one Upazilla HQ to another Upazilla HQ by a single main connection wth National/Regional Highway, through shortest distance/route.	13,678
Total		**21,571**

Source : Bangladesh Gazette, 6 November 2003 and Planning Commission, 2007

RHD has developed the vast majority of the above roads since independence in 1971. During the period 1973 to 2002, over 6 Five-Year Plans, the Government of Bangladesh allocated just over 18,000 Crore Taka, or around US$ 4.5 billion, for the development of the main road network[6] through the Annual Development Programmes (ADP's).

Over the past years, the annual allocations to RHD have been broadly constant, at around 2,300 Crore Taka per year, equivalent to around $US 330 million for the year 2006/07. A significant proportion of the expenditure in the road sector was the result of assistance from Development Partners.

However, this is now declining, both absolutely and as a proportion of total expenditure. During the period 2001/02 to 2003/04, the Development Partners contributed an average of 1,140 Crore Taka per year. During the period 2004/05 to 2006/07 this had reduced to 618 Crore Taka annually.

The growth in the road network in the last 15 years is shown in Table 2-2.

[6] This figure includes allocations for the construction of the Jamuna Bridge, implemented through the Jamuna Multi-purpose Bridge Authority (JMBA), also a department of the Ministry of Communications

Table 2-2 : Growth in the RHD road network

	1991		2007	
	Paved	**Unpaved**	**Paved**	**Unpaved**
National Highway	3,002	161	3,485	85
Regional Highway	2,262	649	4,117	206
Zila Road	4,440	5,156	9,719	3,959
Total	**9,704**	**5,966**	**17,321**	**4,250**

Sources : RHD and Planning Commission

The paved road network under RHD has increased by 7,617 km over the last 15 years, an average growth of 515 km per year. Over the same period the unpaved network has decreased from 5,966km to 4,127 km. In additions, 1,200 km of new Zila Roads have been identified. The total unpaved network now stands at almost 4,250 km, and the implication of this is that these roads will need to be paved in the future.

The development of the road network has tended to exceed the financial and technical capacity of the Department to maintain it adequately.

The number of bridges in the network has also increased dramatically since 1991, as shown in Table 2-3.

Table 2-3 : Growth in number of bridges under RHD

	1991		2006	
	Number of Bridges	**Total Length (m)**	**Number of Bridges**	**Total Length (m)**
National Highways	1,012	55,393	3,617	64,837
Regional Highways	302	9,896	3,535	43,828
Zila Roads	1,843	26,383	7,560	75,933
Total	**3,144**	**91,672**	**14,712**	**184,598**

Source : Bridge Management Wing, RHD

2.2. Road Traffic

Current traffic levels on the RHD paved road network are shown in Table 2-4.

Table 2-4 : Traffic volumes on RHD network

Road Class	Traffic Volume AADT Motorised	Length (km)	Million Vehicle-km per year	% of Vehicle-kilometres
National Highway	< 250	143.2	7	59.0
	250-500	119.2	16	
	500-1000	406.0	111	
	1000-2000	739.9	405	
	2000-3000	811.7	741	
	3000-4000	310.2	396	
	> 4000	954.9	2,930	
	Sub-Total	3,485.0	4,606	
Regional Highway	< 250	732.8	33	23.3
	250-500	620.8	85	
	500-1000	1,156.1	316	
	1000-2000	846.0	463	
	2000-3000	535.6	489	
	3000-4000	112.8	144	
	> 4000	112.8	287	
	Sub-Total	4,117.0	1,818	
Zila Roads	< 250	5,186.4	237	17.7
	250-500	2,694.0	369	
	500-1000	1,347.0	369	
	1000-2000	471.0	258	
	2000-3000	66.9	61	
	3000-4000	66.9	85	
	> 4000	0.0	0	
	Sub-Total	9,832.0	1,378	
Total (all RHD)		**17,434.0**	**7,802**	**100.0**

Source : Road User Charge Study, World Bank, 2005

59% of traffic on RHD's roads is on the National Highways. 38% of all RHD's traffic runs on just 5% of the network (some 955km). These are the main strategic roads connecting Dhaka. Comparable traffic data for 1991 and 2006 are shown in Table 2-5 and Figure 2-1. Observed growth factors by road class are shown in Table 2-8.

Table 2-5 : Percentage Distribution of Traffic by Traffic Volume, 1991 and 2006

Traffic Volume - AADT Motorised	1991	2006
< 250	7.5	2.0
250 – 500	9.3	3.7
500 – 1000	22.3	8.6
1000 – 2000	29.8	15.0
2000 –4000	19.3	31.8
> 4000	11.9	38.9
Total	**100.0**	**100.0**

Source : Road User Charge Study and RHD

Figure 2-1 : Change in composition of traffic by volumes, 1991 to 2006

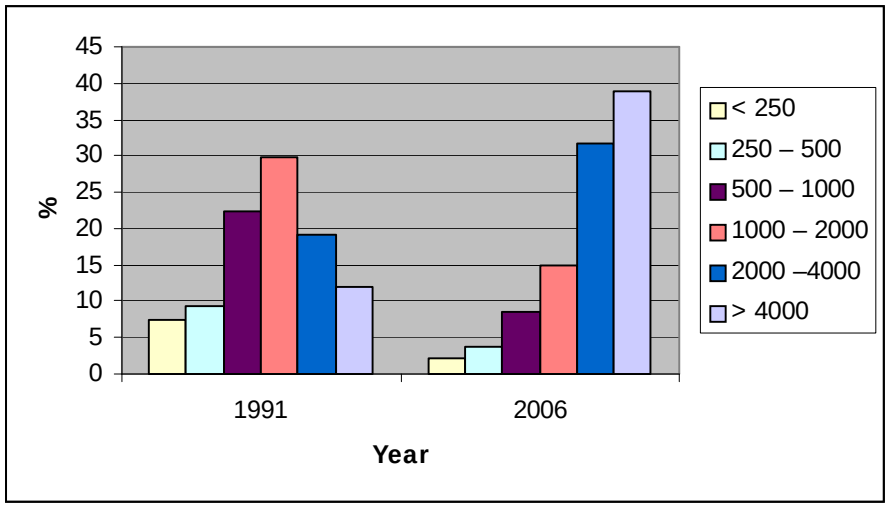


Table 2-6 : Observed traffic growth factors by road class

Road Class	Annual Growth in Motorised Traffic, %
National Highway	5.0
Regional Highway	6.3
Zila Road[7]	6.1

Source : Economics Circle, RHD

Data on registered vehicles from BRTA are shown in Table 2-8. There is a distinct change in numbers registered between 1992 and 1993, which suggests a change in the method of registration. That the figures after 1993 are much higher indicates that only these data should be taken as accurate.

Growth in registered vehicles is shown in Table 2-9. The registered number of trucks has averaged 4.9% per year over the last ten years, along with a 4.0% per year growth in the number of buses. This level of growth is broadly consistent with traffic growth on the National Roads, where buses and trucks dominate the traffic composition.

2.3. Road Classification

The key functional places in Bangladesh (capital, divisional headquarters, sea and land ports) should be connected to the National Highway network.

[7] Previously termed 'Feeder Road Type A'

Table 2-7 lists these places and it can be seen that not all land ports are yet connected to a National Highway. As and when these ports become fully functional the network will need to be re-classified accordingly.

Table 2-7 : National Highway functional connections

Place	Function	Connections
Dhaka	Capital	N1, N2, N3, N4, N5, N8
Chittagong	Divisional Headquarters	N1
Rajshahi	Divisional Headquarters	N6
Khulna	Divisional Headquarters	N7
Sylhet	Divisional Headquarters	N2
Barisal	Divisional Headquarters	N8
Chittagong	Sea Port	N1
Mongla	Sea Port	N7
Benapole	Land Port	N706
Banglabandh	Land Port	N5
Burimari	Land Port	N509
Hili	Land Port	Z5503, Z5856
Sonamasjid	Land Port	Z6801
Tamabil	Land Port	N212
Akhaura	Land Port	Z1216
Haluaghat	Land Port	Z2371
Bhomra	Land Port	Not Connected (LGED road only)
Bibirbazar	Land Port	Not Connected (LGED road only)
Teknaf	Land Port	N1

Source : Consultants

Table 2-8 : Registered Vehicles in Bangladesh, 1988 to 2003

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Car	35,443	38,278	41,340	43,960	45,306	75,243	79,411	86,375	98,854	107,208	113,084	118,070	122,157	128,744	135,501	142,546	147,956	154,387	162,834
Jeep/Station Wagon/Micro bus	23,049	24,893	26,884	28,673	30,140	33,477	36,332	38,513	41,321	43,080	45,253	46,476	48,295	50,760	53,798	55,602	58,116	62,079	67,619
Taxi	1,622	1,719	1,822	1,914	1,933	2,780	2,787	2,804	2,863	2,877	2,980	3,196	3,776	4,547	6,780	11,800	12,340	12,855	13,130
Bus/Mini Bus	16,876	18,031	19,276	19,875	20,408	27,469	28,463	29,484	30,428	31,398	32,281	33,027	33,768	35,580	38,634	40,649	42,128	43,272	44,533
Truck	21,341	22,621	23,978	24,904	25,834	40,373	42,337	45,805	48,734	50,016	52,749	54,767	57,492	60,067	62,444	65,239	67,822	70,613	73,678
Auto-Rickshaw/Tempo	17,429	18,562	19,769	23,430	26,648	43,863	53,851	68,039	79,293	85,839	90,242	92,382	96,517	95,914	101,383	115,249	124,223	129,100	135,998
Motorcycle	97,639	108,379	120,301	130,292	138,709	165,360	173,167	182,035	196,012	208,092	222,617	239,128	253,742	278,151	307,198	328,294	353,235	396,461	447,567
Other	7,373	7,703	7,890	8,040	8,090	8,686	9,210	9,339	10,288	11,861	13,641	16,033	17,165	19,774	22,489	26,865	29,626	32,557	36,270
Total	220,772	240,186	261,260	281,088	297,068	397,251	425,558	462,394	507,793	540,371	572,847	603,079	632,912	673,537	728,227	786,244	835,446	901,324	981,629

Source : BRTA

Table 2-9 : Growth in Registered vehicles (% per year), 1994 to 2006

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average for Last 12 years
Car	8.0	8.0	6.3	3.1	66.1	5.5	8.8	14.4	8.5	5.5	4.4	3.5	5.4	5.2	5.2	3.8	4.3	5.5	6.1
Jeep/Station Wagon/Micro bus	8.0	8.0	6.7	5.1	11.1	8.5	6.0	7.3	4.3	5.0	2.7	3.9	5.1	6.0	3.4	4.5	6.8	8.9	5.3
Taxi	6.0	6.0	5.0	1.0	43.8	0.3	0.6	2.1	0.5	3.6	7.2	18.1	20.4	49.1	74.0	4.6	4.2	2.1	13.7
Bus/Mini Bus	6.8	6.9	3.1	2.7	34.6	3.6	3.6	3.2	3.2	2.8	2.3	2.2	5.4	8.6	5.2	3.6	2.7	2.9	3.8
Truck	6.0	6.0	3.9	3.7	56.3	4.9	8.2	6.4	2.6	5.5	3.8	5.0	4.5	4.0	4.5	4.0	4.1	4.3	4.7
Auto-Rickshaw/Tempo	6.5	6.5	18.5	13.7	64.6	22.8	26.3	16.5	8.3	5.1	2.4	4.5	-0.6	5.7	13.7	7.8	3.9	5.3	8.0
Motorcycle	11.0	11.0	8.3	6.5	19.2	4.7	5.1	7.7	6.2	7.0	7.4	6.1	9.6	10.4	6.9	7.6	12.2	12.9	8.2
Other	4.5	2.4	1.9	0.6	7.4	6.0	1.4	10.2	15.3	15.0	17.5	7.1	15.2	13.7	19.5	10.3	9.9	11.4	12.1

Table 2-10 lists all the District Headquarters. These require to be connected by National Highways or Regional Highways. However, some District Headquarters are connected to National Highways which are not serving the function required in Table 2-1. These should be re-classified as Regional Highways.

Table 2-11 lists these along with roads that require re-classification.

Table 2-10 : District Headquarters Connections

District Headquarters	Connection	District Headquarters	Connection
Bagerhat	Regional Highway	Madaripur	National Highway
Bandarban	National Highway	Magura	National Highway
Barguna	Regional Highway	Manikganj	National Highway
Barisal	National Highway	Meherpur	Regional Highway
Bhola	Regional Highway	Moulvibazar	National Highway
Bogra	National Highway	Munshiganj	Regional Highway
Brahmanbaria	National Highway	Mymensingh	National Highway
Chandpur	Regional Highway	Narail	Regional Highway
Chittagong	National Highway	Narayanganj	Regional Highway
Chuadanga	Regional Highway	Narshingdi	National/Regional Highway
Comilla	National Highway	Natore	National Highway
Cox Bazar	National Highway	Nawabganj	Regional Highway
Dhaka	National Highway	Netrokona	Regional Highway
Dinajpur	National Highway	Nilphamari	Regional Highway
Faridpur	National Highway	Noagaon	Regional Highway
Feni	National Highway	Noakhali	National Highway
Gaibandha	Regional Highway	Pabna	National Highway
Gazipur	Regional Highway	Panchagarh	National Highway
Gopalganj	National Highway	Patuakhali	National Highway
Habiganj	Regional Highway	Pirojpur	Regional Highway
Jamalpur	National Highway	Rajbari	Regional Highway
Jessore	National Highway	Rajshahi	National Highway
Jhalakathi	Regional Highway	Rangamati	National Highway
Jhenaidaha	National Highway	Rangpur	National Highway
Joypurhat	Regional Highway	Satkhira	Regional Highway
Khagrachhari	Regional Highway	Shariatpur	Regional Highway
Khulna	National Highway	Sherpur	Regional Highway
Kishoreganj	Regional Highway	Sirajganj	Regional Highway
Kurigram	National Highway	Sunamganj	Regional Highway
Kushtia	National Highway	Sylhet	National Highway
Lakshmipur	National Highway	Tangail	National Highway
Lalmonirhat	National Highway	Thakurgaon	National Highway

Table 2-11 : Proposed RHD road re-classifications

Road No.	From	To	Remarks	Reason
N506	N509	Kurigram	Should be Regional Highway	Connecting District Headquarters
N508	N509	Dinajpur	Should be Regional Highway	Connecting District Headquarters
N4	Madhupur	Jamalpur	Should be Regional Highway	Connecting District Headquarters
N8	Barisal	Patuakhali	Should be Regional Highway	Connecting District Headquarters
N104	Chowmohani	Noakhali	Should be Regional Highway	Connecting District Headquarters
N890	Barisal	Laksmirpur	Should be Regional Highway	Connecting District Headquarters
N106	Chittagong	Rangamati	Should be Regional Highway	Connecting District Headquarters
N108	N1	Bandabarn	Should be Regional Highway	Connecting District Headquarters
N110	N1	Cox's Bazar	Should be Regional Highway	Connecting District Headquarters
R750 and Z7503	Jessore	N805	Should be National Highway	Connecting Landport with Dhaka
Z6801, Z6816, R680	Sonamasjid	Rajshahi	Should be National Highway	Connecting Landport with Dhaka
Z3711, R371, R370	Mymensingh	Haluaghat	Should be National Highway	Connecting Landport with Dhaka
Z5503	Hilli	Joypurhat	Should be National Highway	Connecting Landport with Dhaka
R550	Joypurhat	N5	Should be National Highway	Connecting Landport with Dhaka
Z1216	Akhaura	N2	Should be National Highway	Connecting Landport with Dhaka
	Bibir Bazar	N1	Should be National Highway	Connecting Landport with Dhaka
R760	Satkira	Khulna	Should be National Highway	Connecting Landport with Dhaka
R856	Gopalganj	Khulna	Should be National Highway	Connecting Divisional Headquarters

2.4. Legal and Regulatory Framework

The primary legislation for the construction and maintenance of roads in Bangladesh is the 1925 Bengal Highways Act. This is supplemented by more recent laws and rules as set out in Table 2-12.

Table 2-12 : RHD Legal Framework

Powers and Responsibilities	Legal Basis
Environmental impact analyses	Environment (Pollution Control) Act 1995
No right of access to motorway or restricted access road	Section 6, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Weight and dimension limits of vehicles	1983 Motor Vehicle Ordinance
Removal of vehicles	Sections 7 and 12, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Prevention and removal of unauthorised structures or works etc	Section 7, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Unlawful use of a motorway or restricted access road	Section 4, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Entering and leaving motorways and restricted access roads	Section 5, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Stopping of vehicles on motorways and restricted access roads	Section 7, Highways (Security, Protection and Restriction of Movement) Rules, 2001
Authorised officers	Section 2, Appendix VIII, Government Estates Manual, 1958

The Ministry of Communications operates under Rules of Business of the Government of Bangladesh, which, inter alia, allow the Ministry, through its agencies, to construct and maintain roads.

Road classification in Bangladesh has been determined by the Ministry of Planning[8], as have design standards for low volume roads[9].

[8] Published in the Official Gazette
[9] Published in the Official Gazette

3. DIAGNOSIS OF EXISTING PROBLEMS

3.1. Road Conditions

3.1.1. Overall Roughness Indicators

The most recent data on road conditions were taken from the RHD surveys carried out in 2005, shown in Table 3-1.

Table 3-1 : RHD Road Network and Roughness Surveyed Length (km)

Zone	Total Road Length (Km)				Roughness Surveyed Length (Km)			
	National	Regional	Zila	Total	National	Regional	Zila	Total
Dhaka	716.99	1,191.35	2,315.11	4,223.44	661.79	805.65	1,200.01	2,667.45
Comilla	313.45	344.97	1,639.60	2,298.02	309.98	259.22	1,014.62	1,583.82
Chittagong	399.48	434.04	1,734.64	2,568.15	390.77	316.04	473.76	1,180.57
Rangpur	605.89	298.68	1,915.08	2,819.65	213.89	270.39	514.78	999.06
Rajshahi	366.39	451.30	1,378.58	2,196.26	261.70	385.93	614.32	1,261.95
Khulna	376.95	589.48	1,706.67	2,673.10	349.07	543.01	733.87	1,625.95
Barisal	406.17	419.56	1,799.88	2,625.61	100.32	374.14	420.03	894.49
Sylhet	344.15	397.73	636.17	1,378.05	335.70	351.23	279.34	966.27
Total	**3,529.47**	**4,127.10**	**13,125.71**	**20,782.29**	**2,623.22**	**3,305.61**	**5,250.72**	**11,179.55**

Source : Maintenance and Rehabilitation Needs Report of 2006 - 2007 for RHD Paved Roads, RHD, 2006

The condition of roads can be shown the roughness, as described in Table 3-2. The average roughness of roads across the country is found from surveys and those carried out in the previous two years are shown in Table 3-3. This reveals that whilst conditions on the National Highways have been kept relatively good, the states of Regional and Zila roads have declined quite sharply. The consequences of the poor conditions of Zila roads cannot be understated. Because of their unique contribution to social cohesion and poverty reduction, the approach to the problems of Zila roads is different to that of the National Highways and Regional Highways.

Table 3-2 : Qualitative Descriptors of IRI Values

	National Highway	Regional Highway	Zila Road
	IRI Values		
Good	0 – 3.9	0 – 4.9	0 – 5.9
Fair	4.0 – 5.9	5.0 – 6.9	6.0 – 7.9
Poor	6.0 – 7.9	7.0 – 8.9	8.0 – 9.9
Very Poor	8.0 +	9.0 +	10.0+

Source : HDM Circle, RHD

Table 3-3 : Average roughness (IRI[10] in m/km) for years 2003 to 2005

Year	National Highway	Regional Highway	Zila Roads	Average
2003	4.1	4.8	5.9	5.6
2004	4.6	6.0	7.0	5.9
2005	4.2	7.0	8.2	6.5

Source : HDM Circle, RHD

[10] International Roughness Index

3.1.2. National Highways and Regional Highways

For the purposes of assessing the conditions of National Highways, the network has been disaggregated into 25 classes, differentiated by traffic and roughness according to Table 3-4.

Table 3-4 : Lengths (km) of National Highways by traffic and roughness

Motorised Vehicles (4+ wheels)	Roughness (IRI)					
	0.0 – 4.9	5.0 – 6.9	7.0 – 8.9	9.0 – 11.9	12 +	Total
0 – 2000	481.9	709.0	167.5	17.2	2.6	1,378.2
2001 – 4000	657.7	226.5	77.7	71.8	6.2	1,039.9
4001 – 6000	282.5	11.3	42.5	54.5	0.1	390.9
6001 – 8000	38.6	20.0	22.0	0.0	5.7	86.3
8000 +	269.2	73.9	18.5	16.9	0.3	278.8
Total	**1,729.8**	**1,040.7**	**328.2**	**160.4**	**14.9**	**3,274.1**

Source : HDM Circle, RHD

3.1.3. Roughness

Roughness ranges of all RHD roads are shown in Table 3-5. Roughness for the whole network is shown in Map 3.1.

Table 3-5 : Roughness of RHD Roads, IRI (m/km)

	Length Distribution (km)		
IRI Range	National	Regional	Zila
0-5	1,730	937	718
5-7	1,041	810	1,360
7-9	328	1,262	3,522
9-12	160	512	2,104
>12	15	90	318
Total	**3,274**	**3,612**	**8,022**

Source : HDM Circle, RHD

3.1.4. Benkelman Beam Deflections (BBD)

BBD[11] results for RHD roads are shown in Table 3-6. Typical BBD's that would be expected for roads in good condition would be 0.7 (National Highways); 1.0 (Regional Highways), and 1.1 (Zila Roads).

Table 3-6 : BBD Results for RHD Roads

	Benkelman Beam Deflection (mm)			
Road Class	Mean	Maximum	Minimum	Std. Dev
National	0.9	3.9	0.5	0.7
Regional	1.4	3.9	0.5	0.7
Zila	1.5	4.0	0.5	0.6

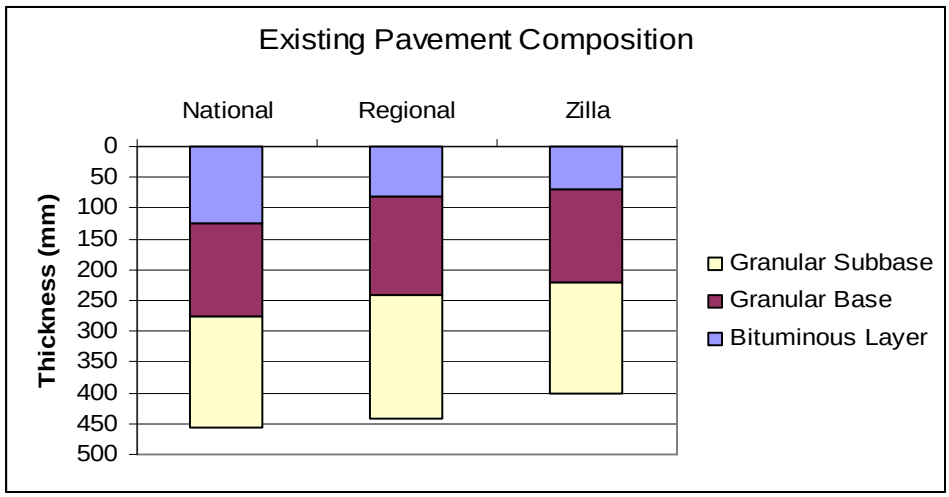
Source : HDM Circle, RHD

[11] BBD Test is a non-destructive pavement investigation method for assessing strength from the deflection (elastic) the pavement undergoes under a standard load (wheel)

3.1.5. Pavement Composition

The bituminous layer consists primarily of open-graded carpeting material in the Regional and Zila roads. In major National roads, the most recent layer appears to be of superior material. The granular base is generally WBM with crushed boulder. The sub-base in most roads is constituted by brick aggregate/soling. Pavement compositions are shown graphically in Figure 3-1.

Figure 3-1 : Average pavement thicknesses, RHD roads



3.1.6. Subgrade

Bangladesh has been divided into 21 Land Systems based on geological and geo-morphological characteristics of soil deposits shown in Map 3.2

3.1.7. Engineering properties of Bangladesh soil

Soil in Bangladesh is predominantly alluvial. Except for Sylhet and Chittagong Hill Tract areas, soil can be classified as ML-CL[12] type ranging from silty clay to clayey silt. The plastic soils have an average Plasticity Index (PI) value of 15. Non-plastic soils comprising silty sand and sand are also found particularly in the old river courses.

California Bearing Ratio (CBR)[13] of the road subgrade is available in RHD's Road Maintenance Management System (RMMS) database. This information was taken into account. However, examining this database, very high (75%) and extremely low (1%) values were observed. In order to arrive at a rational subgrade CBR value for assessing the existing pavement strength and behaviour in the individual road segments, the sample investigation results of soils in different Land Systems[14] were considered. CBR of soil was set to have an upper limit of 15% and lower limit of 3%.

3.1.8. Structural Strength of Existing Pavement

The structural strength of existing pavement was defined in terms of structural number, SN. For each road segment of network, this value needed to be assessed. The existing structural number was estimated from: a) pavement deflection and b) pavement layer composition. RMMS database provided 2004 data for use in both these methods (refer Chapter 7 for detailed discussion on pavement design). A relationship was found between road condition (IRI) and SN. The assessed SN for National and Regional Highways are presented in Table 3-7 and Table 3-8.

[12] Mixture of silt and clay both with low plasticity
[13] California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of road subgrades
[14] Bangladesh Transport Survey, Part 8, Final Report November 1974

Table 3-7 : Structural strength of National Highways

IRI	Condition Type	Structural Number of existing pavement		
0 - 4.99	C1	3.1	4.0	1.4
5.00-6.99	C2	2.8	4.2	1.0
7.00-8.99	C3	2.6	4.2	1.3
9.00-11.99	C4	2.0	3.7	1.1
12.00-120	C5	2.2	3.7	1.3
		Avg	**Max**	**Min**

Source : HDM Circle, RHD

Table 3-8 : Structural Strength of Regional Highways

IRI	Condition Type	Structural Number of existing pavement		
0 - 4.99	C1	2.0	3.7	1.1
5.00-6.99	C2	1.9	3.5	0.7
7.00-8.99	C3	1.8	3.9	0.6
9.00-11.99	C4	1.7	3.6	0.6
12.00-120	C5	1.7	3.4	0.8
		Avg	**Max**	**Min**

Source : HDM Circle, RHD

The roads generally show poor pavement strength indicating need for rehabilitation (the minimum design SN is 4 as explained in Chapter 8). Regional Highways are particularly weak although the average existing pavement thickness is nearly 450mm. This may mean that the pavement materials are inferior in quality.

3.1.9. Carriageway Width

A significant number of National Highways and Regional Highways have insufficient carriageway width, as shown in Table 3-9.

Table 3-9 : Number of lanes on paved RHD roads

	Length (km)		
	National Highway	**Regional Highway**	**Zila Road**
More than Two Lanes	313	57	11
Two Lanes	2,307	924	266
Intermediate Lane	800	1,999	1,002
Single Lane	65	1,137	8,440
Total	**3,485**	**4,117**	**9,719**

Source : RMMS Database, RHD

This present capacity will generate safety problems as traffic volumes grow. Over 8,000 km of Zila Roads are single carriageways. For the most part this does not present a problem, as traffic levels are low.

3.1.10. Routine Maintenance

Routine maintenance is a type of work that is planned and performed on a routine basis to maintain and preserve the condition of the road, both on and off the carriageway, or to respond to specific conditions and events in order to restore the highway system to an adequate level of service. Off-carriageway works include vegetation control, road sign mending and replacement, culvert cleaning, and embankment repair. Examples of works on the carriageways include crack sealing, pothole repair and repair of localised failed areas of pavement.

Most routine maintenance activities are predictable and should therefore be carried out on a planned and regular basis. These activities then serve as a means of identifying pavement defects at a very early stage so small scale interventions can be made quickly, before problems become any greater. This can be supplemented by planned and regular inspections by more senior staff, firstly to ensure that routine works are being carried out properly, and second, to check that defects are being repaired; and thirdly to identify any other defects.

The benefits of routine maintenance are well known. It reduces the time period over which the road quality deteriorates, and hence adds to the preservation of the network. Typical economic rates of return for routine maintenance are in the range 50 to 60%. For Bangladesh it is estimated that the costs of periodic maintenance would be reduced by 15% over the next five years, if full routine maintenance works were carried out.

Some of the cost of routine maintenance is not related to traffic levels, but clearly, roads with higher levels of traffic are more likely to be susceptible to defects and require routine interventions. Even so costs of routine maintenance can be assessed reasonably accurately, as much of the total cost is due to labour. For national highways a cost of Tk.50,000 per kilometre per year in Bangladesh (US$ 710) ought to be adequate. For low volume roads a figure of Tk. 30,000 (US$ 420) per km per year is reasonable. These figures compare well with budget figures of US$ 750 for trunk roads and US$ 400 for low volume roads in Zambia, although in Vietnam typical routine maintenance costs for low volume roads are around $200 per km.

Routine maintenance is necessary for all roads which are in a maintainable condition. For those roads which are beyond periodic maintenance initiatives due to very poor conditions, routine maintenance is still very useful to 'hold' the level of deterioration and to ensure that some form of passage is possible. Hence, as a general rule the whole network ought to be routinely maintained.

The Ministry of Finance (MoF) allocates to the Ministry of Communications, and hence to RHD, a total sum every year for routine maintenance. This is allocated by RHD to the Zones, as shown in Table 3-10. The sum allocated is less than 18% of the requirement, and yet the difference between what is needed and what is allocated is less than 3% of RHD's total budget for the year. The problem derives from the fact that RHD cannot re-allocate the provision made by the MoF, and hence routine maintenance is consistently and unnecessarily under-funded. Because the need for routine maintenance is predictable, a full allocation should be made by the Ministry of Finance every year, and the funds can be spent effectively.

Table 3-10: Allocation of Routine Maintenance Budget (2006-07)

Zone	% km	Budget (Crore Taka)	% of Budget	Need (Crore Taka)
Dhaka	19.4	2.70	25.7	11.50
Chittagong	12.2	1.20	11.4	7.23
Rajshahi	11.3	1.10	10.5	6.70
Khulna	12.7	1.10	10.5	7.53
Barisal	12.5	1.20	11.4	7.41
Comilla	11.9	1.10	10.5	7.06
Rangpur	13.5	1.00	9.5	7.95
Sylhet	6.6	1.10	10.5	3.91
Total		**10.50**		**59.30**

Source : Planning and Mainantenance Wing, RHD and Consultants

3.2. Zila Road Conditions

3.2.1. Current Situation

The analysis of the current situation of the Zila road network and subsequent prioritisation of works is based on the data available from RHD's Road Maintenance Management System (RMMS). The data was extracted from the database in December 2006, and includes road data from the surveys completed in 2004 / 5. Further survey work was carried out in 2006, but this has not yet been entered into the RMMS. Table 3-11 summarises the current condition of the Zila road network.

16 Upazillas are not yet connected by the RHD road network (Map 3.3). There is also one Land Port that is not connected. These are shown in Table 3-12. Whilst an LGED managed rural road may connect these, it is a government requirement that at least a Zila Road connects them.

Table 3-11: Summary of current Zila Road conditions

Road Condition	Length, km	% of Zila road network	
Unpaved	199	2.0%	Total network in poor condition: 2,700 km 26.6%
Very poor (IRI>10)	1,291	12.7%	
Poor (IRI 8-10)	1,211	11.9%	
Fair / Good	3,936	38.7%	
Unknown (not surveyed) *	*3,527*	*34.7%*	
Total	**10,164**	**100.0%**	

*The total length of roads not surveyed is approximate only. This is because some of the sections shown as not surveyed have not been constructed yet and are only planned roads. Source : RHD

Table 3-12: List of Upazilas not currently connected to the RHD network

	RHD Zone	District	Upazila / Thana
Unconnected Upazila Headquarters	Barisal	Barisal	Mehendiganj
	Chittagong	Chittagong	Sandwip
		Cox's Bazaar	Kutubia
		Rangamati	Barkal Belaichhari Juraichhari Langadu
	Dhaka	Kishoreganj	Austagram Itna Mithamain
		Netrakona	Kalmakanda Khaliajuri
	Sylhet	Sunamganj	Bishwambarpur Jamalganj Sulla Tahirpur
		Habiganj	Dwarabazar Asmiriganj

3.3. Bridge Conditions

3.3.1. Introduction

The history of bridge reconstruction in RHD dates back to the independence of Bangladesh in 1971. Hundreds of bridges and culverts in the RHD road network which were damaged during the war of independence were reconstructed. A large number of bridges and culverts, built many years ago, obviously did not meet design standards that are used at present, and also lacked appropriate maintenance. Earlier reconstruction or new construction of bridges in RHD road network were taken up mostly through GOB funded projects. Such programmes were not large, priorities were rarely adhered to and economic analyses were generally absent. Lack of resources meant that RHD was not in a position to give much attention to the new construction or reconstruction of bridges in the big river/channel gaps of RHD road network, and instead the continuity of major roads was maintained through ferries. Later on, reconstruction or new construction of bridges in the National and Regional Highways became part of the foreign aided projects and, separate bridge projects through the Annual Development Programme, started coming up under both local and foreign funding.

3.3.2. Current Situation

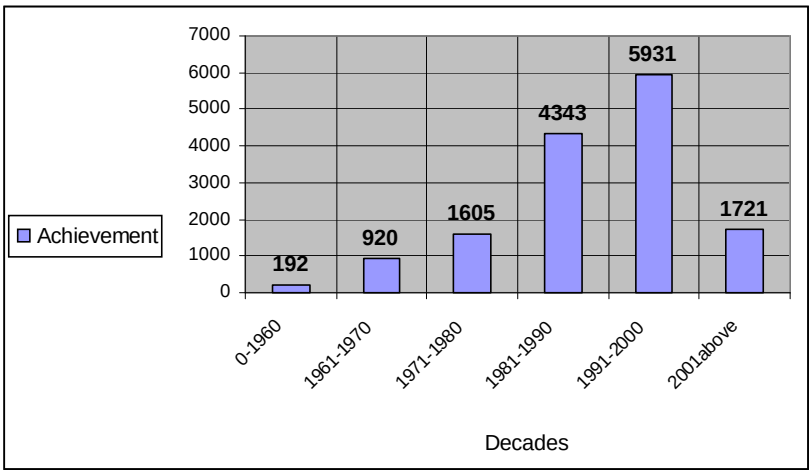
During the last two decades a numbers of bridge projects were taken up by RHD with donor assistance (for example Meghna Bridge, Bhairab Bridge, Paksey Bridge, Shikarpur Dowarika bridges). This has contributed to reducing the travel time and uninterrupted movement of traffic and thus paved the way to develop an efficient road transportation system in Bangladesh. RHD is continuing efforts for taking up large bridges for reconstruction and new constructions with the assistance from the development partners. In addition during the last few years, under the Bridge Replacement Project (BRP), RHD had

undertaken the replacement/reconstruction of several bridges. This project is expected to be completed by the end of 2006-07.

RHD is proposes bridges for reconstruction, rehabilitation or new construction under the Periodic Maintenance Programme (PMP). From 2005-06 RHD started a PMP under the Japan Debt Conversion Fund (JDCF) to include replacement, rehabilitation/repair and reconstruction of bridges and culverts.

Figure 3-2 shows the record of construction of bridges and culverts over the last four decades in Bangladesh.

Figure 3-2: Construction of bridges over the last four decades.



3.3.3. Conditions of Bridges

3.3.3.1. Bridge Condition Survey in RHD

In order to assess the need of repair, rehabilitation and reconstruction of bridges, RHD has adopted a simple but effective way of reporting the condition of bridges/structures. The method is set out in their Bridge Condition Survey Manual. It consists of:

1. Bridge Condition Survey Form 1 (BCS-1), for recording of site inspection and assessment by junior engineers and technicians.
2. Bridge Condition Survey Form 2 (BCS-2), for recording of a summary of BCS-1 and allow Senior Engineer /Executive Engineers to make remarks and decide on appropriate action and give an indicative cost of repair. Data from the BCS-1 and BCS-2 survey is used to determine and monitor routine and periodic maintenance budget and programmes.
3. Bridge Condition Survey Form 3 (BCS-3), A second level, more detailed survey of bridge structure is undertaken by Sub-Divisional Engineer. Data from the BCS-3 survey is used to estimate the rehabilitation costs for national bridge stock and prepare and prioritise work plans.
4. Principal Bridge Inspection (PBI), The larger bridges receive a PBI by suitably qualified staff / Structural Engineer. Data and accurate detailed cost estimates from PBI are used by Network Planning Wing to prepare Annual Rehabilitation Budget (ARB) and to request for allocations according to priority.

3.3.3.2. Bridge Classification System in RHD

The RHD bridge classification system uses four condition categories to assess damage to bridges and culverts in all the types of roads. The condition category and description of damage are shown in Table 3-13 . In the RHD network, according to current survey information (2004-05 survey) there are 14,712 numbers of structures. Out of these 10,610 numbers are culverts and 4,102 numbers are bridges. Table 3-14 shows the break down of these structures by type.

Table 3-13: Type of Condition category and description

Condition Category	Score	Description
A	0	No damage
B	1 to 29	Minor damage
C	30 to 499	Major elemental Damage
D	500	Major structural damage

Table 3-14: **Number of structures by type**

Sl no	Structure type	No of Structure	% 0f Total
1	Box culvert	7,420	50.44
2	Slab culvert	3,190	21.68
3	Arch masonry	302	2.05
4	RCC Bridge with slab	195	1.33
5	RCC Girder Bridge	1,982	13.47
6	PC Girder Bridge	359	2.44
7	Steel beam& RCC Slab	200	1.36
8	Truss with steel deck	193	1.31
9	Truss with RCC slab	28	0.19
10	Portable Steel Bridge with steel deck	815	5.54
11	Portable Steel Bridge with timber deck	18	0.12
12	Truss with timber Deck	6	0.04
13	PC Box	4	0.03

Source : BMMS Database, RHD

All observations of deterioration are recorded as major or minor in extent, the general criteria adopted for major deterioration are as shown in Table 3-15.

Table 3-15 : Degree of Deterioration

Observation	Major Deterioration
Scouring	Underside of pile cap exposed Visible depth of scour exceeds one meter Volume of scour exceeds $15m^3$
Leaning/ Tilting	There is evidence of backfill material having been washed out. Horizontal displacement at top measured with string line exceeds 1 in 30 or maximum 150mm
Settlement	Bridge approaches are average 100 mm lower than the deck at a distance of 1 m. Vertical displacement of superstructure is clearly visible by eye Vertical differential displacement of structures measured on a horizontal string line exceeds 1 in 60, or 50 mm over a length of 3m.
Obstruction	Obstruction can not be removed by hand by local labour and has to be carried out by contract or requires other special attention
Cracks	Cracks in concrete are clearly visible from a distance of 3m Maximum crack width in concrete exceeds 1mm Cracks in concrete occur in critical areas e.g. under bearing, at beam mid span. Any crack in work steel
Concrete spalling	Soffit reinforcement is fully exposed over a single area exceeding 1 m2 of deck or half width of beams
Damaged or missing sections	All structural members in concrete and steel; All holes in concrete decks All railing members
Missing bolts	Structural joints

Source : BCS, RHD

Any other observations, which do not meet the above criteria and condition, are recorded as minor. The number of structures according to condition category is given in Table 3-16.

Table 3-16 : Number of structures by condition category

Category	Description	Number of Bridges and Culverts
A	Good	9,729
B	Minor Elemental damage	2,091
C	Major elemental damage	2,627
D	Major structural damage	715
Total		**14,712**

Source : BMMS Database, RHD

The numbers of all types of structures according to condition category is given in Table 3-17

Table 3-17 : Condition Category by Structures Type

Sl	Structure type	Category A	Category B	Category C	Category D	No of Structures
1	Box Culvert	5,671	917	728	104	7,420
2	Slab culvert	1,843	444	699	204	3,190
3	Arch Masonry	131	57	80	34	302
4	RCC Bridge with slab	94	28	57	16	195
5	RCC Girder Bridge	639	418	677	248	1,982
6	PC Girder Bridge	242	54	52	11	359
7	Steel Beam& RCC Slab	61	30	82	27	200
8	Truss with Steel Deck	141	13	32	7	193
9	Truss with RCC Slab	16	4	7	1	28
10	PSB* with Steel Deck	428	124	205	58	815
11	PSB* with Timber Deck	9	2	3	4	18
12	Truss with Timber Deck	3	0	2	1	6
13	PC Box	1	0	3	0	4
Total		**9,279**	**2,091**	**2,627**	**715**	**14,712**

* Portable Steel Bridge Source : BMMS

3.3.4. Analysis of 'D' Class Structures

Out of the 715 bridges/culverts under category D, only 133 bridges fall within the lengths of 20m and above. These 133 bridges all need rehabilitation or reconstruction. Their lengths by road class are shown in Table 3-18.

Table 3-18 : Category 'D' Class Structures by length and road class

	20m to 50m	50m to 100m	100m Plus	Total
National Highways	11	9	2	22
Regional Highways	33	9	2	44
Zila Roads	58	9	0	67
Total	**102**	**27**	**4**	**133**

Source : BMMS

3.3.5. Analysis of 'C' Class Structures

Out of the 2,627 bridges/culverts under category C, 514 bridges fall within the lengths of 20m and above. These 514 C class bridges need major repairs. Their lengths by road class are shown in Table 3-19.

Table 3-19: Category 'C' Class Structures by length and road class

	20m to 50m	50m to 100m	100m Plus	Total
National Highways	80	33	26	139
Regional Highways	127	30	8	165
Zila Roads	147	49	14	210
Total	**354**	**112**	**48**	**514**

Source : BMMS

3.3.6. Field Surveys

To verify the condition of bridges as given in the BCS forms, RMP experts along with Divisional and Sub-Divisional Engineers of the respective Divisions and Sub-divisions visited 25 Category 'D' bridges between 6 November 2006 and 28 November 2006, and a further 45 bridges between 19 March 2007 and 10 April 2007. The LRP numbers of bridges visited and their locations are shown on Maps 3.4 to 3.8.

- Bridge LRP numbers are not marked on the structure. This adds to time needed to locate structures, and in some cases bridges detailed in BCS-1 reports could not be located.
- The basic details of some structures such as overall length, width, number of spans and type of structure, observed during inspection did not tally with records in the BCS-1 forms.
- The condition assessments of structures for some C and D category bridges recorded in the BCS-1 reports were not in order and needed review.
- 12 bridges on the Zila Road Z1202 were not recorded in the BMMS database and no BCS-1 reports were available.
- RHD staff who undertook the inventory and BCS reports did not appear to be well experienced or properly trained in structures. The bridge inventory and condition survey done appeared to have been a hurriedly completed exercise without proper supervision or checking.
- There was no defined systematic approach adopted for frequency of survey/inspection programmes.
- According to the BCS Manual the survey frequency for BCS-1 and BCS-2 for C and D category bridges is 6 months. However this was not followed.

Figure 3-3 : Examples of damaged bridges

R480 Elaga Bhuanpur Road (km 8.947)
Scouring of bed at pier location

N4 Joydevpur Tangail Jamalpur Road (km75.411)
scouring and wing wall washed away.

3.4. Axle Loads

3.4.1. Survey Equipment

As part of the Road Master Plan (RMP) study, axle load surveys at 11 locations were conducted using a portable weigh pad as shown in Figure 3-4.

Figure 3-4 : Portable Weighbridge used for Axle Load surveys

The pad, manufactured by TREVOR DEAKIN of the UK, was portable and robust. The survey team, comprising a senior Highway Engineer and two technicians, was able to carry the pad around in a microbus. The counter with digital display was accurate to nearest 10 kg.

3.4.2. Survey Locations and Schedule

The locations were carefully chosen to return a representative sample across different geographical areas of Bangladesh, as well as for National, Regional and Zila roads. The survey locations are shown in Map 3.9. The schedule of survey indicating dates and exact spots is shown in Table 3-20. The surveys were conducted between 25 September 2006 and 18 October 2006 generally from 6 am to 6 pm.

3.4.3. Analysis of Survey Data

Standard axle loads used for calculating Equivalent Standard Axle Load[15] (ESAL's) are front (steering) axle - 6600 kg; rear single axle - 8160 kg; and tandem axles - 15000 kg.

The summary of the survey results is presented in Table 3-21 location-wise and broken down into vehicle types. Vehicle-class wise results are presented in the form of charts subsequently.

[15] Measure of the damaging effect of a vehicle on the pavement in terms of the number of standard axle loads of 8.16 tonnes that the vehicle is equivalent to.

Table 3-20: Axle Load Survey Locations and Schedule

Sl. no.	Ref. no.	Date	Road name	Road no.	Thana, District	Location
1	Na-1	25.09.06	Dhaka (Banani)-Joydebpur-Mymensingh Road	N 3	Gazipur Sadar, GAZIPUR	4.5 km north from Joydevpur Intersection
2	Re-1	27.09.06	Mymensingh (D.C Office)-Raghurampur-Netrokona-Mohonganj-Jamalganj-Sunamganj Road	R 370	Phulpur, MYMENSINGH	8.0 km north-east from Raghurampur
3	Re-2	30.09.06	Patiya-Anowara-Banshkhali-Toitong-Pekua-Badarkhali-Chokoria (Eidmoni) Road	R 170	Banshkhali, CHITTAGONG	5.0 km north from Banshkhali
4	Na-2	02.10.06	Dhaka (Jatrabari)-Comilla (Mainamati)-Chittagong-Teknaf Road	N 1	Feni Sadar, FENI	2.0 km north from Elahiganj intersection
5	Zi-1	04.10.06	Haziganj-Ramganj-Lakshmipur Road	Z 1422	Hajiganj, CHANDPUR	4.0 km south from Hajiganj Sadar HQ
6	Na-3	07.10.06	Dhaka (Katchpur)-Bhairab-Jagadishpur-Shaistaganj-Sylhet-Tamabil-Jaflong Road	N 2	Bahubal, HABIGANJ	2.5 km north-east from Saistaganj
7	Na-4	09.10.06	Dhaka (Mirpur)-Utholi-Paturia- Natakhola-Kashinathpur- Bogra-Rangpur-Beldanga-Banglabandh Road	N 5	Rangpur Sadar, RANGPUR	1.0 km north from Damdama
8	Re-3	11.10.06	Rajshahi (Bindur More)-Nawhata-Chowmasia Road	R 685	Mohanpur, RAJSHAHI	4.5 km north from Mohanpur Thana HQ
9	Na-5	14.10.06	Jhenaidah-Kushtia-Paksey Ferry-Dasuria Road	N 704	Bheramara, KUSHTIA	6.8 km south from pakshey bridge
10	Na-6	16.10.06	Jessore (Daratana More)-Magura (Vaina More) Road	N 702	Bagher Para, JESSORE	18.0 km north-east from Jessore
11	Zi-2	18.10.06	Gouranadi-Paisarhat-Kotalipara-Gopalganj Road	Z 8031	Gopalganj Sadar, GOPALGANJ	12 km east from Gopalganj Sadar HQ

Table 3-21: Equivalent Standard Axles obtained at 11 Locations

		Light Truck	Medium Truck	Heavy Truck	MAV	Mini Bus	Std Bus
N1	Chittagong-Dhaka	0.79	8.62	3.08	25.06	0.83	2.87
	Dhaka-Chittagong	0.47	2.10	40.58	8.07	0.58	2.88
N2	Dhaka-Sylhet	0.25	8.29	44.35	7.76	0.95	3.00
	Sylhet-Dhaka	0.32	27.24	49.69			2.86
N3	Dhaka-Mymensingh	0.02	4.42	0.00	22.57	0.73	2.68
	Mymensingh-Dhaka	0.08	1.98	0.00	0.24	0.86	2.87
N5	Dhaka-Rangpur	0.02	7.59	40.12			3.03
	Rangpur-Dhaka		15.89	46.30			2.76
N702	Jessore-Magura		13.31				2.86
	Magura-Jessore	0.10	4.74				3.16
N704	Kustia-Bharamara	0.02	10.11	48.52		1.94	2.40
	Bharamara-Kustia	0.12	11.85	55.21		1.79	4.11
	Average	0.22	9.68	32.79	12.74	1.10	2.96
R170	Chittagong-Cox's Bazar	0.77	7.59	0.00	13.73	0.89	3.11
	Cox's Bazar-Chittagong	0.04	9.22	0.00		0.90	3.27
R370	Netrokona-Mymensingh		5.20	0.00		0.89	3.10
	Mymensingh-Netrokona		4.90	0.00		1.06	2.71
R685	Rajshahi-Manda	0.12	6.91	0.00		0.09	2.71
	Manda-Rajshahi	0.77	4.31	0.00		0.10	2.29
	Average	0.42	6.35	0.00	13.73	0.66	2.86
Z1422	Haziganj-Lakshipur	1.12				0.81	
	Lakshipur-Haziganj					0.42	
Z8031	Gopalganj-Katalipara	0.09	4.50			0.13	3.13
	Katalipara-Goplganj	0.01	0.35			0.12	3.41
	Average	0.40	2.42			0.37	3.27

RHD Pavement Design Guide recommends the following ESAL:

Light Truck	:	1.0	Medium Truck	:	4.62
Heavy Truck	:	4.8	Mini Bus	:	0.50
Standard Bus	:	1.0			

The observed loading situation against these permissible values are presented graphically in Figure 3-5, Figure 3-6 and Figure 3-7.

Figure 3-5 : Equivalent Standard Axle Loads on National Roads

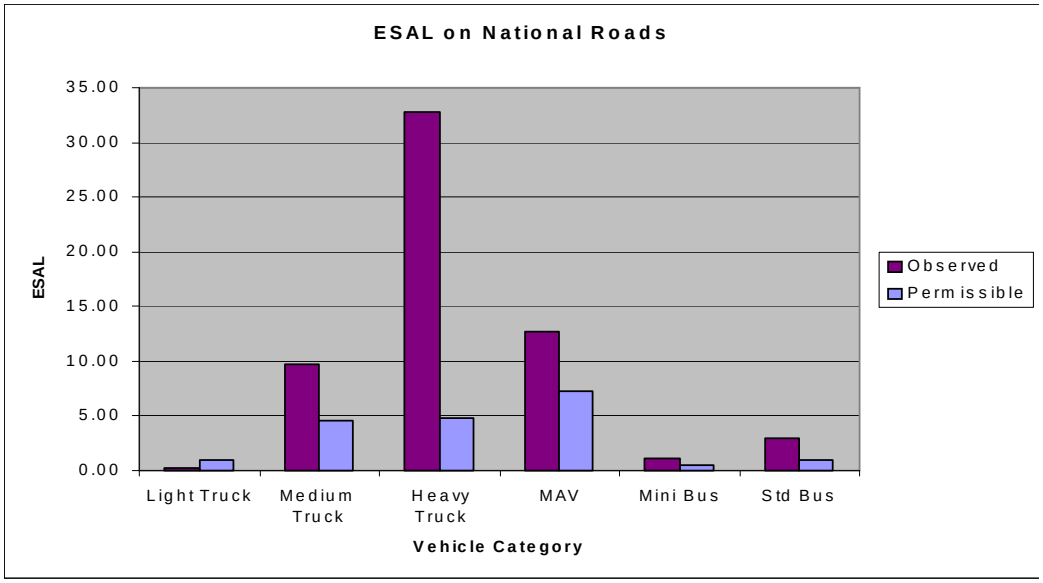
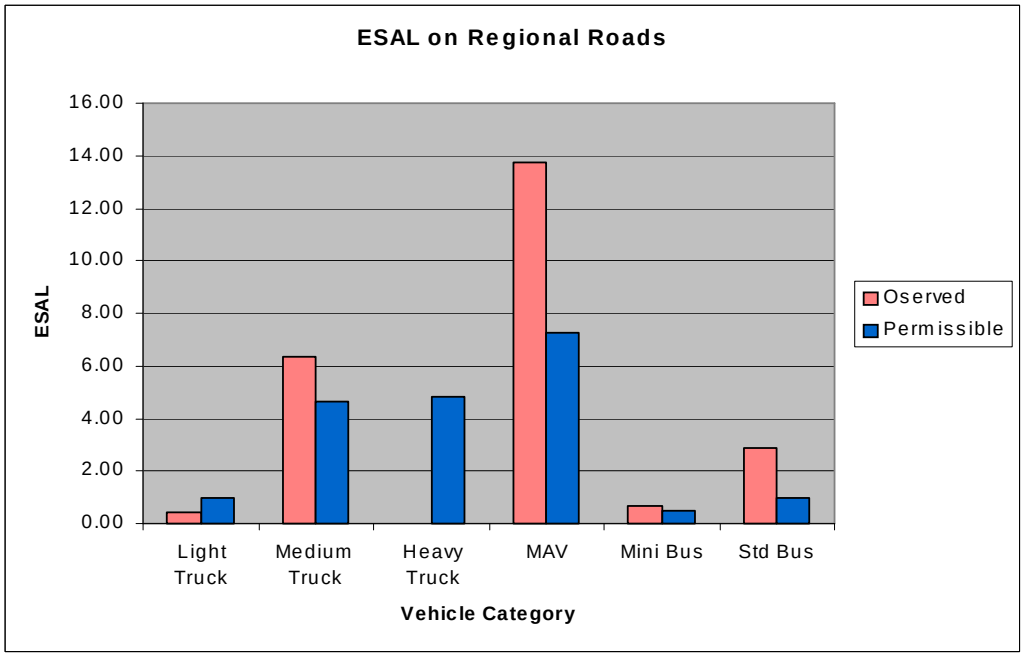
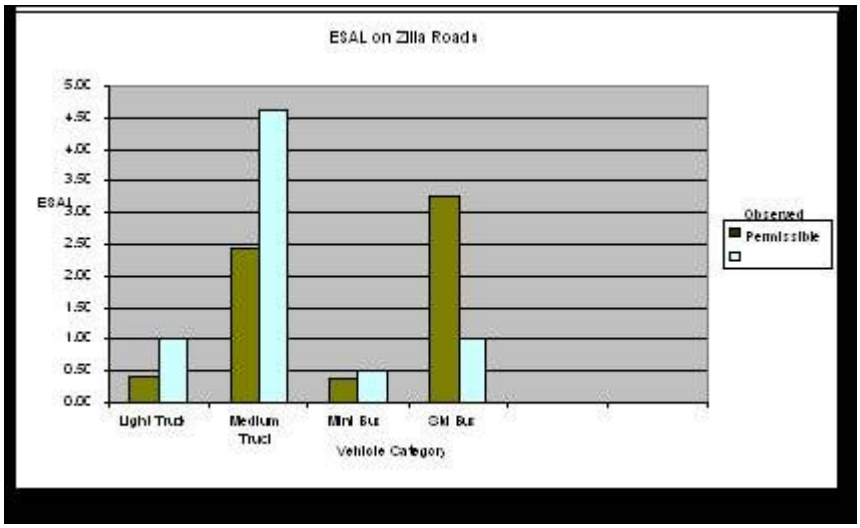


Figure 3-6 ; Equivalent Standard Axle Loads on Regional Highways



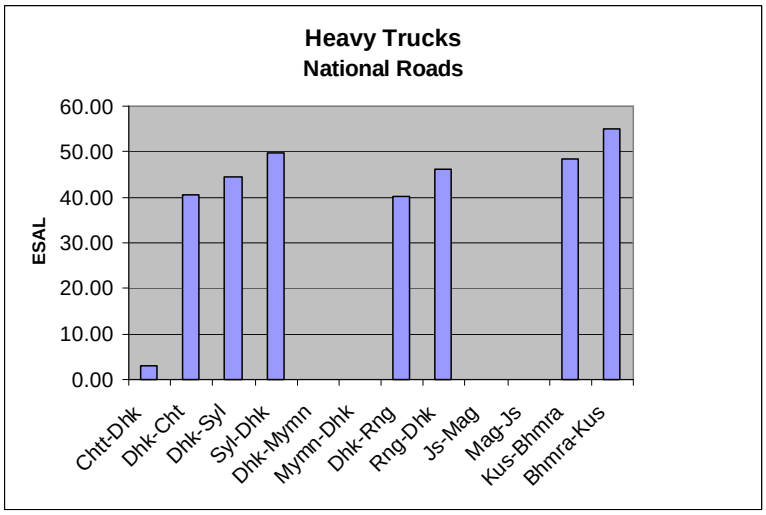
The medium trucks, the heavy trucks and MAV on National Roads were observed to be highly overloaded. The standard buses invariably exhibited almost twice the permissible ESAL.

Figure 3-7 : Equivalent Standard Axle Loads on Zila Roads



The situation on National Highways for heavy trucks is presented in Figure 3-8.

Figure 3-8: Equivalent Standard Axle Loads of Heavy Trucks on National Roads



3.4.4. The Destructive Nature of Overloading

3.4.4.1. Survey Results

Key findings from the surveys can be summarized as follows:

- medium trucks are the predominant freight vehicle type plying on national and Regional Highways;
- buses are frequent on these roads;
- N1 Dhaka-Chittagong corridor experiences high levels of overloading;
- N1 Chittagong-Cox's Bazar route is also subjected to overloading;
- overloading is direction specific on N1, which is to be expected when port traffic is concerned, because imports (steel, food grains etc) are heavier than exports (garments);

- heavy (3-axle) trucks are the worst offender while carrying building materials like stones and sand to Chittagong from the north;
- standard buses also overload considerably;
- on Zila roads, trucks were few and lightly loaded. Standard buses were also found to be overloaded on these roads;
- on average, there is

⇒ 7-8 t overloading on medium trucks. Up to 22 t on rear axle was observed

⇒ 12-t overloading on heavy trucks. Up to 21 t on each tandem axle was recorded

⇒ 3-t overloading on standard buses. Up to 17 t on rear axle was measured;

- other modes are either too few in number or show negligible or no overloading; and
- few empty trucks were found implying the operators attempt to make full utilisation by avoiding empty trips. A nominal 5% empty proportion was assumed for analysis.

Figure 3-9 shows top down cracks observed in the tyre tracks on the N1 Dhaka-Chittagong Highway. Contemporary research has revealed that overloading is the dominant contributory factor of top-down cracks.

Figure 3-9 : Top Down Cracks, N1 Dhaka-Chittagong

3.4.4.2. Implications of Overloading

Pavement structural design requires a quantification of all expected loads that a pavement will encounter over its design life. Under the ESAL method, all loads (including multi-axle loads) are converted to an equivalent number of 8160 kg single axle loads, which is then used for design. A "load equivalency factor" represents the equivalent number of ESAL for the given weight-axle combination. As a rule-of-thumb, the load equivalency of a particular load (and also the pavement damage imparted by a particular load) is roughly related to the load by a power of four. For example, a 16,000 kg (16 T) single axle load will cause about 16 times the damage as an 8160 kg (8.16 T) single axle load.

The general 4^{th} power relationship between ESAL for a 2-axle vehicle and the standard axle loads is:

$$ESAL = (FAW/6.6)^4 + (RAW/8.16)^4$$

Where FAW = front axle weight and RAW = rear axle weight in tonnes

Table 3-22 shows some typical load equivalencies (note that spreading a load out over two closely spaced axles reduces the number of ESAL).

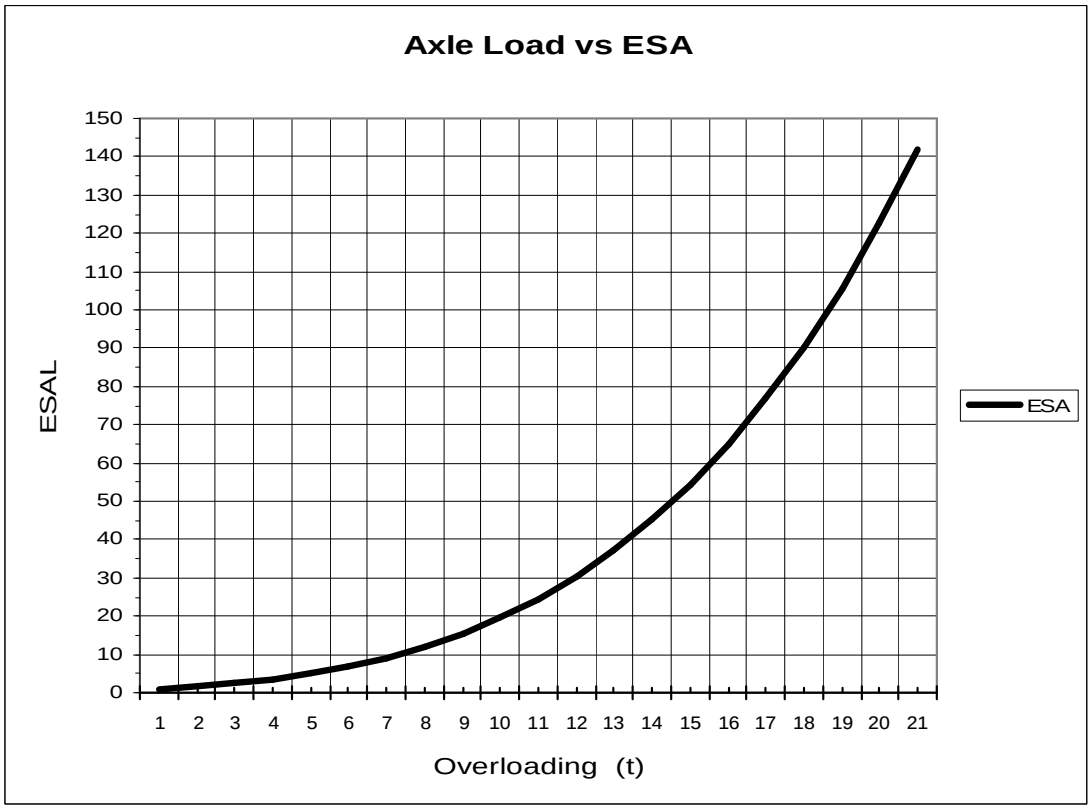
Table 3-22 : Example of Load Equivalencies

Load	Number of ESAL
8160 kg 2-tyred front axle	2.34
8160 kg 4-tyred single axle	1.00
1000 kg 4-tyred single axle	0.0002
14000 kg 4-tyred single axle	8.70
8160 kg 8-tyred tandem axle	0.09
14000 kg 8-tyred tandem axle	0.76

Overloading of an axle therefore has severe effect on the pavement.

Figure 3-10 illustrates the disproportionately large damage imparted to the pavement by every unit increase in overloading.
One of the primary functions of a pavement is load distribution and the pavement design must account for the expected lifetime traffic loads. Since a pavement is designed for the cumulative repetition of equivalent axle loads likely to be imposed, the effect of increase in ESAL because of uncontrolled overloading would be reduction in the life of the pavement i.e. the pavement would fail earlier than it is designed for. Figure 3-11 illustrates this point.

Figure 3-10: Increase in ESAL with Overloading



The initial detrimental effect is rapid and the trend flattens after 5 tonne overloading. This is particularly worrying as the cascading deterioration in the beginning leads to failure of the entire

pavement structure. In addition, the slowing down of loaded vehicles because of poor road condition accelerates the pavement failure process.

The pavement should be designed at least for a higher load limit (say 10.2 t, which means about 2-t overloading). This would ensure that the pavement would last longer (a 2-t overloading would mean about 9-yr loss of pavement life against 14-yr loss if designed for 8.2-t load limit).

Although elastic theory predicts fatigue failure of bituminous pavement layers from load repetition, the effect of application of high intensity point load, even instantaneously, can be most damaging to the entire pavement structure. Research on the damaging effect of extremely high tyre load on flexible and rigid pavement, even when applied over short periods, has been initiated.

In order to sustain the overloaded vehicles, the pavements have to be designed with higher thickness, which translates to higher cost of construction. Standard design methods recommend more or less constant thickness of base and sub-base courses in flexible pavement. To account for excessive axle loads, thicker bituminous binder course (which is an expensive material) layers have to be provided. The increase in unit cost with increase in overloading is shown in Figure 3-12, as calculated in terms of additional binder course thickness.

Figure 3-11 : Loss of Pavement Life with Overloading

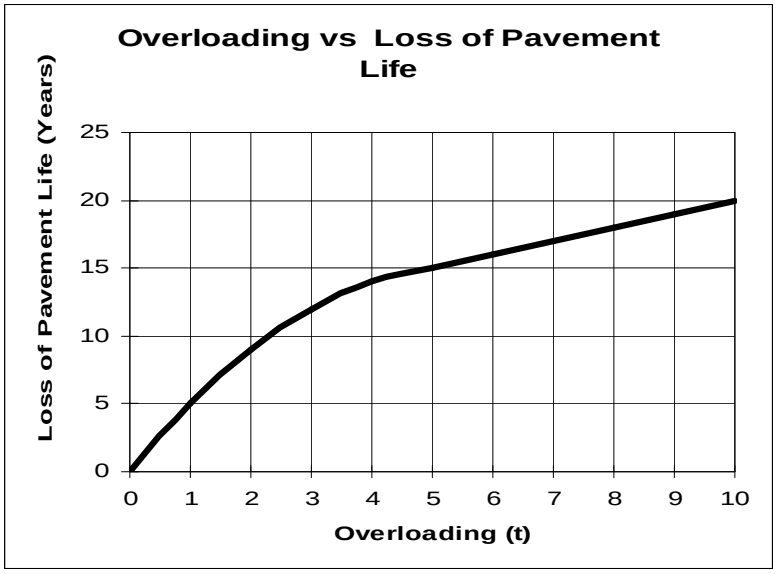
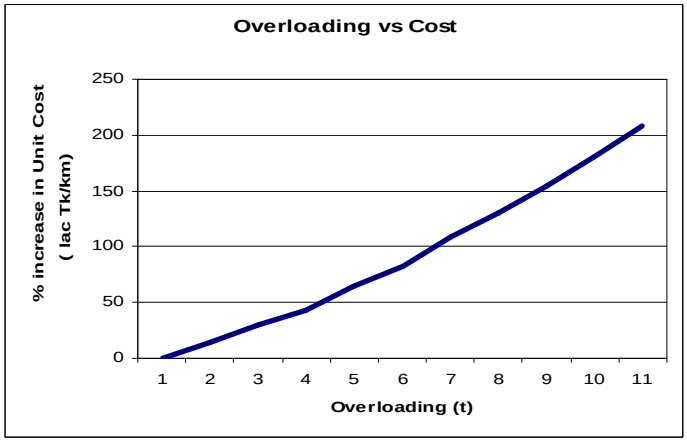


Figure 3-12: Increase in Cost due to Overloading



3.4.5. Conclusions regarding Overloading

Using HDM-4, the study tested the effects of the above findings on RHD roads. The additional maintenance costs caused by overloading are estimated to be over Tk. 300 Crore per year, excluding rebuilding costs. The destruction caused by overloading in Bangladesh is not sustainable. Unless action is taken on the recommendations, the whole effort of this Masterplan will be meaningless.

3.5. Operational Problems on Major Highways

3.5.1. Introduction

It has been observed that the encroachment on the RHD's Right of Way is a regular phenomenon. Unscrupulous people construct shops and establish bazaars on the roadside government land and thereby obtain illegal benefits. These encroachments are the constant source of obstructions and interruption on the through traffic movement on the roads. These affect the safety of pedestrian and motorized traffic. These encroachments have considerable adverse impacts on the operational efficiency of the traffic moving on the highways.

The factors that constrain operational efficiency include: hats and bazaars located on the edge of national highways; plying of non-motorized transport on the main carriageways; stopping of trucks/buses, loading-unloading or parking on the carriageway or shoulder; absence of protected pedestrian crossings and foot over-bridges; and a lack of enforcement of traffic rules and regulations. As a result, the national economy is not getting the optimal return on the huge investments already made on road infrastructure. To address this operational problem, as part of the Road Master Plan preparation, a field study was undertaken covering all the major national highways of Bangladesh. In the subsequent sections, the major findings and the possible solutions to the problems affecting operational efficiency have been presented.

3.5.2. Coverage of the field study

The eight most important national highways N1 to N8 covered by the study have a total length of 2184 km. Besides encroachment on the highways which has direct impact on the operational efficiency, traffic volume and road geometry, as well as road furniture also adversely affect the efficiency. The field study therefore, covered all the above aspects, which are detailed below.

3.5.3. Major problems affecting operational efficiencies

(i) Impacts of haats and bazaars along the highways

A physical survey of 8 national highways having a total length of 2184 km, revealed that there are at least 139 haats and bazaars located along these highways, which stretch over a total length of 73 km. The approximate location of these haats and bazaars are shown in Table 3-23.

The highway traffic faces considerable congestion as they pass through these haats and bazaars, because they are required not only to reduce their speed but sometimes compelled to stop completely, which increases the travel time. Some of the main reasons behind such congestion at the haats and bazaars are: (i) presence of non-motorized transport (NMT) which are plying on the carriageway creating hindrance to through traffic; (ii) buses stopping on the carriage-ways for dropping and picking up passengers, blocking almost 60 % of the road;(iii) trucks are stopping on the shoulder for loading and unloading of goods; (iv) rickshaws, cycle-vans, auto-rickshaws stand and park on the shoulder or very near to the pavement; and (v) a large number of pedestrians moving on the road (irrespective of footpath) without caring for the through traffic. The situation deteriorates further on haat days, which occurs 2-3 times in a week.

It was also observed that congestion was occurring in the bazaar portion of the carriageway where road has not been widened. It was further observed that even where the carriageway has been widened to 4-lanes, the 2nd lanes of the 4 lanes portion of the carriageway were found to be used by buses, rickshaws, tempos for stopping, and for loading/ unloading of goods from trucks. Thus in order to overcome the problem of congestion created by encroachment on the shoulders and carriageways, it would be essential to provide dedicated lanes for buses, trucks and NMTs together with well designed spaces for their loading/unloading, ensure strict enforcement of traffic rules and regulation and provisions for well located passenger sheds and ticket booking counters.

Table 3-23 : No of Haat/ Bazaars Causing Traffic Congestion

Sl No	Road No	Name of Road	No of haat /Bazaars
1	N1	Dhaka-(Jatrabari)-Comilla-(Mainamati) –Chittagong-Teknaf	19
2	N2	Dhaka-(Katchpur)-Bhairab-Jagadishpur-Saistagong-Sylhet-Jaflong	11
3	N3	Dhaka-(Banani)-Joydevpur-Mymensingh	10
4	N4	Joydevpur-Tangail-Jamalpur	12
5	N5	Dhaka-(Mirpur)-Utholi-Paturia-Natakhola-Kashinathpur-Hatikamrul-Rangpur-Beldanga-Banglabandh	46
6	N6	Kashinathpur-Dasuria-Natore-Rajshahi	12
7	N7	Daulatdia-Faridpur-(Goalchamot)-Magura-Jhenaidah-Jessore-Khulna- Mongla	21
8	N8	Dhaka-(Jatrabari)-Mawa-Bhanga-Barisal- Patuakhali	8
Total:			**139**

It is important to note that most of the encroachments referred to above are unauthorized. Most of these structures when built initially on the edge of shoulders did not interfere directly with the traffic. But when these structures are used for commercial purposes, haats and bazaars start developing around them. As a result, local traffic is generated and pedestrian activities increase manifold on particular stretches of the road along the bazaar creating hazards for moving vehicles.

Recently the Government has taken action to evict these unauthorized structures from roadside land owned by the Government. Despite this move, out of 139 encroachments, there are still 54 locations where such encroachments either in the form of haat and bazaars or intersections are continuing to cause traffic congestion on the major national highways.

In order to get rid of encroachment on roadside Government owned RHD lands, there are Acts, Laws and rules, which are quite adequate. But the enforcement of these rules, and regulations by the relevant authorities, has been very weak. This aspect needs to be addressed.

(ii) Impacts of traffic volume on operational efficiency

The level of traffic and its composition has direct impact on the operational efficiency of the highways. On the National Highways, which are mostly 2-lane roads, there are certain percent of non-motorized transport (NMT) plying along side the motorized transport. This situation adversely impacts the operational efficiency of the highways vis-å-vis their designed capacities. The presence of NMT on national highways will continue to affect the carrying capacity and the level of operational efficiency till such time that these are physically segregated from the main stream movement on the carriageways.

(iii) Impacts of road condition, geometry and road furniture on operational efficiency

It is well recognized that road condition, geometry and road furniture have direct impact on the capacity of the highway as well as on the operational efficiency. The physical survey carried out along 8-national highways covering a length of 2184 km revealed that depending on the condition and geometry of the highways, the network could be divided into five different categories as shown in Table 3-24.

Table 3-24 : Summary of Road Operating Categories

Category	Definition of road condition
Very Good	Road sections having nearly perfect condition of pavement and hard shoulders, suitable for high degree of performance. The centerline, edge marking and other types of road markings, sign /signals etc available along almost entire length of the road. No hindrance from traffic congestion due to haats and bazaars or poorly designed intersections. Sight distances are also nearly perfect and adequate cross drainage is properly maintained.
Good	Road sections having an acceptable degree of road geometry and other features and where the riding quality reasonable. All types of road marking, sign/signals, advance distance signboard, etc. are available but not entirely adequate. Sight distance in case of curves is appropriate and cross drainage is OK. Congestions are infrequent.
Fair	Road geometry and road furniture are of reasonable condition. Riding quality is reasonably good. Occasional traffic congestions are encountered in certain stretches of the road, particularly during weekly market days. Level of operation, in totality, cannot be said to be good enough.
Poor	Riding quality is not good. The paved surface is partly deteriorated e.g. ruts, cracks, potholes, undulations and roughness of the surface are noticeable. Hard shoulder is damaged or missing and earthen shoulder is also undulated and poorly maintained. Traffic congestions are also frequent.
Very poor	Such case may arise in the National Highways when the road geometry, surface and other features are greatly damaged which may be due to natural calamity or disaster like flood or cyclone etc. This category shall indicate that traffic cannot operate on such roads without great difficulty and the level of operation is therefore, graded as very poor.

3.6. Road Safety

3.6.1. Introduction

Bangladesh is experiencing a very severe road safety problem and the situation has been deteriorating with increasing number of road accident deaths. This has been happening largely as direct consequences of rapid growth in population, motorization, unplanned urbanization, lack of strict enforcement of traffic rules and regulations, careless behaviour of heavy vehicle drivers and lack of adequate investment in road safety related activities. Bangladesh is a densely populated country with around 150 million inhabitants living in an area of 147,570 sq. km. area i.e. 950 persons per sq. km. The contribution of the transport sector[16] to the GDP at constant prices is about 7 percent. Around 25 percent of the population is currently living in urban areas, and this is expected to rise to 30 percent by 2010 and to 50 percent by the year 2025. This alarmingly high growth rate which will have an adverse impact on roads safety, without institutional and other reforms.

3.6.2. Accident Statistics

An analysis of the reported road accident data showed that in 2003, out of 4,114 reported accidents, there were at least 3,334 fatalities and 3,740 injuries. It was estimated that the actual fatalities could well be 10,000 - 12,000 each year. This indicates that accident data collection and recording is far from perfect. It is, therefore, very crucial that the present system of accident data collection be improved.

The accident statistics revealed that number of fatalities has been increasing, and Bangladesh has one of the highest fatality rates in road accidents, over 100 deaths per 10,000 motor vehicles. This rate is at least 50 times higher than the rates in Western Europe and North America, where such a rate is in fact declining[17]. The fatality rates per 10,000 motor vehicles in some of the other Asian countries are only 4 in Malaysia, 12 in India.

[16] Including storage
[17] Hoque M.M., 2006

In economic terms, road accidents in Bangladesh are costing the community in the order of Tk. 5,000 crore (US $ 850 million), which is nearly 2% of GDP. These figures indicate that road safety is a serious national issue as it affects each and every one of us, whether drivers, travellers or consumers and therefore, demands urgent attention. Road safety should be declared as a *National Priority* by the Prime Minister.

A research study undertaken in Bangladesh in 2003 by TRL & Ross Silcock found that 21 percent of road traffic deaths occurred to household heads among non-poor people, while 32 percent were from poor people. Thus poor people are the major victims of road accidents. Generally speaking, people of 15-44 years old account for more than 50% of all road traffic deaths, and 73% of the people killed are male. The victims being the main earning members of the families involved, they suffer a great deal both financially and otherwise. For the poorer families this effect is much more significant.

Further analysis of the accident data revealed that nearly 37% of the accidents occurred on National Highways, 12% on Regional Highways and 15% on Zila/ Upazila roads. In urban areas, 40% of the accidents occur at intersections while in rural areas during the period 1999-2003, 43% of the accidents on National Highways occurred on 5% of their total length. During the same period, out of all reported accidents, 65% were fatal, 24% were serious, 6% were simple and the remaining 5% were collision type.

3.6.3. Factors contributing to accidents

It is important to understand the causes of accidents. The most common accident types are: hit pedestrian (43.7%), rear end collisions (16.4%), head on collision (13.3%), and overturning (9.4%). These four accident types account for nearly 83% of the accidents. In case of fatal accidents, hit pedestrian accounts for 52.9% followed by rear end and head-on, each 11.9% and overturning 9.8%.

With regard to the causes of road accidents, over 58% are related to human factors and behaviours which include over speeding, overloading, dangerous overtaking, reckless driving, carelessness of road users, failure to obey traffic regulations and ineffective or inefficient enforcement. Another 34% are related to adverse road conditions and roadside environment including poor detailed design of junctions and road sections including road signage. The remaining 8% could be attributed to mechanical faults or defective motor vehicle and conflicting use of roads. The above figures indicate that an integrated multi-disciplinary approach would be needed to effectively deal with all aspects of road accidents. The Accident Research Centre at BUET has already started to include this in its programme.

Studies further revealed that heavy vehicles (both driving and vehicle condition) are major contributors to road accidents (bus/minibus 33%, truck 27%, and in fatal accidents their shares are 35% and 29% respectively. This group of vehicles is heavily involved in pedestrian accidents accounting for about 68% (buses 38% and trucks 30%). Pedestrians are by far the most vulnerable road users in Bangladesh, as they are involved in more than 47% of road accidents and 49% of all fatalities. In urban areas, the percentage is still higher.

In 2004, 25% of fatalities on National Highways occurred on just 12% of the length of the network. The worst stretches of road are shown in Table 3-25. These roads should be the subject of priorities for physical and other measures to reduce accident risk.

Table 3-25 : Worst stretches of National Highways for fatal accidents

Road No.	Name	Fatalities per M Vehicle-km	Fatalaties	Length (km)
N2	Ashugong Sarail	225	19	12
N7	Magura Jhenaidah	149	20	28
N804	Faridpur Bhanga	115	32	30
N508	Dinajpur Beldanga	109	6	16
N104	Feni Noakhali	107	35	49
N506	Rangpur Kurigram	104	17	50
N1	Cox's-Bazaar Teknaf	103	14	79
N1	Comilla Feni	95	69	64
Total			**212**	**328**

Source : Road Safety Cell, BRTA

3.7. Environmental and Social Issues

3.7.1. Environment

Water management is a key feature of life in Bangladesh, and has impacts on all parts of society, but because of a lack of coping mechanisms, the poor often suffer the most. Many new road projects suffer from a lack of a full hydrological study.

Water is scarce during the dry season, but abundant enough to cause flooding during monsoon every year. The situation has been further compounded by the indiscriminate construction of rural roads without adequate discharge structures which cause water logging. Water resources management in Bangladesh faces immense challenge for resolving many diverse problems and issues. The most critical of these are alternating flood and water scarcity during wet and dry seasons respectively, expanding water needs of a growing economy and population, and river sedimentation and bank erosion.

Bangladesh is vulnerable to natural disasters, mainly flood, cyclone, tidal surges and drought. Among these flooding is a regular phenomenon. 80% of the country is on a floodplain, and during a normal monsoon flooding affects 25% of total land area, and serious floods can affect up to about 90% of country. In 1988, 92.5 % of the country was affected damaging a large number of roads and bridges. The 2004 flood lasted for 40 days in 42 districts (about 60% of country), and resulted in the need for two major flood rehabilitation projects in RHD.

Drought is common in the northern region. Special transport interventions are needed to improve the conditions of vulnerability of the people in the drought affected areas.

Many Zila roads have been constructed with inadequate water discharge facilities which have been identified as the key reason for water logging and prolonged flooding. Rural road structures constructed with inadequate drainage structures cause water logging and inadequate clearance can obstruct the movement of country boats.

The use of crushed bricks for aggregate – the result of burning wood and coal, leads to pollution, loss of natural resources, carbon emissions, and land loss. Often big ditches are left which are then used as rubbish tips and waste leaches into groundwater contaminating water supply.

Environmental Impact Assessments should be built into all project preparations, but this is rarely done for Government of Bangladesh funded projects. The impact on the environment from construction and traffic, especially pollution, tend to affect the poor the most. RHD's manual for Environmental Assessment focuses on delivering two outcomes:

- minimising / mitigating potential negative impacts;
- maximising the positive benefits.

Use of the Environmental Assessment Manual is now mandatory.

3.7.2. Resettlement and Land Acquisition

There are serious poverty issues relating to the fact that the poor often use land without legal permission and so are not entitled to compensation under current GOB legislation. Resettlement and land acquisition may have a negative impact on the livelihood choices of the poor and vulnerable. RHD has drafted and approved 'Social Assessment Guidelines' and 'Land Acquisition and Resettlement Guidelines'. These should be incorporated into new legislation.

3.7.3. Human Trafficking

Women and girls have a very low status in Bangladesh society and this is reinforced by social constraints, religious taboos, traditional customs and values. The deep rooted gender discrimination leads to widespread incidence of neglect, violence, trafficking and sexual abuse towards girls and women. Girls are given fewer opportunities than boys and quite often the girls are looked upon as a burden for the family. Although it is against the law, poor families are often forcing their daughters into marriage at a very young age. Biharis (stranded refugees) and the ethnic minorities in the Chittagong Hill Tracts are totally marginalised and in the highest risk group for ending up as child labourers or victims of trafficking and abuse.

Due to poverty, distress and inadequate support structures in the local communities, migration happens from rural to urban areas within country as well as abroad, in search of work to support the household. In these situations, children are very vulnerable to labour, sexual exploitation and trafficking. The consequences, both psychological and physical, on children vary depending on age, gender and socio-economic status.

There is an extensive trafficking of children internally in Bangladesh, and from Bangladesh primarily to India and Pakistan, where children are in demand as child labourers and child prostitutes. India is both a recipient and transit country. Boys are trafficked through India to the Middle East to work as camel jockeys, girls most often trafficked to the sex market, both within and outside of Bangladesh.

Due to the cross border nature of the trafficking problem, regional cooperation is also a central element in the work, and will aim at securing rescue and repatriation possibilities, but also at gathering information and create the fundament for regional advocacy.

Most human traffic uses roads within the country and cross-border. An improved road network can make trafficking easier. Where there are road projects near the Indian border, there ought to be awareness programmes so that local people fully understand that the potential risk of trafficking will be increased.

3.7.4. HIV/AIDS

The Government does not fully recognize HIV or AIDS as a serious problem. However, taking the high prevalence in neighbouring countries into account there is a growing concern among international organisations and NGO's that the problem is another emerging threat. Major road and bridge works, where labour camps are set up and workers live for 3-4 years, are a potential source of HIV or AIDS. There is a high prevalence of prostitution and extra-marital sex in such camps.

International experience suggests that the improvement of the inter-Regional Highway network is likely to lead to an increase in the incidence of HIV or AIDS along these major transport corridors. This is not a problem that RHD can tackle, but it should work closely with the major NGOs that provide support in this area to develop a mitigation plan.

Under the RNIMP-II Project there is a programme for the improvement of public awareness for HIV or AIDS and women trafficking. The Ministry of Women's and Children's Affairs (MOWCA) has established a steering committee consisting of RHD, MOWCA, the Ministry of Health, the Ministry of Home Affairs, an NGO network (Action Against Trafficking and Sexual Exploitation of Children), and Asian Development Bank. MOWCA will finalise and submit to ADB the negotiated contracts for three NGOs to support implementation of the MOWCA component for anti-trafficking and HIV or AIDS awareness. MOWCA will include representation in the steering committee from the three NGOs.

3.7.5. Employment

3.7.5.1. Positive Opportunities

Roads provide employment opportunities for skilled and unskilled workers. In the short term they provide employment during construction. In the longer term they can provide employment for maintenance. For both of these, some activities can be targeted to local unskilled workers from poor or vulnerable households. Jobs may also be created in supporting the transport services along the road – vehicle maintenance and repair, trade with road users, NMV manufacture and repair etc. The general principle of employment should be 'equal pay for equal work' regardless of gender, age, disability, or ethnic / social group.

Labour based construction and maintenance of roads is a proven means of benefiting the poor, especially women[18]. It can be wage targeted towards the poor and maintenance experience in Bangladesh shows that even the drip feed of part time wages can, with imagination, be exploited to lift the most poor out of poverty. However, the image of labour based works among decision

[18] Bruceson and Howe, 1993

makers needs to be improved through the introduction of modern techniques of work organisation and management.
The ILO[19] Equal Remuneration Convention, 1951 (No. 100) was ratified by Bangladesh in 1998. States having ratified the Convention shall promote and, in so far as is consistent with the methods in operation for determining rates of remuneration, ensure the application to all workers of the principle of equal remuneration for men and women workers for work of equal value.

3.7.5.2. Child Labour

The Government has had increasing focus on the formal sector which has led to a decrease in the number of child labourers in ready-made garment sector, but there has been an increase in child labour in the informal sector. The removal of children from garment factories, has led to an increase in their number in the construction industry, and child labourers in the informal sector include brick chippers working on road projects.
The ILO Minimum Age Convention, 1973 (No. 138), has not yet been ratified by Bangladesh. The Convention sets a number of minimum ages depending on the type of employment or work. The first principle is that the minimum age should not be less than for the age for completing compulsory schooling and in no event less than age 15 or 14 for countries whose economic and educational facilities are insufficiently developed. [Compulsory education in Bangladesh is up to grade 5, approximately 11 or 12 years of age] A higher minimum age should be set for hazardous work. This should not be less than 18. For light work the minimum age can be set at 13 or 12.
The ILO Worst forms of child labour (C182) was ratified by Bangladesh in 2001. The Convention applies to all persons under the age of 18. Worst forms of child labour includes 'work which is likely to harm the health, safety or morals of children'. An accompanying recommendation defines 'hazardous work' as 'work which exposes children to physical, psychological or sexual abuse; work underground, under water, at dangerous heights or in confined spaces; work with dangerous machinery or tools, or which involves heavy loads; work in unhealthy environments which may expose children to hazardous substances, temperatures, noise or vibrations'.
The removal of child labour from road projects can be achieved through contract agreements, but they are hard to enforce.

3.8. Ferries

Ferries play an important role in carrying vehicular and passenger traffic across waterways on the RHD network. There are 48 ferry Ghats now in operation under RHD, see Map 3.10. Through these Ghats over 9,000 vehicles ply across rivers and waterways every day.

The ferry service is required to be kept regular round the clock through out the year by providing proper maintenance. Two types of maintenances are done here. For smooth functioning of ferry ghats, the ferries and pontoons are now used throughout the year as shown in Table 3-26

Table 3-26 : RHD Ferries and Pontoons

Sl No.	Type of ferries	Number	Sl No.	Type of pontoons	Number
1	Steel ferries	32	1	Old pontoon(PO)	38
2	Unifloat ferry	29	2	Modified pontoon (PM)	23
3	Utility(type UT-1) ferry	40	3	Improved pontoon (PI)	218
4	Utility(type UT-2) ferry	100	4	Upazila pontoon (PU)	17
5	Utility(type UT-3) ferry	8			
	Total	**209**		**Total**	**296**

Source : Mechanical Wing, RHD

At 11 ghat locations, ferries will be replaced by bridges as shown in Table 3-27.

[19] International Labour Organisation

Table 3-27 : Bridges under construction

Division	Name of Road	Location of Ferry	Width of water way (m)	Bridge length (m)	Remarks
Nawabgonj	Z 6802 Kansat-Gumostapur-Shapahar Rd	15th km	335	335	Almost complete
Sylhet	Z2831Dhakadaksin-Chandpur-Beanibazar Rd	4th km	180	269	Under construction
Chittagong	N1 Maijjartek-BFDC-Fisheries Rd	2nd km	1,000	980	Karnafuli bridge now under construction
Tangail	R506 Aricha-Ghior-Daulatpur-Nagorpur Tangail Rd	39th km	1,000	700	Tenders received
Munshigonj	Fatulla-Munshigonj-Laohojong Rd.	9th km		1,530	Bangladesh-China friend ship bridge under construction
	Duhar-Bashtola-Jhaokanda-Charbhodrason -Faridpur Rd	8th km			Covered by proposed Padma bridge
Gopalganj	Pirojpur-Nazirpur-Matibhanga-Patgati-Ghonapara Rd	Tungipara	300	390	Under construction
Pirojpur	Togra-Zianagar-Balipara-Kolaran-Sanyashi Rd	2nd Km	300	387	Under construction
Khulna	Khulna(Rupsha)-Terokhada Rd	1st km	500	1,400	Parallel to Rupsha bridge at 500m upstream
Khulna	Gallamary-Batiaghata-Dakup-Nalian forest Road	7th km	260	260	Under construction
Patuakhali	N8	Dapdapia			
Patuakhali	N8	Lebukhali			

Source : RHD

Out of the above, 61 ferries and 61 pontoons are more than 25 years old and are beyond economic repair. Major engine overhauling, major repair and major replacements are done by ferry divisions under RHD's Mechanical Zone. Petty repairs and day to day maintenance required to keep the ferry service operation intact round the clock are done by the civil operation zones. The Mechanical Zone generally makes surveys of the ferries and pontoons and prepare estimates, call tenders, select bidders and give work orders. Work is done under supervision of S.O, SDE and Executive Engineer of the Mechanical Zone.

Most ferry ghats are leased out to private operators who are supposed to provide fuel and lubricants. The Mechanical Zone looks after the engine condition and they take care for regular and smooth functioning of ferries. They take care of pontoons as well when major repair/replacement is required. Around Taka 15-20 Crore are spent by the ferry unit alone with a far bigger amount spent by the operation unit for maintaining and operating the ferry ghats.

3.9. Institutional Issues

3.9.1. Organisation and Staff

The Roads and Highways Department's stated aim is to become a modern Highways Agency in an International Context, and it has made great strides over the last ten years towards this. It still remains an organisation which appears to be very hierarchical institution. However, many projects tend to be managed independent of the central management.

From a nominal number of posts of nearly 20,000, current staff strength is about 11,800, of which over 8,000 are in "temporary" posts. 61% of all sanctioned posts are vacant. Many "temporary" staff are long term. Many posts in Class III and IV are no longer relevant for present requirements of a modern organisation.

RHD consists of an aging workforce, in particular amongst Class 1 senior officers, and there will soon be insufficient numbers to fulfil management obligations. 56% of Class 1 officers are 51

years old or older and will all have retired in 7 years time. By 2010, 13 of the 17 Additional Chief Engineers will have retired.

An interim re-organisation for RHD has been approved and largely implemented. A further, far-reaching re-organisation is required to complete this process, but this is likely to meet with strong opposition from the Ministry of Establishment.

3.9.2. Budgetary Control and Financial Issues

In RHD the Executive Engineers have disbursement capabilities. This means that RHD Officers can be Procurer, Paymaster and Engineer in the same projects. In addition to this issue, the audit function is nominal. The Central Management System (CMS) has improved this, but is not fully used yet but it is improving.

3.9.3. RHD Issues of Management Culture

Within RHD there are several collective and supportive organisations (or unions) including the cadre of first class officers. These unions are powerful and can mobilise strong support, and some have demonstrated their ability to close down RHD operations if required.

3.9.4. Current Institutional Change Initiatives in RHD

RHD has been the subject of several institutional studies and development programmes over the years. This is to be expected in the main roads agency of a developing country. Some initiatives have been relatively successful, for example the development of the computer based HDM/RAMS model, whereas others have not been successful, for example the large amount of work which has been undertaken to try to improve the quality of construction works.

3.9.4.1. Transport Sector Management Reform (TSMR)

The longest lasting programme, and the one which is still working within the MoC/RHD is the DFID funded TSMR programme, an extension of the IDC (Institutional Development Component). The objective of this institutional strengthening programme was to modernise RHD with an emphasis on contracting out most of its services, focusing on effective collection, management and analysis of data, thereby permitting the fulfilling of its strategic planning role.
The programme has been partially successful and the latest phase is concentrating on developing the computer based financial/progress monitoring system (CMS), embedding the HDM/RAMS suite, and improving the work on the DFID and JBIC (debt forgiveness) funded Periodic Maintenance Programme (PMP). These programmes are developing, but they all lack real GOB sustainability support. RHD also has several completed initiatives which are in danger of becoming vestigial with the external support removed. The Road Safety and Environmental Circles are not working as they should, the RHD Training Centre lacks funding and has non-permanent posts, and the management manuals are not in use.

3.9.4.2. Institutional Development Action Plan

The World Bank initiative to produce reform in this sector is given the name of IDAP (Institutional Development Action Plan). The main body of this is in the form of a large matrix of suggested actions which have been derived from a variety of sources. There is a proposal for an RHD based TA project to develop the IDAP and facilitate the sector improvements from within it. It is worth noting that two of the sources for the IDAP were the ADB inspired RHD Road Map along with the output from the IDC projects.

3.9.4.3. Operational Risk Assessment

Final Report issued in June. The World Bank Operational Risk Assessment is still reporting. Discussions with the team during their time in Dhaka suggest that they will recommend a series of structural changes which will be required to RHD and other parts of government. Clearly this needs resolution. There is no doubt that in order to achieve the changes required to produce the institutions of the future, external funding will be required. Most importantly, the changes require the Ministries of Communications and Establishment to support the ideas, push through the ideas and include them in the rules and regulations that the RHD works within.

4. FUTURE SCENARIOS

4.1. Population Growth

The population of Bangladesh is expected to grow considerably over the next twenty years. Unofficial forecasts prepared by the Bangladesh Bureau of Statistics and World Bank are shown in Table 4-1.

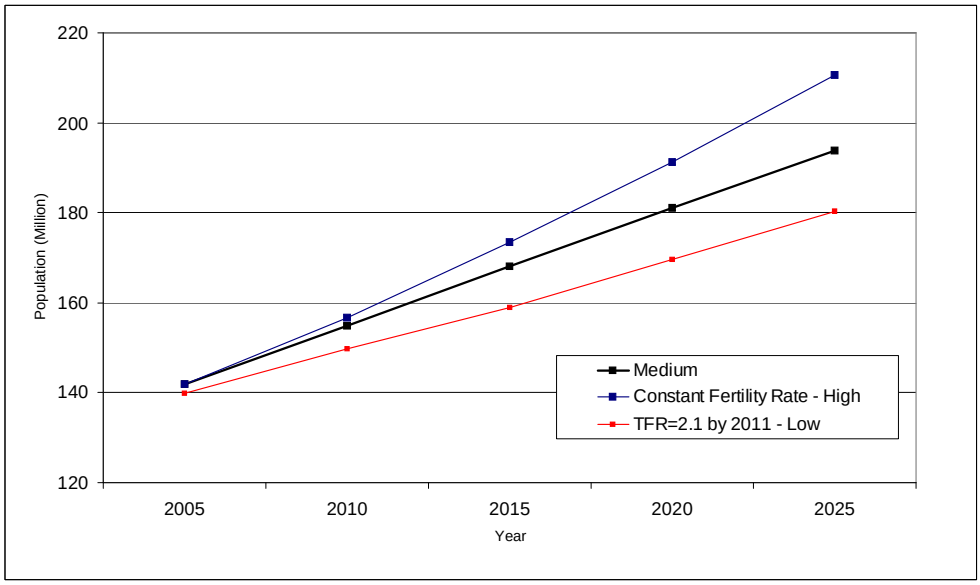
Table 4-1 : National Population forecasts

Year	Medium	High	Low	Constant Fertility Rate	TFR=2.1 by 2011	TFR=2.1 by 2016	TFR=2.1 by 2021
1970	64.9	64.9	64.9	64.9	64.9	64.9	64.9
1975	73.2	73.2	73.2	73.2	73.2	73.2	73.2
1980	82.2	82.2	82.2	82.2	82.2	82.2	82.2
1985	92.8	92.8	92.8	92.8	92.8	92.8	92.8
1990	104.0	104.0	104.0	104.0	104.0	104.0	104.0
1995	116.5	116.5	116.5	116.5	116.5	116.5	116.5
2000	128.9	128.9	128.9	128.9	128.9	128.9	128.9
2005	141.8	141.8	141.8	141.8	139.8	139.8	139.8
2010	155.0	156.5	153.4	156.7	149.7	150.5	151.5
2015	168.2	172.3	164.0	173.4	159.0	161.6	163.4
2020	181.2	188.9	173.5	191.3	169.5	172.2	175.0
2025	193.8	205.4	182.2	210.5	180.2	182.9	185.7

TFR = Total Fertility Rate

For this study, the extreme high and low, and medium variant have been adopted, as shown in Figure 4-1.

Figure 4-1 : Population Forecasts adopted for RMP

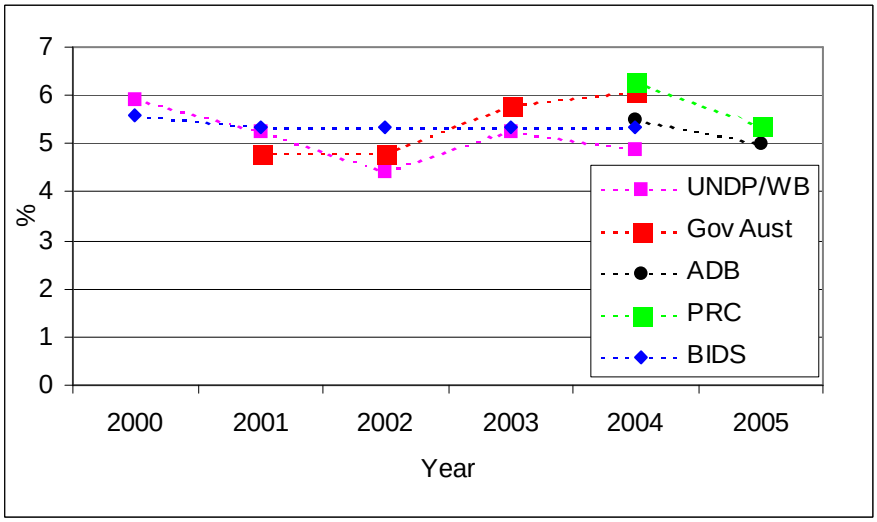


The effective growth rates in population over the twenty-year period 2005 to 2025 are Low: 27%; Medium: 36%; and High: 48%.

4.2. Economic Growth

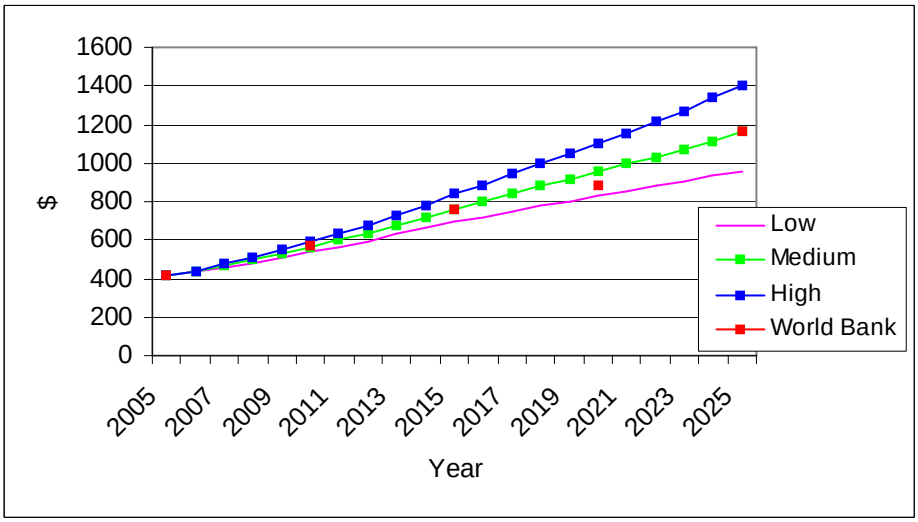
Recent GDP growth in Bangladesh has averaged around 5.5% per year, as shown in Figure 4-2.

Figure 4-2 : Year on Year GDP Growth, 2000 to 2005



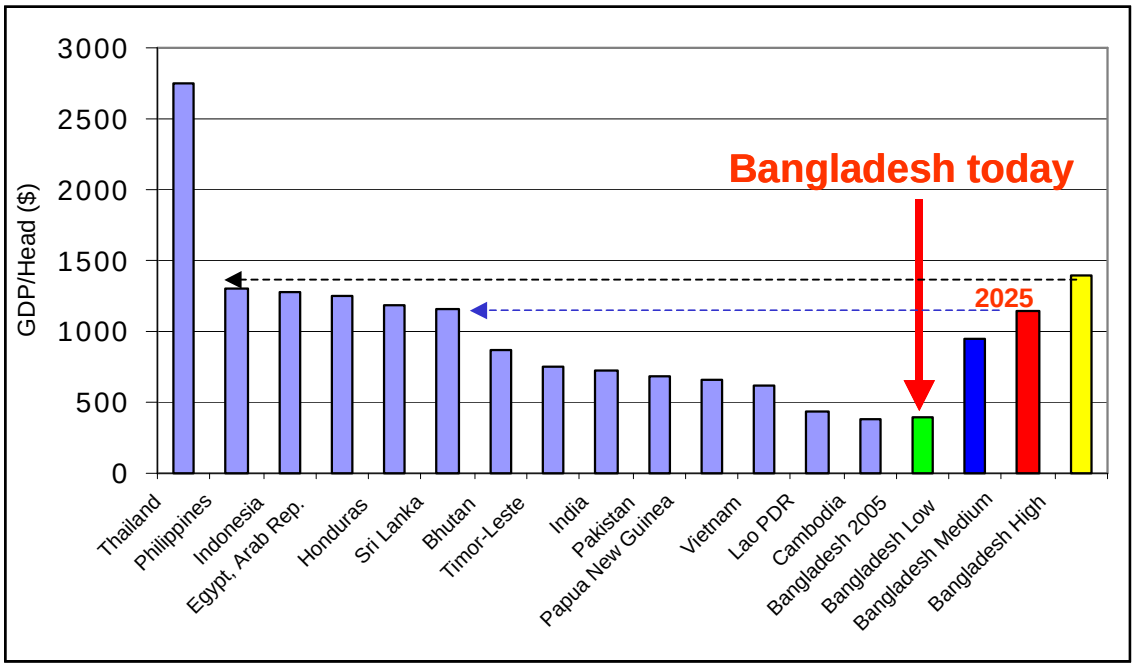
In developing assessments of what future economic growth might be, it was assumed that a continuation of the 5.5% growth would be a reasonable central assumption. This is very much in line with world Bank assumptions. Either side of this, low growth was assumed to be 4.5% per year, and high growth 6.5% per year. The forecast GDP per capita resulting from these are shown in Figure 4-3

Figure 4-3 : GDP Per capita forecasts ($)



The consequences of these levels of economic growth are seen in Figure 4-4 in which forecasts for Bangladesh in 2025 are compared with GDP per capita figures for Asian countries in 2005. The purpose of this is to enable a view to be taken of the *reasonableness* of the forecasts. For example, under the medium growth scenario Bangladesh would in 2025, have the same level of GDP per capita as does Sri Lanka today. Under the high growth scenario, Bangladesh would have the same level of GDP per capita as does the Philippines today.

Figure 4-4 : Comparison of Bangladesh Forecast GDP with other Asian Countries

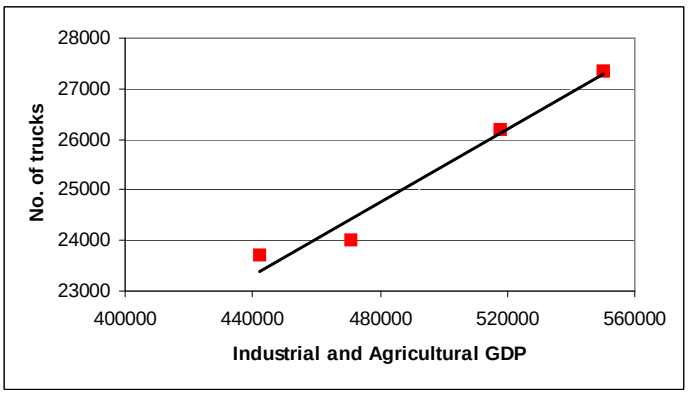


4.3. Vehicle Growth

4.3.1. Trucks

For this study a relationship was derived between the number of trucks in Bangladesh and industrial and agricultural GDP as shown in Figure 4-5.

Figure 4-5 : Recent growth in registered trucks related to GDP



Using the above relationship growth factors (relative to 2005) for trucks were prepared as shown in Figure 4-6

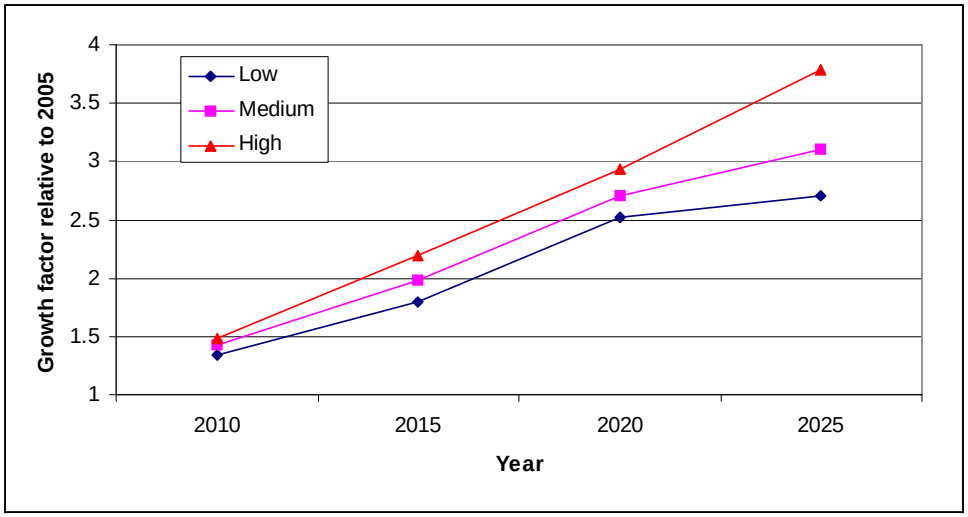


Figure 4-6 : Growth Factors for Trucks

4.3.2. Buses

Bus passenger numbers and bus services are assumed to grow in line with population and current trends in vehicle registration growth. Most recently, the typical year-on-year rise in bus registrations has been around 4%. This is taken to be the medium estimate, with low growth assumed to be 3% per year, and high growth 5% per year. Whilst this might under-estimate the propensity for increased travel with growth in GDP, this is counter-balanced by the shift towards private car travel, and train travel with the proposals for improving the railway network[20]. Figure 4-7 shows the forecast growth in bus travel.

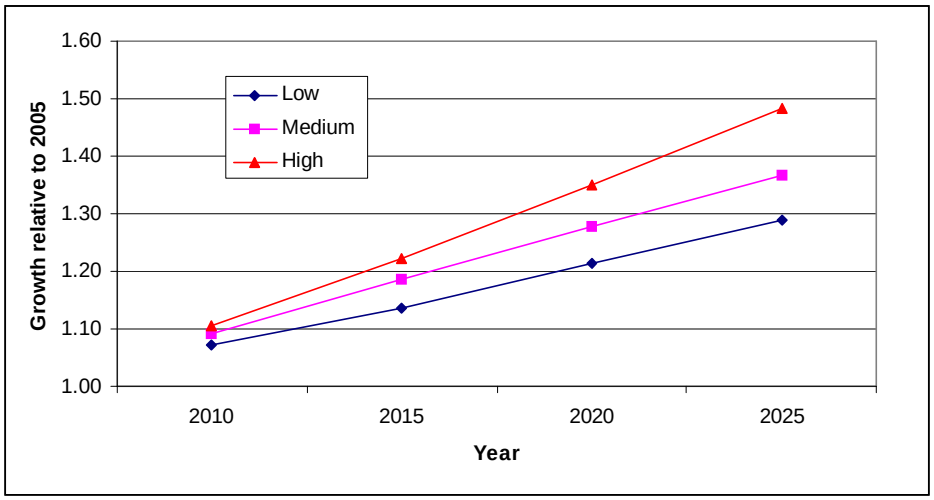


Figure 4-7 : Growth factors for Buses

4.3.3. Cars

Figure 4-8 shows car ownership in selected Asian countries. Using this and GDP data it is possible to derive a relationship as shown in Figure 4-9. Using this relationship estimates of car growth rates are shown in Figure 4-10.

[20] Bangladesh Railway, Railway Development Plan – Interim Report, April 2007

4.3.4. All Vehicles

Taxis, auto-rickshaws and other motorized vehicles have been grouped as 'Other' Their growth rate is assumed to be an average of car and commercial truck growth. Annual average growth rates, by vehicle type used in this study are summarized in Table 4-2

Figure 4-8 : Car Ownership in selected Asian countries, 1997

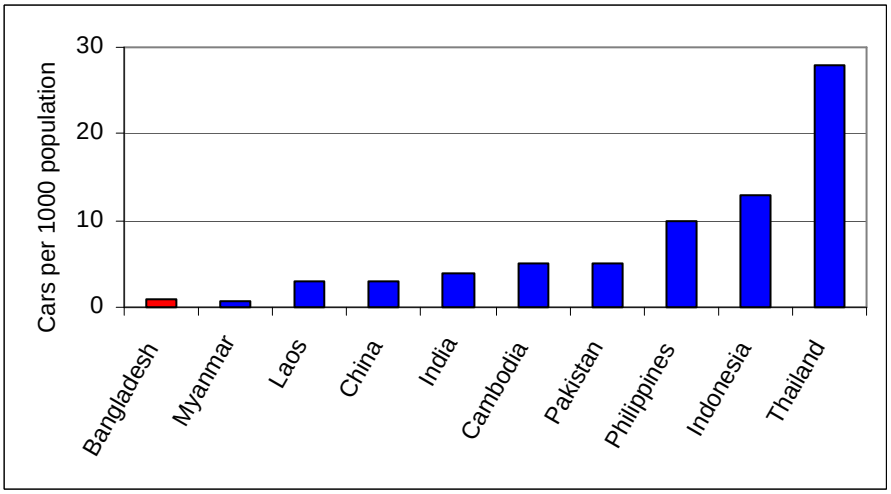


Figure 4-9 : Relation between car ownership and GDP

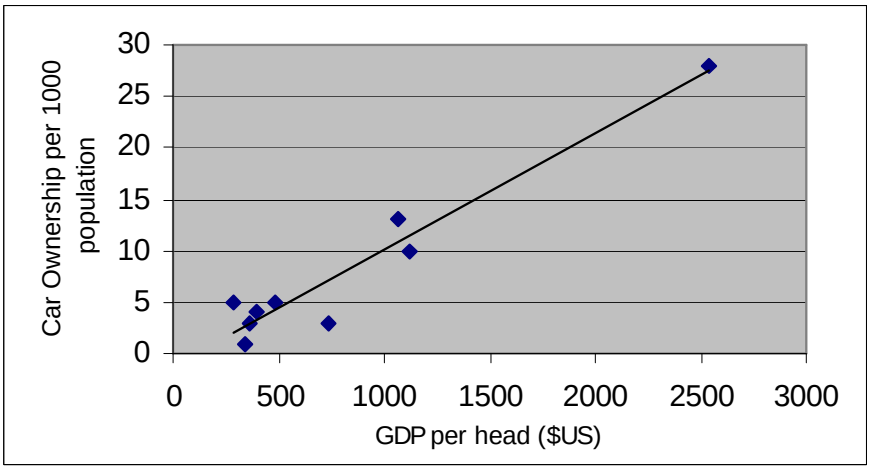


Figure 4-10 : Growth factors for Cars

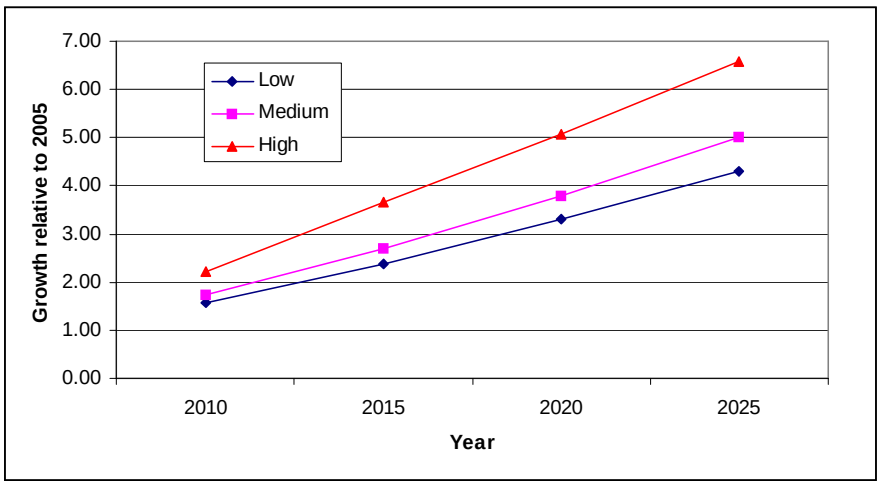


Table 4-2 : Average Annual Forecast Vehicle Growth Rates (%)

	Truck	Bus	Car	Other	All Vehicles
			Low		
2005-2010	6.03	3.00	9.60	8.90	**5.70**
2010-2015	5.95	3.00	8.30	6.70	**5.25**
2015-2020	7.10	3.00	6.90	5.25	**5.15**
2020-2025	1.40	3.00	5.50	2.00	**2.45**
2005-2025	**5.10**	**3.00**	**7.57**	**5.69**	**4.64**
			Medium		
2005-2010	7.25	4.00	11.50	10.40	**6.95**
2010-2015	6.85	4.00	9.15	7.50	**5.82**
2015-2020	6.40	4.00	7.00	5.30	**5.00**
2020-2025	2.80	4.00	5.70	2.90	**3.18**
2005-2025	**5.82**	**4.00**	**8.40**	**6.45**	**5.24**
			High		
2005-2010	8.32	5.00	17.00	11.70	**8.40**
2010-2015	8.00	5.00	10.60	8.30	**7.25**
2015-2020	6.00	5.00	6.80	5.20	**5.50**
2020-2025	5.22	5.00	5.45	4.20	**4.90**
2005-2025	**6.87**	**5.00**	**9.90**	**7.32**	**6.50**

5. POLICIES AND COMMITMENTS

5.1. Road Sector Policy

As part of this study, a Road Sector Policy was drafted in response to the problems identified in Chapter 3. This is set out in Table 5-1. The Road Sector Policy amplifies and expands statements made in the National Land Transport Policy, and was approved by the Road Masterplan Advisory Committee on 10th April 2007.

Table 5-1 : Road Sector Policy

Subject	Government Policy
Integrated planning should be improved	• Development of the strategic road corridors will be planned in co-ordination with the development of the railway and inland waterway networks to ensure that the most appropriate mode is used for the movement of people and goods.
Insufficient attention has been paid in the past to road maintenance. Road maintenance must be given a higher priority, and enough resources allocated. Road maintenance must be performed in a transparent and accountable way.	• Government to establish a '**Road Maintenance Initiative**' to direct development partners to focus their assistance on a single programme for road maintenance and rehabilitation • Government to create a **High Level Committee (headed by Minister)** to oversee Road Maintenance Initiative, to ensure that targets are being met and adequate resources are provided. • Government will create **Road Fund** and autonomous **Board** to manage it. • Board may create a **Technical Advisory Committee** on the Road Maintenance Initiative, comprising all stakeholders, including government, transport industry, road users, industry and commerce, agricultural sector, and construction industry. Technical Advisory Committee to ensure that initiatives are taken to improve road maintenance quality and to meet the agreed standards.
There are no agreed standards and targets for the condition of the road network. By setting targets the Government can expect road agencies to improve performance.	• Road network to be maintained to a set of **agreed standards**. Government will set standards for the quality of the road network and ensure that resources are made available to road agencies for targets to be met.
Routine maintenance is not done properly in Bangladesh. It must have a higher priority	• All roads under RHD to be placed under **routine maintenance** contracts. • Contractors will be asked to tender for 3 year contracts to provide all routine maintenance activities : vegetation control, culvert cleaning, slope protection, pothole filling and crack repairing, signage, lines etc. • **Pilot schemes** will be used to develop the most appropriate form of contract. • RHD to set **performance standards** for these contracts.
Overloaded trucks and buses cause excessive damage to roads and cost the country around Tk. 300 Crore per year in additional maintenance needs. Axle loads need to be controlled	• The Government will confer powers on, and allocate resources to, road agencies to set and **enforce limits on the weights of vehicles** so as to protect the road network from damage caused by overloading. • Government to **consult stakeholders** on the issue of axle-load control in order to ensure understanding and compliance, before measures are introduced. • RHD to **install 18 weighbridges** across the country (First Phase). • Government to **ban import of 2-axle trucks** with an unladen weight of

	more than 5 tonnes from 1 January 2008, and encourage use of multi-axle trucks. Regulations to be enforced to ensure that vehicles are not physically modified from the registered specifications.
Road building can damage the environment and cause social problems	• Government to ensure that measures are introduced and adhered to that **protect the physical and social environmen**t from adverse effects of road construction. • Government will finalise and **approve RHD's draft 'Social Assessment Guidelines' and 'Land Acquisition and Resettlement Guidelines'**. These and the already approved 'Environmental Impact Assessment Guidelines' shall be followed for all road works. • Government shall develop **a revised set of standard contract documents** for maintenance and construction works that include environment and social protection clauses, and promotion of employment opportunities for local people.
More than 20% of the Zila road network is in very poor condition due to a history of poor maintenance.	• The **Zila road network will be rehabilitated** over the next ten years in order to achieve a minimum accessibility level on all Zila roads. • **Minimum accessibility levels** will be defined in the Road Master Plan
Road classification does not fully meet the hierarchy required to assist economic development	• **The road hierarchy will be reviewed** and roads re-classified where necessary to meet economic objectives • Within the hierarchy, **road functions will be determined** to ensure that traffic is managed to improve safety and efficiency of travel.
Design standards and quality can be improved to enhance safety and get better value for money	• **Design standards** will be updated to meet international norms. • The **quality of road infrastructure will be improved** to higher standards
Road safety is a priority and needs to be improved	• On National Highways **strict safety measures** will be enforced to protect vulnerable road users from fast moving traffic • **Encroachment** of roadside activities onto the main carriageway will be prevented, also to protect vulnerable road users in these locations. • **Local committees will be involved** in implementing necessary measures. • **An integrated approach to road safety** will be introduced with agencies and measures coordinated across areas of education, awareness, enforcement and physical improvements
Many level crossings are unsafe, and increased traffic will exacerbate this	• **Grade separation** will be introduced where train frequencies and traffic levels warrant • Unprotected road/rail crossings will be placed in a programme for **safety enhancement** through manned gates • RHD will co-ordinate with Bangladesh Railway on these issues.
Bridges are an important asset for the road network. Their conditions must be improved and maintained	• Bridges in poor (**category 'D' condition) will all be replaced** or undergo major works to ensure safety and access over the next 10 years. • All Portable Steel Bridges (PSBs) will be replaced by permanent structures over the next 20 years. • Regular bridge maintenance will be introduced and enhanced.

	• All narrow bridges (less than 7.3m) on National Roads will be replaced over the next 20 years by bridges having at least 7.3m carriageway • The Government will ask RHD to commission an independent study of the condition of all its bridges, by specialist consultants.
Flooding undermines the investment in roads, and road building needs to take better account of flooding	• The Government will take necessary steps to protect its investment in the strategic road network from the adverse effects of flooding. • All construction and rehabilitation works of **National Highways will ensure that the road crest is at least 1 metre above the highest flood level of 50 years**. • For all other roads, the freeboard will be determined from time to time by the concerned agencies • All new road construction and rehabilitation works will be subjected to a full hydrological and morphological study
The proposed Padma Bridge is urgently needed to unlock the development potential of the south-west of the country.	• Feasibility studies have been undertaken and the Government is fully committed to the construction of the proposed Padma Bridge.
More use should be made of Bangladesh's geographical position to encourage trade	• The Government will seek to make bilateral transport agreements with neighbouring countries to avoid trans-shipment, and reduce transport costs. • In order to facilitate sub-regional movement, the Government will encourage SAARC to adopt a **Sub Regional Transport Facilitation Agreement (STFA).** • The Government will explore investment in additional and enhanced international infrastructure connections where there are clear economic benefits to Bangladesh. • The Government will **ratify the Asian Highway Network Agreement**. • The Government will **Gazette the relevant part of the road network to be part of the Asian Highway**. These roads will be upgraded to appropriate standards to accommodate the growth in traffic from international transit.

The above policy frames the priorities for the Masterplan. However, before these can be finally identified and placed in programmes, account must be taken of the commitments already made in the road sector.

Standards for the condition of the road network should be adopted by Government and made public at the national and local level, along with active publicity.

5.2. Commitments

5.2.1. Introduction

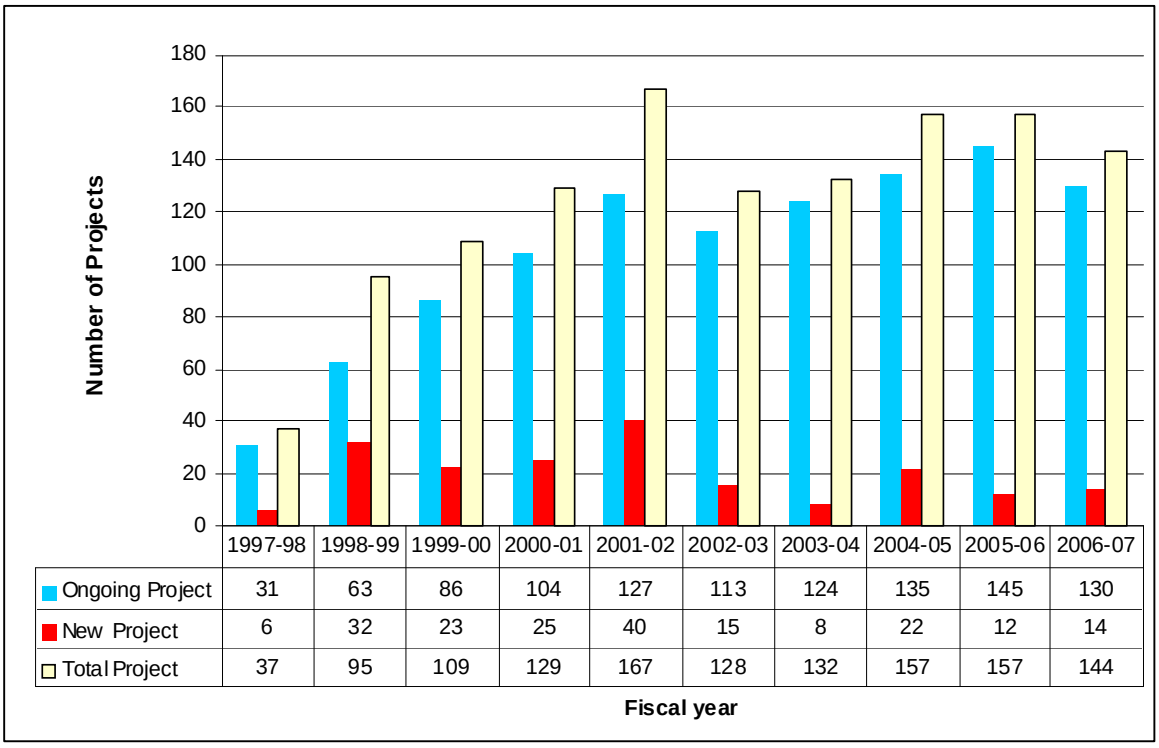
This section provides an analysis of the projects listed under Roads and Highways Department in the 2006/07 Annual Development Programme. The purpose of the analysis is to identify:

- the potential commitments for expenditure on approved projects in the next four years; and

- to provide a basis on which projects can be prioritized in the light of constrained resources.

5.2.2. Size of the ADP

It was observed that the Government's Annual Development Program (ADP) related to Roads and Highways Department (RHD) includes large number of projects, some of which are still unapproved. A detailed analysis of ten years ADP (1997-98 to 2006-07) for RHD revealed that every year new projects were being added without ensuring the completion of large share of on-going projects. As a result, total number of projects has risen by nearly 350% over a period of ten years. Figure 5-1 illustrates how the number of projects in the ADP has been growing year on year.



	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Ongoing Project	31	63	86	104	127	113	124	135	145	130
New Project	6	32	23	25	40	15	8	22	12	14
Total Project	37	95	109	129	167	128	132	157	157	144

Source: ADPs, Bangladesh Planning Commission, Dhaka

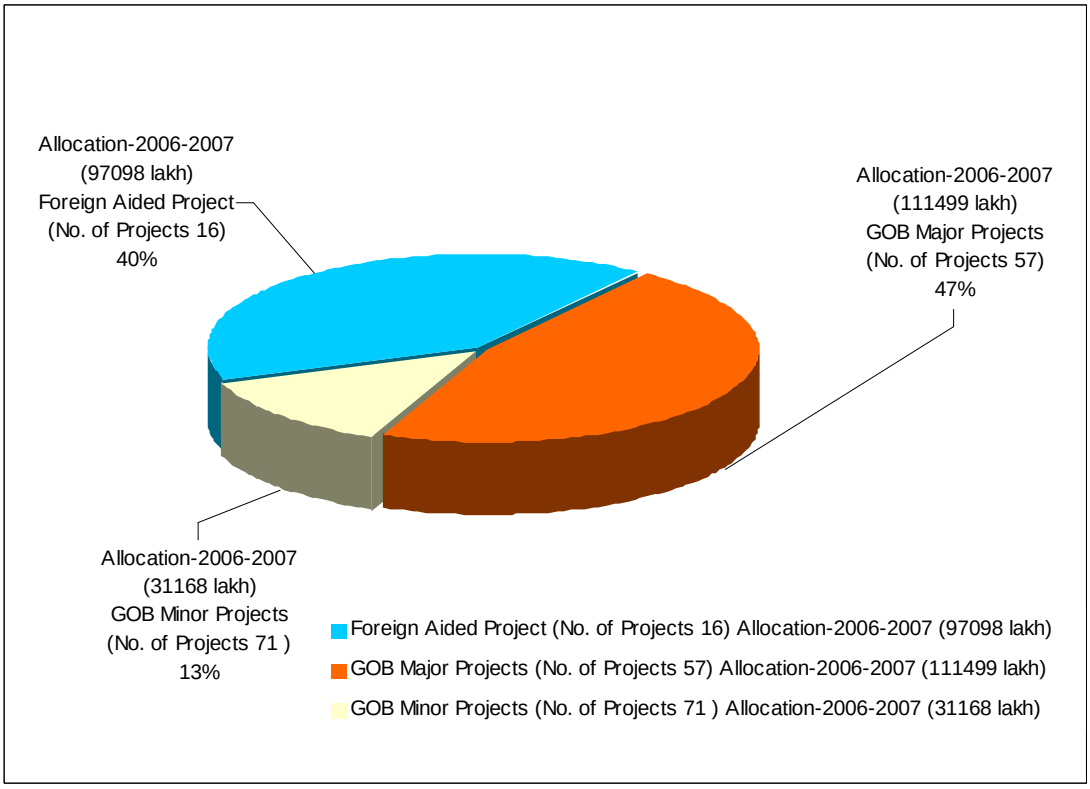
An analysis of the size of the 2006-07 ADP revealed that it includes 144 projects with a total cost estimate of Taka 22,605.99 crore for which an allocation of Taka 2,397.65 crore (USD 343 million), equivalent to 9.42% of the cost, was provided. It was quite noticeable that the 2006-07 ADP contains many projects that have been dragging on for over 8+ years. If this trend continues, many of these projects will not be completed before 25 or 30 years. In addition, the analysis also revealed that ADP for 2006-07 contains several large *cluster projects* that are mini programmes in their own right. These projects have great financial impact on remaining projects in the ADP, as they call for the commitment of large amounts of resources. As Bangladesh, till recently, did not have a well established strategic planning approach, the selection of projects for inclusion in the ADP was fairly arbitrary and very often subjected to political interference. In fact, many of the projects included in the ADP in the past were without proper appraisal. As a result it has become difficult to prioritize projects in the ADP in an efficient manner, for the allocation of scarce resources.

5.2.3. Prioritization within ADP

Figure 5-2 above shows that the Bangladesh Planning Commission already attached higher priority to foreign aided projects over other government (GOB) funded projects. As a result, 40%

of the 2006/07 ADP resources (shown in Appendix 1[21]) were allocated to 16 foreign aided projects. The Planning Commission also attached priority to other major projects, which were included in the ADP based on some sort of feasibility studies. Around 47% of the resources was therefore, allocated to these major projects, whose number stood at 57. The remaining 71 projects were treated as low priority and only 13% of the ADP resources were allocated to these projects. The 16 Foreign aided projects in the ADP are estimated to be completed by 2011/12.

Figure 5-2 : **ADP 2006-07: Percentage of Resource Allocated to Foreign Aided Projects, GOB Major and Minor Projects of RHD**



5.2.4. Rationalization of the ADP

In order to accommodate the new priority projects coming out of the Road Master Plan (in this study), it has become essential to recast the current ADP to make space. All major and minor projects included in the ADP numbering 128, the majority of which have been dragging on for years, for which considerable expenditure has already been incurred, need to be completed within the next 3-4 years. A further analysis of these projects indicates that 49 projects out of 128, could be completed in 1 year, with a resource allocation of Tk.195 crore, while another 33 projects could be completed in 2 years if Tk. 313 crore could be allocated. The Planning Commission should take note of this analysis and act accordingly.

In addition, the ***cluster projects*** listed in separately in the ADP all include a large number of smaller sub-projects. These projects did not go through any project appraisal before their inclusion in the ADP.

As part of the rationalization process, it has become necessary to take out temporarily the *cluster projects,* listed above, from the ADP for a thorough review by RHD. Following the review, only the high priority projects from among the large number of smaller projects included in the 10 cluster projects, could be included in the future ADPs as individual projects. The Planning Commission is already aware of this issue, and as a result of the development of the Masterplan has

[21] Appendix 1 shows the 'white leaf' projects that were approved, and the 'green leaf' projects to be included in the ADP only after approval and allocation from sectoral block.

recommended that those sub-projects which are near completion should be finished with the utmost urgency, and those sub-projects which are not being implemented should be removed from the ADP. It is recommended that RHD provide sufficient information to the Plannning Commission so that all the cluster projects, and sub-projects, can be reviewed in the light of Masterplan priorities. It is further recommended that RHD remove the unjustified sub-proejcts from the ADP and replace them with properly justified projects from the Masterplan.

The forecast committed expenditure over the next four years excluding cluster projects is set out in Table 5-2.

Table 5-2 : Estimated committed expenditure resulting from the 2006/07 ADP

	Expected Expenditure (Crore Taka)				
Project Type	2007/08	2008/09	2009/10	2010/11	Total
Foreign Aided	1,434	747	672	412	3,265
GoB Projects which should have been completed by 2007/08	98	98	0	0	195
GoB Projects which should be completed by 2008/09	78	156	78	0	312
Other GoB Projects	221	245	341	173	979
Total	1,831	1,245	1,091	585	4,751

5.2.5. Committed Road Improvement and Maintenance Projects

Table 5-3 lists the committed project interventions on paved Regional and National Roads, covering 1,975 km. All the remaining National Highways and Regional Highways (5,627km) are considered for interventions in the first 5 years of the Masterplan period (Section 8.4.4).

Table 5-3 : Committed Interventions on paved National and Regional Highways

Road No.	Road Name	Intervention	Length (km)	Project
N1	Chittagong to Dohazari	Improvement	26.2	RNIMP-II
N1	Chandina, Comilla and Feni by-passes	Improvement	51	RMIP
N1	Feni to Chittagong, section 2	Improvement	38	RMIP
N3	Joydebpur to Mymensingh	Improvement	90	RSRP
N3	Tongi to Joydebpur	Improvement	12.5	RSRP
N4	Kaliakoir by-pass	Improvement	3.2	RNIMP-II
N5	Panchagarh to Banglabandh	Improvement	57	RNIMP-II
R280	Sylhet to Sunamganj	Improvement	68	RSRP
R360	Mymensingh to Nandail	Improvement	47	RNIMP-I
R556	Mithapukur to Madhyapara	Improvement	24	RNIMP-I
Sub Total		**Improvement**	**416.9**	
N1	Chittagong to Cox's Bazaar (ch 19.5 to 82.0)	Maintenance	62.5	RMIP
N1	Cox's Bazar to Teknaf (ch 6 to 43)	Maintenance	37	RMIP
N1	Daudkandi to Chandina	Maintenance	28.7	RMIP
N1	Chandina to Feni	Maintenance	34.62	RMIP
N1	Jatrabari to Kanchpur	Maintenance	9	PMP
N1	Chittagong to Cox's Bazar	Maintenance	65	PMP
N102	Comilla to Brahmanbaria (ch. 10 – 27, ch. 67 –77)	Maintenance	27	PMP
N107	Kalurghat to Monesertek	Maintenance	11	RMIP
N2	Dhaka to Sylhet	Maintenance	0.7	PMP
N2	Dhaka to Tamabil	Maintenance	6	PMP
N212	Tamabil Landport connecting road	Maintenance	0.34	PMP
N4	Madhurpur to Jamalpur	Maintenance	41	RNIMP-I
N4	Joydebpur to Jamalpur	Maintenance	28.55	PMP
N4	Joydebpur to Jamalpur	Maintenance	6.63	PMP
N4	Joydebpur to Jamalpur	Maintenance	21.72	PMP
N401	Madhurpur to Mymensingh	Maintenance	47	RNIMP-I

Road No.	Road Name	Intervention	Length (km)	Project
N5	Gaibanda to Rangpur	Maintenance	41	RNIMP-II
N5	Rangpur By-pass	Maintenance	12	RNIMP-II
N5	Beldanga to Panchgarh	Maintenance	76	RNIMP-I
N5	Dhaka – Banglabandh (ch 173 to 188)	Maintenance	15.55	PMP
N5	Dhaka to Rangpur	Maintenance	29	PMP
N5	Dhaka to Rangpur (ch. 188.75 – 207.35)	Maintenance	19	PMP
N506	Rangpur to Kurigram (ch 3 – 23)	Maintenance	20	RNIMP-II
N508	Beldanga to Dinajpur	Maintenance	13.9	RNIMP-I
N509	Rangpur to Barobari	Maintenance	104	RNIMP-II
N516	Noagaon by-pass	Maintenance	8	PMP
N7	Dauladia to Mongla	Maintenance	14.25	PMP
N7	Dauladia to Mongla	Maintenance	14	PMP
N7	Dauladia to Mongla	Maintenance	26	PMP
N7	Dauladia to Khulna (ch. 61.6 – 63.6)	Maintenance	2	PMP
N7	Dauladia to Khulna	Maintenance	18	PMP
N8	Dhaka to Mawa (ch 0 – 2.5)	Maintenance	2.5	PMP
N8	Dhaka – Barisal (ch 121 – 139, 149 – 164)	Maintenance	33	PMP
N8	Dhaka to Barisal (ch 95.5 – 115)	Maintenance	19.55	PMP
N8	Dhaka to Barisal (ch.115 - 121	Maintenance	6	PMP
N809	Barisal to Lakshmipur	Maintenance	10.5	PMP
R111	Narayanganj Link Road (ch. 3 – 15.9)	Maintenance	8.5	PMP
R140	Comilla to Chandpur	Maintenance	50.55	RMIP
R140	Laksmirpur to Raipur	Maintenance	16	RMIP
R140	Raipur to Chandpur	Maintenance	27	RMIP
R140	Comilla to Begumganj (ch. 55 – 69)	Maintenance	14	PMP
R141	Lalmai to Laksham	Maintenance	38	RMIP
R141	Lalmai to Soniamuri (ch 11 – 34.7)	Maintenance	23.77	PMP
R141	Lalmai to Soniamuri (ch 34.7 – 37	Maintenance	2.23	PMP
R142	Begamganj to Ramganj	Maintenance	20.5	PMP
R143	Begumganj to Sonapur	Maintenance	20	RMIP
R143	Maijdi to Chandraganj	Maintenance	11.7	PMP
R151	Baraiyerhat to Fatikchhari	Maintenance	3.5	PMP
R152	Heako to Ramgarh	Maintenance	7.63	PMP
R152	Heako to Ramgarh	Maintenance	3	PMP
R160	Hathazari to Khagrachhari	Maintenance	1.5	PMP
R211	Kishorganj to Katiadi	Maintenance	13	RNIMP-II
R240	Shaistaganj to Sherpur	Maintenance	9.3	PMP
R280	Sylhet to Sunamganj	Maintenance	34	PMP
R281	Rajnagar to Charkhai	Maintenance	10.5	PMP
R281	Charkhai to Baroigram	Maintenance	9.5	PMP
R282	Juri to Lathitila	Maintenance	5.7	PMP
R360	Mymensingh to Kishorganj (ch 89 to 116)	Maintenance	27	RNIMP-II
R360	Mymensingh to Kishorganj (ch 20 to 49)	Maintenance	29	RNIMP-II
R370	Mymensingh to Netrokona (ch 42 to 52)	Maintenance	10	RNIMP-II
R371	Mymensingh to Sherpur (ch 0 to 65)	Maintenance	65	RNIMP-I
R460	Jamalpur to Bangoan	Maintenance	29.93	RNIMP-I
R505	Nabinagar to Kaliakor	Maintenance	12.9	PMP
R555	Palashbari to Gaibanda	Maintenance	15	RNIMP-II
R570	Saidpur to Niliphmari	Maintenance	16	RNIMP-II

Road No.	Road Name	Intervention	Length (km)	Project
R685	Rajshahi to Chowmasia	Maintenance	65	PMP
R710	Ahladipur to Kushtia (ch. 0 –11.17)	Maintenance	11.17	PMP
R760	Khulna to Satkira	Maintenance	17	PMP
R770	Noapara to Pirojpur	Maintenance	12	PMP
R771	Rupsha to Bagerhat	Maintenance	7	PMP
Sub Total		**Maintenance**	**1,557.89**	
Total			**1,974.79**	

5.2.6. Recent Funding Levels

Since Independence the Development Budget for Roads and Highways Department has increased from less than Tk. 100 Crore to over Tk. 2,300 Crore in 2006-07. Over the past seven years the total allocation has been remarkably constant, at an average of Tk. 2,314 Crore. However, this masks a recent shift in burden to the Government of Bangladesh, whose contribution has risen, whilst development partner support has declined from Tk. 1,140 Crore in the first three years of the period to Tk. 618 Crore over the last three years. The revenue budget for road maintenance, excluding work charge employees, is currently around Tk. 800 Crore.

It will not be possible to mobilise additional development partner support in the first two years of the plan period, simply because of the approval times required. Therefore, given the level of commitments there is limited scope for major new projects in the first two years (2007/08 and 2008/09).

Supplementary financing for the road sector, through charges on road users and non-users, and private sector investment must also be considered. In particular, a Road Fund is necessary to fund maintenance and repair of roads and bridges (refer also to Section 17.4.1).

6. APPROACH

6.1. Summary of Issues

The approach to the development of the Road Masterplan is based on addressing the existing problems faced by the road and bridge network, along with the future challenges. The key issues that have emerged from the study are:

- The underlying strength of the National and Regional Highway network, largely due to a lack of maintenance
- Vehicle overloading has contributed significantly to the above
- The operation of the National Highway network is severely hampered by congestion caused by poor local traffic management and encroachment
- The fact that the Zila road network is not fulfilling its full role in rural connectivity because it is partly incomplete, and has suffered from a lack of maintenance
- Bridges have not been properly maintained, with the result that a large number of them already need, or will shortly need replacement, or major repairs
- Road safety is critical and not properly addressed in design or enforcement
- Traffic is forecast to grow by a factor of at least three over the next twenty years, leading to a need to increase capacity significantly on the major strategic corridors
- Maintenance is poor, and needs a higher priority, more resources, improved management, and better quality standards

6.2. Approach

The above 8 issues define the problems that this Masterplan has to address over the next twenty years. The Policy requirements, and the role of the Masterplan in implementing these are set out in Table 6-1. These are need based, determined by the diagnosis in Chapter 3, and traffic growth identified in Chapter 4.

Table 6-1 : Role of the Masterplan in implementing the Road Sector Policy

	Government Policy	Implementation
1.1	Development of the strategic road corridors will be planned in co-ordination with the development of the railway and inland waterway networks to ensure that the most appropriate mode is used for the movement of people and goods.	Planning Commission to coordinate long-term sub-sectoral transport plans
2.1	Government to establish a 'Road Maintenance Initiative'	Cabinet decision required
2.2	Government to create a High Level Committee (headed by Minister) to oversee Road Maintenance Initiative	Cabinet decision required
2.3	Government will create Road Fund and autonomous Board	Government decide to promulgate Road Maintenance Ordinance
2.4	Board may create a Technical Advisory Committee on the Road Maintenance Initiative	For Board to determine
3.1	Road network to be maintained to a set of agreed standards.	Chapter 8 of Road Masterplan (strengthening) and Chapter 15 (Maintenance)

	Government Policy	Implementation
4.1	All roads under RHD to be placed under routine maintenance contracts.	Section 15.1 of Road Masterplan
4.2	Contractors will be asked to tender for 3 year contracts to provide all routine maintenance activities	
4.3	Pilot schemes will be used to develop the most appropriate form of contract.	
4.4	RHD to set performance standards for these contracts.	
5.1	The Government will confer powers on, and allocate resources to, road agencies to set and enforce limits on the weights of vehicles.	Chapter 9 of Road Masterplan
5.2	Government to consult stakeholders on the issue of axle-load control	Ministry of Communications to implement
5.3	RHD to install 18 weighbridges across the country (First Phase)	Section 9.4 of Road Masterplan
5.4	Government to ban import of 2-axle trucks with an unladen weight of more than 5 tonnes from 1 January 2008, and encourage use of multi-axle trucks.	Cabinet Decision required
6.1	Government to ensure that measures are introduced and adhered to that protect the physical and social environment from adverse effects of road construction.	Chapter 18 of the Road Masterplan
6.2	Government will finalise and approve RHD's draft 'Social Assessment Guidelines' and 'Land Acquisition and Resettlement Guidelines'. These and the already approved 'Environmental Impact Assessment Guidelines' shall be followed for all road works.	Section 18.1of the Road Masterplan
6.3	Government shall develop a revised set of standard contract documents for maintenance and construction works that include environment and social protection clauses, and promotion of employment opportunities for local people.	Section 18.5 of the Road Masterplan
7.1	The Zila road network will be rehabilitated over the next ten years in order to achieve a minimum accessibility level on all Zila roads.	Chapter 11 of the Road Masterplan
7.2	Minimum accessibility levels will be defined in the Road Master Plan	Section 11.4 of the Road Masterplan
8.1	The road hierarchy will be reviewed and roads re-classified where necessary to meet economic objectives	Section 2.3 of the Road Masterplan
8.2	Within the hierarchy, road functions will be determined to ensure that traffic is managed to improve safety and efficiency of travel	Ministry of Communications to determine
9.1	Design standards will be updated to meet international norms.	Chapter 7 of the Road Masterplan
9.2	The quality of road infrastructure will be improved to higher standards	Chapter 8 of the Road Masterplan
10.1	On National Highways strict safety measures will be enforced to protect vulnerable road users from fast moving	Chapter 10 of the Road Masterplan

	Government Policy	Implementation
	traffic	
10.2	Encroachment of roadside activities onto the main carriageway will be prevented, also to protect vulnerable road users in these locations.	Section 10.1 of the Road Masterplan
10.3	Local committees will be involved in implementing necessary measures.	Section 13.3 of the Road Masterplan
10.4	An integrated approach to road safety will be introduced with agencies and measures coordinated across areas of education, awareness, enforcement and physical improvements	Chapter 13 of the Road Masterplan
11.1	Grade separation will be introduced where train frequencies and traffic levels warrant	Section 13.4 of the Road Masterplan
11.2	Unprotected road/rail crossings will be placed in a programme for safety enhancement through manned gates	Section 13.5.3 of the road Masterplan
11.3	RHD will co-ordinate with Bangladesh Railway on these issues.	RHD to implement
12.1	Bridges in poor (category 'D' condition) will all be replaced or undergo major works to ensure safety and access over the next 10 years.	Chapter 12 of the Road Masterplan
12.2	All Portable Steel Bridges (PSBs) will be replaced by permanent structures over the next 20 years.	Section 12.8 of Road Masterplan
12.3	Regular bridge maintenance will be introduced and enhanced.	Chapter 16 of the Road Masterplan
12.4	All narrow bridges (less than 7.3m) on National Roads will be replaced over the next 20 years by bridges having at least 7.3m carriageway	Section 12.7 of the Road Masterplan
12.5	The Government will ask RHD to commission an independent study of the condition of all its bridges, by specialist consultants.	Section 12.12.2 of the Road Masterplan
13.1	The Government will take necessary steps to protect its investment in the strategic road network from the adverse effects of flooding.	Section 7.6 of the Road Masterplan
13.2	All construction and rehabilitation works of National Highways will ensure that the road crest is at least 1 metre above the highest flood level of 50 years.	Section 7.6 of the Road Masterplan
13.3	For all other roads, the freeboard will be determined from time to time by the concerned agencies	Section 7.6 of the Road Masterplan
13.4	All new road construction and rehabilitation works will be subjected to a full hydrological and morphological study	Section 18.7.1 of the Road Masterplan
14.1	Feasibility studies have been undertaken and the Government is fully committed to the construction of the proposed Padma Bridge	Chapter 14 of the Road Masterplan
15.1	The Government will seek to make bilateral transport agreements with neighbouring countries to avoid trans-	Cabinet decision required

	Government Policy	Implementation
	shipment, and reduce transport costs.	
15.2	In order to facilitate sub-regional movement, the Government will encourage SAARC to adopt a Sub Regional Transport Facilitation Agreement (STFA).	Cabinet decision required
15.3	The Government will explore investment in additional and enhanced international infrastructure connections where there are clear economic benefits to Bangladesh.	Section 14.14 of the Road Masterplan
15.4	The Government will ratify the Asian Highway Network Agreement.	Cabinet decision required
	The Government will Gazette the relevant part of the road network to be part of the Asian Highway. These roads will be upgraded to appropriate standards to accommodate the growth in traffic from international transit.	Cabinet decision required

7. PROPOSED DESIGN STANDARDS

7.1. Introduction

The design standards and specifications for roads and bridges highlighted in this chapter are meant primarily for use in the Road Master Plan study. The suggestions given here, however, may form the basis for updating the official RHD guidelines[22]. Further study in this direction is recommended.

7.1.1. Approach

The guidelines of RHD currently in circulation have been found to be generally in order and therefore considered as the base. The chapter discusses the rationale for recommending a change in the value of a design parameter, while the actual values – whether changed or already in use - are included in tabular forms as annex at the end of the chapter.

7.1.2. Geometric Standards

The "Geometric Design Standards of Roads and Highways Department" is considered as the official document for the relevant standards for use by RHD. The discussions on geometric standards for roads in the following sections pertain to the recommendations contained in this and the accompanying two documents (referred to as the RHD Standards).

7.2. Design and Permissible Speeds

Since the design speed governs most of the geometric parameters, adoption of an appropriate value is most essential for road planning and design.

The standard speed values universally followed are given below. The figures within parenthesis denote the original values from which the present ones in SI unit have been derived.

50 km/h (30 mph)

65 km/h (40 mph)

80 km/h (50 mph)

100 km/h (60 mph)

Most roads in the country have single carriageway and pass through bazaar areas at regular intervals. There is usually no access control or any segregation between NMT and MT. Besides, the fitness of the vehicles (brake, lights, steering), particularly of loaded trucks, is seldom passable under a proper test. Thus, from the standpoint of safety, traffic must not be allowed to travel at speeds that would make control of the vehicles difficult in unforeseen situations such as sudden intrusion of NMV and pedestrian in the MV stream, friction loss in road surface, sharp curves, loss of visibility, mechanical failure etc. The RHD Standards recognizes this fact and have made a case for restricting the *design* speed to 80 km/hr. At this point there is a need to differentiate between *Design* speed and *Permissible* speed. The former is defined as the speed adopted for the design of various elements and sections of the road while the latter is the speed limit imposed by the road authority on the vehicles for reasons of safety. Therefore, if ground conditions permit, design speed as high as 100 km/h can be adopted for design of individual elements like curves or sections like urban stretches. But, the permissible speed must be restricted to 80 km/h. As a rule, Permissible Speed (speed limit) should be at least one stop below the Design Speed to make allowance for occasional violation. If required, speed limit should be reduced further at urban and bazaar areas, where NMT is high. For dual carriageway roads with 4 or more lanes, the design speed and the permissible speed can be the same.

Table 7-1 presents the speed values for road design and operation in plain terrain.

Table 7-1 : Design and Permissible Speeds

[22] Ministry of Communications, Geometric Design Standards of Roads & Highways Department, July 2001
[22] Ministry of Communications, Standard Tender Documents, Technical Specifications, May 2001
[22] Ministry of Communications, Geometric Pavement Design Guide for Roads & Highways Department, April 2005

	Dual Carriageway	Single Carriageway		
	More than 4 lanes	7.3 m wide	5.5 m wide	3.5-3.75 m wide
Design Speed (km/h)	100	100	80	80
Permissible Speed (km/h)	100	80	65	50

Note : the speeds indicated are the maximum that can be adopted.

In the case of road upgrading and rehabilitation, there is usually very little scope for improving the road geometry without major land acquisition. Hence, design speeds (and in turn the permissible speeds) may need to be judiciously reduced while designing elements like super-elevation, horizontal and vertical curves.

For rolling and hilly terrain, the speed limits should be respectively one step and two steps lower than the corresponding values shown above.

Under constrained conditions, the design speed may therefore vary from element to element or from section to section. But the allowable speed over a distance must be determined by the most critical condition in that section.

This fact has been recognized while preparing Table 2.2 of RHD Standards (Geometric) where the ruling design speed is linked to the road configuration (directional segregation, lane width). However, Table 2.1, to which Table 2.2 refers, needs review. For example, for Design Type 3 (7.3m wide single carriageway 2-way road), 2100 passenger car units (pcu)/hr is shown as the maximum design year traffic volume whereas Figure 4.4 later in the document indicates 2100 pcu/hr as the *capacity* for the same road cross-section.

7.3. Passenger Car Unit

The pcu factors adopted in the RHD Standards generally reflect the traffic classification and composition on Bangladesh roads. Nevertheless, the modifications shown in Table 7-2 are suggested:

Table 7-2 : Modifications proposed to PCU's

Vehicle Type	Passenger Car Unit	
	RHD Standard-2001	Suggested for RMP
Minibus	3.0	2.0
Motorcycle	0.75	0.50

A minibus has a capacity of 30 passengers compared to 52 for a standard bus (size ratio~0.60). Although minibuses stop and go in the same manner as its larger cousin, it has more manoeuvrability. In view of this, a reduced pcu factor of 2.0 is suggested. Motorcycles travel fast and are in no way more obstructive than a bicycle, which has a pcu factor of 0.5. Therefore, it is reasonable to adopt a value of 0.5 for all motorized 2-wheelers including motorcycles and scooters.

7.4. Level of Service

The RHD document recommends Level of Service (LOS) E (v/c ranging from 0.64 to 1.00) as the level for upgrading to the next higher design type (configuration). The range is wide and leaves room for ambiguity. Letting congestion reach a critical stage (near the upper limit of the range) defined in LOS E will not be conducive to growth. Instead, a definite cut off at v/c = 0.7 is deemed to be a reasonable trigger level for the National and Regional Highways.

7.5. Shoulder

The usefulness of a paved (or even hard) shoulder is beyond dispute. One of the most important uses of a shoulder is to provide space for movement of slow-moving vehicles and for routine and emergency parking of vehicles.

Paved shoulders should be at least 2 m wide on both sides of single carriageway 2-lane roads. A narrow shoulder of 1.5 m is not wide enough to accommodate fully an animal-drawn cart or a

parked or stranded truck. Thus the carriageway, particularly in the case of 2-lane undivided roads, is encroached upon.

The flow of traffic on the main carriageway is likely to benefit most from segregating slow moving, non-motorised traffic and pedestrians from motorised traffic. Therefore, the most appropriate solution is to provide a wide shoulder of relatively thin construction.

A wider shoulder of 2.0m width will eliminate this problem. If a wide shoulder with physical separation is provided, it will not be necessary to use full pavement construction, as traffic loads will be light. On the other hand, where there is no separation and a narrow shoulder is provided, evidence suggests that heavy vehicles will routinely travel on the shoulder and it is therefore appropriate to use full depth construction.

Consideration should be given to the surface texture of the carriageway and the shoulders. On the main carriageway, it is important to have a relatively high coefficient of friction to assist vehicle traction and braking, whereas on the shoulder a smoother finish is better for bicycles and other non-motorised traffic. If the shoulders are constructed to, at least, the same dimensional tolerances as the main carriageway, and are designed to remain in such condition with minimal maintenance, there will be less reason for pedestrians and users of non-motorised vehicles to stray on to the main carriageway.

Although some will ignore road signs and markings, there is evidence that the majority of road users will usually respect them. Therefore allowance should be made for much improved marking and signage. In particular, the edge of the main running carriageway should be marked with a continuous line, preferably reflective and ridged.

Clear segregation of NMV and MV through wide shoulders can significantly improve the capacity and safety of existing roads.

The RHD Standards recommends no edge drop between carriageway and paved shoulder (although in reality edge drop is commonly provided). Cross –section drawings unfortunately do not always bear out this fact. A 2-2.5m wide paved shoulder with leaner pavement than the main carriageway will obviate the need for the edge drop.

In narrower roads, heavy vehicles frequently steer out of the carriageway to pass an approaching vehicle without slowing down. Providing a paved shoulder in such roads would give the driver a false impression of width and the shoulder will be routinely used a part of carriageway. This will necessitate as strong a pavement for the shoulder as the pavement of the main carriageway, thus defeating the very purpose of retaining the narrow road width. Instead of paved shoulders, narrow roads (<7.3m) should be provided with hard shoulders built with granular material of sub base quality having CBR not less than 30%.

The verge should be minimum 1.5m to allow for 0.5m rounding-off at the edge of embankment and erecting of signs and other items of road furniture.

7.6. Freeboard

In a flood prone country like Bangladesh, keeping the important highways above submergence level is essential. Yet the need for economy (avoiding over-design) cannot be over-emphasised. Therefore, the road level must be judiciously fixed looking at the frequency of disruption as predicted from return periods of flood i.e. HFL (high flood level) for 20-yr and 50-yr return periods. Broadly, the freeboards for National and Regional Highways should be:

- 1m to 1.2m above 50-year HFL measured from the HFL to the road top at embankment edge
- 0.30 m above 50-year HFL measured from HFL to top of subgrade (bottom of pavement)
- 1.5 m above ponding level measured from stagnant water level to top of subgrade (to avoid saturation of subgrade owing to capillary action).
- Highest level calculated from the above three criteria shall be applicable. In case of Zila roads 20-year HFL may be considered.

The embankment height for important new roads such as bypasses must be designed strictly in accordance with these freeboard guidelines. For upgrading existing roads, especially in built-up areas, the freeboard may have to be reduced for other considerations.

7.7. Crossfall

The normal carriageway crossfall for a high grade bituminous surfacing such as asphalt concrete can be 2.5%. The paved shoulder crossfall with an inferior surfacing material should be 3%. In super-elevated sections, the roll-over camber between the outmost carriageway and shoulder interface should not exceed 8% to ensure safety (mainly of NMVs). On roads where traffic intensity warrants only surface treatment (AADT <4000), a 3% camber may be provided in the carriageway. The paved shoulder, in that case, would have 0.5% steeper crossfall.

7.8. Super-elevation

There is serious reservation about capping the maximum allowable super-elevation at 7%. Super-elevation design assumes that 85 percentile of all vehicles will travel at the design speed. In a situation where there is a large number of NMV and heavily loaded trucks, such an assumption is not realistic. For vehicles travelling at speeds considerably below the design value, 7% super-elevation may cause the slow vehicles to slide towards the inner lanes thus posing great danger of accident at sharp curves. A limit of 5% is suitable for roads in Bangladesh with mixed traffic. The permissible speeds may be calculated accordingly.

7.9. Longitudinal Gradient

For a flat country like Bangladesh, a minimum longitudinal gradient for roads should be specified. A value of 0.5% is suggested. However, introducing a minimum gradient in an existing inter-urban section may be difficult. If the section is on an embankment, prescribed cross-fall should be able to facilitate surface run-off even if sufficient gradient cannot be provided. New roads should be provided with a minimum 0.5% longitudinal gradient. The maximum gradient should be 4% for National Highways and Regional Highways[23], with a maximum on Zila Roads of 2.5% to account for the high proportion of non-motorised vehicles.

7.10. Pavement Design

The base document for pavement design is “Pavement Design Guide for Roads & Highways Department” published by the Roads and Railways Division of Ministry of Communications in April 2005, in short RHD Guide-2005. The discussion will be confined to the need for change and not on the acceptable parameters or design methodology.

7.11. Traffic Count

For the purposes of detailed pavement design, a 7-day 24-hour classified traffic volume count is needed. The count should be representative of the section under design. The choice of survey location is therefore most important. Since pavement design is based on the cumulative number of standard axles that are likely to be imposed on the section during the design period, the proportions of different types of vehicles needs to be known. Therefore, the traffic count period should include working days and a weekend to account for fluctuations during one whole week at least.

7.12. Design Life

The RHD Standards suggest a design period of 20 years. This may need re-consideration. In the case of Bangladesh, future development will depend on a number of probable crucial events such as construction of the Padma Bridge; opening of sections of the Asian Highway on major shift in trans-border trade policy. The network traffic pattern will be affected by the occurrence or otherwise of these events. Not only the events themselves but also their timing would be of great significance. Obviously, the pavement for a road section cannot be designed for all alternative traffic scenarios, that too over a 20-year uncertain period. It would be wiser to restrict the design period to a more realistic time span of 10 years and adopt one most probable traffic projection. This strategy will limit the risk of over/under estimation of traffic and will allow revision of projection at the time of stage design for the next 10-years and so on.

[23] the standards may be relaxed with the agreement of the Chief Engineer

7.13. Equivalence Factor

The Equivalence Factor is a major issue and has been dealt with in detail separately in Section 3.4.4. The findings and recommendations are summarised here as they directly and primarily affect the pavement design. At present, with little or no control on loads carried by commercial vehicles, the spectrum of axle loads of trucks and buses in the country has been observed to be quite different from what is assumed in the guide. Sample surveys conducted recently, as part of this study, reveal the following average ESAL per vehicle or equivalence factor:

Light truck	= 1.0
Medium truck	= 15 for Rangpur and Sylhet zones and 7.5 for the other 6 zones
Heavy truck	= 30
Minibus	= 1.0
Standard Bus	= 2.8

According to RHD Guidelines, the factor for medium truck is 4.62 and for heavy truck 4.8 and for standard bus is 1. Obviously these are gross underestimates. The observed very high values of ESAL have largely been responsible for the rapid and widespread deterioration of the road network, as the pavement design did not take these equivalence factors into account.

There is an urgent need to impose immediate and strict axle load control all over the country. The legal load limits proposed for different type of commercial vehicles would produce the following equivalence factors:

Light truck	= 1.0
Medium truck	= 2.7
Heavy truck	= 3.5
Minibus	= 0.8
Standard Bus	= 1.0

Once axle load control is implemented across the country, these factors should be used in pavement design. However, in the interim period, primary axle load survey on specific project roads should be conducted and the result used in the pavement design.

7.14. Improved Subgrade

The RHD Standards recommend an improved subgrade (capping) layer over the subgrade if the latter has a CBR value of 4% or less. The available data of subgrade strength of existing roads show an average value of about 5%. Thus the need for improved subgrade is not universal and hence should be provided selectively as it is a costly item.

7.15. Vertical Clearance

Structures above waterways should be construcuted in accordance with BIWTA's published clearances for Class I to IV navigable waterways. For structures above other waterways, a survey of craft using the waterways should be carried out prior to design to enable the appropriate clearance to be incorporated. It is recommended that the Planning Commission check that this is adhered to in Development Project Proformas (DPP's).

7.16. Land Acquisition

Agricultural land is being lost in Bangladesh at the rate of around 1% per year. Whislt road building is by no means the biggest culprit, every effort should be taken to minimise the loss in agricultural land for road projects. DPP's for road projects shall include an Initial Social Assessment, and if the proposed requirement for agricultural land is significant, then a full Social Assessment is recommended.

7.17. Costs

Project costs estimated in this plan are based on existing road construction costs in Bangladesh at 2007 prices. When projects are brought forward from the Masterplan in the forms of DPP's then detailed cost estimates should be provided on the basis of full engineering surveys.

8. IMPROVING ROAD STRENGTH

8.1. Background

A major issue that emerged as a result of the diagnostic analysis of the road network was the need for sustainable medium and long term solutions to the poor performance of the National and the Regional Highways. Historically, the National Highways have always received more attention than the Regional Highways. Among the National Highways, the investment on the major corridors like N1, N3 etc. has been much more than the others. Even the expenditure that has been made by the government did not yield the desired result because of the lack of a comprehensive improvement and maintenance plan based on accurate data and analysis. As a result, the network as a whole failed to provide any impetus to the overall development of the country. The recent introduction of the system of preparing and following the annual 'Needs Report' based on HDM output was a step in the right direction by RHD. However, the primary focus of this report has been preventive maintenance only as a means of preserving the road asset. The rationale for such an approach could justifiably be the chronic absence of assured fund for capital investment and the backlog thereof.

The master plan provides the right opportunity to address the issue of inadequacies in the road network in a comprehensive manner. There is no scope for deferring action any longer on the plea of fund shortage. Appropriate and sufficient investment for medium to long term benefit has become imperative now. This chapter discusses this issue and provides the basis for a physical programme under the Master Plan.

The objective of the repair and rehabilitation programme is to strengthen the road pavement of the network sufficiently so as to support the projected traffic load – during the master plan period - without frequent capital interventions subsequently.

8.2. The Problem

Initially, the Consultants believed that the major thrust would be needed towards routine and periodic maintenance of the National and Regional Highway network under a policy of preserving the existing assets. The problem of the road network is much more than poor maintenance. The analysis of RMMS data for the National and Regional Highways (Section 3.1.8) has indicated that the underlying strength of the roads is, in general, low. In other words, the pavements were not strong enough to support the projected traffic loading. There can be several reasons. The weakness in the pavement structure can be attributed to premature damage imparted by overloaded vehicles; inadequacy in the pavement thickness; poor quality of materials and workmanship, and lack of maintenance.

Assessment of the existing condition revealed that almost all roads would require attention in one form or another to remain serviceable over the plan period. The picture that emerged pointed towards the fact that, although majority of the roads have riding quality ranging between Good and Fair, they are deficient in pavement strength for the traffic loading for a design period of 10 years based on model generated traffic forecast. Mere preventive maintenance with the aim to preserve the surface of the road by repairing the cracks and/or road profile will no longer be economical on life-cycle consideration. Surface treatments like reseal and seal coat only conceal the weakness of the pavement structure. The intervention that appeared most appropriate was bituminous overlay on the existing surface, thickness of which would vary depending on the present condition and future traffic. Obviously specific levels of intervention would be necessary for individual road sections. The intervention for distressed pavements can be of the following two basic types:

- Periodic or preventive maintenance with a thin overlay only
- Rehabilitation for pavement strengthening with a thicker overlay or by reconstruction

These options can be defined broadly as:

Maintenance: this intervention would be warranted when the existing pavement is reasonably strong but the surface is in distress. There can be several levels of maintenance depending on the traffic and existing surface condition (IRI value).

Rehabilitation: this strengthening intervention would be necessary if the present and the projected traffic is high and the pavement is weak. The assessment of existing pavement strength, derived from either deflection value and/or pavement composition, is essential.

8.3. Approach

It was not practical or possible to carry out analysis for individual road sections of the national and Regional Highway network of over 6500km. The HDM database is actually broken down into 409 National road segments and 764 Regional Highway segments of uniform properties. Hence a macro approach, based on developing a road network matrix of representative road links, was adopted. Roads were classified by traffic and pavement condition levels, which are the key attributes that influence pavement performance and road user costs the most. Thus, 5 traffic levels (T1 to T5) and 5 pavement condition/strength levels (C1 to C5), identical with HDM Circle classification, defined the matrix comprising 25 representative road sections.

Two separate matrices, one each for National and Regional Highways, were developed. The weighted averages of 2005 traffic, roughness and other condition parameters were used as historical inputs for the hypothetical road section that each cell represented. Each cell possessed a single set of properties and required the same interventions for improvement. These data were analysed to formulate typical proposals for repair and rehabilitation of the roads.

8.3.1. Classification by Traffic

The traffic on a road segment in the RHD network is designated by Average Annual Daily Traffic (AADT). For the purposes of the design for strengthening, however, two components of the total AADT were considered:

- Motorised traffic excluding two and three wheelers
- Commercial vehicles comprising trucks and buses only

The 5 traffic levels (similar to those adopted for HDM) were defined in terms of the ranges of AADT of motorised traffic as shown in Table 8-1. The same classifications were used for National and Regional Highways.

Table 8-1 : Grouped Traffic Levels

Traffic Level	AADT* range	Description
T1	0 - 1999	Very Low
T2	2000 - 3999	Low
T3	4000 - 5999	Moderate
T4	6000 - 7999	High
T5	>8000	Very High

* AADT of motorised traffic excluding 2- and 3-wheelers

8.3.2. Condition Levels

The same ranges of roughness, in terms of IRI, as used for HDM programme analysis of the network were adopted to define 5 conditions levels for the matrix. The standard ranges of roughness shown in Table 8-2. As a general rule, roughness in excess of IRI 9 means the surface has reached a condition that cannot be rectified by a mere maintenance overlay while IRI above 12 signifies reconstruction is necessary by scarifying the surface.

Table 8-2 : Grouped Road Condition Levels

Condition Level	IRI Range	Description
C1	0 - 4.99	Good (G)
C2	5 – 6.99	Fair (F)
C3	7 – 8.99	Moderate (M)
C4	9 – 11.99	Poor (P)
C5	12 - 120	Bad (B)

8.3.3. Matrix Structure

The classification of the segments by traffic and pavement condition gave rise to a 5 x 5 matrices with cells designated as T1C1, T1C2 …T4C3, T5C5 etc. As each cell also had an existing Structural Number (SNexist) attributed to it and the SNexist values with respect to Condition Values varied considerably between National and Regional Highways, two separate 5 x 5 matrices had to be developed. Each cell was considered as a hypothetical road segment possessing a single set of historical parameters (AADT, IRI, SNexist) derived from weighted average values of all segments (of National or Regional Highways as the case may be) that satisfied the cell criteria. Therefore, specific intervention (SN after works, equivalent bituminous overlay thickness) for each of the 25 hypothetical segments for National roads - and the same number for Regional Highways - had to be ascertained based on the design strength and the existing strength of the cell pavement. The following sections discuss the derivation of the 'after works' parameters for different cells of the two matrices.

8.3.4. Intervention Design

The primary input for pavement design is the number of repetitions of standard axles expected to be imposed during the design period. This is a function of base AADT (MT except 2/3 wheelers), composition of heavy vehicles in the stream (discussed later in the chapter) and their respective growth rates during design period, the design period and ESAL for different vehicles.

8.3.5. Design Period

A design period of 10 years was adopted for all roads segments for reasons explained in *Appendix 2: Design Standards and Specifications.* A staged construction strategy with a rehabilitation overlay after 10 years to prolong the life of the pavement to the end of the plan period of 20 years was considered.

8.3.6. Growth Rates

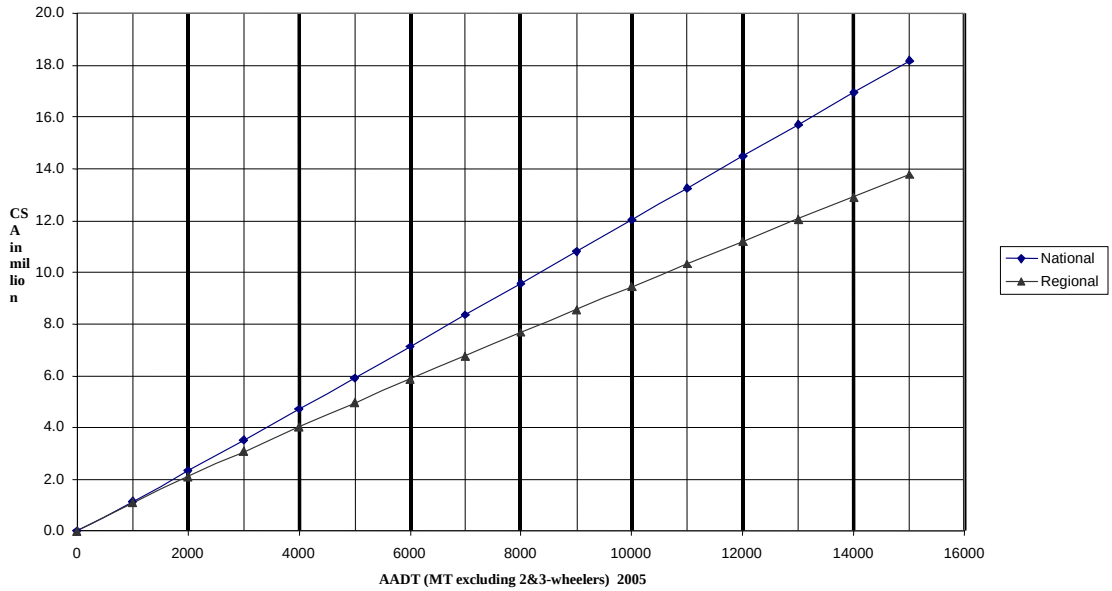
The traffic forecast model provided different sets of growth rates for three scenarios of high, medium and low economic growths of the country for National and Regional Highways. For the purpose of pavement design, the respective medium growth rates were considered for all vehicles modes including the commercial ones. During the Plan period of 20 years, the growth rates changed every 5 years.

8.3.7. Cumulative Standard Axles

Based on the above factors, the cumulative number of standard axles (CSA) from 2007 to 2016 had to be estimated and assigned to different cells of the two matrices. In the ultimate analysis, CSA had to be co-related to the traffic levels T1, T2 etc. A regression analysis was carried out to derive a relationship between AADT of motorised vehicles (excluding 2- and 3-wheelers) and the traffic loading from commercial vehicles expressed in terms of million CSA.

Figure 8-1shows the graphs so obtained for National and Regional Highways. In each regression, R^2 value of 0.88 was returned, which was considered to be quite acceptable. The average design CSA for the traffic level (T1, T2 etc) was assessed for the two graphs separately. For example, in National roads, loading would be 4 million CSA for traffic level T2 and 12 million CSA for T5. Similarly, in Regional Highways, loading over 10 years would be 3 for traffic level T2 and 9 million CSA for T5.

Figure 8-1 : Relationship between CSA and AADT



8.4. Pavement Strength

8.4.1. Design Pavement Strength

Differential Structural Number method was employed to estimate the rehabilitation need of the pavement. The difference between the design structural number and the existing structural number of the pavement determined the equivalent overlay thickness.

The following AASHTO relationship was used to calculate the design Structural Number, SN_{design}:

$$\log_{10}(W_{18}) = Z_R \times S_0 + 9.36 \times \log_{10}(SN+1) - 0.20 + \left(\log_{10}\left[(\Delta PSI)/4.2\text{-}1.5\right]\right) / \left(0.40 + (1094/((SN+1)^{5.19}))\right) + 2.32 \times \log_{10}(M_R) - 8.07$$

Where

W_{18} = Predicted number of 18 – kip (8160 kg) equivalent standard axle load applications = CSA

Z_R = Standard Normal Deviate = -1.645

S_0 = Combined Standard Error of the traffic prediction and performance prediction = 0.45

Δ (PSI) = difference between the initial design serviceability index P_0, and the design terminal serviceability index P_t, = 2

M_R = Resilient Modulus (psi) = 1500 x CBR = 7500

A universal 4-day soaked CBR value of 5% was adopted for simplicity.

8.4.2. Existing Pavement Strength

In all pavement rehabilitation projects, it is essential to ascertain the residual strength of the existing pavement so that the additional strengthening layer(s) to bring it to the design strength can be provided. The residual strength is usually determined by the non-destructive deflection method and the destructive layer coefficient method. Fortunately RMMS provided 2004 data for BBD values and existing layer composition at 1 km interval on most of the segments.

Structural Number from deflection was calculated from the formulae:

$SNC = 3.2 \times (def)^{-0.63}$

SNdef = SNC – SNSG where SNSG is the subgrade structural number.

SNSG = $(3.5 \times \log_{10}(CBR) - 0.85 \times (\log_{10}(CBR))^2 - 1.43)$

Adjusted BBD values and existing subgrade CBR values were used as mentioned in Section 3.1.6.

The equation used for determining the Structural Number from pavement composition was:

$$SNpavement = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

Where :

a_1 = layer coefficient of bituminous layer = 0.32 for N roads and 0.30 for R roads

a_2 = layer coefficient of granular base layer = 0.13 for N roads and 0.12 for R roads

a_3 = layer coefficient of granular subbase layer = .09 for all roads

D_i = layer thickness (inches) and

$m_2 = m_3$ = layer drainage factor = 1 assumed considering poor drainage

The weighted average of the SN from the two methods was used in design calculation. SNdef was given twice the weightage of SNpavement as deflection data were thought to be more reliable. SNexist was assumed to be a function of pavement condition i.e. IRI. It was possible to establish a correlation between the two variables as given in the *Tables 7.1 and 7.2.*

8.4.3. Equivalent Overlay Thickness

The design strengthening overlay was calculated as an equivalent dense bituminous layer with a strength coefficient of 0.40 per inch thickness for simplicity.

Equivalent overlay thickness (mm) = SNoverlay x 25.4/0.40

In practical terms, however, a combination of binder and wearing course or partial reconstruction will be necessary during implementation. In fact, if the existing IRI exceeds 9 or the equivalent overlay thickness is more than 180mm, reconstruction after scarification would generally be cost-effective. The required overlay thickness, which is in effect the rehabilitation or strengthening layer, for individual cells computed by the above method is presented in Table 8-3 and Table 8-4.

Table 8-3: SN values for National Roads

	C1	C2	C3	C4	C5	
T1	0.9	1.2	1.4	2.0	2.0	SN*overlay*
	4.0	4.0	4.0	4.0	4.0	SN*design*
	3.1	2.8	2.6	2.0	2.0	SN*exist*
T2	1.3	1.6	1.8	2.4	2.4	SN*overlay*
	4.4	4.4	4.4	4.4	4.4	SN*design*
	3.1	2.8	2.6	2.0	2.0	SN*exist*
T3	1.6	1.9	2.1	2.7	2.7	SN*overlay*
	4.7	4.7	4.7	4.7	4.7	SN*design*
	3.1	2.8	2.6	2.0	2.0	SN*exist*
T4	1.8	2.1	2.3	2.9	2.9	SN*overlay*
	4.9	4.9	4.9	4.9	4.9	SN*design*
	3.1	2.8	2.6	2.0	2.0	SN*exist*
T5	2.0	2.3	2.5	3.1	3.1	SN*overlay*
	5.1	5.1	5.1	5.1	5.1	SN*design*
	3.1	2.8	2.6	2.0	2.0	SN*exist*

Table 8-4 : SN values for Regional Highways

	C1	C2	C3	C4	C5	
T1	2.0	2.1	2.2	2.3	2.3	SN*overlay*
	4.0	4.0	4.0	4.0	4.0	SN*design*
	2.0	1.9	1.8	1.7	1.7	SN*exist*
T2	2.2	2.3	2.4	2.5	2.5	SN*overlay*
	4.2	4.2	4.2	4.2	4.2	SN*design*
	2.0	1.9	1.8	1.7	1.7	SN*exist*
T3	2.5	2.6	2.7	2.8	2.8	SN*overlay*
	4.5	4.5	4.5	4.5	4.5	SN*design*
	2.0	1.9	1.8	1.7	1.7	SN*exist*
T4	2.7	2.8	2.9	3.0	3.0	SN*overlay*
	4.7	4.7	4.7	4.7	4.7	SN*design*
	2.0	1.9	1.8	1.7	1.7	SN*exist*
T5	2.9	3.0	3.1	3.2	3.2	SN*overlay*
	4.9	4.9	4.9	4.9	4.9	SN*design*
	2.0	1.9	1.8	1.7	1.7	SN*exist*

8.4.4. Intervention Schedule

As per HDM input, the rehabilitation intervention was proposed on all the road segments in the year 2007 so that economic evaluation could be done on a uniform basis. The future interventions, again for uniformity, were scheduled in the same years. The general intervention programme proposed for the purpose of analysis is as under:

- Rehabilitation overlay in the 1st year
- Periodic maintenance (functional overlay) in the 5th year
- Structural overlay in the 10th year, and
- Periodic maintenance (functional overlay) in the 15th year

8.5. Cost of Intervention

The inputs of HDM Circle of RHD formed the basis for financial unit costs for this analysis. A factor of 1.1 was adopted for bringing the HDM values to the current year. Necessary extrapolations were needed for higher overlay thickness proposed here. For confirmation, independent estimation was carried out using RHD Schedule of Rates for roads and was found to compare reasonably well. The unit cost of overlay in square meters for different interventions are presented in the input matrices (see para. 8.6)

8.6. Input Matrices

The outcome of the design exercise described in this chapter so far was the matrices for National and Regional Highways. These Input Matrices were prepared for use as inputs for the HDM analysis of rehabilitation intervention programme, as discussed in the following sections. The consolidated Input Matrices are presented in Table 8-5 and Table 8-6. The input matrices cover 6,891.4 km of National and Regional Highways, and do not include the 710.6 km of roads under the 2005/06 Periodic Maintenance Programme[24].

[24] Giving a total of 7,602 km paved National and Regional Highways

Table 8-5 : Input Matrix for National Roads

AADT		IRI					
		0 - 4.99	5.00-6.99	7.00-8.99	9.00-11.99	12.00-120	
		C1	C2	C3	C4	C5	
0-1999	T1	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		3.1	2.8	2.6	2.0	2.0	SNexist
		4.0	4.0	4.0	4.0	4.0	SNdesign
		60	**80**	**90**	**130**	**130**	**Surf_thick (mm) of *Rehab Overlay***
		595	790	888	1279	1279	Fin-unit cost (Tk/m2)
		482	**709**	**168**	**17**	**3**	**Length (km)**
		3.6	5.7	8.1	10.4	13.4	Initial IRI
		1386	883	1227	1388	910	Traffic
		199	**389**	**103**	**15**	**2**	**Approx. Cost (Tk Crore)**
2000-3999	T2	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		3.1	2.8	2.6	2.0	2.0	SNexist
		4.4	4.4	4.4	4.4	4.4	SNdesign
		90	**110**	**120**	**160**	**160**	**Surf_thick (mm) of *Rehab Overlay***
		888	1084	1182	1573	1573	Fin-unit cost (Tk/m2)
		658	**227**	**78**	**72**	**6**	**Length (km)**
		4.0	5.9	8.1	10.1	13.0	Initial IRI
		2801	2899	2770	3070	2855	Traffic
		405	**170**	**64**	**78**	**7**	**Approx. Cost (Tk Crore)**
4000-5999	T3	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		3.1	2.8	2.6	2.0	2.0	SNexist
		4.7	4.7	4.7	4.7	4.7	SNdesign
		110	**130**	**140**	**180**	**180**	**Surf_thick (mm) of *Rehab Overlay***
		1084	1279	1377	1768	1768	Fin-unit cost (Tk/m2)
		283	**11**	**43**	**55**	**0.1**	**Length (km)**
		3.6	5.8	7.7	10.6	12.8	Initial IRI
		4721	4728	5490	4949	4086	Traffic
		213	**10**	**41**	**67**	**0**	**Approx. Cost (Tk Crore)**
6000-7999	T4	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		3.1	2.8	2.6	2.0	2.0	SNexist
		4.9	4.9	4.9	4.9	4.9	SNdesign
		120	**140**	**150**	**190**	**190**	**Surf_thick (mm) of *Rehab Overlay***
		1182	1377	1475	1866	1866	Fin-unit cost (Tk/m2)
		39	**20**	**22**	**0.0**	**6**	**Length (km)**
		3.9	6.2	8.6		14.5	Initial IRI
		7749	6876	7055		7141	Traffic
		32	**19**	**22**	**0**	**7**	**Approx. Cost (Tk Crore)**
8000++ (10000)	T5	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		3.1	2.8	2.6	2.0	2.0	SNexist
		5.1	5.1	5.1	5.1	5.1	SNdesign
		130	**150**	**160**	**200**	**200**	**Surf_thick (mm) of *Rehab Overlay***
		1279	1475	1573	1964	1964	Fin-unit cost (Tk/m2)
		269	**74**	**19**	**17**	**0.3**	**Length (km)**
		3.8	5.5	7.7	10.5	12.4	Initial IRI
		11521	12018	20000	9103	12794	Traffic
		239	**76**	**20**	**23**	**0**	**Approx. Cost (Tk Crore)**

Table 8-6 : Input Matrix for Regional Highways

AADT		IRI					
		0 - 4.99 (2.5)	5.00-6.99 (6.0)	7.00-8.99 (8.0)	9.00-11.99 (11.0)	12.00-120 (14.0)	
		C1	C2	C3	C4	C5	
0-1999	T1	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		2.0	1.9	1.8	1.7	1.7	SNexist
		4.0	4.0	4.0	4.0	4.0	SNdesign
		130	**140**	**140**	**150**	**150**	**Surf_thick (mm) of *Rehab Overlay***
		1279	1377	1377	1475	1475	Fin-unit cost (Tk/m2)
		831	**699**	**1045**	**395**	**84**	**Length (km)**
		3.9	6.2	7.9	10.3	13.6	Initial IRI
		980	614	537	653	796	Traffic
		510	**462**	**691**	**279**	**59**	**Approx. Cost (Tk Crore)**
2000-3999	T2	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		2.0	1.9	1.8	1.7	1.7	SNexist
		4.2	4.2	4.2	4.2	4.2	SNdesign
		150	**150**	**160**	**160**	**160**	**Surf_thick (mm) of *Rehab Overlay***
		1475	1475	1573	1573	1573	Fin-unit cost (Tk/m2)
		82	**89**	**215**	**115**	**6**	**Length (km)**
		4.5	5.9	8.1	10.2	13.4	Initial IRI
		2536	2562	2468	2570	2419	Traffic
		58	**63**	**163**	**87**	**5**	**Approx. Cost (Tk Crore)**
4000-5999	T3	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		2.0	1.9	1.8	1.7	1.7	SNexist
		4.5	4.5	4.5	4.5	4.5	SNdesign
		160	**170**	**180**	**180**	**180**	**Surf_thick (mm) of *Rehab Overlay***
		1573	1671	1768	1768	1768	Fin-unit cost (Tk/m2)
		9	**9**	**0**	**1**	**0.0**	**Length (km)**
		4.7	5.9	0.0	9.4	0.0	Initial IRI
		4309	4175	0	4224	0	Traffic
		7	**7**	**0**	**1**	**0**	**Approx. Cost (Tk Crore)**
6000-7999	T4	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		2.0	1.9	1.8	1.7	1.7	SNexist
		4.7	4.7	4.7	4.7	4.7	SNdesign
		180	**180**	**190**	**190**	**200**	**Surf_thick (mm) of *Rehab Overlay***
		1768	1768	1866	1866	1964	Fin-unit cost (Tk/m2)
		0	**14**	**1**	**0.0**	**0**	**Length (km)**
		0.0	5.4	8.3	0.0	0.0	Initial IRI
		0	6504	7256	0	0	Traffic
		0	**12**	**1**	**0**	**0**	**Approx. Cost (Tk Crore)**
8000++ (10000)	T5	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Rehab Overlay	Improvement Type
		2.0	1.9	1.8	1.7	1.7	SNexist
		4.9	4.9	4.9	4.9	4.9	SNdesign
		190	**200**	**200**	**210**	**210**	**Surf_thick (mm) of *Rehab Overlay***
		1866	1964	1964	2062	2062	Fin-unit cost (Tk/m2)
		16	**0**	**0**	**2**	**0.0**	**Length (km)**
		3.3	0.0	7.5	10.8	0.0	Initial IRI
		11160	0	11160	8307	0	Traffic
		14	**0**	**0**	**1**	**0**	**Approx. Cost (Tk Crore)**

8.7. Interventions Required

The resulting interventions from the HDM runs are set out in aggregate form in Table 8-7. This table shows the total lengths of roads in each Circle that require some form of maintenance or rehabilitation intervention over the next five years. 4,780 km are proposed for interventions in this Masterplan at cost of Taka 3,909 Crore[25]. 1,974 km are committed under projects and programmes identified in Table 5-3, a further 710 km are committed under the 2005/06 PMP, and 138 km are not proposed for any intervention in the first 5 years.[26]

Interventions are shown, by Zone, in Maps 8.1 through 8.8. Interventions for Barisal, Chittagong, Comilla, Dhaka, Rangpur, Khulna, Rajshahi, and Sylhet Zones are listed in Table 8-8, Table 8-9, Table 8-10, Table 8-11, Table 8-12, Table 8-13, Table 8-14, and Table 8-15 respectively.

Table 8-15 is likely to involve rehabilitation, and 81% overlays. Using the above costs, the programme estimate was uprated, using an average cost of Taka 1.13 Crore per km, to Taka 5,407 Crore.

Table 8-7 : Interventions Required on National Highways and Regional Highways (Km)

Year	Dhaka	Comilla	Chittagong	Sylhet	Khulna	Barisal	Rajshahi	Rangpur	Total
1	176.7	50.1	55.9	77.5	0	6.7	29.2	7.0	403.1
2	126.3	95.3	131.5	237.8	271.4	124.3	142.1	55.3	1,184.0
3	101.7	3.7		149.6	199.4	198.9	109.8	109.3	872.4
4	232.4	62.0	218.7	124.3	132.5	79	285.7	46.7	1,181.3
5	266.3	19.2	126.3	0	119.8	207.7	205.0	195.1	1,139.4
Total	**903.4**	**230.3**	**532.4**	**589.2**	**723.1**	**616.6**	**771.8**	**413.4**	**4,780.2**

Table 8-8 : Interventions in first 5 years of Masterplan, Barisal Zone

Road No.	Name	Length (km)	Year
N803	Alipur to SS Ghat	6.72	1
N804	Bhanga to Goalchamot More	124.3	2
N7	Daulatdia Ferryghat to Kamarkhali Bridge		2
N8	Tarail to Takerhat		2
R580	Takerhat to Gonapara	198.89	3
R860	Mostafapur to Ibrahimpur Ferry ghat		3
R861	Monoharpur to Sariatpur(Premtala)		3
R870	Barisal(Rupatala Bus stand) to Pirojpur(Thana More)		3
R770	Boleswar Bridge to Pirojpur(CO office)		3
R890	Puran Talukdarhat to Burhanuddin(Keramatganj)		3
R881	Amtali to Kuakata	79.04	4
R710	Kushtia to Pangsha		4
R711	Baghmara to Joukura Ferryghat		4
N8	Mawa Ferryghat West to Tarail	207.74	5
N8	Takerhat to Rajoir		5
N8	Joysree to Rahmatpur		5
N809	Barisal(Medical more to Chatarmatha		5
N8	Barisal(Medical more to Patuakhali		5
R890	Burhanuddin(Keramatganj) to Char Manik		5

[25] Using HDM cost rates (see para. 8.9)
[26] Giving a total of 7,602 km of paved National and Regional Roads.

Table 8-9 : Interventions in first 5 years of Masterplan, Chittagong Zone

Road No.	Name	Length (km)	Year
N1	Baraiyerhat to Mirsarai	55.85	1
R163	Chittagong(Mohora) to Chandraghona		1
R160	Chittagong(Hathazari) to Manikchhari	131.53	2
N110	Link road(Teknaf road diversion N1) to Old Jhenuk Market		2
N1	Chittagong(Bohadderhat) To Maizzertek		2
N1	Lohagara(Aziznagar) To Eidgah		2
R170	Patiya To Gunaigari	218.74	4
R170	Banshkhali to Toitong		4
N108	Keranirhat to Bandarban(Shisu Academy)		4
R161	Chandraghona to Bandarban(Shisu Academy)		4
R164	Baraichhari to Kaptai		4
R162	Khagrachhari to Manikchhari		4
R160	Manikchhari(Thana) to Khagrachhari		4
R151	Baraiyerhat to Fatikchhari(Haidchokia)	126.29	5
N106	Chittagong(Hathazari) to Rangamati		5
R161	Ghagra to Chandraghona		5

Table 8-10 : Interventions in first 5 years of Masterplan, Comilla Zone

Road No.	Name	Length (km)	Year
R142	Chatkhil to Ramganj	50.11	1
N1	Lalpur to Baraiyerhat		1
N1	Daudkandi Bridge to Baldar Khal(Toll plaza)		1
N2	Bhairab Bridge end to Madhabpur	95.33	2
N104	Feni to Chowmohoni		2
R140	Lakshmipur Uttar Tamohoni to Chowmonohi		2
R140	Lakshmipur New Bus Terminal to Uttar Tamohoni	3.66	3
R220	Sarail to Nasirnagar	62.04	4
R203	Nabinagar to Bancharampur		4
R203	Bancharampur To Meghna River		4
R860	Harina Ferryghat to Vatialpur	19.23	5

Table 8-11 : Interventions in first 5 years of Masterplan, Dhaka Zone

Road No.	Name	Length (km)	Year
N8	Postagola to Baorvita		1
R810	Shampur to Chashara		1
R110	Jatrabari to Chashara		1
N3	Banani to Abdullahpur		1
R301	Tongi to Kaliganj(Arikhola)		1
N302	Abdullahpur to Baipal		1
N4	Joydevpur to Mirzapur	176.72	1
N405	Elenga to Jamuna Bridge Access Road East Side		1
R370	Netrakona(Mogra Bridge) to Netrakona(Rajur Bazar)		1
R370	Thakurakona to Mohanganj		1
N5	Golra To Paturia Ferryghat		2
N2	Kanchpur To Bhulta(intersection)+6.6km	126.31	2
R370	Mymensingh(Charpara more) to Netrakona(Mogra Bridge)		2
R504	Hemayetpur to Manikganj		3
N501	Road Chn 1.70Km to Dhour		3
R314	Mawna to Bormibazar		3
R314	Bormibazar To Gafargaon		3
R301	Kaliganj(Arikhola) to West side of Moizuddin Bridge	101.75	3
R301	East side of Moizuddin Bridge to Panchdona		3
N501	Mirpur Bridge to Chn500m		3
R506	Barangail to Tangail		4
R313	Mawna To kapasia		4
R312	Kapasia To Toke		4
R211	Itakhola To Motkhola		4
R212	Akhdaria(C&B Bazar) To Agarpur		4
R202	Rupganj To Bhulta	232.39	4
R203	Bhulta To Ramchandri		4
N5	Savar To Golra		4
N4	Porabari To Madhupur		4
R820	Zinzira To Srinagar		5
N8	Baorvita To Mawa		5
R812	Munshiganj To Mawa		5
R113	Madanpur To Sayedpur		5
N105	Madanpur To Kanchon Bridge		5
R114	Narsingdi to Bostail		5
R210	Shahepratap To Narsingdi	266.29	5
R302	Kaliganj Bazar Portion		5
N105	Debogram To Intersection with R301		5
R310	Joydevpur to Chn11.95km		5
R315	Mawna To Dulivita		5

Table 8-12 : Interventions in first 5 years of Masterplan, Rangpur Zone

Road No.	Name	Length (km)	Year
N517	Rangpur(Modern more) To Medical more	6.97	1
R546	Dhaka road To Shantahar	55.32	2
N502	Bogra(Jahangirabad) To Nandigram		2
R555	Gaibandha	109.26	3
R585	Fulbari To Gabindaganj		3
R550	Mokamtala To Jaypurhat(Rail gate)		3
R545	Dhamoirhat To Jaypurhat(Oachur more)	46.65	4
R549	Paharpur To Khanjanpur		4
N506	Rangpur(Modern more) To Mohiganj		4
N506	Teesta Bridge west side To Kurigram(Shapla chatter)		4
N518	Sayedpur(Sutkir more) To Sonapukur	195.05	5
R585	Dinajpur(Hospital more) To Fulbari		5
R558	Moheshpur To Barapukuria		5
R556	Mithapukur To Fulbari		5
R557	Madhaypara To Badarganj		5
N5	Bairagiganj To Beldanga		5

With regard to Dhaka Zone (Table 8-11), intervention on the N501 (Dhaka by-pass) is proposed, as a result of the HDM analysis, in year 5. However, visual inspection of this road reveals that it is seriously failing, despite being recently constructed. Intervention will be needed before year 5.

Table 8-13 : Interventions in first 5 years of Masterplan, Khulna Zone

Road No.	Name	Length (km)	Year
N704	Jhenaidah To Bheramara		2
N7	Jhenaidah To		2
N7	Kaliganj To		2
N7	-		2
N7	-		2
N702	Jessore(Doratana more) to Magura(Vaina more)	271.41	2
N707	Palbari To Murali		2
N706	Jessore Daratana More To Banapole		2
R755	Jessore(Rajarhat) To Chuknagar		2
N7	Jessore(Palbari) To		2
N7	Phultala To Khulna(Ferryghat)		2
N7	Mongla		2
R745	Jhenaidah(Bata more) To Chuadanga		3
R748	Chuadanga(Boro bazaar) To Kaliganj		3
R760	Khulna(Power house) To Athara Mile Bazar		3
R760	Satkhira	199.44	3
R856	Katakhali To Mollarhat		3
R770	Katakhali		3
R770	Bagerhat(Circuit House) To Boleswar Bridge West Side		3
R713	Charaikal To Shelaidah		4
R710	Khoksha To Kushtia(Chowrhash)	132.52	4
R720	Magura(Old bus Stand) To Narail		4
R771	Rupsha To Bagerhat(Khanzahan Ali Mazar)		4
R745	Kushtia(Trimohoni) To Meherpur		5
R746	Meherpur To Mujibnagar(BDR Camp)	119.78	5
R749	Darshana(Chowmatha Traffic Point) To Mujibnagar(Monument)		5

Table 8-14 : Interventions in first 5 years of Masterplan, Rajshahi Zone

Road No.	Name	Length (km)	Year
N405	Jamuna Bridge West side To Hatikamrul	29.22	1
R604	Pabna Bus Terminal To Gaspara		1
N5	Hatikamrul To Chandikona	142.05	2
N502	Omarpur		2
N704	Paksey Ferryghat To Dasuria		2
N705	Ruppur To Dasuria		2
N6	Tebunia To Rajshahi(Court)		2
N602	Natore (Bus stand) To Harishpur		2
R601	Pabna To Sujanagar	109.78	3
R680	Rajshahi(Court) To Nawabganj		3
R545	Patnitala To Santahar Bypass End(Dhaka road)		3
R545	Patnitala To Khanjanpur	285.66	4
R547	Naogaon To Shapahar		4
R549	Badalgachhi To Paharpur		4
R548	Naogaon To Atrai		4
R548	Natore		4
N502	Omarpur To Natore		4
N507	Hatikamrul To Baraigram		4
R450	Jamuna Bridge(Saidabad) To Sirajganj		4
N6	Kashinatpur To Tebunia		4
R451	Sirajganj To Nolka	204.95	5
R604	Tebunia To Chatmohor		5
R604	Humkurai		5
N5	Natakhola To Satiakhola		5
N5	Paikpara To Hatikamrul		5
R603	Belpukur To Kasiadanga		5
R681	Bijoynagar To Uzanpara		5
R547	Shapahar To Gomastpur		5

Table 8-15 : Interventions in first 5 years of Masterplan, Sylhet Zone

Road No.	Name	Length (km)	Year
N205	Sylhet (Chandipool) To Sylhet (Keen Bridge)	77.46	1
N206	Sylhet (GPO) To Nayerpool		1
R250	Sylhet (Keen Bridge) To Charkhai		1
R251	Golapganj To Vadeswar(Kura bridge)		1
R281	Juri To Barlekha		1
R281	Bairagirbazar To Sepla		1
N2	Madhabpur To Mirpur	237.81	2
N204	Jagadishpur To Shaistaganj		2
N207	Mirpur To Sherpur		2
N2	Tajpur To Sylhet(National Eid gah)		2
N208	Moulvibazar To Fenchuganj		2
N2	Sylhet To Tamabil		2
R241	Pagla To Jagannathpur	149.59	3
R240	Hobiganj To Auskandi		3
R281	Rajnagar To Kulaura		3
R250	Charkhai To Zakiganj		3
R241	Auskandi		3
N2	Mirpur To Tajpur	124.33	4
N208	Moulvibazar To Fenchuganj		4
R282	Juri		4
R282	Lathitila		4
R281	Kulaura To Juri		4

8.8. Updating Prices of Vehicle Operating Cost Components

8.8.1. General

The Economics Circle of RHD regularly publishes the RHD Road User Cost Report, which gives information on the vehicle operating costs (VOC). The latest available report, the fifth update, is for the year 2004-05. In this report, the data on the costs and prices of different VOC components such as vehicle, tyre, fuel, spare parts, crew, etc. pertain to the year 2004. Since 2004, significant changes that have occurred in the national economy include surging of global oil prices, changes in duties and taxes on imported items, exchange rate fluctuation and rise in inflation. As all of these factors are likely to impact both the financial and economic prices of VOC components it was necessary to update the price data to the current 2006-07 level in order to obtain realistic values.

Given that it was not possible to carry out a full-fledged analysis from basic data within the study period, RHD's 2004-05 data and methodology were broadly adopted. Current (2006-07) information was obtained for major items like import prices, foreign exchange rate, and rates of applicable taxes and duties, while remaining items were simply updated using the inflation factor for the period 2004-06. The financial or retail prices were broken down into its constituent parts to identify taxation and foreign currency elements. Duties and taxes are charged on the CIF or Assessable Value (AV) of the import, after conversion to Bangladeshi Taka. "Other Costs" include port dues, transportation, assembling (for knocked down products), dealers' overheads and profit margins. The economic prices, net of taxes and duties, were calculated as the CIF plus Other Costs, shadow priced according to the Standard Conversion Factor (SCF) of 0.8. The average annual inflation factor over the period 2004-06 was taken to be 6.76%.

The VOC components considered include:

- Vehicle purchase cost

- Tyre cost
- Cost of fuel & lubricants
- Vehicle maintenance, e.g. cost of spare parts and maintenance labour
- Crew cost, and
- Overheads

8.8.2. Vehicle Purchase Cost

The CIF[27] and Assessable Values (AV), in Taka of different categories of vehicles were collected from some established dealers in Dhaka. The tariffs payable include Landing Permit Fee (LPF), Customs Duty (CD), Supplementary Duty (SD), Value Added Tax (VAT), Advance Income Tax (AIT), Infrastructure Development Surcharge (IDSC), Advance Trade VAT (ATVAT), and Pre-shipping Inspection Fee (PSI). These are set out in Table 8-16.

Table 8-16 : Percentage tariffs applicable to representative vehicles and tyres

Vehicle Category	LPF on CIF	CD on AV	SD on AV+CD	VAT on AV+CD+SD	AIT on AV	IDSC on AV	ATVAT*	PSI on CIF
Medium Truck	1%	25%	-	15%	3%	4%	1.5%	1%
Small Truck	1%	25%	-	15%	3%	4%	1.5%	1%
Large Bus	1%	12%	-	15%	3%	4%	1.5%	1%
Mini Bus	1%	12%	-	15%	3%	4%	1.5%	1%
Micro Bus	1%	25%	-	15%	3%	4%	1.5%	1%
Utility (jeep)	1%	25%	65%	15%	3%	4%	1.5%	1%
Car	1%	25%	25%	15%	3%	4%	1.5%	1%
Motor Cycle	1%	25%	15%	15%	3%	4%	1.5%	1%
Autorickshaw	1%	25%	15%	15%	3%	4%	1.5%	1%
All Tyres	1%	25%	-	15%	3%	4%	1.5%	-

* on 110% of AV+CD+IDSC

Table 8-17 presents a breakdown of vehicle purchase costs.

Table 8-17: New Vehicle Purchase Costs (Taka in 2006-07 prices)

Vehicle Category	CIF Value	Tariffs	Other Costs	Total Financial	Total Economic
Medium Truck	839,340	456,746	816,589	2,112,675	1,501,004
Small Truck	716,188	389,730	547,988	1,653,906	1,161,740
Large Bus	908,911	355,304	1,751,416	3,015,630	2,319,133
Mini Bus	735,000	287,320	784,810	1,807,130	1,370,198
Micro Bus	774,257	421,252	82,633	1,278,143	848,107
Utility (jeep)	976,238	1,452,438	979,858	3,408,534	1,769,886
Car	495,050	449,030	90,384	1,034,464	572,307
Motor Cycle	51,122	38,948	13,700	103,770	62,593
Autorickshaw	124,195	94,618	29,408	248,221	148,963

8.8.3. Tyre cost

Table 8-18 presents the breakdown of new tyre prices for each vehicle category.

[27] CIF - Cost, Insurance and Freight

Table 8-18: Cost of New Tyre (Taka in 2006-07 prices)

Vehicle Category	CIF Value	Tariffs	Other Costs	Total Financial	Total Economic
Medium Truck	9,000	4,807	2,779	16,586	11,313
Small Truck	6,000	3,204	1,853	11,057	7,542
Large Bus	8,000	4,273	2,471	14,743	10,056
Mini Bus	6,000	3,204	1,853	11,057	7,542
Micro Bus	1,700	908	525	3,133	2,137
Utility (jeep)	4,700	2,510	1,451	8,662	5,908
Car	1,900	1,015	587	3,501	2,388
Motor Cycle	775	414	239	1,428	974
Autorickshaw	450	240	139	829	566

8.8.4. Fuel and Lubricants

Global prices of crude petroleum rose to an all-time high of $70 per barrel in 2005. Prices of refined oils also increased significantly in the last 2 years. But the government has been selling fuel oils, especially diesel, at prices lower than the import costs. At present, Bangladesh Petroleum Corporation (BPC) imports diesel at around $69.45 per barrel and petrol at $63.93 per barrel. The Tariff Value (TV) is a value fixed by the government, which is different (lower) than the actual cost and is used as the base for calculation of taxes and duties. The TV for refined oils is fixed at $0.31 per litre. The import cost of each litre of diesel stands at Tk. 37.27 and petrol at Tk. 34.90. The import costs include Tk. 7.56 as government taxes for each litre of fuel oil. Taxes comprise Customs Duty @ 13%, IDSC @ 4%, VAT @ 15%, and ATVAT @ 1.5%. Additional costs[28] are taken to be Tk. 1.35 per litre for diesel and Tk. 1.70 per litre for petrol, as estimated in the Road User Charges Study[29]. The selling price at petrol pumps is Tk. 31 per litre for diesel and Tk. 53 per litre for petrol. The economic price was calculated from the above, taking into consideration the profit/subsidy component.

In the case of lubricants, the 2004 values given in RHD Report have been inflated to 2006-07 levels using the average annual inflation rate of 6.76%.

The financial and economic prices of petrol, diesel and lubricants are presented in Table 8-19.

Table 8-19 : Economic and Financial Prices of Fuel (Taka per litre in 2006-07 prices)

Item	Petrol		Diesel		Lubricants	
	Financial	Economic	Financial	Economic	Financial	Economic
Import price	27.34	27.34	29.70	29.70	23.33	23.33
Tariff Value	21.08	-	21.80	-	-	-
Taxes	7.56	-	7.56	-	10.91	-
Price incl. taxes	34.90	-	37.27	-	-	-
Other costs	1.70	1.36	1.35	1.08	40.14	32.11
Profit (+)/Subsidy (-)	16.40	13.12	(-) 7.62	7.62		
Total	**53.00**	**41.82**	**31.00**	**38.40**	**74.38**	**55.45**

8.8.5. Maintenance Labour Costs

The average financial cost of maintenance labour in the RHD Report was taken as Taka 70 per hour. This translates into a monthly salary of Taka 16,800 assuming an average workday of 8

[28] These include transportation, marketing margins, dealer/agent commission, depreciation, etc.
[29] *Road User Charges Study, 2006* by WSP for World Bank (Road Sector Reform Project) and RHD.

hours duration. As this appeared to be much too high, the cost of labour was re-estimated for the present study.

The average wage rate of skilled manufacturing workers (felt applicable for mechanics engaged in vehicle maintenance) was estimated as Tk. 98.46 per day in 1998/99[30]. The nominal wage rate index for the manufacturing sector, according to Bangladesh Bureau of Statistics (BBS) data, increased from 2,522 in 1998-99 to 4,445 in 2005-06. Based on this, the present wage rate is estimated as Tk. 174 per day, which translates to Tk. 22 per hour. The financial cost to the user is typically 2.5 times the wage rate, giving an hourly rate of Tk. 55 per hour.

Thus, the financial cost of maintenance labour for 2006-07 is taken as Taka 55 per hour and the economic cost is Taka 44 per hour for all vehicle types.

8.8.6. Crew Costs

The crew wage costs, presented in the RHD Report, were updated to 2006-07 levels using the inflation factor and set out in Table 8-20.

Table 8-20 : Crew Wage Cost (Taka per hour in 2006-07 prices)

Vehicle Category	Total Financial	Total Economic	Vehicle Category	Total Financial	Total Economic
Medium Truck	34	27	Micro Bus	26	21
Small Truck	22	17	Utility (jeep)	17	14
Large Bus	50	40	Car	28	23
Mini Bus	35	28	Autorickshaw	24	19

8.8.7. Overheads

Overhead costs comprise office administration and rentals, garaging, insurance, vehicle excise duty/VAT, and tolls/route permit fees. Table 8-21 presents the annual overhead costs by vehicle category for 2006-07, obtained by inflating the 2004 Report values.

Table 8-21: Annual Overhead Costs (Taka in 2006-07 prices)

Vehicle Category	Total Financial	Total Economic
Medium Truck	199,460	109,988
Small Truck	92,321	59,040
Large Bus	430,074	247,748
Mini Bus	238,782	153,527
Micro Bus	161,847	139,394
Utility (jeep)	28,494	22,909
Car	121,385	84,685
Motor Cycle	9,916	7,340
Autorickshaw	32,597	26,272

8.8.8. Summary of VOC Inputs

The updated VOC inputs used to run the HDM model are summarized in Table 8-25.

8.9. Economic Appraisal

Using the revised economic and financial inputs for HDM, the resultant NPV's divided by capital cost are shown in Table 8-22. All the interventions show a benefit greater than cost. The highest priorities, and therefore earliest interventions, are on the T5 (highly trafficked) road sections.

[30] *Decomposing Wage Inequality Change in Bangladesh*, 2002, Research paper by Mustafa Mujeri and Bazlul Khondker.

Table 8-22 : NPV/Capital Cost for National Highway and Regional Highway Interventions

	C1	C2	C3	C4	C5	
T1	1.7	1.3	3.2	3.5	2.2	National
	1.8	1.1	1.3	2.2	3.5	Regional
T2	5.3	7.2	7.0	7.7	8.0	National
	7.7	9.4	9.9	11.0	11.9	Regional
T3	9.4	11.6	15.9	13.1	11.0	National
	12.1	12.56		15.3		Regional
T4	18.4	17.9	19.6		19.6	National
		15.3	16.7			Regional
T5	24.9	25.3	25.4	22.16	26.1	National
	10.7		12.9	14.5		Regional

8.10. Summary of Interventions on National and Regional Highways

Table 8-23 : Summary of Committed and Proposed interventions on National and Regional Highways (first 5 years)

Intervention	Km
Proposed Road Masterplan Rehabilitation/Maintenance[31] Projects	4,780
Committed Improvement and Maintenance Projects	1,974
PMP 2005/06	710
No intervention	138
Total	**7,602**

Table 8-24 : Programme Requirements

Year	1	2	3	4	5	Total
Year start June	2007	2008	2009	2010	2011	
Cost (Crore Taka)	246	1,086	1,227	1,353	1,495	5,407

[31] Some interventions will have to be reconstruction

Table 8-25 : Summary of VOC Inputs - 2006-07 prices					
Cost Item	Unit	Medium Truck		Small Truck	
		Fin	Eco	Fin	Eco
New Vehicle	Tk '000 per veh	2,113	1,493	1,654	1,155
New Tyre	Tk per tyre	16,586	11,223	11,057	7,482
Maintenance Labour	Tk per hour	55	44	55	44
Overheads	Tk '000 per annum	199	110	92	59
Crew wages	Tk per hour	34	27	22	17
Fuel - Diesel	Tk per litre	31.00	38.40	31.00	38.40
Fuel - Petrol	Tk per litre	-	-	-	-
Lubricants	Tk per litre	74	55	74	55
Cost Item	Unit	Micro Bus		Utility	
		Fin	Eco	Fin	Eco
New Vehicle	Tk '000 per veh	1,278	840	3,409	1,760
New Tyre	Tk per tyre	3,133	2,120	8,662	5,861
Maintenance Labour	Tk per hour	55	44	55	44
Overheads	Tk '000 per annum	162	139	28	23
Crew wages	Tk per hour	26	21	17	14
Fuel - Diesel	Tk per litre	-	-	-	-
Fuel - Petrol	Tk per litre	53.00	41.82	53.00	41.82
Lubricants	Tk per litre	74	55	74	55
Cost Item	Unit	Large Bus		Mini Bus	
		Fin	Eco	Fin	Eco
New Vehicle	Tk '000 per veh	3,016	2,310	1,807	1,363
New Tyre	Tk per tyre	14,743	9,976	11,057	7,482
Maintenance Labour	Tk per hour	55	44	55	44
Overheads	Tk '000 per annum	430	248	239	154
Crew wages	Tk per hour	50	40	35	28
Fuel - Diesel	Tk per litre	31.00	38.40	31.00	38.40
Fuel - Petrol	Tk per litre	-	-	-	-
Lubricants	Tk per litre	74	55	74	55
Cost Item	Unit	Car			
		Fin	Fin		
New Vehicle	Tk '000 per veh	1,034	567		
New Tyre	Tk per tyre	3,501	2,369		
Maintenance Labour	Tk per hour	55	44		
Overheads	Tk '000 per annum	121	85		
Crew wages	Tk per hour	28	23		
Fuel - Diesel	Tk per litre	-	-		
Fuel - Petrol	Tk per litre	53.00	41.82		
Lubricants	Tk per litre	74	55		

9. AXLE LOAD CONTROL

9.1. Emerging Issues

The problem of overloading can be tackled in two fundamental ways:

- Axle load control
- Incorporate overloading in design

The second option is the one followed in the country presently. Obviously this is not an acceptable situation. An illegal act like overloading cannot be given legitimacy by providing higher pavement thickness and turning a blind eye to the offence itself. The only solution is to impose strict axle load control. These controls should address the facts as mentioned below.

- Overloading is rampant especially on National Highways and therefore axle load control is necessary.
- There is too high a proportion of 2-axle medium trucks, which cause severe pavement damage. Government must actively encourage import/manufacture of multi-axle trucks and ban imports of 2-axle trucks above a certain weight.
- Truck owners commonly strengthen the chassis and the suspension to enable carrying of extreme loads.
- Standard buses are guilty of overloading too.
- Pavements constructed to the highest standards show signs of distress well before the end of design life. This is even when normal overloading is taken into account in design.

9.2. Load Limit

At the outset, the following legal load limits can be imposed:

Front 2-tyre single axle	:	6000 kg
4-tyre single axle	:	10200 kg
8-tyre tandem axle	:	20000 kg

A maximum tyre pressure of 80 psi (5.5 kg/cm2) should be allowed.

9.3. Equipment

Two types of axle load weighing equipment are available. There are the fixed type weighbridges and the portable weighing pads like the one used for the survey in this study.

Fixed Weighbridges

As the name implies, these are fixed installations on the roadside where the entire vehicle is weighed. The distribution of load to the individual axles may be calculated from standard factors. These weighing scales have very high range and are accurate. As installation is expensive, the number and locations have to be selected judiciously.

Portable Weighing Pads

Portable weigh pads can be inexpensive yet efficient. Pads are useful for spot weighing of the axle load directly. However, portability results in loss in accuracy to some extent. The pads are usually meant for static weighing, which is acceptable for most purposes. Portable weighbridges should be used to supplement the static weighbridges, and should be used at locations where temporary overloading is detected.

9.4. Strategic Locations for fixed Weighbridges

Fixed weighbridges at strategic locations are best suited for continuous enforcement and monitoring of axle load control. Bangladesh has a few fixed weighbridges in the process of construction. These have to be made operational immediately. More such facilities have to be

installed. Out-sourcing to private agencies with suitable incentive is a viable option. The control points can primarily be on highways where overloading is most prevalent. N1, N2 and N5 are some of the roads that seem to warrant load control. The government has taken initiative to address the problem by planning some fixed weighbridges at five strategic points:

- Auskandi on Dhaka- Sylhet road (N2) – installed but not operating
- Jamuna Bridge – installed and currently operating after long period of inactivity
- Sitakunda on Dhaka-Chittagong (N1) – work in progress
- Dhaleshwari on Dhaka-Mawa (N8) – work in progress
- Dhamrai on Dhaka – Aricha Highway – modern and nearly complete

A further 18 weighbridges are recommended (Table 9-1) to be permanently installed across the country. The selected locations are on major roads where truck volumes are high, on roads where trucks routinely carry heavy goods, e.g. near ports, and sources of sand and stone, and on the roads that cover virtually all strategic movements in Bangladesh. However, installation alone will not suffice but operation and enforcement must be ensured. Initially there would be significant need of policing and legal action. However, in due course of time, the very knowledge of the presence of control points will be deterrent enough. In addition, the police may be equipped with portable weighing pads and empowered to stop and weigh any vehicle on any road. Thus the element of surprise will be present nationwide.

9.5. Proposed Weighbridge Locations

Proposed weighbridge locations are shown in Table 9-1 and Map 9.1.

Table 9-1 : Proposed Weighbridge Locations

Location	
Existing/Under Construction (5) (Green in Map 9.1)	
N1, Shittakunda	
N2, Auskandi	
N4, Jamuna Bridge	
N5, Manikganj	
N8, Dhaleshwari	
Immediate Proposed (18) (Red in Map 9.1)	**Future Proposals (4) (Yellow in Map 9.1)**
N1,Feni	Bhomra Landport
N1, Teknaf	Sonamasjid Landport
N1, south of Daudkandi	Hilli Landport
Chittagong Port	Halaughat Landport
Mongla Port	
N2, Brahmanbaria	
N2, Narsingdi	
N207, south of Mouvlibazar	
N3, Gazipur Sadar	
N5,Rangpur Sadar	
N5, Tetulia	
N509, Patgram	
N706, Benapole Landport	
N704,Bheramara, Kustia	
N102, Mynamati-Brahmanbaria	
R170,Banskhali, Chittagong	
R371,Phulpur, Mymensingh	
R685,Mohanpur, Rajshahi	

9.6. Actions Required

The following actions are required to underpin axle-load control:

- A ban on the import of 2 axle trucks with gross weight over 6 tonnes
- Enhanced enforcement
- Placing the Highway Police under RHD
- Issuing penalty tickets for overloading
- Direct charging using toll mechanism
- Fine and tolls should be more than the benefit of overloading
- Allowing a small margin of overloading (say, 0.5 tonnes)

Table 9-2 lists the advantages and disadvantages of various means of enforcing axle-load control at weighbridges.

Table 9-2 : Options for Ensuring compliance

Option	Advantages	Disadvantages
Off-Loading overweight goods (and/or passengers)	Protects road from damage from remainder of journey	Requires storage space, and labour
	Major deterrent	Security problems
Vehicle continues journey	No management issues	Vehicle continues to damage road
		No deterrent if vehicle does not pay high enough fine or toll
Vehicle stopped from proceeding, and returns the ways it has come	No management issues	Vehicle continues to damage road
	Major deterrent	Potential for confrontation
		Vehicle may seek alternative route to avoid weighbridge

9.7. Proposed Level of Fine or Toll

The Ministry of Communications has already approved tariffs related to overloading for the weighbridge at the N2 Auskandi toll plaza, but the tariffs do not meet the objective of recovering damage done by the various levels of overloading. Recommended tariffs are set out in Table 9-3.

Table 9-3 : Proposed Tariffs at Auskandi Weighbridge

Axle Overload (tonnes)	Current Level of Tariff (Tk)	Proposed Level of Tariff (Tk)
1	50	300
2	120	720
3	200	1200
4	300	1800
5	700	4200
6	1,100	6,600
7	1,700	10,200
8	2,500	15,000

9.8. Costs of Axle Load Control

The capital costs of installing the weighbridges recommended in this chapter are around Tk 220 Crore. The benefits of axle load control estimated using HDM4 are over Tk 300 Crore per year.

Weighbridges and toll collection will be closely linked, and better control over toll collection also requires to be introduced. A fully computerized toll collection system, with central management is estimated to cost Tk 100 Crore. The expenditure programme is set out in Table 9-4

Table 9-4 : Expenditure Programme for Axle Load Control (Crore Taka)

Year ending July	Weighbridges	Toll Collection Equipment	Total
2008	110	10	120
2009	110	40	150
2010	-	40	40
2011	-	10	10
Total	**220**	**100**	**320**

9.9. Next Steps

Consultations with associations of bus and truck owners carried out during this study revealed considerable support for axle load control. Inactivity on the part of the Government over the last ten years has cost the country '000's of Crores of Taka in additional road maintenance and rehabilitation, along with increased costs to vehicle operators.

If the steps outlined in this Chapter are not taken then the value of the investment proposals outlined in the remainder of this report will be severely eroded, and the Masterplan will bear little relation to reality. There is no alternative to proper axle load control. Most countries with a modicum of financial prudence enforce weight limits on trucks without civil unrest or inflated food prices. Any worry that trucks from outside the country using the Asian Highway (Section 14.14) might damage Bangladesh's roads through overloading can be dispelled with effective axle load control.

The next steps should be:

- Place responsibility for axle load control clearly under RHD, as the owner of the road assets, so that they can take the following actions required
- Immediate major publicity drive to sensitise owners and drivers
- Highlight benefits to road users of reducing axle loads
- Operate first 5 weighbridges from September 2007
- Use toll mechanism as means of fining overloading
- Use private sector contractors to operate Vehicle Overloading Control Stations
- Ask Police to enforce 'No Passage' to overloaded trucks, under Advisor decree
- Approve DPP[32] for additional weighbridges
- Introduce 18 new weighbridges over next two years
- Draft stronger legislation to assist operation and enforcement

9.10. Implementation

Axle load control is a cornerstone of the Road Masterplan. The Ministry of Communications should take necessary initiatives to implement the recommended measures to control vehicle overloading as soon as possible.

[32] Development Project Proforma

10. IMPROVING THE OPERATION OF MAJOR HIGHWAYS

10.1. Solutions to the operational problems

Section 3.5 of this report revealed the operational problems on the major Highways. Based on a careful review of these, and depending on the type of encroachment and other constraints indicated below, certain possible solutions have been proposed which are shown in Table 10-1.

Table 10-1 : Types of Encroachments and Possible Solutions

Sl. No.	Encroachments	Possible Solutions	
		Category	Type of Solution
1	Major haats and bazaars are located along the highway and sufficient vacant land is not available on the road side within the RHD's right of way (ROW) for widening and straightening of the carriageway, or for creating service lanes for buses, trucks, NMTs, as well as for providing bus-bays/stops, and for temporary parking of vehicles	A	Provide separate by-pass road with special design criteria, together with service lanes and well planned inter-sections.
2	Sizeable encroachment exists on the highway, but land within the ROW can be restored through eviction of encroachments to provide service lanes for buses, trucks and NMTs, or if enough land is not available within the ROW, additional land required can be procured with less hassle, through easy resettlement of original owners.	B	Provide service lanes for buses, trucks and NMTs, and also bays for loading/unloading together with foot over bridge(s) and iron fencing barriers on both sides of the road prohibiting all entry into the main carriageways around bazaar area with requisite road furniture.
3	Railway crosses the national highway at the market place, and there is densely built-up area and home-stead just outside the ROW (may be on the private land) and spread over wide area on both sides of the road in such a way that land for future road expansion becomes expensive.	C	Provide over bridges for thorough traffic, and separate lanes for NMTs, and bus stops at the ground level, with requisite road furniture and delineators. .
4	There are certain inter-sections on the national highways, which are unable to cope with the present level of traffic. These should therefore be designed properly.	D	Need to improve designs of inter-sections, roundabouts and islands at critical road crossings, and wherever possible use traffic signals, or other traffic management techniques.

A further analysis of the various solutions that could be applied to different types of encroachment in hats and bazaars located along the 8 major National Highways revealed that to overcome the congestion problems at these hats and bazaars, it would be necessary to build 13 by-passes, segregated service lanes at 111 locations, and 4 over bridges. The details are shown in Table 10-2. Map 10.1 shows the locations of Hats and Bazaars on the N1 National Highway.

Table 10-2: Summary Table- Categories of Solutions necessary to address Encroachment Problems on major National Highways

Sl. No.	Road No.	Name of road	Length (km)	Category				
				A	B	C	D	Total Locations
1	N1	Dhaka (Jatrabari) - Comilla (Mainamati) - Chittagong Teknaf	461	2	15	-	1	18
2	N2	Dhaka (Katchpur) - Bhairab Jagadishpur - Saistagong -Sylhet - Jaflong	287	1	7	-	3	11
3	N3	Dhaka (Banani) - Joydevpur - Mymensingh	115	-	9	-	1	10
4	N4	Joydevpur – Tangail – Jamalpur	146	1	10	-	1	12
5	N5	Dhaka (Mirpur) - Utholi Paturia – Natakhola - Kashinathpur – Hatikamrul – Rangpur – Beldanga – Banglabandh	529	4	40	1	1	46
6	N6	Kashinathpur – Dasuria – Nator - Rajshahi	150	1	10	1	-	12
7	N7	Daulatdia – Faridpur - (Goalchamot) – Magura – Jhenaidah – Jessore – Khulna - Mongla	252	5	14	2	-	21
8	N8	Dhaka (Jatrabari) – Mawa – Bhanga – Barisal - Patuakhali	202	1	6	-	2	9
Total			**2,142**	**15**	**111**	**4**	**9**	**139**

10.2. Proposed By-passes

Based on earlier studies, RHD has already built a number of by-passes to overcome congestion problems created by location of towns along the national highways. Several by-passes are currently under construction. But the current study on the congestion created by different types of encroachment, such as haats and bazaars along the eight National Highways has now come up with a recommendation that 15 more by-passes are required. Out of these by-passes, it is learnt that one along Kaliakoir on N4 is already under construction. For detailed location of these by-passes, see Table 10-3, and Map 10.2. All of the proposed by-passes in Table 10-3 should be the subject of design and feasibility studies.

10.3. Access to Inland River Ports

Roads linking the network with inland river ports should facilitate easy and smooth access to river ports. Road improvements that meet these objectives will be highlighted in the forthcoming Inland Water Transport Masterplan.

10.4. Programme Costs of Other Interventions

The remaining interventions for traffic management on the major highways should be implemented over the next 5 years. After that period new problems will emerge on these roads and elsewhere, that require traffic management solutions. Hence budget provision should be made for this. The costs of the interventions required in Table 10-2 are set out in Table 10-4.

Table 10-3 : Locations of the Proposed by- passes,major National Highways (N1-N8)

Sl No	Section Code	Road No	Proposed Place/Haat Bazaars to be by-passed	Chainage & length			Estimated Cost (Crore Taka)
				From	To	Length (km)	
1	S1-8	N1	Mirershari	178+650	179+000	0.35	6.0
2	S1-12		Patiya	258+900	260+400	1.50	25.7
3	S2-19	N2	Goala Bazaar	197+000	198+000	0.30	5.1
4	S4-8	N4	Kaliakoir	20+900	21+800	0.90	By pass under construction
5	S5-58	N5	Gobindagong	248+000	249+800	1.80	30.9
6	S5-64		Polashbari	265+200	266+700	1.50	25.7
7	S5-66		Daperhat Bazaar	272+800	273+500	0.70	12.0
8	S5-88		Boda Bus-stand Bazaar	452+000	452+900	0.90	15.4
9	S6-6	N6	Ataikhola Bazaar	24+200	25+300	1.10	18.9
10	S7-20	N7	Kaligong Bazaar	119+500	120+500	1.00	17.1
11	S7-10		Magura	74+600	75+000	0.4	6.9
12	S7-28		Rupdia Bazaar	159+300	159+800	0.50	8.6
13	S7-32		Noapara Bazaar	175+200	177+800	2.60	44.6
14	S7-34		Fultala Bazaar	186+ 900	187+400	0.50	8.6
15	S8-16 S8-18	N8	Barisal	152+750	156+600	3.85	66.0
Total							**291.4**

Table 10-4 : Traffic Management Cost Estimates (Crore Taka)

	Service Roads	Overbridges	Junction Improvements	Total
N1	30	0	1.2	31.2
N2	14	0	3.6	17.6
N3	18	0	1.2	19.2
N4	20	0	1.2	21.2
N5	80	0.5	1.2	81.7
N6	20	0.5	0	20.5
N7	28	1	0	29.0
N8	12	0	2.4	14.4
Total	**222**	**2**	**10.8**	**234.8**

10.5. Programme Costs

The first five years traffic management costs are estimated to be Taka 234.8 Crore (Table 10-4). Provision for future years should be made at the same rate, and projects should be identified on the basis of future traffic problems. Total programme costs for these improvements are Taka 526.2 Crore (Table 10-5).

Table 10-5 : Traffic Management Programme Costs

Component	Cost (Crore Taka)
By-passes	291.4
Traffic Management (1st 5 years)	234.8
Traffic Management (years 6 to 20)	704.4
Total	**1,230.6**

11. ZILA ROAD RECOVERY PROGRAMME

11.1. Importance and Function of Zila Roads

Zila roads perform an essential function in providing road access to and supporting social and economic development of rural areas. They do this by connecting the rural areas of Bangladesh, the majority of the country, with the major towns and trading routes. These roads are the key to unlocking the potential of rural areas to social and economic development. In particular they:

- connect Upazila Growth Centres to the larger markets at District and Regional headquarter towns, and to the national road network to open linkages with Dhaka and international trading routes;
- improve flow of goods, especially agricultural and industrial inputs and outputs, and access to cold storage for example, to support economic development of rural areas.

Zila roads also promote social and economic development by making it easier to travel between Upazila headquarters and towns, and through the national road network to Dhaka, promoting better communications links between the administrative levels. They also make it easier to find good quality staff to fulfil government and NGO posts at the local level, by enabling frequent trips back to their hometowns and families. The effect of this is:

- improved quality and more reliable services including education and health facilities, public administration and governance;
- improved communications for Government and NGOs to deliver social and economic development programmes to support equitable development.

11.2. Prioritisation of Road Projects

Bangladesh currently uses two methods for prioritising works on the RHD network. The first is to use HDM to prioritise rehabilitation and maintenance works on the National and Regional Highway network. The second is to follow the method described in the Project Appraisal Framework. This section explains why these two methods are not appropriate for analysing the Zila Road network at the strategic level required to prepare the Road Master Plan.

11.2.1. Why not HDM?

The National and Regional Highway network has sufficient traffic and vehicle data to support economic analysis using HDM to calculate an Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit Cost Ratio (BCR), based on estimating benefits such as Vehicle Operating Cost (VOC) Savings and Travel Time Cost (TTC) Savings. RHD are experienced in prioritising investment on this basis.

There is, however, negligible traffic data available for the Zila road network, and the nature of traffic using Zila roads means such analysis would be unlikely to capture fully the social benefits of these roads. Most Zila roads have a low traffic volume that is comprised mostly of non-motorised vehicles (NMVs), mainly rickshaws, rickshaw vans, bicycles and pedestrians. It is extremely difficult to measure VOC savings (which are usually very low) for such means of transport.

It is even more difficult to measure Travel Time Cost (TTC) Savings, especially in the Bangladesh context where work patterns, particularly of the rural poor, are so diverse. This is exacerbated by the different perspectives of the concept of time and the value of time among rural people, who often do not refer to clocks or watches and therefore do not measure time or follow schedules in the same way as workers do in urban areas.

A study carried out by IT Transport under DFID's Knowledge and Research (KaR) programme[33] investigated the value of time based on field research in Jessore District of Bangladesh. It found that the options for many rural travellers were extremely limited, if there was any option at all

[33] The Value of Time in Least Developed Countries, Final Report, IT Transport. Published by DFID (UK), July 2002. KaR R7785

other than to walk, and therefore no trade offs between transport modalities could be made. This meant that no meaningful valuation of time savings could be calculated. The issue is further complicated by lack of timetabled passenger services leading to significant variation in waiting times, and variation in journey times due to obstacles along the road (e.g. accidents, road works, other buses / trucks blocking the road at market places, etc).It also found a significant difference in value of time derived from 'Willingness to Pay' to save time depending on:

- The gender of traveller
- Whether the traveller has permanent employment or casual labourer
- Whether travelling with / without a load
- Whether travel is on market day or other days
- The poverty status of traveller

Whilst the study calculated a series of Value of Time figures that could be used in HDM analysis, the results would be biased towards wealthier male business travellers, hence neglecting the needs and rights of access to travel by the poor and women. This would be in direct conflict with the strategic objectives of poverty reduction and equitable social development of rural areas as defined in the National Strategy for Accelerated Poverty Reduction.

For this reason, the use of traditional economic analysis using HDM is not considered appropriate for the planning and prioritisation of investment in the Zila road network.

11.2.2. Why not PAF method?

The Project Appraisal Framework (PAF) provides detailed guidance for appraising individual road projects. The level of data required for the equity indicators (women and poor people living within area of influence, among road users and potential labour force, etc.) and efficiency indicators (EIRR and reliability) is not available for most roads. Nor is it appropriate to undertake a major data collection exercise for the strategic prioritisation process required to prepare the Road Master Plan.

It is therefore necessary to develop a modified methodology for prioritising Zila road investment, whilst meeting the same overall objectives of equitable social and economic development.

11.3. General Approach

11.3.1. Strategic Objectives

The National Land Transport Policy document expressed a ***vision*** for the road network as:

> *"The development and maintenance of a road network that serves the economic and social needs of the country, and which can be used safely by all vehicle types."*

The Road Sector Policy document prepared as part of the Road Master Plan study identifies a number of ***strategic objectives*** necessary to achieve this vision. These are in line with the Government of Bangladesh National Strategy for Accelerated Poverty Reduction, and include:

- To develop and manage strategic road corridors to underpin the economic development of all regions of the country and contribute to the Government's poverty reduction objectives
- To link all rural areas with the national road network to provide basic social access and promote pro-poor growth

The first is primarily concerned with the National and Regional Highways, although the requirement to contribute to the Government's poverty reduction objectives applies to all roads. The second is very much concerned with the Zila road network.

In order to achieve the strategic objectives and support the social and economic development of rural areas, the Road Sector Policy suggests the following:

- The Zila road network will be rehabilitated over the next ten years in order to achieve a minimum accessibility level on all Zila roads
- Roads which serve the highest concentrations of poverty will be treated as priorities for rehabilitation
- Priorities for Zila road improvements will be based on analysis of socio-economic indicators

11.4. Approach to Prioritisation

The Planning Commission requires that all growth centres, Upazila headquarters, land and sea ports should have all weather year round vehicular access. The RMP therefore takes this as its minimum accessibility target. To achieve this target and meet the strategic objectives in the most efficient manner, the RMP has defined three Priority Levels. These are summarised in Table 11-1 below, and explained in the following sub-sections.

Table 11-1: Summary of Priority Levels

Priority Level 1 = Primary / Secondary Roads	Priority Level 2 = Road Condition	Priority Level 3 = Socio-Economic Score
1. Primary Zila Roads	1. Upgrade unpaved roads	Rank highest SE Score first
	2. Rehabilitate roads with IRI >10	Rank highest SE Score first
	3. Rehabilitate roads with IRI 8-10	Rank highest SE Score first
2. Secondary Zila Roads	1. Upgrade unpaved roads	Rank highest SE Score first
	2. Rehabilitate roads with IRI >10	Rank highest SE Score first
	3. Rehabilitate roads with IRI 8-10	Rank highest SE Score first

11.4.1. Priority Level 1: Primary and Secondary Roads

The first priority will be to make sure that the roads that provide a direct connection between an Upazila Headquarter, Land or Sea Port and the nearest major town and / or Highway meet the all weather vehicular access standard. These are referred to as 'primary' Zila roads and are strategically more important than the remaining 'secondary' roads. Table 11-2 summarises the characteristics of Primary and Secondary Zila Roads.

The proposed investment and work plans aim to recover the Primary Roads first, and then the Secondary Roads.

Table 11-2: Characteristics of Primary and Secondary Zila Roads.

	Primary Zila Roads	Secondary Zila Roads
1	Provide essential link between lower and higher service levels (vertical link)	Provide a convenient link between lower levels in different locations (horizontal link)
2	Promote social and economic development of local area	Promote social and economic interaction at local level
3	Provide the only means of access to services, so if the road is not accessible, the community is cut off from those services	Provide an alternative means of access to services, so if the road is not accessible, the community can still gain access to those services through another route.

For Upazila headquarters, land and sea ports that are not yet connected by a Highway or Zila road, new Zila roads should be constructed to provide the Primary road access to that location.

11.4.2. Priority Level 2: Road Condition

To meet the requirement of providing all weather vehicular access, the road must be maintained and kept in a good or fair condition. Due to lack of funds, many of the Zila roads have been

neglected and are in poor condition, or are not paved. These roads do not therefore meet the minimum accessibility criteria. They should be recovered, and the RMP proposals prioritise their recovery as follows:

1. Unpaved roads provide unreliable access. They are usually inaccessible at certain times of the year (during the rainy season) and they deteriorate rapidly leading to difficult vehicular access. All such roads should be upgraded to paved standard.
2. Roads with an International Roughness Index (IRI) of greater than 10 m/km are in very poor condition and are considered inaccessible to vehicles. They should be rehabilitated.
3. Roads with an IRI between 8 and 10 m/km are in poor condition and provide difficult vehicular access. They should be rehabilitated.

The road condition is used to prioritise individual roads within the Priority Level 1 – Primary / Secondary Road categories.

11.4.3. Priority Level 3: Socio-Economic Score

The socio-economic prioritisation approach is a proxy evaluation that aims for investments to reach the most people, the most poor people and the most social and economic facilities that each Zila road serves. The socio-economic indicators used are:

- Population density
- Poverty density
- Density of social facilities (education, health, community, religious)
- Density of economic facilities (markets, industry, agricultural production, animal husbandry, natural resources, etc)

Based on these four indicators, a socio-economic (SE) score is calculated for each Upazila or Thana, shown in Map 11.1.

An average socio-economic score is then calculated for each road by multiplying the length of the road in each Upazila or Thana by its SE score for each section of road and then dividing it by the total road length. This socio-economic score is then used to rank individual roads within the Priority Level 2 – Road Condition categories.

11.5. The Recovery Programme

11.5.1. Priority Level 1 – Primary and Secondary Roads

A manual review of the road network maps has identified which roads are primary and which are secondary – see Section 11.4.1 for an explanation of primary and secondary roads. In some cases, only some sections of a road actually provide the functions associated with Primary roads, but due to the amount of data to be processed and time constraints, the RMP has assumed that if any section of a road is a primary road, then the whole length of that road shall be assigned primary status.

Using this approach, approximately 5,400 km (53%) of the Zila road network have been assigned primary road status.

11.5.2. Priority Level 2 – Road Condition

Once the roads have been assigned primary or secondary status, they are prioritised based on their road condition. Many roads are not in a consistent condition, with different sections being in better or worse condition than others.

The RMP team debated whether it was better to apply the concept of ‘spot improvements’ where short sections in very bad condition are recovered first and then other sections are recovered according to their condition. However this approach was thought to add an onerous planning and

management burden on the already overstretched RHD staff in terms of procurement and contract management, as well as being generally unpopular with local communities who suffer from extended road works as a result of piecemeal recovery programmes.

For these reasons, the RMP prioritises roads based on the section of road in the worst condition to ensure that a minimum level of accessibility is achieved for the whole road length. This means that the recovery programme includes the whole length of the road, and so recovery contracts may include some sections that require different types of recovery works, or some sections that only require periodic maintenance, or some sections that do not require any works at all. This approach also allows the recovery programme to include sections that have not been surveyed.

11.5.3. Cost Estimates

The cost estimates for recovery works are based on unit rates per km as defined in Table 11-3 below. For partially surveyed roads, the cost estimate for the not surveyed sections is based on the assigned need (see Section 3.2). Whilst the prioritisation may be based on the worst section of a road as explained above, the cost estimate is based on the actual condition as defined by the survey data and hence on the actual works needed for each road section to meet the minimum accessibility criteria.

Table 11-3: Unit rates for cost estimates

Works Required	Cost per km Laky Tk.
Periodic Maintenance	35
Rehabilitation IRI 8-10	40
Rehabilitation IRI >10	60
New Construction – Hilly	120
New Construction – Plain	130
New Construction - Swampy	250

New Construction rates apply to the paving of unpaved roads. These rates are taken from Table 17 of the Planning Commission's Design Standards for Low Volume Roads, 2004, using the average of the ranges given for Design Type 6.

The assignment of topography type (hilly, swampy, and plain) is approximate only and is shown in Map 11.2.

The rates for Rehabilitation and Maintenance are based on recent experience of RMP Team.

11.5.4. Prioritisation

The prioritisation process was undertaken using an MS Excel spreadsheet. A copy of this spreadsheet can be provided on request, and a 'user manual' that explains the step by step analysis process to enable RHD staff or their consultants to update the RMP in the future is currently under preparation.

The following paragraphs provide a summary of the prioritisation process.

11.5.5. Priority Levels

The analysis assigns each road with a priority level. This is a number that differentiates between primary and secondary roads, and the condition status or recovery need of the worst section of the road. A description of the priority levels is given in

Table 11-4.

Table 11-4: Description of priority levels

Priority Level	Primary / Secondary	Current Condition (of worst section)
P1	Primary	Unpaved
P2	Primary	Very Poor, IRI>10
P3	Primary	Poor, IRI 8-10
S11,S12,S13	Secondary	As for 1-3 but for secondary roads
14,15	Primary or Secondary	Not surveyed so condition unknown. 15 is roads that are believed to be under construction.
21	Primary or Secondary	In good or fair condition, IRI<8.
3	Third Priority	Roads which are identified as Zila roads, but not yet constructed, eg. Upazilla to Upazilla connections

Once the priority level for each road has been defined, the spreadsheet sorts the roads into a list that follows the priority levels in the order shown in

Table 11-4.

Within each priority level, the roads are then sub-prioritised based on the socio-economic score. The roads that have the highest Total Socio-economic score are ranked highest.

An annual workplan for the recovery programme is then estimated based on this prioritised list. The detailed recovery programme recommendations are shown in Maps 11.3 through 11.50.

11.5.6. Recovery Workplan

The total works required to bring the Zila road network up to the minimum accessibility standard are summarised in Table 11-5. The total estimated cost for the recovery programme is 2,657 Crore Taka (26 million Taka). This does not include the roads where no survey data is available, which is approximately 17% of the total Zila road network as defined in the RMMS. As no data is available for these roads, the RMP has applied a pro-rata estimate and therefore includes a contingency amount of 20% (=17/83) for additional recovery works on these not surveyed roads.

Table 11-5: Cost estimate for Recovery Programme

Priority Level	Length, km	Cost (Crore Taka)
P1 (unpaved)	845	791
P2 (IRI >10)	2,089	960

P3 (IRI 8-10)	2,440	733
Sub-total	5,374	2,484
S11 (unpaved)	27	36
S12 (IRI >10)	256	122
S13 (IRI 8-10)	64	15
Sub-total	347	173
Total	***5,721***	***2,657***
Contingency for roads not surveyed	*1,144*	*531*
TOTAL	**6,865**	**3,188**

This is a considerable work load and so it has been broken down into annual work plans as follows. It is assumed at this stage that the additional works for roads that have not yet been surveyed (i.e. the contingency amounts) will be undertaken after the priority 1-3 and 11-13 roads have been completed.

The annual workplan for the recovery programme is given in Table 11-6. The detailed list of roads, and maps showing the annual workplan are provided in Maps 11.3 through 11.50.

Table 11-6: Recovery Programme Annual Work Plan (Crore Taka)

	2008	2009	2010	2011	2012	2013	2014	TOTAL
P 1	545	246						791
P 2		303	563	94				960
P 3				451	282			733
S 11-13						173		173
Contingency					218	213	100	*531*
Total	545	549	563	545	500	386	100	3,188

11.6. New Construction Programme

11.6.1. Prioritisation of New Roads Required

The RMMS and GIS suggests that there are 16 Upazilas and 1 Land Port that are not yet connected to the RHD road network, see Table 3-12. It is a government requirement that these be connected by at least a Zila road.

Table 11-7 below shows the new roads to be constructed and socio-economic data for the Upazila they connect (including the Upazila of the land port to be connected). Of the 16 Upazilas not yet connected, 12 (75%) have the lowest possible Socio-economic score of 4. This means that the Socio-economic score is not sufficient to prioritise the new roads to be constructed. For this reason, Table 11-7 shows the total population and total poor people living in the Upazila to be connected, and associated rank numbers for population, poor people, and the average of these two indicators. The roads connect new land ports are Zila Roads (Table 2-11) and have therefore been omitted from Table 11-7, and included as new National Highways in Chapter 14.

Table 11-8 shows the prioritised list of the new roads required, with the land port connection placed first in the list and followed by the Upazilas prioritised by average rank of population and number of poor people in that Upazila. Where two Upazilas have the same average ranking, the one with the highest total population has been prioritised first. A connection for Barkal, across Kaptai Lake, is not considered viable, and it is not included in Table 11-8.

The proposed road on a Bangladesh Water Development Board embankment between Dohar and Balirtac should be included in the plan at a cost of Taka 25 Crore.

Table 11-7: List of New Roads required and Socio-economic data

RHD Zone	District	Upazila / Thana	SE Score	Population ('000)	Pop'n Rank	Poverty ('000)	Poverty Rank	Average Rank
Barisal	Barisal	Mehendiganj	4	296	1	151	1	1
Chittagong	Chittagong	Sandwip	4	293	2	147	2	2
	Cox's Bazaar	Kutubia	5	106	10	63	8	9
	Rangamati	Barkal	4	43	14	15	15	14.5
		Belaichhari	4	26	15	18	14	14.5
		Juraichhari	4	24	16	13	16	16
		Langadu	4	69	13	37	12	12.5
Dhaka	Kishoreganj	Austagram	4	145	5	57	9	7
		Itna	4	148	4	73	6	5
		Mithamain	4	122	9	50	10	9.5
	Netrakona	Kalmakanda	6	234	3	119	3	3
		Khaliajuri	4	79	12	34	13	12.5
Sylhet	Sunamganj	Bishwambarpur	7	126	8	73	6	7
		Jamalganj	4	139	6	75	5	5.5
		Sulla	4	89	11	40	11	11
		Tahirpur	5	131	7	82	4	5.5

Table 11-8: Prioritised list of new zila roads required.

Priority Order	Average Rank	Length (km)	Cost (Crore Taka)	Upazila / Thana
1	1	24	24.4	Mehendiganj
2	2	10	10.2	Sandwip
3	3	21	21.3	Kalmakanda
4	5	17	17.3	Itna
5	5.5	24	24.4	Jamalganj
6	5.5	29	29.4	Tahirpur
7	7	17	17.3	Austagram
8	7	15	15.2	Bishwambarpur
9	9	9	9.1	Kutubia
10	9.5	13	13.2	Mithamain
11	11	25	25.4	Sulla
12	12.5	15	15.2	Khaliajuri
13	12.5	16	16.2	Langadu
14	14.5	-	0.0	Barkal
15	14.5	55	55.9	Belaichhari
16	16	51	51.8	Juraichhari
Total		**356**	**346.2**	

11.7. Remaining Unpaved Roads

The result of the Zila Road Recovery Programme, and associated paving to provide basic access, will mean that, at the end of the programme, there will remain 3,603 km of unpaved Zila Roads. The cost of paving all these roads is estimated to be Taka 5,781 Crore. These roads generally provide additional access, e.g. between Upazilla Headquarters. They are considered for inclusion in the 20-year Masterplan after the Zila Road Recovery Programme has been completed.

11.8. Routine Maintenance

Routine maintenance should be carried out on all roads regardless of their condition, to ensure that whatever level of accessibility they currently provide is maintained (para. 15.1.1).

11.9. Periodic Maintenance and Rehabilitation

Periodic maintenance should be carried out only on roads that are in maintainable condition, i.e. those roads with an IRI of less than 8. When a road is rehabilitated or upgraded, it is assumed that the IRI shall be approximately 2.5. HDM analysis suggests that with a traffic load of 800 commercial vehicles per day, on average the Zila roads recovered will require periodic maintenance after 8 years. In many cases this is a conservative estimate, but allows for increases in traffic levels and changes in traffic composition that may occur as a result of social and economic development in the rural areas served.

In the future, five year and annual periodic maintenance plans can be prepared based on the condition surveys of the Zila road network and assumed deterioration rates. However, for the purposes of this RMP, the average annual cost for periodic maintenance and/or rehabilitation in the long term has been calculated by taking the total length of the Zila road network expected to be in maintainable condition. This is summarized in Table 11-9.

Table 11-9 : Summary of Zila Road network proposed for periodic maintenance

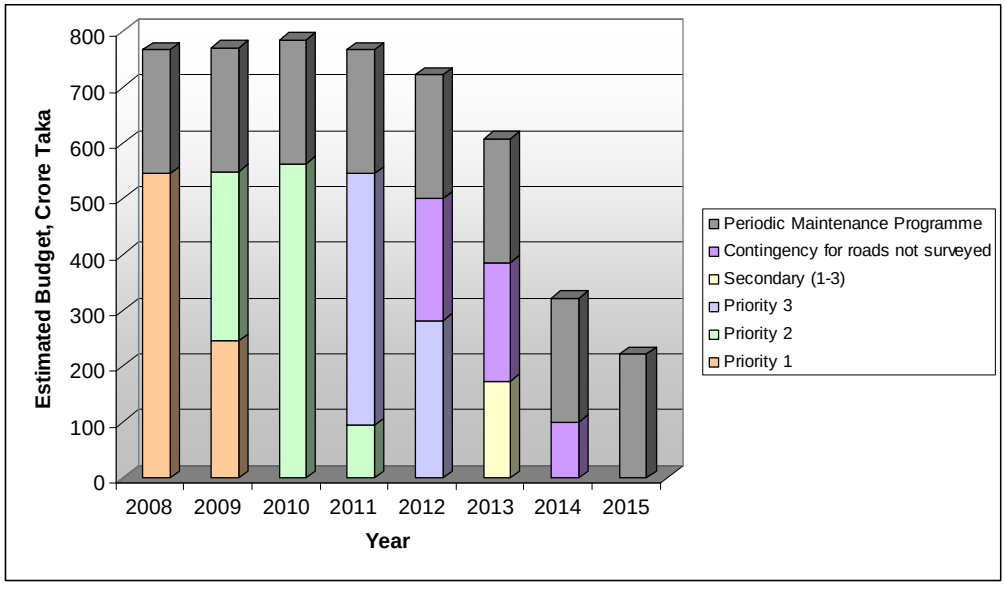
Year	Length (km)
2007	2,854
2012	6,625
2017	10,065
2022	11,420
2026	13,227[34]

11.10. Conclusions and Recommendations

11.10.1. Summary of Zila Road Recovery Programme

Figure 11-1 shows the proposed Zila road programme, including the recovery, new construction and maintenance programmes.

Figure 11-1: Summary of Zila Road Programme for next 10 years.



11.10.2. Future Updates

The Zila road programme is based on road inventory and condition data contained in the RMMS, GIS data, and assumptions for cost estimates and deterioration rates based on national

[34] Not the total of 13,678 km as around 451 km of roads still being paved in final year

averages. It is highly likely that some roads will deteriorate faster than others, and that natural or even man-made disasters may potentially influence the future condition of the Zila roads. Detailed analysis and design of the roads and inflation may significantly influence the cost of the Zila road programme, and changes in the political, social, technical and physical environments may prevent the implementation of the Zila road programme in accordance with the suggestions made in this RMP. It is therefore recommended that the Zila road programme be reviewed at least every five years, based on the latest available inventory, condition and cost data.

11.10.3. Summary of Interventions

Table 11-10 : Summary of interventions on Zila Road network

Intervention	Length (km)
Periodic Maintenance[35]	2,854
Rehabilitation	6,865
Paving to meet Minimum Accessibility Criteria	356
Paving remainder of network	3,603
Total	**13,678**

11.10.4. Impacts

The impacts of the Zila road programme over the Masterplan period are expected to be very significant. At the end of the programme, a total of 469 Upazilla Headquarters[36] will have paved access to the main road network, serving an additional 32 million people, including more than 18 million people currently classified as poor.

[35] Includes rehabilitation if required
[36] Out of a total of 481 (Reported by BBS, defined by LGRD Ministry and Police Headquarters, December 2006)

12. BRIDGE REPAIR AND CONSTRUCTION PROGRAMME

12.1. Bridge condition category

Based on the condition category of bridges and their location in the road network, a Bridge Reconstruction Programme has been prepared. From Table 3-16 it is clear that 63.09% of the bridges (Category A) are without any damage, and are in good condition. 14.20% (Category B) of bridges have minor damage but are good enough for safe traffic movement. The minor damage in Category B bridges includes damage like honeycomb, minor cracks, sapling in railing, sidewalk, toe wall, pier cap, delaminating of wearing course in deck, minor rusting of truss bridges etc, identified in the Bridge Condition Survey carried out in 2004. Most of the minor damage as identified are repairable to bring their status up to A condition. Thus 77.3% of the bridges in RHD road network are suitable and safe for traffic movement

12.1.1. Major damage

The remaining 22.7% of RHD bridges and culverts are the subject of major structural deficiencies (Category D) or major elemental damage (Category C) which require treatment like improvement, rehabilitation or reconstruction depending on the extent and type of damage occurred in individual structures.

12.1.2. Narrow width

There is also a large number of narrow bridges in the RHD road network. There are 146 narrow bridges (less than 3.7m carriageway width) on National and Regional Roads that need to be addressed in the Masterplan. A Bridge Replacement Programme (BRP) project for replacing narrow bridges on mainly Zila Roads began in 2003-04.

12.1.3. Bridges length over 100m and above

There are 190 long bridges having a total length of 100m or above. These are shown in Table 12-1 by condition category and in Table 12-2 by road classification. This excludes the ten longest bridges on the RHD network (ranging from 646m to 1786 m). Since the long bridges in the higher classified roads are of national importance, the 36 C and D category bridges on the National and Regional Highways have the highest priority for reconstruction or rehabilitation.

Table 12-1 : Bridge length 100 m and above by category

Category	Number
A	108
B	32
C	46
D	4
Total	**190**

Table 12-2 : Bridge length 100 m and above by road classification

Road Classification	Category				
	A	B	C	D	Total
National	38	17	24	2	81
Regional	30	7	8	2	47
Zila	40	8	14	-	62
Total	**108**	**32**	**46**	**4**	**190**

12.2. Replacement/reconstruction/repair work in progress

Through BRP, 36 nos. of bridges and culverts have been taken up by RHD for replacement and expected to be completed during current fiscal year. Further to this, 50 nos. of bridges (excluding culverts) have been taken up for improvement, reconstruction or major repair through Periodic Maintenance Programme of RHD under Japan Debt Conversion Funding arrangement. Under this programme RHD is preparing proposals for 139 nos. of bridges to be taken up for improvement and reconstruction during the coming years. In addition 10 nos. of bridges or culverts earlier marked for taking up in BRP project will also come under the umbrella of PMP bridge programme.

During the study, it was revealed that about 25 nos. of bridges for reconstruction or new construction or major repair are included in the routine maintenance programme and further proposal for inclusion under this programme is under study.

12.2.1. Major bridges

In case where replacement or periodic rehabilitation works are substantial it may be necessary to include these in the Annual Development Programme (ADP) as separate projects. This issue as well as criteria for inclusion in the ADP needs to be resolved and require further consideration. This issue has not been taken into account in the preparation of candidate list for 2006-07.

12.3. Prioritisation

12.3.1. Priority of roads

RHD prepares a Road Network Maintenance and Rehabilitation Assessment Report for each financial year by undertaking programme analysis of all bituminous roads of the whole of RHD road network. For the programme analysis, HDM circle of RHD uses HDM4 software and identifies candidate road sections for maintenance, rehabilitation etc. and develops an optimized list of roads and programme of work. Finally the Annual Road Network Needs Assessment report (Annual Needs report for short) is published by the HDM Circle for the purposes of identifying the priority roads in the RHD network. The prioritisation of these roads is based on EIRR and NPV/cost ratio.

12.3.2. Priority of Bridge Reconstruction and Repair

Procedure for preparation of bridge programme

The operational procedure no. OP/PD/3.2 of Bridge Management Wing Manual no 5 of RHD Management plan describes the steps to be followed in preparing the draft programme and budget for ADP listed bridges (Development Budget) and prioritized bridges and culverts under revenue budget (Periodic Maintenance) in a particular year.

12.4. Identification of Bridges on maps

RAMS (Road Asset Management System) maps are used for identifying road, bridge and ferries on the RHD road network. The critical and priority bridges with treatment required, as well as on-going bridge projects are shown in the RHD Divisional maps through legends and colours. The GIS Cell of RHD is at present responsible for preparing RAMS maps and the TSMR (Transport Sector Management Reform) consultant is assisting RHD in producing those RAMS maps.

The bridges are identified in the RAMS map using a Location Referencing Points (LRP) for a given road. Plotting bridge locations on the map requires geographical coordinates (i.e. latitude and longitude). The whole process of plotting is carried out through 'ArcGIS' software produced by the GIS cell of RHD. The colour and shape to identify the bridges in the map signifies the rank and treatment, and shows Red as critical, Blue as priority and Green as ongoing.

The critical and priority status of the bridges for required treatment is determined on the order of score of risk factors. The critical bridges are those which are in the highest order of risk factor with danger of immediate failure. Table 12-3 and Figure 12-1 show an example RAMS output for Feni Division, indicating the ranking and location of bridges.

12.5. Site Surveys

12.5.1. BCS data base

The BMMS Database of RHD was used as basic data for review and preparing the analyses. All elemental condition in BCS-1 were properly reviewed and entered into the Database. The results and recommendations of BCS-1 were compared with those of BCS-2 & BCS-3.

12.5.2. Site Verification of BCS data base

There are 133 Nos. of 'D' condition category bridges having length more than 20 m. Of these, 25 Nos. bridges were visited for verification.

There are 514 Nos. of 'C' condition category bridges having length more than 20 m. Of these, 45 Nos. bridges were visited for verification.

A separate **'Bridge site inspection report'** has been prepared incorporating inspection observations, conclusions and recommendations which should be adopted by RHD.

Table 12-3 : RAMS Bridge Options for 2006-2007 in Feni Road Division

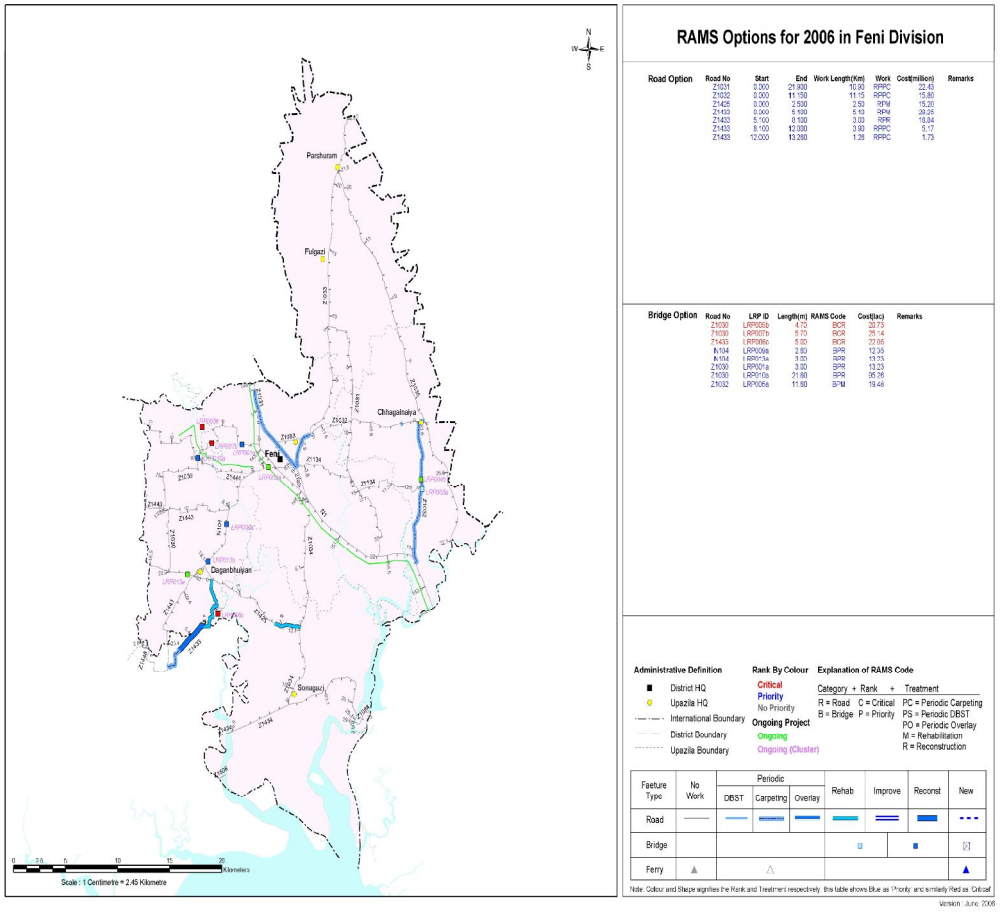
Road no	LRP ID	Identification		
		Critical	Priority	On-going
Z1030	005b	■		
Z1030	007b	■		
Z1433	006c	■		
N104	009a		■	
N104	013a		■	
Z1030	001a		■	
Z1030	010a		■	
Z1032	005a		■	
Z1425	015a			■
N1	002a			■
Z1032	004b			■
Feature Type	**Rehabilitation/Improvement**		**Reconstruction**	**New**
Bridges	■		■	☒

12.6. Unit price and Estimated cost

12.6.1. Unit Rates

The unit price (cost /sq. m.) and estimated cost for the reconstruction of each bridge will vary depending on type, length and width of structure, construction method, depth and type of foundation, cost of temporary works / diversion works and locations etc. RHD's Schedule of Standard Rates covers unit rates for different items of bridge works. The RHD Zones prepare estimates using these unit rates.

Figure 12-1 : RAMS Map for Feni Road Division



12.6.2. Estimated costs

Reconstruction of Bridges

- Unit cost for reconstruction cost of bridge was calculated from average estimated costs of 13 Nos. of projects under the PMP
- Average unit price is Taka 58,300 / sq. m (cost of structure excluding cost of diversion and approaches)
- Average unit price is Taka 85,000 / sq. m (Total cost of structure including cost of diversion and approaches)

Estimated cost (For repair of bridges)

- Unit cost for repair of bridges was calculated from average estimated costs of 15 Nos. of projects under the PMP
- Average unit price is Taka 200,000 per metre length of structure.

12.6.3. Priority of Repair and Reconstruction of Bridges

The general principles for prioritizing bridges (C and D Category) for repair or reconstruction are:

- Risk factor and consequences of failure of bridge structures is high
- Bridges/culverts having bridge decks/girders, abutments, wing walls, piers, damaged or settled partly or fully
- Bridges/culverts which have width constraints and which have bailey bridges as superstructure

The priorities for Bridge Reconstruction (Table 12-4) are based on the following criteria:

- Abutments/piers partly/seriously damaged/tilted/settled, priority-01
- Deck/girders partly/seriously damaged, priority-01
- Open foundation scoured, priority-01
- Cracked slab over steel beams, priority-01
- Important Road bridges with damages & narrow carriageway widths, priority-01
- Bridges under category D (20m & above) with defects/damages other than the above have been put in priority-02

Table 12-4 : Priority of Reconstruction of Bridges

Programme	Number of Bridges	Cost (Crore Taka)
Reconstruction, National Highways, Priority 1	11	75.4
Reconstruction, National Highways, Priority 2	11	42.0
Reconstruction, Regional Highways, Priority 1	35	127.8
Reconstruction, Regional Highways, Priority 2	9	27.5
Reconstruction, Zila Roads, Priority 1	40	115.9
Reconstruction, Zila Roads, Priority 2	27	89.1
Total	**133**	**477.7**

Table 12-5 : Priority 1 Bridges for Reconstruction, National Highways

Road No.	Div. Name	LRP. Name.	Chain age	Length (m)
N6	Natore	IRP09a	90.376	106.96
N208	Sylhet	LRP058b	58.49	387
N509	Lalmonirhat	LRP019a	19.55	56.27
N804	Faridpur	LRP004a	4.742	51.07
N804	Faridpur	LRP005b	5.819	50.98
N302	Dhaka	LRP05b	5.71	65.6
N106	Rangamati	LRP024a	40.007	95
N1	Cox's Bazar	LRP396b	392.907	61.3
N5	Sirajgonj	LRP128a	127.016	43.68
N102	Brahmanbaria	LRP067c	68.007	48.4
N506	Rangpur	LRP009a	8.612	29.2

Table 12-6 : Priority 2 Bridges for Reconstruction, National Highways

Road No	Div. Name	LRP. Name.	Chain age	Length (m)
N5	Manikgonj	LRP065a	64.24	50
N4	Tangail	LPR078a	78.98	71
N2	Brahmanbaria	LRP075b	75.77	79.75
N208	Sylhet	LRP042a	41.766	36.4
N3	Mymensing	LRP075a	73.086	26
N4	Tangail	LRP074c	75.411	36.5
N4	Tangail	LRP076a	77.366	40
N5	Sirajgonj	LRP127a	126.806	43.8
N8	Barisal	LRP138a	136.699	24.15
N5	Manikgonj	LRP065a	64.24	50
N8	Barisal	LRP095a	94.098	36.76

The priorities for Bridge Repair (Table 12-7) were based on the following points:

- Abutments/piers/wing wall minor cracks/ spelled /damaged priority-01
- Deck/girders minor cracks/corrosion of reinforcement/ minor damages, priority-01

- Open foundation minor scoured, priority-01
- Important Road bridges with damages & narrow carriageway widths, priority-01
- Bridges under category C (20m & above) with defects/damages other than the above have been put in priority-02
- Portable Steel Bridges are not included, as they are programmed for replacement under Section 12.8

Maps 12.1 to 12.3 show the priorities for reconstruction and repair on the National Highways.

Table 12-7 : Priority Programme for Bridge Repair

Programme	Number of Bridges	Cost (Crore Taka)
Repair, National Highways, Priority 1	58	89.1
Repair, National Highways, Priority 2	86	147.8
Repair, Regional Highways	127	132.8
Repair, Zila Roads	147	220.6
Total	**418**	**590.3**

12.7. Narrow Bridges

The Narrow Bridge replacement programme will address 18 bridges on National Highways (Table 12-8), and 108 bridges on Regional Highways (

Table 12-9). Programme costs are summarized in Table 12-10.

Table 12-8 : Narrow Bridges on National Highways

Zone	Road No.	LRP	Name	Length (m)
Nilphamari	N518	LRP004a	.	49
Dinajpur	N5	LRP392a	.	44
Shaistagonj	N2	LRP181d	Bata Pur	35
Faridpur-2	N804	LRP014a	.	25
Sylhet	N2	LRP200a	Brommon Gram	25
Jamalpur-1	N4	LRP130a	Roghunathpur Bridge	24
Cox's Bazar - 2	N1	LRP400b	Chadirikhana	24
Cox's Bazar - 2	N1	LRP400c	Chadirikhana	24
Fatikchari	N106	LRP023b	Jananihat Bridge	23
Cox's Bazar - 2	N1	LRP404b	Ukhiya Bazar	21
Bhola	N809	LRP038a	.	12
Cox's Bazar - 2	N1	LRP398b	Cox’s Bazaar Muslim Hospital	11
Barisal-1	N8	LRP151a	.	10
Jhenaidah	N7	LRP125b	.	9
Cox's Bazar-1	N1	LRP380e	South Mitta Chori	8
Barisal-1	N8	LRP141a	.	8
Bhola	N809	LRP037a	.	8
Lalmonirhat	N509	LRP011a	.	7

Table 12-9 : Narrow Bridges on Regional Highways

Zone	Road No.	LRP	Name	Length (m)
Netrokona	R370	LRP050a	Thagurakona	372
Sariatpur	R860	LRP021a	Angaria Bridge	148.8
Naogaon	R548	LRP028b	Atrai Bridge	142.1
Sariatpur	R860	LRP017a	.	102.4
Nayarhat	R315	LRP038a	Gadob Doctor Bridge	102
Manikganj	R506		Srighur Nagar	101.4
Sariatpur	R860	LRP053d	.	92.6
Sunamganj	R280	LRP061a	Chakni Kara Bridge	82.9
Chattak	R280	LRP028a	Bukar Vanga	75.4
Kulaura	R281	LRP037a	Horirampur Bridge	69.5
Golapganj	R281	LRP069a	Khasir	66.6
Rangamati-2	R162	LRP011a	Kaghari Para Bridge	64.5
Golapganj	R250	LRP044a	Sorifa Bad Bridge	61.2
Narsingdi	R114	LRP032b	Puranpara Bridge	59.9
Chattak	R280	LRP029a	Jatua Bridge	59.4
Golapganj	R250	LRP049a	Satpari	56.4
Chattak	R280	LRP033a	Jawa Bazar Bridge	56.4
Dhaka, Sub-division - 2	R812	LRP006a	Shahed Pur	55.2
Rajshahi-1	R685	LRP010c	Nawhata Bridge	54.54
Tangail	R480	LRP002b	Shampur Bridge	49.85
Chattak	R241		Aktapara	47
Chittagong	R164	LRP006c	Ballur Chora	45.8
Sunamganj	R280	LRP058a	Janigram Bridge	43.5
Dighinala	R160	LRP044a	Manick Chori	43.4
Rangamati-2	R162	LRP029a	Slona Bath Chari.	43.4
Patuakhali-2	R881	LRP005a	.	43.4
Kawkhali	R870	LRP048a	.	43.35
Sariatpur	R860	LRP047a	.	41.74
Dohazari	R170	LRP053a	Pushuri Prem	41
Chattak	R241	LRP036a	Counder Nola Bridge	40.6
Chattak	R280	LRP024a	Talalpur Bridge	38.1
Khagrachari-1	R160	LRP078a	Shapmara Bridge	37
Golapganj	R250	LRP070a	Sajapur Bridge	36.9
Rajbari	R710	LRP018a	.	36.8
Bhola	R890	LRP016a	.	36.65
Jhalokati	R870	LRP014b	.	36.5
Chattak	R280	LRP030a	Baws Bridge	36.2
Sunamganj	R280	LRP064a	Ojkhali Bridge	35
Chattak	R280	LRP032a	Rawli Bridge	34.2
Rangamati-2	R162	LRP024a	Bogachara	33.9
Narail	R720	LRP044a	.	33.03
Jhalokati	R870	LRP040a	.	31.15
Patiya	R170	LRP018b	Shili Kora	30.5
Tangail	R506		Vathra Bazar Bridge	30.5
Tangail	R506		Buikuta Bridge	30.5
Bhola	R890	LRP028a	.	30.4
Bhaluka	R314	LRP014f	Borkul Bridge(2)	29
Rajbari	R710	LRP031a		28.1
Jhalokati	R870	LRP038a	.	28.15
Barguna	R880	LRP046b	.	27.27
Munshiganj	R812	LRP014a	Bait Para	27.2
Golapganj	R250	LRP061a	Ray Gram	26.5
Chattak	R280	LRP023a	Takirai Bridge	26.5
Golapganj	R281	LRP071a	Angarjor	26.1
Golapganj	R250	LRP069a	Hamygram Bridge	26

Zone	Road No.	LRP	Name	Length (m)
Golapganj	R250	LRP071a	Kaja Pur Bridge	25.5
Golapganj	R250	LRP034a	Sonia Beel Bridge	25.2
Golapganj	R281	LRP074a	Unogaliss Rcc Bridge	24.6
Charfession	R890	LRP095c	.	24.34
Golapganj	R250	LRP083a	Elabag Bridge	24.1
Golapganj	R251	LRPSa	Tikorbari Bridge	23.7
Munshiganj	R812	LRP017a	Borolia	20.5
Jhalokati	R870	LRP030a	.	19
Patuakhali-2	R881	LRP033a	.	19
Bhaluka	R314		Boli Para Boro Bridge	18.3
Sariatpur	R860	LRP053a	.	18.2
Golapganj	R250	LRP054a	Maswdgram	18
Golapganj	R250	LRP063c	Kalygonj Bazar	17.3
Golapganj	R281	LRP074c	Bagni Rcc Girder Bridge	17.25
Golapganj	R250	LRP063a	Bollar Pool	17.1
Golapganj	R250	LRP051a	Doyarimati	17
Golapganj	R250	LRP052a	Eidga Rcc Gider Bridge	17
Golapganj	R281	LRP072a	Kakordia	16.9
Kulaura	R281	LRP045b	Kathal Toli Rcc Bridge	16.8
Golapganj	R251	LRP010d	Purbo Bag Bridge	16.7
Golapganj	R281	LRP061f	Jaldub	16.7
Golapganj	R250	LRP035a	Natair Sor Bridge	16.6
Golapganj	R250	LRP074a	Baro Thakur Bridge	16.5
Golapganj	R250	LRP041a	Shaha Goli Bridge	16.4
Joydepur-1	R315	LRP006b	Hashi Kali Bridge	15.5
Bhola	R890	LRPSa	.	14.03
Golapganj	R251	LRP006f	Dhaka Dakhin Bazar	14
Sitakunda	R152	LRP011b	Gadar Dokan	13.2
Bhola	R890	LRP004a	.	12.5
Bhaluka	R314	LRP005b	Tangora Culvert	12.2
Brahmanbaria	R220	LRP5c	Ziload	12.15
Golapganj	R250	LRP087a	Mosum The Khal	12
Brahmanbaria	R220	LRP002a	Borganara	11.9
Chandpur	R140	LRP058a	Mohamaya	11.5
Golapganj	R250	LRP084a	Holat Rcc Girder Bridge	11.5
Golapganj	R250	LRP069c	South Koskonapur	11.4
Dohazari	R170	LRP050c	Napura Bazar	11.3
Sariatpur	R860	LRP051d	.	11.2
Golapganj	R250	LRP080a	Noyagram	9.8
Kulaura	R281	LRP048b	Borolekha Soru Setu	9.6
Golapganj	R250	LRP080c	Gonga Bazar	9.5
Kushtia	R713	LRP002a	.	9.2
Kushtia	R713	LRP002a	.	9.2
Narsingdi	R114	LRP047a	Sherpur.	9
Brahmanbaria	R220	LRP002c	Surjakadi	8.8
Rajbari	R711	LRP002b	.	8.53
Nayarhat	R315	LRP044b	Bangal Para Bridge	8.5
Ramgonj	R140		Roadas Pull Bridge	8.4
Bancharampur	R203	LRP034b	Banchrampur	8
Bhola	R890	LRPSc	.	7.55
Patiya	R170	LRP005b	Boria Rcc Gider Bridge	7.4
Pabna-1	R601	LRP011b	.	7.05
Shibpur	R212	LRP013c	Golgolia	6.1
Narsingdi	R114	LRP038c	Goraman Bridge.	6

Table 12-10 : Summary Priority of Narrow Bridges Replacement

Programme	Number of Bridges	Cost (Crore Taka)
National Highways	18	115.8
Regional Highways	108	328.0

Total	**126**	**443.8**

12.8. Replacement of Portable Steel Bridges

In accordance with Policy 12.2 of the Road Sector Policy (Section 6.2) portable steel bridges are to replaced by permanent structures. Table 12-11 lists the 23 bridges for replacement on National Highways, at an estimated cost of Taka 114.8 Crore.

Table 12-11 : Portable Steel Bridges on National Highways proposed for replacement

Road	Chainage	LRP	Name	Length (m)
N2	284.46	LRP285b	.	40
N3	90.169	LRP092a	Trisal Bazar	13.8
N4	20.285	LRP020a	Lotif Pur Bridge	80
N4	73.276	LRP072a	Sarkail	64.5
N8	95.526	LRP096a	.	36.1
N8	96.879	LRP098a	.	121.5
N8	100.676	LRP101a	.	42.8
N8	176.88	LRP178a	.	39.5
N8	180.819	LRP182a	.	33.5
N8	197.413	LRP198c	.	73.54
N8	199.222	LRP200c	.	21.3
N105	26.697	LRP027a	Ulakola	209
N105	29.116	LRP029b	Shamarsingh	160
N106	16.038	LRP017a	Fouzia Bazar	37.3
N107	0.052	LRPSa	Kalurghat Bridge	23.8
N107	1.917	LRP001a	Afolahmed Bridge	9.1
N108	6.175	LRP006a	Bajalia	21.7
N204	12.136	LRP014a	Sath Sari	24.8
N208	9.392	LRP009a	Asraful Kapul	41.7
N401	32.093	LRP032a	Mukiagasa New	23.7
N506	19.896	LRP020b	.	12.15
N803	4.726	LRP004b	.	33.5
N809	26.642	LRP026a	.	42.6
N809	28.999	LRP028a	.	128.76

There are 239 Portable steel bridges on Regional Highways, shown in Table 12-12. The total replacement cost of these bridges is estimated to be Taka 639.8 Crore.

Table 12-12 : Portable Steel Bridges on Regional Highways proposed for replacement

Road No.	Chainage	LRP No.	Name	Length (m)
R140	80.597	80.597	Dakatia Bridge	102
R140	92.832	92.832	Mb Bridge	12
R151	3.712	LRP004a	Teli Gram Bridge	15.2
R151	4.013	LRP004c	Laxmisora Bridge	15.3
R151	4.644	LRP005a	Karer Hat Bazar	9.9
R151	10.225	LRP011a	Tulatuli Bridge	24.3
R151	10.823	LRP012a	Bur Caamp Bridge	30.2
R151	14.886	LRP016a	Koila Bazar	37.2
R151	15.645	LRP016c	Balutila Bazar	21.25
R151	16.806	LRP018a	Fullchar	15.25
R151	29.267	LRP031a	Narayanpur Bailey With Steel Deck	19
R151	32.981	LRP035a	Mizzar Hat Bailey With Steel Deck	25
R151	34.516	LRP036e	Mizzar Hat Bailey With Steel Deck	31
R152	12.709	LRP013a	Bagan Bazar Bridge	18.5
R160	23.954	LRP024b	Flazi Digio Baily Bridge	16.5
R160	25.713	LRP026b	Flazi Bailey With Steel Deck	18.5
R160	26.447	LRP027a	Fhaindom	15.5
R160	30.01	LRP030a	Kanchon Nagor	24.6
R160	30.48	LRP031a	Baganbari	18.5

Road No.	Chainage	LRP No.	Name	Length (m)
R160	35.064	LRP035a	Notunmosjid Baily Bridge	22.8
R160	37.727	LRP038b	Boraitoli Baily Bridge	24.5
R160	41.854	LRP042a	Tinotada Bridge	30.7
R160	43.655	LRP044c	Manichari Bridge	16.1
R160	43.671	LRP044d	Mainchan	16.1
R160	46.517	LRP047c	Gacch Bil Baily	18.45
R160	47.188	LRP048b	Gaccaha Bridge	23
R160	55.797	LRP056a	Kalapani Baily Bridge	18.7
R160	58.739	LRP059a	Guitara Bazar	76.5
R160	64.674	LRP065b	Baliachari	44.2
R160	65.069	LRP066a	Balu Chori Bailey With Steel Deck	42.4
R160	74.757	LRP076a	Bangchori Baily With Steel Deek	26
R160	84.321	LRP085b	AlutilacBridge	45.8
R160	87.36	LRP088e	Changi Bridge	111
R160	87.739	LRP089a	Sengipara	6
R160	88.004	LRP089b	Kasaem S Mill	6
R160	88.28	LRP089c	Bus terminal	6
R160	88.469	LRP089d	Khagrachari	10.3
R160	88.818	LRP090b	Collage Gate Bridge	6.1
R161	1.756	LRP001a	Dangmara Baily Bridge	33.65
R161	12.348	LRP012a	Hedmar Para	9
R161	21.371	LRP021d	Noapara	8.2
R161	32.203	LRP032b	Bangalhalia Bazar	30.45
R161	33.249	LRP033b	Kodum Chora Baily	27.6
R161	34.584	LRP035a	Chagolkhaia Baily	18.5
R161	37.069	LRP037a	Udalbana Bazer	18.4
R161	37.236	LRP037c	Sultan Shah Bazar Bridge	103
R161	39.087	LRP039a	Napit Pukaria Baily Bridge	93.3
R161	40.851	LRP041a	Dal- Bala Bailey With Steel Deck	15.5
R161	41.157	LRP041c	Dack Bala Bailey With Steel Deck	18.6
R161	41.517	LRP041e	Kawali Para Bailey With Steel Deck	33.5
R161	41.839	LRP042a	Kawa Para Bailey With Steel Deck	12.4
R161	41.899	LRP042c	Kawa Para Bailey With Steel Deck	15.5
R161	42.57	LRP043a	Kebro Para Bailey With Steel Deck	12.4
R161	42.772	LRP043b	Kabra Para Bailey With Steel Deck	15.6
R161	42.87	LRP043d	Kabro Para Bailey With Steel Deck	12.4
R161	43.476	LRP043f	Bhoda Chori Bailey With Steeldeck	18.5
R161	44.839	LRP045a	Amtali Bailey With Steel Deck	18.5
R161	45.117	LRP045c	Amtali Bailey With Steel Deck	21.6
R161	45.533	LRP045e	Kawaltali Bailey With Steel Deck	15.5
R161	46.045	LRP046a	Amtali Bailey With Steel Deck	18.5
R161	46.183	LRP046c	Amtali Bailey With Steel Deck	12.4
R161	47.024	LRP047a	Noyapara Bailey With Steel Deck	36.7
R161	48.799	LRP049a	Dulpara Bailey With Steel Deck	21.3
R161	49.363	LRP049d	Dolu Para Bailey With Steel Deck	9
R161	50.445	LRP050b	Tamolang (3)Bailey Bridge	18.2
R161	50.463	LRP050c	Steel Bridge	7
R161	54.725	LRP055a	Keamoron Culvert	9
R161	55.657	LRP055e	Pakuchora Baily	9.1
R161	56.415	LRP056c	Boddojati Bridge	40
R161	58.794	LRP059a	Balakata Baily Bridge	9.1
R162	34.504	LRP035a	Bailey Bridge	33.5
R162	42.333	LRP045a	Changachari	27.6
R162	49.266	LRP052a	Manikchari Baily Deck	30.5
R162	59.736	LRP062a	Takar Chora Bayli Bridge	35
R164	5.563	LRP006a	Shetar Ghat	25
R170	3.186	LRP003a	Vatikhin Bailey With Steel Deck	9
R170	8.603	LRP008b	Murali	15.2

Road No.	Chainage	LRP No.	Name	Length (m)
R170	15.135	LRP015a	Golden Park Bailey With Steel Deck	36.5
R170	15.426	LRP015c	Bolg Bailey With Steel Deck	16
R170	45.493	LRP045b	Shilxup Bally	34.5
R170	47.121	LRP047a	Chambol	25.2
R170	49.977	LRP050a	Na Para Sheet	25.2
R171	0.975	LRPSb	Chunti Bazar	14
R171	10.878	LRP010c	Monir Fokir Hat Bailey With Steel Deck	20
R203	5.085	LRP005a	Kalibari Bailey With Steel Deck	36
R203	10.118	LRP010a	Arihazar	36
R203	13.964	LRP014a	Sadadia Bailey With Steel Deck	18
R203	17.764	LRP018a	Daribisnondi	10
R203	18.146	LRP018d	Bisnandi Bailey	30
R212	8.048	LRP008a	Vayar Bazar Bridge	19.2
R212	10.76	LRP010e	Bogli Bailey With Steel Deck	24.9
R220	39.84	39.84	Raishal Karal Bailey With Steel Deck	9
R220	42.275	42.275	Sotun Bailey With Steel Deck	81.65
R220	46.33	46.33	Lokra Bailey With Steel Deck	42.7
R220	48.604	48.604	Langra Bailey With Steel Deck	43.4
R220	50.324	50.324	Wakhirpul Bailey With Steel Deck	24.01
R240	16.695	LRP016a	Kuy Steel Bridge	91.5
R240	20.54	LRP020b	Balikhal Steel Bridge	110.25
R240	27.063	LRP027a	Ujirpur	27.5
R240	33.28	LRP033a	Chandpur	20
R240	48.27	LRP048a	Paipur Bailey With Steel Deck	24.3
R241	28.857	LRP028c	Majidpur Truss Bridge	37.9
R241	31.212	LRP031a	Khasira Bailey With Steel Deck	17.5
R241	33.759	LRP033b	Gongur Bailey With Steel Deck	14.2
R241	42.018	42.018	Darga Vasa Bailey With Steel Deck	23.7
R250	36.223	LRP036a	Kakora Bridge	79.5
R250	62.79	LRP061c	Ballapoll Bailey With Steel Deck Bridge	10.2
R280	34.968	LRP035a	Jawa Steel	41.3
R280	38.296	LRP038c	Mobeg Bridge	78.45
R280	50.925	LRP051a	Joykalas Bridge	42.76
R280	51.072	LRP051c	Jaykalash Bridge	42.7
R280	52.681	LRP053a	Ahasan Bridge	146
R281	18.221	LRP019a	Chatol Gaon Bailey With Steel Deck	22.7
R281	29.782	LRP030a	Bhuyai Bridge	27.3
R281	30.75	LRP031a	Buktera Bridge	24.5
R281	31.894	LRP032b	Bella Gawn	60.48
R282	0.046	LRPSa	Juribail With Steel Deck	9.4
R282	0.757	LRP001c	Juribazr Steel Bridge	18.2
R282	1.622	LRP002a	Juri Baily With Steel Deck	36.5
R282	1.946	LRP002c	Juri-College Road Bridge	22.3
R282	2.936	LRP003b	Juri Lalhidila Road	27.3
R282	4.526	LRP005a	Noya Bazar	18.3
R282	6.82	LRP006c	Goalbari Bridge	6.1
R282	7.306	LRP007a	Goyal Mary	24.3
R282	8.114	LRP008a	East Goalbari	6
R282	8.734	LRP008b	Silloh Steel Bridge	6
R282	9.491	LRP009c	Silloh Steel Bridge	3
R282	11.245	LRP011a	Kuchai Bridge	9
R282	12.8	LRP012c	Kuchai-3	6
R282	14.133	LRP014a	Kusaitui Baily With Steel	15.25
R282	14.995	LRP014e	Dilkhush Baily With Steel Deck	21.5
R301	3.563	LRP003c	Nimtoli Bailey With Steel Deck	36.8
R301	10.777	LRP010b	Pubail	117
R310	7.232	LRP007a	Thitkhul Bridge	75
R312	9.929	LRP010a	Rajabari Steel Bridge	61

Road No.	Chainage	LRP No.	Name	Length (m)
R312	10.992	LRP010d	Razabari Haluebulsteel Bridge	15.24
R315	39.275	LRP040b	Rodaltlki Baily Bridge	73.5
R315	49.134	LRP050a	Sharif Bag Bridge	113.3
R360	63.479	LRP063a	Aowrargat Bailey With Steel Deck	38
R360	106.265	LRP106a	Boktarmara	36
R360	108.77	LRP109a	Akbor Nagar Bailey With Steel Deck	25.6
R360	111.459	LRP111a	Gazirtak Bailey With Steel Deck	32.2
R370	58.15	LRP058a	Barhatta	6.1
R370	60.008	LRP059e	Otilepur	18.6
R370	61.705	LRP061c	Otilepur	18
R450	0.918	LRP002a	.	12.92
R451	0.907	LRP001a	.	50.8
R451	6.561	LRP007a	Steel Baily Bridge	58.8
R451	10.62	LRP011a	Baily Bridge	24.6
R504	7.982	LRP007c	Bomdokham Bailey With Steel Deck	75
R504	8.717	LRP008c	Bakkon Bralakat Bailey With Steel Deck	75
R504	16.639	LRP016c	Kashemnagar Bridge	22.2
R504	17.476	LRP017b	Kula Para Bailey With Steel Deck	24.5
R506	0.02	LRPSa	Aricha -Gorai Bailey With Steel Deck	36.8
R506	2.8	LRP002a	Bridge Coulvert	21.4
R506	6.726	LRP006a	Gaiur Bazar Bailey With Steel Deck	30.5
R506	7.207	LRP007a	Coestha Bailey With Steel Deck	15.45
R506	12.072	12.072	Mandarta Bridge	33.4
R506	13.422	13.422	Mulkandi Bridge	12
R506	14.399	14.399	Chakmir Pur Bridge(L)	30.5
R506	14.399	14.399	Chak Mir Pur Bridge(R)	30.5
R506	19.542	19.542	Arrokomatvatra	30.5
R506	20.902	20.902	Georpoll Bridge(R)	29.9
R506	21.232	21.232	Dhalapara	22.2
R506	25.782	25.782	Dalaysori Bridge	65.3
R506	29.262	29.262	Georpoll Bridge	29
R506	30.252	30.252	Dhala Para	22.2
R506	38.081	38.081	Alasi Bridge	36
R506	39.152	39.152	Elasin Bazar Bridge	36
R545	100.323	LRP099b	.	36.8
R547	21.519	LRP021a	.	39
R549	0.452	LRPSa	Badalgachi Baily Bridge	74
R555	8.768	LRP008b	.	39.85
R585	80.501	LRP080a	Ichamati Bridge	24.75
R602	0.038	LRPSa	.	18.47
R681	9.968	LRP010a	Baily Bridge	36.2
R710	25.201	LRP026a	Chandrana Bridge.	55.93
R710	37.151	LRP038b	.	18.25
R710	40.205	LRP041a	.	24.7
R710	43.356	LRP044a	.	15.4
R746	6.857	LRP006a	Monakhalir Bridge	93.15
R747	11.198	LRP011a	.	36.63
R749	5.56	LRP005a	Golaidari Ghat Bridge	111.23
R770	9.77	LRP010a	.	25
R770	23.258	LRP022a	.	29.5
R770	30.527	LRP030a	.	18.45
R770	33.912	LRP033a	.	24.51
R770	38.315	LRP037b	.	21.35
R771	4.084	LRP004b	.	18.3
R812	10.729	LRP010b	Dashxani Bridge	36.5
R812	11.051	LRP010d	Bania Bari Bailey With Steel Deck	20
R812	18.526	LRP018a	Tongi Bari Bailey With Steel Deck	42.6
R812	22.77	LRP022a	Boly Bailey With Steel Deck	39.7

Road No.	Chainage	LRP No.	Name	Length (m)
R812	24.447	LRP023c	Taxi 2	36.5
R812	26.274	LRP025a	Baligaon Bailey With Steel Deck	73
R812	27.443	LRP026a	Kather Para	46.5
R812	28.957	LRP028a	Purbo Burdia	56.3
R812	30.467	LRP029a	Fultoli	78.5
R812	31.989	LRP031a	Kolkata Bailey With Steel Deck	61.5
R812	33.414	LRP032b	Maleranko Bazar Bailey With Steel Deck	30.3
R812	35.525	LRP035a	Masahat Goan	18.5
R812	36.708	LRP036a	Konokshar Bailey With Steel Deck	37.5
R812	37.606	LRP037a	Dokhin Holda	36.7
R813	0.732	LRPSb	Mirashare Bridge	24.3
R813	0.897	LRPSd	Nayagoan	18.3
R820	8.096	LRP008a	Shakta Bridge	37.5
R820	10.922	LRP011b	Ramar-Kanda Bridge	15.75
R820	11.108	LRP011e	Ramer Konda	12.5
R820	11.723	LRP012b	Rohilpur Bridge	31.5
R820	23.951	LRP024a	Gukul Nagor	30.6
R820	38.706	LRP038e	Chalni Bailey With Steel Deck	30.4
R820	47.201	LRP047c	Shutar Para Bailey With Steel Deck	39.8
R820	56.498	LRP056a	Syen Pukur Par Bridge	27.4
R820	57.369	LRP057a	Jahanabad Bailey With Steel Deck	27.2
R820	58.403	LRP058b	Bagra Bailey With Steel Deck	18.5
R860	12.796	LRP013a	.	31.2
R860	16.224	LRP016b	.	31.2
R860	17.39	LRP017d	.	31.15
R860	27.317	LRP028g	.	15.25
R860	27.753	LRP029b	.	12.25
R860	27.919	LRP029d	.	16.4
R860	29.6	LRP031a	.	28.89
R860	32.943	LRP034a	.	33.4
R860	34.021	LRP035a	.	30.5
R860	43.024	LRP044c	Gazipur Bridge	110.89
R860	53.333	LRP054a	.	18.2
R860	54.695	LRP056a	.	24.3
R861	1.442	LRP001a	.	15.15
R870	29.806	LRP029a	.	24.55
R870	30.071	LRP029d	.	36.7
R890	21.584	LRP021a	.	24.3
R890	29.847	LRP029b	.	18.2
R890	45.766	LRP045a	.	61.75
R890	53.689	LRP053b	.	33.6
R890	83.498	LRP083a	.	24.4
R161	50.908	LRP051a	Camolou(I) Bridge	12.4
R161	52.756	LRP053a	Kamolaw (2)Baily Bridge	15.5
R170	17.059	LRP017a	Shoylok Bailey With Timber Deck	9
R506	1.21	LRP001a	Shaily Bailey With Steel Deck	42.25
Total				**7,539.3**

12.9. Upgrade Condition B to Condition A

29.467 km of condition B structures should be improved to condition A at a repair cost of Tk. 16,500 per metre length, at a total cost of Taka 48.6 Crore.

12.10. Ferry Replacement Programme

12.10.1. National and Regional Highways

Para 5.9.5 of the National Land Transport Policy states that ferries will be replaced by bridges on National roads, where economic benefits are proved. There are 2 ferries on National Highways, and 11 ferries on Regional Highways which are considered as candidates for replacing with bridges, and these should be considered as the first priority. However, there are two potentially very long spans on Regional Highways (Jowkura Nazirganj on R602 of 3km, and on the Patuakhali-Amtoli-Barguna-Kakchira Road – R880, of 2.5km. These are unlikely to be economically viable and are not included in the Masterplan. Bridges at the locations listed in Table 12-13 are included at a total cost of Taka 600 Crore. All proposed bridges in Table 12-13 should be subjected to a full economic appraisal.

Table 12-13 : Recommended new bridge locations on National and Regional Highways

Name of Road	Road	Location of Ferry	Approximate width of water way (m)	Approximate length of bridge required To replace the ferry (m)	Cost of Bridge Crore Taka
Bhatiapara-Kalna Rd	N806	4th km	600	900	76.4
Barisal-Bhola-Laxmipur Rd	N809	3rd km	300	500	42.4
Ghagra-Chandragona-Bangalkhalia-Bandarban Rd	R161	16th km	356	450	38.2
Bhulta-Rupgonj-Badda Rd	R202	9th km	390	420	35.6
Madaripur-Shariatpur-Bhedorgonj-Chandpur Rd.	R860	4th km	300	300	25.5
Barisal-Jhalokati-Bhandaria-Pirojpur Rd	R870	55th km	1250	1400	118.8
Patuakhali-Amtoli-Barguna-Kakchira Rd	R880	53rd km Amtali	1100	1600	135.8
Barguna -Kakchira	R880	Baraitoli	500	600	50.4
Amtoli-Khepupara -Kuakata Rd (R881)	R881	18th km	300	350	29.7
Amtoli-Khepupara -Kuakata Rd (R881)	R881	30th km	320	370	31.4
Amtoli-Khepupara -Kuakata Rd (R881)	R881	36th km	130	180	15.3

12.10.2. Zila Roads

Table 12-14 lists 8 ferry locations on Zila roads where bridge construction is expected to economicallt viable in the next twenty years, and these should be considered as the second priority. The total cost of these 8 bridges is Taka 230 Crore.

Table 12-14 : Recommended new bridge locations on Zila Roads

Name of Road	Road	Location	Width of water way (m)	Length of replacement bridge (m)	Cost of Bridge Crore Taka
Sathkhira-Assashuni-Goaldnanga-Paikgacha Rd	Z7603	26th km	250	260	22
Bhaberchor-Gozaria-Munshigonj Rd	Z1063	7th km	300	330	28
Betgram-Tala-Paikgacha-Koira Rd	Z7604	51st km	223	223	19
Gallamary-Batiaghata-Dakup-Nalian forest Road	Z7606	21st km	250	300	25
Panchar-Shaibchar-Madaripur Rd	Z8011	18th km	162	162	14
Magura-Mohammedpur Rd	Z7012	27th km	305	335	28
Narail-kalia Rd	Z7502	21st km	750	600	51
Kachua-Betagi-Patuakhali-Lohalia-Kalaya Rd (Z8052)	Z8052	17th km	350	500	42

A further 14 ferry locations on Zila roads are unlikey to prove economically viable if bridged in the next 20 years. These can be considered third priority, and are not included in the masterplan, although listed in Table 12-15.

Table 12-15 : Ferry locations on Zila roads where new bridges are not recommended

Name of Road	Road	Location	Width of water way (m)	Length of replacement bridge (m)	Cost of Bridge Crore Taka
Matlab north-south connection Rd.	Z1069	Matlab	220	260	22
Lebukhali-Dumki-Boga-Kalaya-Dashmina-Golachipa- Amragachia Rd (Z8806)	Z8806	78th km	200	250	21
Khulna-Mongla Rd	Z7701	42nd km	400	500	42
Signboard-Morrelgonj-Rayenda-Sarankhola-Bogi Rd.	Z7702	7th km	710	825	70
Lebukhali-Dumki-Boga-Dashmina-Golachipa- Amragachia Rd (Z8806)	Z8806	59th km	400	500	42
Lebukhali-Dumki-Boga-Dashmina-Golachipa- Amragachia Rd (Z8806)	Z8806	14th km	400	660	56
Kachua-Betagi-Patuakhali-Lohalia-Kalaya Rd (Z8052)	Z8052	17th km	2,250	3,000	255
Razapur-Noikati-Bekutia-Pirojpur Rd	Z8702	52nd km	1,250	1,500	127
Shatapakia to Nalcity from Barisal- Jhalokati Rd	Z8709	3rd km	600	900	76
Lebukhali-Dumki-Boga-Dashmina-Golachipa- Amragachia Rd (Z8806)	Z8806	70th km	1,225	1,500	127
Rahmatpur-Babugonj-Muladi-Hizla Rd	Z8034	8th km	1,200	1,500	127
Norail-Lohagora-Naragati Rd	Z7503	1st km	130	119	10
Mehendigonj-Barisal(Laharhat) link Rd		4th km	800	1,000	85
Mehendigonj-Barisal(Laharhat) link Rd		13th	3,000	3,500	297
Laxmipur-Panti-Kumarkhali-Pabna Rd		21st km	600	650	55

12.10.3. River Training

River training costs should be included in the cost estimates for new bridges where possible and needed.

12.11. Economic Appraisal

An economic appraisal was carried out to assess the feasibility of a repair programme for bridges in Category C. The Bridge Maintenance Management System (BMMS) database, available on the RHD website, provides basic information about the RHD bridge network. The Road Master Plan proposes to replace all D category bridges, and carry out repairs to C category bridges. All the bridges, classified by age and condition categories A-D, are presented in Table 12-16. The mean (weighted) age in each category was found to be as set out in Table 12-17.

Table 12-16 : Overall Age and Condition of RHD Bridges

Age Group (yrs)	Condition Category									
	A		B		C		D		All	
	No	%	No	%	No	%	No	%	No	%
0-10	3,079	33	314	15	311	12	34	5	3,738	25
11-20	4,382	47	891	43	890	34	158	22	6,321	43
21-30	1,348	15	595	28	876	33	202	28	3,021	21
31-40	251	3	151	7	302	12	185	26	889	6
> 41	220	2	144	7	248	9	136	19	748	5
Total	**9,280**	**100**	**2,095**	**100**	**2,627**	**100**	**715**	**100**	**14,717**	**100**

Table 12-17 : Average Age by Condition of RHD Bridges

Category	A	B	C	D
Mean Age (yrs) - calculated	14	20	22	28
Mean Age (yrs) – rounded	15	20	25	30

The conclusions that emerge from the age and condition analysis are that the design life of a bridge, with proper maintenance, should be 50 years. However, the bridges in need of replacement (D class) have an average age of 30 years. Thus, the lack of maintenance causes the life of a bridge to reduce to 60 percent of its original life. The 5-year lag between the average ages in each category implies that a bridge slides down the condition scale (from A to B to C to D) every 5 years, also due to inadequate maintenance.

12.11.1. Deterioration and Remaining Life of C Class Bridges

The analysis for D class bridges was used to validate our assumptions regarding deterioration rates and replacement years for C class bridges. Thus, it is presumed that without maintenance and repair, the real/effective age of C class bridges is already double the actual age. If repairs and maintenance are not done even now, life will be further eroded by 50% and need for replacement hastened. Table 12-18 gives the actual age of C class bridges as a consequence of lack of repairs and their remaining life if the situation persists.

Table 12-18: Real Age and Remaining Life for C Class Bridges (Years)

Age Group (yrs)	0-10	11-20	21-30	31-40	> 41
Actual Age	5	15	25	35	45
Real Age	10	30	50	70	90
Remaining Life - today	40	20	0	-	-
Remaining Life – do nothing	20	10	-	-	-

The number of C class bridges analysed, after excluding the narrow bridges, are shown in Table 12-19.

Table 12-19 : C Class Bridges after excluding Narrow Bridges

Condition Category	Age Group (yrs)					
	0-10	11-20	21-30	31-40	> 41	All
C	215	631	593	216	149	1,804

12.11.2. Cost of the Bridge Repair Programme

The unit costs estimated for the different components of the programme, and their years of application, are given below:

Major repairs to C class bridges	Tk 230,000 per m
Periodic maintenance (5 yearly)	Tk 10,000 per m
Routine maintenance (annual)	Tk 500 per m

The weighted average length of the C class bridges selected for analysis (after excluding narrow bridges) was found to be 15.35m. Based on the total number of bridges, average length of a bridge and the unit rates, the cost streams of the repair programme were calculated. The financial costs were converted into economic costs by applying a Standard Conversion Factor (SCF) of 0.8.

12.11.3. Benefits

The benefits of undertaking major repairs to bridges are mainly the savings in the cost of replacement. The unit cost of replacement of a structure is estimated as Taka 600,000 per metre.

Based on the unit cost, average length, and the number of bridges in different age groups, the replacement costs were calculated and are shown in

Table 12-20. The start years for replacement are shown in Table 12-21.

Table 12-20 : Replacement Costs of C Class Bridges

	Age Group (yrs)					
	0-10	**11-20**	**21-30**	**31-40**	**> 41**	**All**
Number of bridges (C)	215	631	593	216	149	1,804
Replacement Cost –Financial (Crore Taka)	198	581	546	199	137	
Replacement Cost –Economic (Crore Taka)	158	465	437	159	110	

Table 12-21 : Start years for Replacement of C Class Bridges

Age Group (Years)	**0-10**	**11-20**	**21-30**	**31-40**	**> 41**
Start Year of Replacement	20	10	2	2	2

12.11.4. Cost-Benefit Analysis

Based on the above, an economic appraisal of the Repair Programme for C class bridges, having carriageway widths greater than 3.7 metres, was carried out. The economic cost and benefit streams were prepared for an analysis period of 30 years, and economic internal rate of return (EIRR) calculated using discounted cash flow method.

The EIRR of the project is 43%, which indicates that the benefits of repair or the savings in replacement cost far outweigh the costs of repair. It is therefore economically feasible to undertake the Major Repair Programme for C class bridges.

Table 12-22 : presents the results of the economic analysis.

12.12. Recommendations

12.12.1. Updating of BCS survey data

The majority of BMMS data come from the Bridge Condition Surveys carried out by RHD as per procedures and instructions laid down in the BCS Manual. As per provision in the manual, occasional and periodic updating of the field data has been recommended. Since the data in BMMS are based on survey done in the year 2004, it is now necessary to go for revalidation and updating of the data.

Modification in prioritisation may be required to match Updated BMMS data base, which can be done considering proposed prioritisation criteria.

12.12.2. Recommendations for updating of BCS data base

- The present BCS data is based on survey done in year 2004. It is necessary to revalidate and update the data.
- The scoring system adopted for condition categorisation of bridges needs to be revised and to be made more specific and systematic.
- A comprehensive survey and analysis is recommended to be carried out annually.
- Updated BCS data should form the basis for preparation of the ADP.
- All existing ferry locations should be identified with LRP numbers.
- Identification of bridge structure by LRP as per BCS Manual should be adopted for all references.
- All other identifications being presently used should be replaced immediately**.**
- The cost of this is estimated to be Taka 5 Crore.

Table 12-22 : Economic Evaluation of Repair Programme for C Class Bridges (CW width > 3.7 m), Million Taka

Year	Economic Costs				Economic Benefits – Savings in Replacement Cost						
	Major Repair Cost	Routine Maint.	Periodic Maint.	Total Costs	5 yr old	15 yr old	25 yr old	35 yr old	45 yr old	Total Benefits	Net Benefits
2007	1,019			1,019						0	-1,019
2008	1,019			1,019			874	318	220	1,412	393
2009	1,019			1,019			874	318	220	1,412	393
2010	1,019			1,019			874	318	220	1,412	393
2011	1,019			1,019			874	318	220	1,412	393
2012		11		11			874	318	220	1,412	1,401
2013		11		11						0	-11
2014		11		11						0	-11
2015		11		11						0	-11
2016		11	221	232		930				930	698
2017		11		11		930				930	919
2018		11		11		930				930	919
2019		11		11		930				930	919
2020		11		11		930				930	919
2021		11	221	232						0	-232
2022		11		11						0	-11
2023		11		11						0	-11
2024		11		11						0	-11
2025		11		11						0	-11
2026		11	221	232	317					317	85
2027		11		11	317					317	306
2028		11		11	317					317	306
2029		11		11	317					317	306
2030		11		11	317					317	306
2031		11	221	232						0	-232
2032		11		11						0	-11
2033		11		11						0	-11
2034		11		11						0	-11
2035		11		11						0	-11
2036		11	221	232						0	-232
							EIRR = 42.96%				

12.12.3. Recommendations for RHD Programme Management

- A comprehensive survey and analysis is recommended to be carried out by experts in bridges before updating of BCS data base.
- RHD should devote more to overall project management and outsource actual execution and responsibility of day to day management to experts in bridges.
- RHD should concentrate its resources in protecting its National Assets, Planning and budgetary monitoring, providing efficient and safe highway network.

12.13. Programme Summary

The total costs of the Bridge Repair and Replacement Programme is Tk 3,403 Crore, as shown inTable 12-23.

Table 12-23 : Priority Bridge Construction, Repair and Reconstruction Programme cost summary

Item	Number of Bridges	Cost (Crore Taka)
Reconstruction	133	477.7
Major Repair	418	627.5
Narrow Bridge Replacement	126	443.8
PSB Replacement	262	756.4
Minor Repair	730	48.6
Ferry Replacement (Priority 1)	13	600
Ferry Replacement (Priority 2)	8	230
Condition Survey	-	5
Total	**1,690**	**3,189**

The interventions proposed for the D and C class structures are set out in Table 12-24 and Table 12-25. The overall summary is shown in Table 12-26.

Table 12-24 : D Class Structure Interventions

Intervention	No. of Structures
Replacement of Portable Steel Bridges	62
Replacement of Narrow Bridges	25
Reconstruction of Bridges of 20m span or greater	133
Culverts replaced under road rehabilitation	318
Short structures replaced under road rehabilitation	177
Total	**715**

Table 12-25 : C Class Structure Interventions

Intervention	No. of Structures
Replacement of Portable Steel Bridges	200
Replacement of Narrow Bridges	101
Repair of Bridges of 20m span or greater	418
Culverts repaired under road rehabilitation	1,427
Short structures repaired under road rehabilitation	481
Total	**2,627**

Table 12-26 : Summary of proposed bridge interventions

	A	B	C	D	Total
Maintain	9,279				9,279
Repair		2,091	418		2,509
Reconstruct				133	133
Replace PSB's			200	62	262
Replace Narrow Bridges			101	25	126
Repair/replace culverts			1,427	318	1,745
Repair/replace short structures			481	177	658
	9,279	2,091	2,627	715	14,712

13. ROAD SAFETY

13.1. Road Safety: Priority Action Areas

In order to address road safety issues comprehensively, there is a need for identification of accident prevention priorities. Road safety issues which need priority attention are:

- adoption of certain effective measures to reduce and control speeds; Highway Police need to go for random radar spot speed checks, and enforce heavy penalties for violators;
- promotion of pedestrian safety, for which adequate pedestrian facilities are to be built by RHD, at major haats and bazaars along the highway;
- full implementation of the road safety audit process into the road planning and design, and RHD to ensure that all the safety provisions are strictly implemented during construction;
- RHD should consider improved design arrangements for safety of non-motorised transport on National Highways, through, for example, wider shoulders, and physical separation of the main carriageway from NMT facilities;
- RHD should act to intervene with physical measures to improve road geometry and safety features at identified 'black spots.'[37]
- RHD should carry out road safety audits, and should enforce strictly safety features in the design and construction of all new road schemes;
- RHD to provide special facilities for non-motorized vehicles, and service lanes for buses and trucks along all major haats and bazaars located on highways;
- Strict police enforcement of traffic laws and regulations to deter unsafe behaviour and violations using both known and perceived enforcement strategies;
- RHD to take initiative in securing donor funds to involve NGOs in creating mass awareness about various aspects of road safety through print and electronic media. NRSC (National Road Safety Council) to ensure that 'road safety education' is included in all school curriculum as part of public education program, especially for small children;
- RHD to take initiative in involving NGOs in promoting more safety conscious behaviour of road users, heavy vehicle drivers through a focused and effective motivational programs, including sanctions and licensing requirements;
- BRTA to ensure effective driver testing with the help of certified examiners, as well as promote establishment of high quality and well equipped private sector run driving schools, duly certified and registered with them, to ensure quality training. BRTA also need to deal strictly with fake license holders. In this context, introduction of High Security Driving License by BRTA has been a very useful step;
- BRTA to further strengthen technical inspection system for checking and testing vehicle standard and fitness. To this end, BRTA should consider selecting, based on a transparent inspection procedure, a number of top quality private motor vehicle workshops, which could be given the license to issue *vehicle fitness certificate*. BRTA should however, continue to oversee the tasks being performed by these private workshops;

[37] Black spots can be defined as clearly identifiable points on roads where accidents repeatedly occur, and hence where these occurrences are not 'accidents' but usually a fault of the road design, geometry or lack of safety features.

- Government should make compulsory, the uses of *seat–belts* in cars, jeeps, buses and trucks, as well as uses of *helmets* for motorcyclist and encouraged for use by cyclists;
- NRSC to ensure prompt emergency assistance and efficient trauma care management to enhance patient survival and minimize road accident deaths following the injury;
- NRSC to take measures for strengthening governments' coordination mechanism for accident and casualty data collection system (between police, hospital, insurance, and Accident Research Centre) for enhancing reliability of such data, and for a clear understanding of the causes of accidents; It is also necessary to establish *trauma centres* with supporting facilities, at convenient locations along the national/ regional highways;
- Accident Research Centre (ARC) at BUET could undertake detailed scientific analysis of accident and casualty data, and develop effective countermeasures, based on continued research to improve the current road safety scenario. NRSC should extend support to ARC in mobilizing donor assistance for such research activities;
- BRTA's institutional and professional capability should be strengthened through recruitment for the recently sanctioned 253 posts, for effective implementation of road safety measures. Additional institutional reforms have also been suggested (see para. 13.2) in pursuance of the anticipated Government's new strategy to declare that *Road Safety a National Priority;* and
- Highway and traffic police capacities should be strengthened.

13.2. Institutional Reform

A review of the present institutional set up responsible for road safety revealed that there is a major weakness in respect of enforcement, as a result road safety situation is deteriorating rapidly. It is therefore, important that a major institutional reform is undertaken to address the current weaknesses. The National Road Safety Council (NRSC) is the highest body in the country responsible for, among others, setting road safety policies, formulation of short and long term road safety action plans, advise the ministries and agencies concerned on developing ways and means of implementing the action plans. But it meets only once in every six months. Indicated below are some of the recommendations.

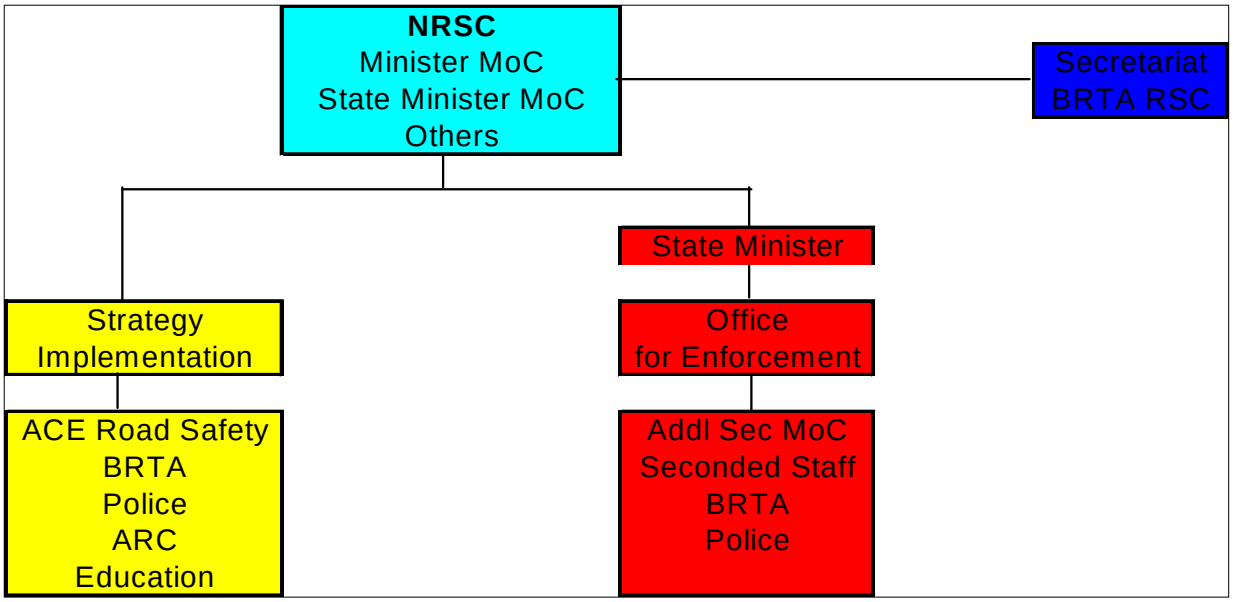
- It is, therefore, important to set up a working level committee to pursue the implementation of the decisions of NRSC. In addition, the NRSC should also ensure availability of adequate resources for implementation of the action plans, which need to be spelled out in detail, with indication of deadlines, and names of agencies responsible for implementation.
- A Mid-level Committee, headed by the Chairman BRTA was established earlier to pursue the decisions of NRSC, but it is not functioning presently. It is essential therefore, to revive that Mid-level Committee.
- BRTA needs further strengthening. With the appointment of 253 staff against newly created posts, BRTA should be in a position to carry out strictly all its tasks in respect of annual road tax, vehicle fitness certificate, issuance of driving license, addressing the problem of fake driving license, etc. BRTA together with Traffic Police/ Highway Police should regularly monitor whether the vehicle owners and drivers are defaulting in any of the above items, and deal strictly with the defaulters.
- RHD needs to create a post of Additional Chief Engineer (ACE), Road Safety. This is necessary to enhance the profile of activities related to road safety in RHD. All new road projects should have a road safety component included in the cost estimate, and these activities carried out as part of project

implementation. To carry out road safety related activities on existing roads, ACE(Road Safety) should clearly identify road safety improvement programmes, and adequate budget should be made available for these to RHD, by the government.

- Recognizing that lack of strict enforcement of traffic rules and regulations has led to the present state of road safety situation in the country, it has become essential to establish in the Ministry of Communications(RHD), a high level *Enforcement Office, headed by the State Minister*. The secretariat of this office could be headed by the Additional Secretary of the Ministry. This new office could be manned by bringing officers and staff on lien from BRTA, Police Department, and RHD. The above mentioned institutional reforms are shown in Figure 13-1.

- Re-constitute the NRSC as a Statutory body under law, with powers, funding and staff to deliver the components of Figure 13-1.

Figure 13-1 : Proposed Arrangements for Road Safety



13.3. Integrated Pilot Project

There is a pressing need to pilot new ideas on road safety in Bangladesh. It is recommended that the N5 Dhaka-Aricha Road is the subject of such a pilot scheme. The scheme will need to be designed in detail following baseline surveys of existing physical, social, traffic and accident conditions, but it is expected that it will address the issues in Table 13-1.

The Pilot Concept will:

- Improve selected sections of national and regional highway to incorporate physical road safety measures
- Enforce all traffic and vehicle rules and regulations along that section, impose fines
- Work closely with the bus and truck operators that use that section of road – owners and drivers. Perhaps initiate a reward scheme for safe drivers.
- Work closely with roadside communities, especially at markets and schools, to raise road safety awareness.
- Work with roadside market committees to identify and implement physical works to improve safety

- Monitor and evaluate the economic and social impacts of the road safety pilot programme (before and after studies) to quantify benefits (and costs) to road users, to roadside communities, to the economy and poverty reduction efforts.

Table 13-1 : Issues and Solutions for the Road Safety Pilot Scheme

Physical Issues ■ Central reserve and safety fencing / barriers ■ Separate lanes for NMVs ■ Footpaths in urban / market areas ■ Barriers to prevent market encroachment ■ Junction and interchange design ■ Access roads / entrances	**Operational Issues:** ■ Driver licensing ■ Road safety awareness and training ■ Speed control ■ Enforcement of rules and regulations ■ Unsafe vehicles and overloading ■ Dangerous overtaking ■ Vehicles stopping on carriageway ■ Encroachment (markets etc)
Physical Solutions: ■ Apply RHD road safety design standards on highways ■ Conduct road safety audits on all road projects, and design for safety	**Operational Solutions:** ■ Enforce traffic rules and regulations ■ Train and change attitudes / behaviour of professional drivers ■ Raise road safety awareness in roadside communities

It is estimated that the cost of the pilot project will be around Taka 33 Crore, representing around 1.0% of the total budget for roads and bridges. It is recommended that an allowance be made in the Masterplan for specific road safety projects, to be identified following the pilot project, of 2.0% of the total budget for roads and bridges on an annual basis. The total cost of road safety projects is estimated to be Taka 1,039 Crore over the twenty year period.

13.4. Level Crossing Replacement Programme

13.4.1. Level Crossing Data

Road/rail grade intersections, commonly known as 'level crossings', present a case of two infrastructure systems, with different responsibilities and travelled by vehicles with dramatically different performances, which converge during their normal operation. The result is that these crossings constitute high-risk spots for the users. Accidents at level crossings not only cause deaths of, or serious injuries to, thousands of road users and railway passengers, but also impose a heavy financial burden in terms of interruption of railway and road services and damage to railway and road vehicles and property. Grade separators ensure uninterrupted flow of trains and road vehicles.

This section presents a brief analysis of level crossing information for Bangladesh and a methodology for evaluating and prioritising locations that warrant grade separation. Since a broad assessment of a very large number (over 2,000) of level crossings is intended for this study, many simplified assumptions were applied for railway operation and traffic data. Although detailed economic evaluation, with project-specific data, should be done for decision-making of individual cases, this approach may serve as an appropriate screening tool.

Data provided by Bangladesh Railways (BR) indicates the characteristics of level crossings in the country (Table 13-2).

Table 13-2 : Level Crossing Characteristics - Bangladesh

Zone	Installing Agency	Approved* Level Crossings		Unapproved*/ Unprotected	Total
		Protected	Unprotected		
East	Local government departments	134	360	517	1,084
	RHD	21	26	26	
West	Local government departments	122	776	267	1,241
	RHD	46	24	6	
Total		**323**	**1,186**	**816**	**2,325**

** - by Bangladesh Railways*

Out of a total railway route-km of 2855, the numbers of level crossings are 2325. This indicates an average level crossing density of one every 1.2 km. (This is even higher than India's (one in 1.5 km), whose railway network and level crossings are both about 20 times that of Bangladesh). Level crossings that have been established by the road agencies, without seeking the permission of BR, are "unapproved" and all of these are unprotected, i.e. without barrier or gate-man. The number of such unapproved level crossings is high (35 percent). Many (more than 78 percent) approved level crossings also remain unprotected due to the establishing agency defaulting in its responsibility of providing the necessary facilities (such as barrier and gateman's work station). Such unprotected crossings were originally permitted at locations on unpaved roads with only pedestrian/animal crossings. But, with the paving of rural roads and increasing motorisation, these crossings are the sites of frequent accidents.

Considering the high level crossing density, the large number of unprotected crossings and the high rate of accidents, fatalities and injuries at these crossings, there is an urgent need to provide appropriate safety facilities at level crossings.

13.4.2. Grade Separation Proposals

In most Asian countries it is difficult to monitor level crossing safety effectively even if the railways take adequate measures to improve the safety of their level crossing installations. This is primarily due to the indiscipline of road users, who try to proceed through crossings as the barriers are closing and after they have closed. In such situations the best solution for safety enhancement is to physically segregate the road and the rail traffic. One of the policy prescriptions of the Road Master Plan for Bangladesh is that safety will be improved at level crossings on the main road network by introducing grade separation.

In addition to the safety concerns, at-grade crossings typically result in delay to the road traffic, which has to wait for the train to pass. Clearly, crossings carrying a high volume of road traffic and where barriers remain closed for excessive periods result in vehicular congestion and slow discharge of the accumulated road traffic. Delay at these crossings can be removed by separating the rail traffic from the highway traffic by constructing "road over bridges" (ROB) or "under passes" at the locations that affect the greatest number of vehicles.

13.4.3. Intervention Criteria

The first step is to identify locations on the National and Regional Highways network that are in need of grade separators. In many countries it is government policy to provide grade separation whenever it is justified by the frequency of accidents and the combined volume of road and rail traffic at the crossing locations under assessment. If the "crossing exposure", or the product of number of trains and traffic volume per day, exceeds a certain level, the crossing is a candidate for grade separation.

Suitable warrants for establishing the requirement of grade separators at level crossings are not adopted in Bangladesh. In the absence of these, the intervention criterion given in the Indian Roads Congress Code, IRC-62 (1976) was used. The IRC also uses "crossing exposure" as the criterion for grade separation. According to this code, '*ROB should be provided across existing*

railway crossing if the product of ADT (fast moving vehicles) and the number of trains per day exceeds 50,000 within the next 5 years'.

Application of this criterion resulted in a number of level crossings warranting grade separators immediately. These are listed in Table 13-3+.

13.5. Evaluation Methodology

Level crossings satisfying the above traffic warrant can be considered for grade separation if they are also found to be economically feasible. Economic evaluation involves carrying out a cost-benefit analysis to ensure that an adequate return, in terms of benefits, results from the capital investment. Thus, estimates need to be made not only of the life cycle costs associated with converting a level crossing into a grade separator, but also of the user benefits that are expected to accrue.

13.5.1. Benefits

The first benefit is that of eliminating collisions between trains and motor vehicles at level crossings, and thereby eliminating the deaths and injuries associated with these collisions. The second is that of minimizing the delays to road traffic as a result of barrier closures. Although the first is of paramount importance, it was not possible to include it in this analysis, as data on accidents at individual crossings are not readily available. The present analysis has thus focussed only on the benefits to motorised traffic due to delay reduction. However, for project specific analysis, it is essential to collect and analyse level crossing accident data and the benefits due to accident reduction. An additional benefit, in the form of saving in idling fuel consumption, would accrue to vehicles waiting at the level crossing barriers with their engines running for the duration of the gate closure. However, as this is not expected to be very significant, it is not included in the analysis.

Delay Reduction

The calculation of existing and future delays at rail crossings takes into account the number of trains passing the crossing per day, the gate closure time per train, and the road traffic affected. Ideally, for project-specific analysis, a survey should be conducted for obtaining this information at each level crossing. However, owing to the large number of crossings involved, and the preliminary nature of this analysis, data from secondary sources, supplemented by some simplifying assumptions, is sufficient.

Road Traffic

It was necessary to estimate future traffic streams for each level crossing. The base year (2004) road traffic was obtained from the CIDC-3 survey (WSP), while projected traffic figures for some cardinal years (2010, 2015, 2020 and 2025) were taken from the Bangladesh Traffic Model (WSP). Traffic for the intermediate years was estimated through interpolation.

Train Operations

The number of passenger and freight trains passing each level crossing was obtained from the railway reports and yearbooks. Train frequencies are assumed to remain constant in future mainly because little or no growth in route-kilometres is observed over the past 10 years. The gate closure times for passenger and freight trains have been taken to be different due to the difference in their lengths and speeds. A few sample observations in Dhaka city were made to confirm this and to obtain typical gate closure times per train type - 5 minutes per passenger train and 10 minutes per freight train.

Table 13-3: Level Crossings Requiring Grade Separation

Sl. No.	Level Crossing location (RRID[38])	Road No	Thana Name	MT[39] per day (2011)	No of trains per day	Warrant (MT*Trains > 50,000)
National Roads						
1	1	N2	Bhairab	2,943	42	123,623
2	2	N2	Brahmanbaria Sadar	1,565	41	64,154
3	3	N2	Habiganj Sadar	5,872	26	152,672
4	5	N2	Habiganj Sadar	6,314	21	132,585
5	6	N8	Dhaka City (Tejgaon)	10,806	20	216,112
6	11	N704	Kushtia Sadar	5,302	10	53,020
7	12	N1	Comilla Sadar (Kotwali)	25,393	39	990,343
8	14	N1	Feni Sadar	20,826	35	728,905
9	18	N6	Ishwardi	6,538	13	84,999
10	21	N6	Natore Sadar	3,179	17	54,037
11	37	N7	Bagher Para	2,719	20	54,388
12	42	N205	Sylhet Kotwali	3,183	22	70,019
13	50	N401	Mymensingh Sadar	2,212	24	53,084
14	53	N4	Jamalpur Sadar	3,158	24	75,804
15	54	N4	Jamalpur Sadar	3,158	24	75,804
16	55	N706	Jessore Kotwali	6,447	20	128,937
17	91	N7	Jessore Kotwali	6,447	18	116,044
18	92	N7	Goalandaghat	5,990	10	59,897
19	115	N7	Bagher Para	2,719	20	54,388
20	117	N7	Abhaynagar	2,719	20	54,388
21	120	N7	Abhaynagar	2,719	20	54,388
22	121	N7	Abhaynagar	2,719	20	54,388
23	130	N102	Brahmanbaria Sadar	6,404	41	262,577
24	215	N5	Ullah Para	6,587	13	85,637
25	219	N105	Gazipur Sadar	2,301	42	96,632
26	225	N5	Rangpur Sadar	3,700	15	55,503
Regional Highways						
1	19	R301	Gazipur Sadar	2,301	42	96,632
2	100	R301	Rupganj	2,301	42	96,632
3	108	R301	Rupganj	2,301	42	96,632
4	123	R140	Comilla Sadar (Kotwali)	6,809	39	265,548
5	223	R151	Mirsharai	5,109	35	178,828
6	234	R370	Mymensingh Sadar	6,245	24	149,887
7	240	R370	Mymensingh Sadar	6,245	24	149,887

Delay Analysis

Based on the above, the average period per barrier closure and the daily delay, i.e. the number of minutes in a day that the gate remains closed, are calculated. The daily delay, as a percentage of 1440 (i.e. 24*60) minutes per day, when applied to the projected daily traffic (AADT) on the highway section, gives an estimate of the average number of vehicles per day detained at the crossing during the period of barrier closure. Assuming only 50 percent of the vehicles in the queue experience delay equal to the closure time, the collective delay per day, in total vehicular-

[38] Rail Road Identifier
[39] Motorised Traffic

hours, is calculated by taking into account the vehicular volumes and the average duration of every barrier closure. In future years, as highway traffic continues to grow, the delay continues to increase. The annual vehicular delay for each vehicle type, or the time lost, is given by the following formula:

$D_{vt} = (V_t * 365 * T_c * 0.5)/60$ minutes

Where: D_{vt} = Annual Delay to vehicle type 't' in vehicle-hours;

V_t = Number of vehicles of type 't' held up per day; and

T_c = Average duration (in minutes) of every barrier closure.

Summation of all vehicle types gives the total vehicular delay per annum. The benefits of grade separation are in terms of elimination of these delays and the costs associated with them. The cost of delay is the value of the time lost. Delay costs vary for the different vehicle types, depending on their respective values of travel time.

Value of Travel Time

The value of travel time (VOT) or the travel time costs (TTC) vary between different vehicle types according to the socio-economic characteristics of the occupants, their trip purpose and the type of freight carried. TTC also varies geographically, depending on the socio-economic condition of the region. However, conventionally, a national average TTC is adopted in all analysis.

The Economics Circle of RHD has been conducting annual TTC surveys since 1997 in order to estimate a common national set of TTC by vehicle types for Bangladesh. For passenger vehicles, the analysis uses the average wage approach, where wage rates of vehicle occupants are assumed to reflect their value of time, and also takes into account their work time (WT) and non-work time (NWT). The cost of delays in transporting freight consists chiefly of costs due to interest on the capital that the goods represent, costs due to damage or spoilage of perishable goods, or other ancillary costs that can arise as a consequence of journey time. These costs represent the value of time for freight vehicles. TTC are expressed as hourly values per vehicle by assuming average occupancies and loading factors for each vehicle type. The results of these surveys are published in the RHD Road User Cost Annual Reports.

The TTC values for the present analysis are based on the Road User Cost Annual Report (2004-05). As TTC values for trucks are not presented in this Report, this value has been taken from the Planning Commission's Project Appraisal Framework, Road Sector Manual (2005). The 2004 TTC values, in financial terms, have been updated to 2006 using an average inflation rate of 7.04% per annum. The economic TTC are derived from the financial values by applying the standard conversion factor of 0.8, generally applicable for Bangladesh. Vehicle occupancies and the financial and economic TTC per vehicle for car, bus and truck are presented in Table 13-4.

Table 13-4: Financial and Economic TTC for Motorised Vehicles

Vehicle Type	Average Occupancy (number)	TTC (2004)			TTC (2006)	
		Financial		Economic	Financial	Economic
		TTC per passenger (taka/hr)	TTC per vehicle (taka/hr)	TTC Per vehicle (taka/hr)	TTC Per vehicle (taka/hr)	TTC Per vehicle (taka/hr)
Car	3	38.6	123.30	98.60	141.30	113.0
Bus	36.4	22.0	816.60	653.30	935.60	748.5
Truck	-	-	125.05	100.04	143.30	114.6

Source: For car and bus, Road User Cost Annual Report, 2004-05, Economics Circle, RHD.
For truck, Project Appraisal Framework, Road Sector Manual, 2005, Planning Commission.

Costs

The cost of construction of a typical road over bridge (ROB), comprising earthwork, pavement and bridge structure cost, has been broadly estimated for this analysis. It assumes a clear span of 16m, 160 m approach roads on either side @ 4% gradient. The economic cost is estimated by applying the SCF of 0.8. The annual maintenance cost is assumed to be 1 percent of the capital

cost. The financial and economic costs of a 2-lane and 4-lane ROB are presented in Table 13-5. The cost is phased equally over a 2 years (2007 and 2008) construction period.

Table 13-5 : Construction and Maintenance Costs of Typical ROB's (in million Taka)

ROB Type	Financial	Economic
2 – lane		
Construction Cost	70	56
Annual Maintenance Cost	0.7	0.56
4 - lane		
Construction Cost	126	100.8
Annual Maintenance Cost	1.26	1.008

13.5.2. Economic Evaluation

In order to determine whether the investment on an ROB will yield adequate economic returns, a cost-benefit analysis was carried out for each ROB candidate location. The costs and benefits streams are built up over the analysis period of 20 years (2009-2026). Using discounted cash flow technique, the economic internal rates of return (EIRR's) and the net present values were calculated. The project is considered to be economically viable if the EIRR is above the country's planning discount rate of 12%. The EIRR's for the various locations, where ROB's are justified, are presented in Table 13-6. The locations are listed in order of priority, and are shown in Map 13.1.

Table 13-6: Level Crossings where ROB's are justified

Sl	RRID No	Road No	Thana Name	EIRR (%)
1	12	N1	Comilla Sadar (Kotwali)	83.1
2	123	R140	Comilla Sadar (Kotwali)	62.7
3	14	N1	Feni Sadar	60.8
4	130	N102	Brahmanbaria Sadar	53.0
5	6	N8	Dhaka City (Tejgaon)	34.3
6	3	N2	Habiganj Sadar	30.0
7	5	N2	Habiganj Sadar	26.2
8	223	R151	Mirsharai	26.0
9	234	R370	Mymensingh Sadar	20.3
10	240	R370	Mymensingh Sadar	20.3
11	1	N2	Bhairab	18.5
12	55	N706	Jessore Kotwali	16.2
13	42	N205	Sylhet Kotwali	15.4
14	91	N7	Jessore Kotwali	14.9
15	215	N5	Ullah Para	12.5

13.5.3. Protection at Other Level Crossings

As grade separators are expensive solutions, these should be provided only where they are absolutely necessary and also economically feasible. Level crossings that do not warrant grade separators, or where grade separators are not viable solutions, also need to be provided with adequate protection systems. The different level crossing types found in most countries include:

- Manned crossings which are manually controlled by full width lifting barriers
- Manned and fitted with mechanical full width swinging barriers integrated with signal interlocking system

- Unmanned –without barriers but with warning signs; and
- Unmanned - open crossings without barriers or warning signs

It is important to develop warrants for identifying the appropriate protection for these other types of level crossings. A systematic approach for crossing protection is carried out by the Indian Railways, which uses the Train Vehicle Unit (TVU) criteria. The TVU is the product of the daily road traffic (motorised and non-motorised) volume at the level crossing and the daily number of trains passing through that crossing. Whereas the warrant for grade separators takes into account only the motorised traffic, the warrant for other level crossing types pertains to the total traffic. The TVU criteria applied in India are shown in Table 13-7.

Table 13-7: TVU Criteria for Level Crossing Type

Item	Train Vehicle Unit	Type of Crossing Indicated
1	TVU < 6000	Unmanned level crossing with warning signs
2	6000 < = TVU < 10,000	Unmanned crossing to be manned on priority basis
3	10,000 <= TVU < 100,000	Manned level crossing

In addition to the traffic warrants, other factors such as the importance of the road corridor, train speeds, etc. should be taken into consideration while deciding on the crossing type. For manned crossings, the type of protection system, whether manual or mechanical, will again depend on the cost involved and the funds available. An additional Tk 550 Lakh provision is made for other protection measures.

13.5.4. Programme Cost

The total cost of the first phase of the grade separation programme for level crossings is Tk 149.8 Crore.

14. TRAFFIC GROWTH

14.1. Approach

Section 4.3 revealed the forecast growth in traffic across Bangladesh as a whole. One of the greatest challenges for the road network over the next twenty years will be to accommodate growth in traffic volumes, to ensure economic efficiency. The Bangladesh Traffic Model (BTM) has been used as the main forecasting task for the RHD National Highways and Regional Highways between 2005 and 2025. The trip forecasting methods worked as the input to the traffic forecasting model along with the simulation of ferry delay, tolls, narrow bridges etc. in the final version of the BTM modelled in SATURN™ modelling software. The objective of traffic forecasting is to identify the need to increase capacity on the major strategic corridors considering different scenarios and major interventions during the Masterplan period.

14.2. Traffic Forecasting

The forecasting horizon is up to 2025, and used historical vehicle and trip data, which had been collected from Bangladesh Road Transport Authority (BRTA), and primary Origin-Destination (O-D) data collected by the CIDC3 project. Sectoral GDP (Industry, agriculture, and service), population and household information collected from Bangladesh Bureau of Statistics (BBS) act as independent parameters in the trip forecasting process. The trip forecasting method uses the same spatial segregation as the BTM so as to be consistent with it.

The independent parameters used in the trip forecasting methods can be sensitive to other factors, which are hard to simulate, so three scenarios have been established for the trip forecasting process. These three scenarios set out in Section 4.2 are:

- Low Growth Scenario
- Medium Growth Scenario
- High Growth Scenario

The following common assumptions for all forecasts were made:

- The spatial distribution of trips is consistent with the O-D survey commissioned in 2004[40]
- The latest national socio-economic data and forecasts (GDP, Population, Household information etc.) are used
- Forecast of socio-economic forecasts will be continued to be consistent as the available data
- Trip rates per registered vehicle will remain constant in the future year for all modes

Thus, the model establishes simple relationships between key socio-economic variables and vehicle ownership and usage to assess future trends. In this course, following assumptions on socio-economic variables are made:

- Real GDP growth is used to predict growth in truck traffic;
- Disposable income growth is used to predict growth in passenger car;
- Population growth is used to predict growth in bus; and
- Average rate growth rate for truck and passenger car is used for other motorized vehicle (Micro bus, jeep, utility etc)

14.3. Traffic Model Development

The Bangladesh Traffic Model (BTM) includes all the national and the Regional Highways and a few key urban roads. The model also includes 2006 toll rates on all the roads and the bridges, and the ferry rates and average ferry waiting time. Each road is represented in the model by its

[40] Report on Road Side Interview Survey

length, capacity and speed (free flow and at capacity). The change in speed with traffic volume is represented by speed-flow curves equivalent to the speed-flow curves used in the UK (COBA[41] default curves) for appropriate road types, which was then adjusted to reflect the traffic environment in Bangladesh.

The accuracy of the road length used in the model was checked against RHD GIS data source. This GIS data source is reported to be highly accurate, in light of that the network representation in the model should be considered acceptably accurate.

The model consists of 91 traffic zones in total covering the entire country. The model zoning system is shown in Map M13.1. Except for five most populated districts, each administrative district is represented by a single traffic zone. The five most populated districts are further disaggregated as follow - Dhaka into 5 zones, Chittagong into 4 zones, Comilla into 3 zones, Mymensingh and Tangail each into 2 zones. Separate traffic zones were used to represent the following landports with India and Myanmar:

- India at Benapole
- India at Meherpur
- India at Banglabandha and Burimari
- India at Tamabil
- India at Akhaura
- India at Sherpur
- India at Hilli and
- Myanmar at Teknaf

The model outputs are given in

- AADT (Annual Average Daily Traffic) for four types of vehicles: bus, truck, car and other motorised vehicles, mainly micro buses and utility vehicles. It was assumed that buses run on predetermined routes while other vehicles are free to choose minimum cost routes as perceived by them.
- Volume-Capacity ratio
- Average vehicle speeds, degree of congestion, vehicle-km, vehicle-hrs etc on selected roads as well as overall network statistics.

The trip matrices representing different classes of vehicles have been developed based on two types of surveys:

- Origin destination survey (OD survey) – A sample of each type of vehicle drivers were interviewed and their origin, destination information were collected.
- Classified Count Data – On a selected number of links total traffic flow by different type of vehicles were recorded.

To avoid any bias all the surveys were done for 24 hours on a weekday.

It was recognised that for economic evaluation it was important that the model travel time be representative of the actual network travel time. Journey time surveys were carried out along the eight major national road corridors (N1 to N8).

After satisfactory validation result the model has been calibrated and run under base year scenario and in forecasting mode. The model has been used to test different Road Master Plan scenarios and to assess degree of saturation along each corridor and will help to identify bottlenecks at key locations. This helped to assess how a change in one road may change traffic there and in the broader area and to compare vehicle-km and vehicle-hours increase/ saving along key corridors for economic appraisal.

[41] COBA = Cost Benefit Analysis, extensively used in UK Design Manual for Roads and Bridges (DMRB)

14.4. Traffic Modelling Schedule

The BTM was run for the following forecast years in a Base or 'Do-nothing' condition:

- 2010
- 2015
- 2020
- 2025

For each of these years, an analysis was made of the likely traffic conditions under low, medium and high growth assumptions.

14.5. Forecast Increases in Traffic

The overall forecast growth rates for traffic, expressed in Vehicle-kilometres on the National Highways and Regional Highway network are set out in Table 14-1. The medium growth forecast over the Masterplan period is just under 6% per year. In the absence of other data, it is recommended that individual scheme appraisals use as an aggregate growth rate for all traffic of 6% in future.

Table 14-1 : Forecast annual average % growth in vehicle-km, National and Regional Highway network

	Low	Medium	High
2005-2010	6.71	7.52	8.13
2010-2015	6.01	6.40	6.98
2015-2020	6.18	5.84	5.71
2020-2025	3.28	3.86	4.98
2005-2025	5.54	5.90	6.44

14.6. 2010 Base Year

The 2010 Base year run revealed the following potential traffic problems on the network:

- N1 Dhaka to Feni, volume to capacity ratio > 70%
- N102 Mynamati to Brahmanbaria, volume to capacity ratio > 70%
- N1 Chittagong to Patiya, volume to capacity ratio > 70%
- R504, Dhaka to Manikganj, volume to capacity ratio > 70%
- Aricha Ferry, over capacity

14.7. 2015 Base Conditions

In addition to the above, the following problems are predicted:

- N4 Dhaka to Tangail, volume to capacity ratio > 70%
- N704 Kushtia to Pabna, volume to capacity ratio > 70%
- R180, N110, Cox's Bazar to N, volume to capacity ratio > 70%
- N1 Feni to Mirsarai, volume to capacity ratio > 70%
- R812, Tongibari to Munshiganj, volume to capacity ratio > 70%
- Meghna and Meghna Gumati Bridges over capacity

14.8. 2020 Base Conditions

In addition to the above, the following problems are predicted:

- N5 Dhaka to Aricha, volume to capacity ratio > 70%
- N074 Jhenaidah to Kushtia, volume to capacity ratio > 70%
- N405 Jamuna Bridge Approach Roads, volume to capacity ratio > 70%
- N405, Nolka to Hatikamrul, volume to capacity ratio > 70%
- R114, Dhaka to Narshingdi, volume to capacity ratio > 70%
- R140, Noakhali to Laxmipur, volume to capacity ratio > 70%
- N1 Cox's Bazar to Patiya, volume to capacity ratio > 60%
- R160, Chittagong to Khagrachhary, volume to capacity ratio > 70%
- N106, Chittagong to Rangamati, volume to capacity ratio > 70%
- R161, Rangamati to Bandabarn, volume to capacity ratio > 70%
- N1, Chittagong to Mirsarai, volume to capacity ratio > 70%

14.9. 2025 Base Conditions

- N702 Jessore to Magura, volume to capacity ratio > 70%
- N5, Hatikamrul to Bogra, volume to capacity ratio > 70%
- N401, Mymensingh to Madhupur, volume to capacity ratio > 70%
- N3 Dhaka to Mymensingh, volume to capacity ratio > 90%
- N104/R141, Noakhali to Comilla, volume to capacity ratio > 70%
- N507, Hatikamrul to Baraigram, volume to capacity ratio > 70%
- R170, Chakaria to Patiya, volume to capacity ratio > 70%
- N804, Rajbari to Bangha, volume to capacity ratio > 70%

14.10. Scheme Identification

In order to address the problems caused by traffic growth on the network the schemes listed in Table 14-2 have

been identified as candidates for preliminary appraisal. For Dhaka, scheme identification is integrated and with STP[42] proposals, and implementation of the road masterlan should be co-ordionated with that of the STP. For each project the network-wide total pcu-km and pcu-hours were extracted from the traffic model. These were then converted into vehicle-km, and vehicle-hours. For each scheme, the savings in each of the outputs was calculated by taking the difference between a Base Case (without scheme), and a Do-Something Case (with scheme). The savings are shown in Table 14-3.

[42] Strategic Transport Plan for Dhaka, Ministry of Communications, December 2005 (Draft)

Table 14-2 : Road Masterplan, Preliminary Scheme Identification

Road Number	Section	Type of Improvement	Required Opening Year
N1	Dhaka - Chittagong	Widening to 4 lanes	2010
N3	Tongi - Mawna	Widening to 4 lanes	2015
N102	Mynamati - Brahmanbari	Repair and removing unsafe bends	2010
R280	Sylhet - Sunamganj	Repair and removing unsafe bends	2010
N8	Dhaka - Mawa	Widening to 4 lanes	2015
N1	2nd Meghna and Meghna Gumpti Bridges	New Bridges	2013
N1 – N3 Link	Dhaka Eastern By-pass	New Road	2015
N8	Padma Bridge	New Bridge	2015
N8 – N5 Link	Dhaka Western By-pass	New Road	2016
R750/Z7503	Narail to Jessore	Upgrading and widening to 4 lanes	2015
N4	Dhaka - Tangail	Widening to 4 lanes	2015
N706	Jessore - Benapole	Widening to 4 lanes	2020
N2	Dhaka – Bhairab	Widening to 4 lanes	2020
N5	Dhaka - Baniajuri	Widening to 4 lanes	2020
N1	Chittagong By-pass	New Road	2020
N1 – N106 Link	Kumira - Hatazari	New Road	2003
N1	Chakaria to Chittagong	Widening to 4 lanes	2020
	Dhaka Outer Orbital Road	New Road	2024
N6	Baneshwar - Bhelpukur	Widening to 4 lanes	2025
N8	Lebukhali Ferry Replacement	New Bridge	2025
	Dhaka-Chittagong Expressway	New Road (Tolled)	2020

Table 14-3 : Savings in Vehicle-hours and Vehicle-km per day for selected schemes

Scheme	Year of Calculation	Vehicle KM Savings	Vehicle Hour Savings
N1 Dhaka-Chittagong	2025	1,510,865	57,784
N3 Tongi-Mymensingh	2015	5,878	101,441
N102 Mynamati-Brahmanbaria	2015	3,346	3,038
R280 Sylhet-Sunamganj	2015	949	0
N8 Dhaka-Mawa	2015	9,321	44,994
N1 2nd Meghna/Daudkandi Bridge	2015	61,878	125,164
N1 2nd Meghna-Gumpti Bridge	2015	61,878	125,164
Dhaka Eastern Bypass	2020	1,094,797	102,919
Padma Bridge	2015	64,440	27,240
Dhaka Western Bypass	2025	81,240	16,422
Dhaka Eastern By-pass	2025	4,017,440	136,435
R750-Z7503 Jessor-Lohagari	2020	95,600	448,363
N4 Dhaka-Tangail	2020	7,099	12,567
N1 Deepsea Port-Sonadia	2025	14,976	0
N1 Chakaria-Chittagong	2020	36,955	85,752
N8 Jessore-Benapole	2025	2,465	70,000
N5 Dhaka-Baniajuri	2025	32,995	146,080
Chittagong Bypass	2025	25,603	758,121
N6 Baneshar - Belepur	2025	8,653	105,264
Dhaka Outer Orbital	2025	43,294	19,701

14.11. Preliminary Project Appraisal

Table 14-4 : Project Costs and Benefits

Scheme	Year of Opening	EIRR	Cost (Crore Taka)
N3 Tongi-Mymensingh	2011	12	500
N102 Mynamati-Brahmanbaria	2012	67	360
R280 Sylhet-Sunamganj	2012	17	212
N1 Dhaka-Chittagong	2012	45	1,867
N8 Dhaka-Mawa	2013	16	600
N1 2nd Meghna-Gumpti Bridge	2014	44	650
N1 2nd Meghna/Daudkandi Bridge	2014	41	750
Dhaka Eastern Bypass	2016	27	300
Padma Bridge	2016	16	10,080
Dhaka Western Bypass	2017	16	360
R750-Z7503 Jessore-Lohagari	2018	74	600
N4 Dhaka-Tangail	2019	12	690
N1 Chakaria-Chittagong	2021	85	1,060
N8 Jessore-Benapole	2021	22	330
N1 Deepsea Port-Sonadia	2021	14	400
N5 Dhaka-Baniajuri	2022	24	780
Chittagong Bypass	2024	94	210
N6 Baneshar - Belepur	2025	31	600
Dhaka Outer Orbital	2025	20	1,500
N1 Chakaria-Chittagong	2025	16	1,060
N1 - Hatazari Link Road	2025	31	200

In addition to the above, and in the light of Asian Highway proposals (section 14.14), the following schemes should be included in the Masterplan:

- N2 Dhaka to Bhairab (70 km, widening to 4 lanes)
- N2 Bhairab to Mouvlibazar (120 km, widening to 4 lanes); and
- N2 Mouvlibazar to Sylhet (96 km, widening to 4 lanes)

14.12. N1 (Dhaka-Chittagong) Improvement

RHD is currently drawing designs for the possible 4-laning of the Dhaka-Chittagong highway. As shown in Table 14-4, this is a relatively expensive scheme. If implemented, the case for a Dhaka-Chittagong expressway is eroded, to the extent that it would not be viable before 2020. It may, therefore, make more sense to promote the case for an expressway, funded by the private sector, in advance of any improvement to the existing highway using Government funds. Traffic forecasts for an expressway have been made and are shown in Table 14-5

Table 14-5 : Selected Traffic Forecasts, Dhaka-Chittagong Highway

	Section	Truck (vehicle)	Car (vehicle)	Other (pcu)	Bus (vehicle)
N1 2 lane	Daudkandi – Comilla	10,169	1,836	8,429	8,332
N1 4 lane	Daudkandi – Comilla	12,197	3,078	8,429	8,332
Off line Expressway	River Meghna to Chandpur	10,194	719	1,369	2,000
On-line Expressway	Daudkandi – Comilla	9,130	2,343	6,322	3,000

The financial consequences of the proposed private sector express have been examined. The total cost of the 'off-line' option is Tk. 5,824 Crore. Tariff levels of Tk 100 per section for trucks were tested, on each of the 6 sections. An 'on line' option was also tested with similar tariff levels, and a similar cost (reflecting the increased cost of land acquisition). In order for a private sector concessionaire to realize a 10% financial internal rate of return the Government would have to provide a subsidy in each case. This has been capitalized and is shown in Table 14-6

Table 14-6 : Costs to Government of Capacity Increase, Dhaka-Chittagong

Option	Cost to Government (Crore Taka)	Total Resultant Capacity
4-Lane existing highway	1,867	4 lanes
Off-line 4 lane expressway	2,184	6 lanes
On-line 4 lane Expressway	1,164	6 lanes

The lowest cost to the government and the most beneficial in traffic terms is the 'on-line' Expressway.

14.13. Land Port Connections

Landport connections to the National Highway network are required for the ports listed in Table 14-7.

Table 14-7 : Costs of new Landport connections

Landport	Current Connection	Length (km)	Cost (crore Taka)
Hili	Z5503, Z5856	23	115
Sonamasjid	Z6801	5	25
Akhaura	Z1216	8.5	42.5
Haluaghat	Z2371	10	50
Bhomra	None	7	70
Bibirbazar	None	8	80
Total		**61.5**	**382.5**

14.14. Asian Highway

14.14.1. Background

The Asian Highway project was conceived by UN-ECAFE (United Nations Economic Commission for Asia and the Far East) in 1959 with the aim of establishing regional cooperation among the main land countries of Asia, based on road transport linkages. This name was subsequently changed to UN-ESCAP (United Nations Economic and Social Commission for Asia and the Pacific) in 1974. The Asian Highway network is now 141,000 km long and across 32 Asian countries with linkages to Europe. The Asian Highway is now one of the three pillars of Asian Land Transport Infrastructure Development (ALTID) project comprising the Asian Highway, the Trans-Asian Railway and facilitation measures for border crossing.

In order to formalize the establishment of the Asian Highway network and to ensure commitment of the member governments towards its further development, standardization and maintenance, an Intergovernmental Agreement on the Asian Highway Network was adopted on 18 November 2003 in Bangkok. The last date of signing the Agreement was December 31, 2005. By June 2007, the Agreement was signed by 28 member states out of 32 members, of which 19 have already become Parties.

1,761 kms of Bangladesh national highways are included in the Asian Highway network. Two major routes of the Asian Highway, AH-1 and AH-2 cross Bangladesh. Route AH-1 enters Bangladesh at Tamabil in the East and passes through Sylhet-Dhaka-Padma Bridge-Narail-Jessore –Benapole. Route AH-2 also enters Bangladesh through Tamabil and follows the same

route as that of AH-1 up to Dhaka and then takes a turn towards Tangail in the North-West direction. AH-2 then passes through Jamuna Bridge-Bogra-Rangpur-Dinajpur-Banglabandh. The other Asian Highway route AH-41 connects the two sea-ports of Bangladesh with the AH-1 and AH-2. Standards have already been adopted (Table 14-8). Bangladesh has upgraded most of its network to Asian Highway class II standard, except the portions on the N1 and N5 as shown in Table 14-9.

The Asian Highway Agreement provides a framework for coordinated development of this international highway in Asia, as well as between Asia and Europe. It provides the member countries a platform to discuss technical and institutional issues to improve the quality of the network and increase the efficiency of its operation, as well as to discuss changes if any to the network. Unfortunately Bangladesh has not signed the agreement as yet. It is, however, still possible to accede to the agreement, by signing the ***accession form*** of the UN.

Table 14-8 : Asian Highway Design Standards

Highway classification		Primary (4 or more lanes)				Class I (4 or more lanes)				Class II (2 lanes)				Class III (2 lanes)			
Terrain classification		L	R	M	S	L	R	M	S	L	R	M	S	L	R	M	S
Design speed(km/h)		120	100	80	60	100	80	50		80	60	50	40	60	50	40	30
Width (m)	Right of way	(50)				(40)				(40)				(30)			
	Lane	3.50				3.50				3.50				3.00(3.25)			
	Shoulder	3.00		2.50		3.00		2.50		2.50		2.00		1.5(2.0)		0.75(1.5)	
	Medium strip	4.00		3.00		3.00		2.50		N/A		N/A		N/A		N/A	
Min. radii of horizontal curve (m)		520	350	210	115	350	210	80		210	115	80	50	115	80	50	30
Pavement slope (%)		2				2				2				2-5			
Shoulder slope (%)		3-6				3-6				3-6				3-6			
Type of pavement		Asphalt/cement concrete				Asphalt/cement concrete				Asphalt/cement concrete				Dbl. bituminous treatment			
Max superelevation (%)		10				10				10				10			
Max. vertical grade (%)		4	5	6	7	4	5	6	7	4	5	6	7	4	5	6	7
Structure loading (minimum)		HS20-44				HS20-44				HS20-44				HS20-44			

Notes: Figures in parentheses are desirable values.
Minimum radii of horizontal curve should be determined in conjunction with super-elevation.
The recommended width of the median can be reduced with the proper type of guard fence.
The Parties should apply their national standards when constructing structures such as bridges, culverts and tunnels along the Asian Highway

14.14.2. Road Upgrading to Asian Highway Standards

The roads listed in Table 14-9 need to upgraded as part of the Road Masterplan in order to meet Asian Highway standards. The total cost is estimated to be Taka 536.1 Crore.

Table 14-9 : Costs of upgrading to Asian Highway standards

Road	Section	Current Width	Length (km)	Upgrading Cost (Crore Taka)
N1 / AH41	Cox's Bazaar - Teknaf	5.75m	80	169.9
N5 / AH2	Taraganj - Boda	5.5m	110	271.2
N5 / AH2	Panchagarth - Tetulia	3.65m	19	95.0
Total			**209**	**536.1**

14.15. Private Sector Involvement

As noted in Section 14.12 there is potential for private sector participation in the capacity expansion of the N1 Dhaka-Chittagong Highway. Compared the cost of 4-laning the existing highway, the equivalent private sector contribution to an expressway ought to be at least 700 Crore Taka[43]. This figure is conservative, and will be probably rise as result of detailed feasibilities studies.

Other candidates for private sector participation are:

- Dhaka Eastern By-pass

[43] Tk 1,867 Crore (cost to Government) minus Taka 1,164 Crore (net cost to Government of expressway)

- 2nd Meghna-Gamati Bridge
- 2nd Meghna-Daudkandi Bridge
- Dhaka Western By-pass

14.16. Paving National and Regional Roads

85 km of National Highways and 207 km of Regional Highways should be paved during the Masterplan period, and unit cost rates of Taka 8 Crore, and Taka 6 Crore, per km respectively have been taken, giving a total cost of Taka 1,916 Crore. This should be done after the rehabilitation programme (Section 8.10), and hence is programmed to start in the financial year beginning June 2012.

14.17. Network Connectivity

The consequence of all the above proposals will be improved connectivity across the network, particularly along the major strategic corridors and access to key traffic generators, such as land and sea ports, and the Madhyapara coal mine.

14.18. Safeguarding

Road widening schemes and new roads will require land acquisition. This can be a cumbersome process if buildings and structures have been constructed by the time the land is needed. Hence safeguarding is required. It is recommended that the Ministry of Communications and RHD put in place safeguarding measures for new road and road widening proposals. A special committee may be formed to investigate the appropriate powers to do this.

15. ROAD MAINTENANCE

15.1. Routine Maintenance

15.1.1. Costs

The costs of routine maintenance for the RHD paved road network should be around Tk. 60 Crore per year (Table 15-1). This is a small figure in comparison to periodic maintenance requirements. It should have priority in resource allocation, simply on the basis of economic return. Two HDM runs were commissioned, with and without routine maintenance. A comparison of the intervention costs required revealed that the value of routine maintenance is a saving in other forms of intervention of around Tk 300 Crore per year.

Table 15-1 : Routine Maintenance Costs of the existing paved network

Road Class	Paved length (km)	Annual Routine Maintenance Cost (Crore Taka)
National	3,485	17.4
Regional	4,117	12.4
Zila	9,832	29.5
Total	**17,434**	**59.3**

Routine maintenance costs will rise as the paved road network is increased in length. The total costs of routine maintenance over the 20-year period are estimated to be Taka 1,392.4 Crore.

15.1.2. Institutional Arrangements

Some allocation of routine maintenance is made by RHD, but is insufficient and inefficiently used. RHD still uses force-account working for routine maintenance, despite the experience of the vast majority of countries with similar problems who have moved to contracting out routine maintenance. Routine maintenance needs a serious planned and managed attitude to off-carriageway care, coupled with a responsive and professional attitude to on-carriageway works. Because there is very little culture or history of routine maintenance in Bangladesh, these qualities are missing in RHD. As a result, institutional reform and capacity building is required to ensure that routine maintenance is carried out efficiently.

Off-carriageway works are often carried out by individuals responsible for a specific stretch of road (the lengths man principle). They are usually local inhabitants employed through a simple contract. It is not necessary to have a large labour force within the road administration for this purpose.

For carriageway repair, access to some machinery and materials is required. Historically these have been kept at local depots but without regular and predictable funding machinery is not maintained properly and stocks of bitumen are often inadequate. The delivery of this kind of maintenance is best undertaken by a responsive team with clear terms of reference and accountability.

Routine maintenance is a very visible activity and demonstrates to the public and road users that the road administration is active in road care. On-carriageway works are often small in nature and do not require the road to be closed. Road agencies can transfer this accountability to contactors through performance-based contracts for routine maintenance, and this approach is adopted is many countries already. Contracts for routine maintenance can have a strong labour-based content, especially for off-carriageway works, can use a lengths man approach, and can employ a large quotient of female workers. For low volume roads, equipment need not be very sophisticated, so, for example, a manual roller can be used for pot-hole filling. For high volume roads, reasonably well experienced and competent contractors are required, in order to ensure safety of workers and access to good materials and equipment.

Even where routine maintenance is contracted out, the road agency needs to have appropriate arrangements in place to manage the activity effectively. For the National Highways, routine maintenance is so important that it needs to take precedence in budget allocation. Responsibility for it should lie with the ACE (Planning and Maintenance), and all contracts monitored by his

office. Once established budget allocations will be reasonably predictable. Three-year contracts for total lengths of around 150 km would be worth around Taka 2.2 Crore, and on average (currently) seven or eight contracts would be let annually. Supervision and inspection would be carried out by Executive Engineers in the Divisions.

Routine maintenance of Regional and Zila roads is administered at a local level with devolved responsibility. For RHD, there are three options.

- To disaggregate the network into manageable sizes of the 128 operational highway engineering Sub-Divisions, giving an average of around 165 km of routine maintenance for each area. This road length might be divided into lots of around 40km, depending on geography. An annual routine maintenance contract for 40km would be worth of the order of Tk 16 lakh. A Sub-Divisional Engineer would be responsible for ensuring that the contractors in his/her area met the contract performance targets.
- To designate a specific engineer in each of the 64 RHD Divisions to be the Maintenance Engineer and to be responsible for, on average 330 km of roads under routine maintenance contracts. He/she might then delegate inspection work to Sub-Divisional Engineers in the respective sub-divisions.
- To designate one Executive Engineer from each Circle to be the EE (Maintenance) for that whole Circle. He would be responsible for all routine maintenance contracts in that Circle, totalling, on average around 1200 km. His previous other responsibilities would be shared by the EE's in the other Divisions of that Circle.

15.2. Periodic Maintenance

It is vital that sufficient resources are devoted to periodic maintenance on an annual basis. The actual needs will de determined by HDM each year, but the average expected needs are set out in Table 15-2. The HDM Circle will need to fully sustained over the masterplan period.

Table 15-2 : Periodic Maintenance Costs

Road	Annual Requirement (Crore Taka)		Requirement over 20-year plan period
	Rising from	To	
National Highways	250	850	11,421
Regional Highways	150	250	4,050
Zila Roads	125	560	7,620
Total	**500**	**1,760**	**23,091**

16. BRIDGE MAINTENANCE INTERVENTIONS

16.1. Introduction

Failure to maintain bridges will lead to rapid deterioration which in turn will lead to increases in road user cost and accidents and the need for expensive re-construction work. Well-maintained bridges make a valuable contribution towards the country's economy.

Lack of regular bridge maintenance has led to deterioration of some bridges rather early in their life, and quite a few bridges have had to be replaced much earlier than their designed life. Incidences of structural deterioration and collapse of bridges have been growing recently. Maintenance of bridges generally gets neglected in this country because of a prevailing misconception that bridges once constructed do not need any substantial maintenance, particularly in first couple of years after construction.

Large numbers of bridges have been constructed on various roads throughout the country and the pace of activity have been particularly intensive in the last two to three decades. Attention in the next few decades thus needs to be focused on the preservation and rational management of the large stock of bridges built in the recent past and to rehabilitate and strengthen the older bridges which have deteriorated due to inadequate maintenance.

16.2. Maintenance Goal

RHD is committed to raising the standard of maintenance of bridges. As such the maintenance goal shall be

> *To maintain the Road and Bridge Network of the RHD to an optimum level in order to maximise the potential economic returns to the Country whilst providing the travelling public with a safe, cost effective highway network.*

16.3. The Benefits of Maintenance

Of all the possible types of spending on road network, Preventive Maintenance is the most beneficial. This is because a small amount of money on timely maintenance can preserve the massive initial expenditure which was made at the time of construction. The benefits of maintenance are;

- Saving cost of the Road Agency
- Saving cost to the Road Users
- Improved Road User Safety and Road User Satisfaction

16.3.1. Maintenance Activities

The basic objective of regular maintenance of the main bridge elements is to keep the bridge in sound structural condition and extending the life of structures. RHD have a very large number of bridges to maintain and hence they require attention to ensure that minor faults do not lead to further major problems and failures.

Routine Maintenance should include:

- Simple cleaning by hand or scraper of the carriage way, Footpath and Median verge to remove debris, soil and foreign material such as trash etc
- Removal of parasitic vegetation and similar operations
- Cleaning of drains, gulleys and storm water pipes etc
- Small restorations, repointing of masonry and brickwork
- Localised repairs to pavement, pothole filling etc
- Cleaning vent holes of superstructure
- Localised painting operation to protect against corrosion

- Rectification to safety barriers
- Rectification to sign boards
- Removal of clogging in channel bed

Periodic Maintenance should include:

- Restoration of brick or masonry structure.
- Restoration of concrete structural parts with different techniques.
- Injection of cement grout or thermosetting resin into cracks.
- Maintenance of bolts, welding, cleaning greasing of metallic structure.
- Repair or reconstruction of expansion joints.
- Repair or reconstruction of pavement or waterproofing of deck.
- Maintenance of Bearings and setting of same.

Emergency maintenance is defined as;

- Works to respond to natural calamities such as Flood, Cyclone, Earth slide and Earthquakes

There are a total of 14,712 structures on different roads of RHD Network. The maintenance of bridges should be the responsibility of RHD, with maintenance devolved to Zones and Divisions who manage the implementation of works in accordance with the Annual Bridge Maintenance Plan.

Table 16-1 : List of Category 'A' and 'B' Bridges (by Structure Type)

Sl no	Structure type	Category A	Category B	No. of Structures
1	Box Culvert	5,671	917	6,588
2	Slab culvert	1,843	444	2,287
3	Arch Masonry	131	57	188
4	RCC Bridge	94	28	122
5	RCC Girder Bridge	639	418	1,057
6	PC Girder Bridge	242	54	296
7	Steel Beam& RCC Slab	61	30	91
8	Truss with Steel Deck	141	13	154
9	Truss with RCC Slab	16	4	20
10	Bailey with Steel Deck	428	124	552
11	Bailey with Timber Deck	9	2	11
12	Truss with Timber Deck	3	0	3
13	PC Box	1	0	1
	Grand total:	**9,279**	**2,091**	**11,370**

16.4. Supervision and Execution plan

Bridge Maintenance Work Supervision

- Routine Maintenance : Departmentally by Sub-Divisional Engineer
- Periodic Maintenance : By Divisional Engineer or Experts in Bridges

Bridge Maintenance Work Execution

- Routine Maintenance : By direct labour or small contractor hiring departmental equipment
- Periodic Maintenance : By Contracts only.

  Small Scale Works --- By approved General Contractor
  Large Scale Works ---By prequalified, National Contractors in General Class

Other activities that will be outsourced include surveys, specialist inspections and investigations, detailed designs, studies associated with the design of improvement and rehabilitation works. Such work will should be executed by contractors working under consultant supervision.

16.5. Monitoring and Evaluation

Routine Maintenance reports will indicate the physical and financial percentage completion of works under each sub division.

Periodic Maintenance will be reported using the standardized format of ADP projects with details of all major items of work, their quality and individual costs. The Physical and financial compliance will then be reported.

Annual data collection provides information on the state of the bridges throughout the country. Hence it is possible to asses the performance of each operational group whether RHD as a whole or an individual Sub-division. This makes evaluation of the impact of work programme available to the managers in the department and will be available to the Government.

16.6. Bridge Maintenance Cost Rates

Unit prices

The unit price (cost /m.) and estimated cost for Routine and Periodic Maintenance of bridge vary depending on the type, length, and width of structure. RHD's Schedule of Standard Rates covers unit rates for different items of bridge works. The RHD Zones prepare estimates using these unit rates.

Estimated costs

- Unit cost for maintenance of bridges is calculated from estimated cost of maintenance activities required., with unit cost calculated in CIDC3, indexed by 80% for inflation)
- Average unit price for routine maintenance is = **Taka 500 / m** length of structure / year.
- Average unit price for periodic maintenance is = **Taka 10000 / m** length of structure / 5 years.

16.7. Cost Estimates for the Road Masterplan

The costs of maintaining RHD's bridges will alter over the Masterplan period. Routine and Periodic maintenance programmes should be brought in immediately for all Category A and B Bridges. When bridges are repaired or reconstructed in line with the proposals in Chapter 12 then they should also be brought under routine and periodic maintenance regimes.

Table 16-2 : Bridge Maintenance Requirements of the Road Masterplan (Crore taka)

Year Starting July	Routine	Periodic
2007	6.6	20.4
2008	6.6	20.4
2009	6.6	20.4
2010	6.7	20.4
2011	6.8	20.4
2012	6.9	26.3
2013	7.0	26.3
2014	7.1	26.5
2015	7.2	26.9
2016	7.3	27.2
2017	7.4	27.7
2018	7.6	28.0
2019	7.8	28.3
2020	7.9	28.9
2021	8.0	29.5
2022	8.2	29.8
2023	8.2	30.6
2024	8.2	31.3
2025	8.2	31.8
2026	8.2	32.2
Total	**148.3**	**533.6**

16.8. Economic Appraisal

16.8.1. Age and Condition Analysis

All the bridges, classified by age and condition categories A-D, are presented in Table 12-16. The mean (weighted average) age in each category was set out in Table 12-17. The conclusions that emerge from the age and condition analysis are as follows:

- The design life of a bridge, with proper maintenance, is assumed to be 50 years. However, the bridges in need of replacement (D class) have an average age of 30 years. Thus, the lack of maintenance causes the life of a bridge to reduce to 60 percent of its original life.

- The 5-year lag between the average ages in each category implies that a bridge slides down the condition scale (from A to B to C to D) every 5 years, also due to inadequate maintenance.

16.8.2. Deterioration and Remaining Life of A & B Class Bridges

The analysis for D class bridges was used to validate the assumptions regarding deterioration rates and replacement years for A and B class bridges. Thus, it is presumed that their remaining life, in the absence of a rigorous maintenance programme, would also be reduced to 60 percent of the original life. Table 16-3 gives the remaining life for bridges in different age groups for “with” and “without” maintenance scenarios. The remaining life indicates, at least theoretically, the year when the bridge needs to be replaced.

Table 16-3 : Remaining Life for A & B Bridges “With” and “Without” Maintenance (Yrs)

Age Group (yrs)	0-10	11-20	21-30	31-40	> 41
Average age	5	15	25	35	45
Remaining Life “with” maintenance	45	35	25	15	5
Remaining Life “without” maintenance	27	21	15	9	3

The total number of bridges in A & B categories is 11,375, comprising 9280 in Class A and 2095 in Class B. The present analysis excludes all narrow bridges, as they are likely to be taken up by RHD under a separate scheme. A narrow bridge is defined as one with carriageway width "less than" or "equal to" 3.7 metres. Table 16-4 presents the number of bridges in A and B categories, classified by age, after excluding narrow bridges.

Table 16-4 : A & B Class Bridges after excluding Narrow Bridges

Condition Category	Number of Bridges by Age Group (years)					
	0-10	11-20	21-30	31-40	> 41	All
A	2,296	3,174	986	197	179	6,832
B	257	677	459	130	111	1,634
Total	**2,553**	**3,851**	**1,445**	**327**	**290**	**8,466**

16.8.3. Cost of the Maintenance Programme

The maintenance programme for A and B class bridges would comprise the following.

- Minor repairs to B class bridges to take care of the years of neglect in maintaining them and to bring them up to a minimum acceptable standard. This would involve a one-time investment at the beginning of the analysis period.
- Periodic maintenance, once every 5 years, and.
- Annual routine maintenance.

The unit costs estimated for the different components, and their years of application, are given below:

Minor repairs to B class bridges (once)	Tk 16,500 per m
Periodic maintenance (5 yearly)	Tk 10,000 per m
Routine maintenance (annual)	Tk 500 per m

The weighted average length of the A and B class bridges selected for analysis (after excluding narrow bridges) was found to be 10.56 m. Based on the total number of bridges, average length of a bridge and the unit rates, the cost streams of the maintenance programme were calculated. The financial costs were converted into economic costs by applying a Standard Conversion Factor (SCF) of 0.8.

16.8.4. Benefits

The benefits of maintaining bridges are mainly the savings in the cost of replacement. The unit cost of replacement of a structure is estimated as Taka 600,000 per metre.

Based on the unit cost, average length, and the number of bridges in different age groups, the replacement costs were calculated as shown in Table 16-5

Table 16-5 : Bridge Replacement Costs without Maintenance

	Age Group (yrs)					
	0-10	11-20	21-30	31-40	> 41	All
Number of bridges (A&B)	2,553	3,851	1,445	327	290	8,466
Replacement Cost –Financial (Tk million)	16,179	24,405	9,157	2,072	1,838	
Replacement Cost –Economic (Tk million)	12,943	19,524	7,326	1,658	1,470	

Considering the very large number of bridges involved, this cost had to be phased out. As the number of bridges in the 41+ age group, and needing replacement within the next 3 years, is small (290), it was thought practical to club them with the 31-40 age group and replace all 617 bridges over a period of 5 years beginning Year 9. All other bridge categories (very large number) would take 10 years to replace. The start years of replacement assumed are shown in Table 16-6.

Table 16-6 : Replacement Needs for Bridges by Age (without maintenance)

Age Group (Years)	0-10	11-20	21-30	31-40	> 41
Start Year of Replacement	27	21	15	9	9

16.8.5. Cost-Benefit Analysis

Based on the above, an economic appraisal of the Maintenance Programme for A & B class bridges, having carriageway widths greater than 3.7 metres, was carried out. The economic cost and benefit streams were prepared for an analysis period of 30 years, and economic internal rate of return (EIRR) calculated using discounted cash flow method.

Table 16-7 presents the results of the economic analysis.

The EIRR of the project is 22.18%, which indicates that the benefits of maintenance or the savings in replacement cost far outweigh the costs of maintenance and, therefore, it is economically feasible to undertake the Maintenance Programme for A and B class bridges.

16.9. Conclusions and Recommendation

- A comprehensive bridge survey and analysis is recommended to be carried out by experts in bridges before updating the BCS data base. Annually up-dated BCS data should form the basis for preparation of budgets.
- Identification of bridge structures by LRP as per BCS Manual shall be adopted for all references and all other identifications being presently used to be replaced immediately**.**
- The maintenance manual for different types of bridge structure to be prepared for proper execution of bridge maintenance.
- Bridge maintenance requires team work involving various level of responsibilities and skills. Training programme to be organized to develop expertise and team work. Training facility shall be set up at central level.
- There is considerable gap between present bridge maintenance practices and desired maintenance practices. All aspects of bridge maintenance must be gained and disseminated.
- Presently no priority is given for bridge maintenance and also very less fund provision is made in the budget for bridge maintenance. It is recommended to give High Priority to bridge maintenance, and a separate provision of cost of bridge maintenance of bridge shall be made through the annual budget.

Table 16-7 : Economic Evaluation of Maintenance Programme for A and B Class Bridges with CW width > 3.7 m

Year	Economic Costs				Economic Benefits – Savings in Replacement Cost						
	Minor Repairs to B	Routine Maint.	Periodic Maint.	Total Costs	5 yr old	15 yr old	25 yr old	35 yr old	45 yr old	Total Benefits	Net Benefits
2007	267.67			267.67						0.00	-267.67
2008		35.77		35.77						0.00	-35.77
2009		35.77		35.77						0.00	-35.77
2010		35.77		35.77						0.00	-35.77
2011		35.77		35.77						0.00	-35.77
2012		35.77	715.34	751.11						0.00	-751.11
2013		35.77		35.77						0.00	-35.77
2014		35.77		35.77						0.00	-35.77
2015		35.77		35.77				331.56	294.05	625.61	589.84
2016		35.77		35.77				331.56	294.05	625.61	589.84
2017		35.77	715.34	751.11				331.56	294.05	625.61	-125.50
2018		35.77		35.77				331.56	294.05	625.61	589.84
2019		35.77		35.77				331.56	294.05	625.61	589.84
2020		35.77		35.77						0.00	-35.77
2021		35.77		35.77			732.58			732.58	696.81
2022		35.77	715.34	751.11			732.58			732.58	-18.53
2023		35.77		35.77			732.58			732.58	696.81
2024		35.77		35.77			732.58			732.58	696.81
2025		35.77		35.77			732.58			732.58	696.81
2026		35.77		35.77			732.58			732.58	696.81
2027		35.77	715.34	751.11		1,952.36	732.58			2,684.94	1,933.83
2028		35.77		35.77		1,952.36	732.58			2,684.94	2,649.17
2029		35.77		35.77		1,952.36	732.58			2,684.94	2,649.17
2030		35.77		35.77		1,952.36	732.58			2,684.94	2,649.17
2031		35.77		35.77		1,952.36				1,952.36	1,916.60
2032		35.77	715.34	751.11		1,952.36				1,952.36	1,201.25
2033		35.77		35.77	1,294.31	1,952.36				3,246.67	3,210.90
2034		35.77		35.77	1,294.31	1,952.36				3,246.67	3,210.90
2035		35.77		35.77	1,294.31	1,952.36				3,246.67	3,210.90
2036		35.77		35.77	1,294.31	1,952.36				3,246.67	3,210.90

EIRR = 22.18%

17. PROGRAMME COSTS

17.1. Programme Component Costs

The cost components and references are listed in Table 17-1. The total cost including Padma Bridge is US $ 11.5 Billion[44]

Table 17-1 : Road Masterplan Programmes and Costs

Programme	Cost (Crore Taka)	Paragraph Reference
Commitments	2,921	5.2.4
National And Regional Repair and Rehabilitation	5,407	8.10
Axle Load Control	320	9.90
Major National Highway Bypasses	291	10.3
Traffic Management (Urgent)	235	10.3
Traffic Management (Provisional)	704	10.4
Zila Road Recovery	3,188	11.5
New Zila Roads	371	11.6.2
Paving Zila Roads	5,781	11.7
Bridge Reconstruction	1,053	12.6
Bridge Repair and Maintenance	682	12.6
Narrow Bridge Replacement	444	12.7
PSB Replacement	755	12.8
Upgrade Condition B bridges to A	49	12.9
Ferry Replacement	830	12.10
Condition Survey	5	12.11.2
Road Safety	1,075	13.3
Level Crossings	150	13.5.4
N1 Chakaria-Chittagong	1,060	14.11
Dhaka Eastern Bypass	500	14.11
N102 Mynamati-Brahmanbaria	421	14.11
N8 Jessore-Benapole	330	14.11
Chittagong Bypass	210	14.11
N3 Tongi-Mymensingh	800	14.11
N1 2nd Meghna-Gumpti Bridge	650	14.11
N6 Baneshar - Belepur	400	14.11
N1 Deepsea Port-Sonadia	400	14.11
N1 2nd Meghna/Daudkandi Bridge	750	14.11
N1 Hatazari Link	200	14.11
N2 Bhairab-Habiganj	1,200	14.11
N2 Dhaka – Bhairab	700	14.11
N2 Habiganj - Sylhet	960	14.11
Dhaka Western Bypass	360	14.11
Dhaka Outer Orbital	1,500	14.11
R280 Sylhet-Sunamganj	212	14.11
N8 Dhaka-Mawa	600	14.11
N1 Dhaka-Chittagong	1,867	14.11
N4 Dhaka-Tangail	690	14.11
R750-Z7503 Jessor-Lohagari	600	14.11
N5 Dhaka-Baniajuri	780	14.11
Landport Connections	383	14.13
Asian Highway	536	14.14
Road Routine Maintenance	1,392	15.1.1
Road Periodic Maintenance	23,091	15.2
Paving National and Regional Highways	1,918	14.16
Total	66,768	
Padma Bridge	10,080	14.11
Total	**76,848**	

[44] US$ = Taka 70

17.2. Overall Programme

The overall cost of investment required for the (RHD) road sector over the 20 years is Tk 68,768 Crore, or around US$ 10 Billion. This represents an annual average requirement of Tk 3,430 Crore per year. Table 17-2 lists the recurrent expenditure total component of the Road Masterplan.

Table 17-2 : Recurrent Expenditure Programmes and Projects of the Road Masterplan, 2008/09 to 2027/28

Programme	Cost (Crore Taka)	Type of Expenditure
Recurrent Traffic Management	939	Recurrent
Road Routine Maintenance	1,392	Recurrent
Periodic Maintenance National Roads	11,421	Recurrent
Periodic Maintenance Regional Highways	4,050	Recurrent
Periodic Maintenance Zila Roads	7,620	Recurrent
Bridge Repair and Maintenance	735	Recurrent
Road Safety Measures	1,075	Recurrent
Total	**27,232**	

Table 17-3 lists the capital programmes and projects of the Road Masterplan.

17.3. Prioritisation of the Masterplan

The following principles have been used to phase the required expenditure over the plan period, and to prioritise programmes and projects.

- Recurrent (maintenance) expenditure should have the first priority, and full needs should be planned for on an annual basis
- The rehabilitation of National Highways, Regional Highways and Zila Roads must be considered a priority, as delay will increase the costs of recovery
- Road and bridge projects that are related to traffic growth should be programmed according to dates that they are needed
- Bridge replacement and repair programmes are a priority, but have to be phased in order to respect human capacity constraints in RHD
- Axle load control is of the utmost priority, and

Padma Bridge is a priority of the Government, but should not be included in the RHD programme

The Road Masterplan is shown in Table 17.7

17.4. Funding

17.4.1. Road Fund

Funding for road and bridge maintenance should come from the Road Fund. Draft legislation for the Road Fund also provides for powers for the fund to pay for road safety measures. Full funding for road and bridge maintenance should be provided by the Government of Bangladesh until the matter of the Road fund establishment is finalised.

17.4.2. Annual Development Programme

Other recurrent expenditure on traffic management measures should be prepared as projects on a 3-year rolling basis, funded by the Annual Development Programme (ADP). Capital projects should be funded through the ADP.

Table 17-3 : Capital Programmes and Projects of the RHD Road Masterplan, 2007/08 to 2026/27

Programme	Cost (Crore Taka)	Type of Expenditure
National Highway and Regional Highway Rehabilitation	5,407	Capital
Axle Load Control	320	Capital
Major National Highway By-passes	291	Capital
Zila Road Recovery Programme	3,188	Capital
Bridge Reconstruction Programme	1056	Capital
Narrow Bridge Replacement Programme	444	Capital
PSB Replacement Programme	755	Capital
Ferry Replacement Programme	830	Capital
N1 Dhaka-Chittagong 4-Lane	1867	Capital
N3 Tongi-Mymensingh	800	Capital
N102 Mynamati-Brahmanbaria	421	Capital
R260 Sylhet-Sunamganj	212	Capital
Dhaka Eastern By-Pass	500	Capital
Dhaka Western By-Pass	360	Capital
Dhaka Outer Orbital Route	1,500	Capital
R750/Z7503 Jessore to Lohagari	600	Capital
Deep Sea Port Sonadia - N1 link	400	Capital
N1 4 lane Chakaria to Chittagong 106 km	1,060	Capital
N8 Dhaka-Mawa 4 Lane 60km	600	Capital
N4 Dhaka-Tangail 4 Lane 69 km	690	Capital
N6 Beneshwar-Belpuhur 16km	400	Capital
N5 Dhaka Baniajuri 78 km	780	Capital
N2 Bhairab-Mouvlibazar 120 km	1,200	Capital
N2 Dhaka - Bhairab 70 km	700	Capital
N2 Habiganj - Sylhet 96 km	960	Capital
N8 Jessore Benapole 4 Lane	330	Capital
Chittagong By-pass	210	Capital
N1-Hatazari Link Road	200	Capital
N1 2nd Meghna Bridge	750	Capital
N1 2nd Meghna Gumpti Bridge	650	Capital
New Zila Roads	371	Capital
Paving Zila Roads	5,781	Capital
Commitments	2,921	Capital
Level Crossing Replacement	150	Capital
Landport Connections	383	Capital
Asian Highway	536	Capital
Paving National and Regional Highways	1,918	Capital
Total	**39,536**	

17.4.3. Private Sector

Table 17-4 lists the projects which are suitable candidates for private sector participation in funding. In addition to this list, the private sector could be encouraged to invest in improved landport connections.

Table 17-4 : Potential Private Sector Participation Projects

Project	Total Project Cost (Crore Taka)
N1 Dhaka – Chittagong Highway	1,867
Dhaka Eastern By-pass	500
2nd Meghna Gumati Bridge	650
2nd Meghna Daudkandi Bridge	750
Dhaka Western By-pass	360
Deep Sea Port Sonadia - N1 link	400
Ferry Replacement Propramme	830
N4 Dhaka-Tangail 4 Lane 69 km	690
N2 Bhairab-Habiganj 120 km	1,200
N2 Dhaka - Bhairab 70 km	700
N2 Habiganj - Sylhet 96 km	960
N1-Hatazari Link Road	200
Total	**9,107**

The Government of Bangladesh has adopted a policy to facilitate private investment in infrastructure and approved the Bangladesh Private Sector Infrastructure Guidelines (PSIG) on 2 October 2004 by a notification of the Cabinet Division. The Private Sector Infrastructure Guidelines establishes procedures to identify, procure and implement Private Infrastructure Projects and establishes institutional arrangements to monitor and expedite implementation of these projects at national level.

For promotion and efficient processing of Private Infrastructure Projects in Bangladesh, a national Private Infrastructure Committee (PICOM) has been set up under the Prime Minister's Office on 5 October 2005 by another notification of the Cabinet Division, for implementing the Guidelines. The Committee is headed by the Principal Secretary of the Government. Since the adoption of PSIG, increased interest of the private sector has been observed in infrastructure development in Bangladesh, but surprisingly, the private sector involvement in transport infrastructure has been very limited so far.

On those roads where traffic and potential toll income are high, the private sector could be invited to invest on Build –Operate- Transfer (BOT) basis. In such cases, Government may have to assume the role of acquiring land, and possibly fund part of the equity. In these cases, concession periods could be of the order of 25 to 30 years, with provision for three yearly tariff reviews. However, where traffic levels do not warrant BOT involvement, the Government could consider the annuity concept where the private sector would invest in improving a road on an existing right of way (ROW), and recoup its investment from annual Government contributions.

In order to facilitate greater involvement of the private sector in infrastructure development, a new relationship needs to emerge between the Government and agencies responsible for development and management of government's road assets. (Section 19.2).

It is recommded that the Minstry of Communications take immediate steps to investigate options for modalities of greater private sector participation in project funding. A high-powered committee may be established comprising officials of the Ministry, RHD and the Planning Commission to do this. The experience of the Masterplan consultants may be used to assist this committee.

17.4.4. Development Partners

It is recommended that Development Partner assistance be sought for major development (not rehabilitation, recovery or repair projects and programmes)., as well as axle load control. Development partners' assistance at the rate of 62% of project cost is assumed, with projects shown in Table 17-5.

Table 17-5 : Potential Projects for Development Partner Support

Programme	Project Cost (Crore Taka)	Comment
National and Regional Highway Rehabilitation	5,407	
Paving National and Regional Highways	1,918	
Axle Load Control	320	
N3 Tongi-Mymensingh	800	World Bank Proposed
N102 Mynamati-Brahmanbaria	421	World Bank Proposed
R260 Sylhet-Sunamganj	212	World Bank Proposed
Dhaka Outer Orbital Route	1,500	
R750/Z7503 Jessore to Narail Batiapara	600	
N1 4 lane Chakaria to Chittagong 106 km	1,060	
N8 Dhaka-Mawa 4 Lane 60km	600	
N6 Beneshwar-Belpuhur 16km	400	
N5 Dhaka Baniajuri 78 km	780	
N8 Jessore Benapole 4 Lane	330	
Chittagong By-pass	210	
Commitments, Foreign Aided Projects	1,831	Committed
Level Crossing Replacement	150	
Landport Connections	383	
Asian Highway	536	
Total	**17,456**	

17.4.5. Summary of Funding

Table 17-6 lists the funding summary.

Table 17-6 : Summary of Funding Sources for RHD Road Masterplan

Funding Source	Crore Taka
Road Fund	27,233
Private Sector	9,107
Development Partners	10,823
Government of Bangladesh co-funding	6,633
Government of Bangladesh own projects	12,972
Total	**66,768**

17.5. Private Sector Involvement

17.5.1. Adminstrative Arrangements

Administration and management of Public-Private Partnerships (PPP) Programme in Bangladesh are carried out through the Bangladesh Private Sector Infrastructure Guidelines (PSIG). The PSIG is the first official policy document adopted by GOB providing a framework for private sector investments in infrastructure. Appreciating the need for infrastructure, GOB has undertaken necessary steps for opening the infrastructure development to the private sector – both local and foreign.

The key institutional framework for private infrastructure projects is centered on the "Private Infrastructure Committee" known as PICOM. This has been formed under the Prime Minister's office, with the Principal Secretary as the Chairman, and the Board of Investment as its Secretariat.

The objective of PICOM is to co-ordinate, monitor and expedite the resources, strengths and capabilities of both the private and public sectors through the implementation of private iInfrastructure projects. PICOM is the focal point for promoting and progressing private infrastructure projects across all infrastructure sectors in the country.

17.5.2. Benefits

The involvement of the private sector in the new road projects brings investment potential, and can also contribute to greater efficiency and innovation. The general principle is that roads will be tolled in order to provide an income stream. However, private participation itself will not ensure economic efficiency. The problem is that toll roads are types of infrastructure that result in monopolies. Because of their large fixed costs and economies of scale, direct competition in the market is not feasible in the provision of the infrastructure itself. Even so, under certain conditions, competition can be created for the market (through concessions) where companies bid for the right to provide a service that will have no competition in the market. In such a case, due to the lack of direct competitive pressures on the firm to ensure efficiency, the concession bidding stage is a critical moment in the whole life-cycle of the project when the economic and financial conditions of the contract can be optimised from the Government's as well as from the users' and tax-payers' point of view.

Once set, these conditions will be binding for both parties until the end of the contract period. Therefore, it is essential to create the best conditions for: strong competition in the bidding stage; and appropriate monitoring and enforcing of the terms of the concession contract.

17.5.3. Direct Competition in Bidding

Having taken into consideration the need for sufficient competition in a Private Public Partnership (PPP) or Concession bidding process as well as the Bangladeshi experience in tendering, a direct competition system is recommended, in which:

- Open tendering procedure is used.
- The PPP/Concession model is precisely defined by the Government in advance.
- A larger number of bidders compete against each other.
- Economic and financial quantifiable and clear-cut parameters of the PPP/Concession agreement are used as evaluation criteria of the proposals. Excessive complexity of the evaluation system for proposals should be avoided.
- Evaluation criteria are established and disclosed in advance by the awarding authority.
- The Concession/PPP contract is awarded directly to the company whose offer has been evaluated as the best one based on evaluation criteria.
- The proposals of the bidders are binding for them and cannot be changed or negotiated after the best offer is chosen.
- Financial close is normally not required before the Concession / PPP contract award.

Such a model has a series of advantages:

- It ensures more competition, which in turn results in better conditions for the awarding authority, the users and the taxpayers.
- It provides for comparability of submitted proposals.
- It provides for more objective bid evaluation and more certainty as far as the selection of the best offer is concerned.

- It requires less time for the selection of the private partner than the negotiated procedure.
- It is also cheaper for the bidders as well as for the Government.

The public interest in the PPPs is fundamentally concerned with getting the best value for money. The bidding procedure must be designed first and foremost for this purpose. It is clear that the natural interest of the private partner is to maximize profits. Restriction of the competition allows to the bidder to impose terms as favourable as possible for him. Negotiations limited to one preferred bidder create therefore perfect conditions to reach an agreement in which the economic and financial conditions are skewed to the interests of the private partner. This could be the case in Bangladesh where the awarding authorities are less experienced than their counterparts in other countries with longer PPP experience records.

In spite of that, they will have to face the negotiations with private companies that have greater knowledge and technical, legal and financial expertise and better access to specialized assistance. It may be naive to think that such negotiations will be used by the bidder to develop innovative solutions adjusted to the needs of the contracting body. In such case, the main objective of the bidder will be to improve the contract conditions for him and therefore it is the contracting body who will have to take care of its own needs and to provide a framework that allows covering them at the least possible cost.

Conversely, in the model that is based more on broad competition, the whole effort of bidders is directed to propose better conditions than the opponents will do within the framework established by the Government. Unlike in the negotiated procedure with limited competition, in the direct competition model bidders have no possibility to put all effort to improve their position, and exploit the information asymmetry or possible omissions or failures by public authority.

The advantage of stronger competitive tension does not only refer to competition between bidders. Thus, if financial close is not required from bidders before submission of their proposals, the use of advantages of a competitive market can be made also in the case of project's financing. After the concession/PPP contract is awarded, the winning consortium can negotiate the financing package with all possibly interested financial institutions. The financial close has to be reached within a period specified in the bidding documentation (e.g. 6 months). If the financing closure were required before the submission of proposals, financial institutions would be not likely to offer their best conditions due to a high number of bidders competing for financing.

Bidders will collaborate with financing institutions in the process of preparation of proposals in order to assure a realistic financing structure. All bidders should justify and provide in their proposals guarantees (in form of indicative letters of support from financial institutions) that sufficient financing for the project is assured. Such guarantees should cover the whole period starting from the signature of the Concession Agreement till completion of all investments and financing according to the proposal. Nevertheless, the requirement of such guarantees does not mean complete arrangement of the financing package before submission of bids. Financing conditions could be improved by the winning consortium or even arranged with other financial entities within the period between contract award and the deadline specified in the bidding documentation.

17.5.4. Project Definition

In order to ensure comparability of proposals, the Government should define the project's specifications in sufficient detail, including :

- The scope of works to be carried out and a specification of outputs to be provided by private partners;
- The technical and financial feasibility as well as a social benefit.
- The Concession Agreement conditions that are not to be negotiated and those subject to be proposed by bidders must be clearly defined.

- Bidding documentation including fixed Concession Agreement clauses and those to be proposed by the bidders should be prepared.

The Concession Agreement stipulated in the bidding documentation will have to be accepted by the bidder and only a small margin of arrangements will be left to be proposed by bidders. However, this margin must be wide enough to detect significant differences between offers and to allow important improvements of the project by bidders, if there is a possibility that they can add sufficient value for the Government and users. On the other hand, this margin must be narrow enough so that the comparability of proposals does not get lost.

17.5.5. Transparency in Bidding

Bids evaluation must be based on clear-cut quantifiable variables so that there is no margin left for discretion in the process. In this way a complete and undisputable comparability of proposals and at the same time more transparency of the bidding process is achieved.

The selection of evaluation variables depends on the infrastructure policy of the government, characteristics of a project, the needs it has to satisfy, and its financing possibilities.

The variables may include:

- toll structure and rates;
- concession period;
- public financial support for the concessionaire (which could be co-funded by the ADB);
- payment offered by the concessionaire for transfer of assets or rights to be used for the provision of services that are subject of concession;
- present value of revenues;
- assets reversion price (especially in the case of short term PPP/concession contracts);
- minimum traffic, income, return or any other Government guarantee;
- capitalization ratio, solvency ratio, disbursed capital;
- project financing guarantees (from financing institutions),

The choice of evaluation variables should also comply with transport objectives of the Government. If the Government's priority is to have low tolls, in order to optimize usage and economic benefits, then variables related to tolls shall be fixed in advance. If the Government wants to limit its contingent liabilities, Sovereign Guarantees for credits should be excluded from the bidding documentation and the bidding criteria.

When deciding which criteria to choose to evaluate proposals, it is convenient not to opt for variables that are interdependent. For instance, evaluating bids on the basis of proposed concession period, tolls and public support creates a problem of lack of comparability of bids as all these variables are interrelated and the trade-offs between them may be difficult to evaluate. It can allow gathering by the bidders points that do not reflect real advantages of their proposals. In such cases, it's advisable to reduce the number of variables and to fix those that are related to the Government's clear objectives and priorities and allow the bidders to adjust other variables in their proposals.

On the other hand, the reduction of the number of bidding variables must not be excessive. It could create a danger of insufficient consideration of financial credibility, technical preparation and experience of bidders, which is also very important for the success of a project. Indeed, it is useless to award a contract to a company that proposes the best technical and financial conditions, being incapable of keeping them. Therefore, the pre-qualification stage should be used to ensure the credibility of the bidders, including technical quality as well as technical and financial solvency. This allows for a limited number of evaluation criteria to be selected.

17.5.6. Time and Transaction Costs

The direct competition model requires less time than the alternative procurement in which the whole contractual framework may be negotiated. In the procurement model based on competitive negotiations the whole process lasts between 2 and 4 years on average and the proposed model should not require more than 6-8 months.

Experience shows that negotiating PPP deals involves high transaction costs that finally at least partially offset the PPP benefits at micro-level and significantly reduce the attractiveness of this way of procurement.

The costs incurred in the preparation of bids and negotiation with the Government finally become sunk costs for the bidders that fail to win. Thus, it must be stressed that specialized legal, technical and financial support required during such negotiations by the Government as well as by bidders, is extremely high and normally reaches sums in the order of USD 4 to 16 millions. In addition, the total cost of employing advisers to negotiate terms of a complicated contract is so high that it can impede effective competition as only a small number of competitors can afford them.

The direct competition model means lower costs for the Government thanks to shortening of the procedure, lack of necessity of exhaustive negotiations of the Concession Agreement and increased comparability of proposals. The estimated costs of such procedure should not exceed USD 1.5 million. Preparation of the project before starting the bidding procedure may require advisory and consultant services whose overall cost could reach around 3% of the total project construction cost.

17.5.7. Staged Implementation of a PPP Bidding Process

1.Project preparation. - the project should be thoroughly prepared by the Government in order to:

- provide the awarding authority with sufficient information on conditions that they may expect from the market;
- reduce unnecessary risk; and
- build a solid base for the selection of the private partner.

Complete information on the project characteristics and minimized legal, administrative and environmental uncertainties regarding the project should reduce the necessity of post-bid negotiations.

2.Dissemination of information on the envisaged project, including its technical parameters, envisaged funding model (real tolls [including their structure and maximum levels], shadow tolls, level of public aid (that might be subsequently co-funded with ADB Funds) in the construction period, etc.) to potentially interested bidders.

3.Receiving feedback on the project from potential bidders and its possible modification focused on improvement of its functionality, costs and attractiveness for the private participation, but still safeguarding the public interest. - This can be done during a "road show"[45] which serves for presentation of the project to potential bidders and direct discussion of its details. The objective of this activity is to ensure that the technical specifications and service requirements are viable, to detect which parts of the project require improvements and take into account the expectations of private investors. Such adaptation may be necessary in order to attract to the bidding process as many participants as possible to make the competition for the project is more intensive. Additionally, the probability that any problems may appear in the concession award stage is significantly reduced. Finally, if all contentious or omitted issues are detected in this stage and incorporated into the bidding documentation and Concession Agreement, the necessity of post-bid negotiations can be practically eliminated.

[45] This method was used successfully in the privatization process of Rupali Bank

4.Public, formal notification of the intent to procure a PPP project including a request for proposals.

5.Distribution complete information on the project, including bidding documentation, draft Concession Agreement (both updated after receiving potential bidder's comments in the activity No 3), preliminary studies results (demand projections etc.), environmental impact studies. In the bidding process a two-phase procedure that involves a sequential evaluation of the technical (7) and financial proposals (8), preceded by qualification of bidders, is recommended.

6.Qualification phase. The objective of this phase is to ensure that the winning consortium has the technical and financial capacity to operate the concession successfully. Consortia whose reputation, experience or financial standing is deemed not sufficient to guarantee the success of the project, are to be excluded from the procedure at this stage, but always in accordance with the criteria disclosed in advance in the bidding documentation. The qualification criteria can refer both to quantitative (e.g. minimum required equity of companies that form a consortium, similar operations in comparable markets, financial strength of consortium members, etc.) and qualitative aspects of the bidders (e.g. cost efficiency in other projects [both construction and operation]).

It is important that qualification is carried out at the bidding stage, as opposed to pre-qualification. In this way, bidders will have to prove that they meet established qualification criteria at the time of submission of proposals. Interested companies will have more time to form consortia, and by putting qualification and actual biding together, there will be an increase of competition in the process. This measure will avoid a situation where a very small number of companies pre-qualify, which can reduce competitive pressure.

7.Evaluation of technical proposals. As all participants bid on the basis of the same technical specifications prepared initially by the Government and then fine-tuned in discussions with potentially interested investors, the technical evaluation stage can be conducted on a simple pass/fail basis, i.e. the compliance or non-compliance of the proposals with the technical specifications should be evaluated. This way, only financial proposals of those bidders:

- whose technical offers comply with the technical specifications of the project; and
- who fulfill all requirements regarding financial and technical capacity (evaluated in the qualification phase)

are evaluated, and no marks or scores are carried over.

8.Evaluation of financial proposals. The concession is awarded to the bidder with the best financial proposal. This could be in the form of a positive contribution to Government, or a subsidy or annuity requirement. It is advisable to keep the system of the evaluation of proposals as simple as possible in order to ensure transparency, comparability of proposals and ease of award. The variables that are not predefined by the infrastructure policy and can represent a clear economic advantage of one offer over the rest should be the focus of the evaluation. In fact, it is best to select a single evaluation criterion. Given that it is expected the toll road project will require :

- public aid for investment,
- compensations for the use of toll roads by vehicles legally exempted from tolls,

then the best variables for evaluation are :

- the total amount of public support[46] (which could be co-funded from the ADB), and/or
- the concession period.

Adjusting the financial equilibrium of a PPP deal based on the amount of public aid is the best

[46] Or positive cash contribution

way to ensure that:

- the public support is used efficiently, i.e. only the amount required to ensure financial feasibility of the project is used;
- the return from the project for the private partner is reduced to the minimum (the most efficient proposal in terms of Value for Money is chosen);
- economic efficiency in terms of efficient investment and operation is promoted; and
- socially important variables such as tolls can be controlled by Government in line with policy, and inter-dependency of future projects.

Table 17-7 : Potential Timetable for Private Sector Road Project Preparation and Bidding

Phase	No.	Stage	Evaluation	Time Needed
Before Bidding	1	Project Preparation	N/a	12 months
	2	Information Dissemination	n/a	3 months
	3	Road Show	n/a	4 months
	4	Public Notification	n/a	1 month
	5	Distribution of Documentation	Na/	3 months
Bidding and Award	6	Qualification of Bidders	Technical Capacity Financial capacity	4 months
	7	Technical Evaluation	Compliance (Yes/no)	
	8	Financial Evaluation	Least public aid	
	9	Award		1 month
After Bidding	10	Financial Closure		Up to 6 months
Total				34 months

Table 17-8 : Road Masterplan

18. SOCIAL CONSEQUENCES OF THE ROAD MASTERPLAN

18.1. Resettlement and Land Acquisition

Resettlement and land acquisition issues are recognised by RHD as important and in 2003 it prepared 'Guidelines for Resettlement Management in Roads and Highways Projects' through an ADB funded Technical Assistance project (ADB TA 4006-BAN) as a preliminary step in preparing a Resettlement Policy for Bangladesh. In August 2005, RHD published the 'Draft Guidelines for Land Acquisition and Resettlement within RHD', with support from the DFID funded CIDC3 project.

These draft Guidelines include a simple Social Impact Assessment process, and are complemented by the by draft manual (discussion document) for 'Social Assessment in the Roads and Highways Department', both of which are designed to assist RHD in planning and implementing the 'softer' aspects of roads and highways projects. The draft land acquisition and resettlement guidelines includes recommendations of Implementation Procedures and Compensation Matrices that draw upon the principles of equity and best practice advocated in the National Strategy for Accelerated Poverty Reduction, whilst maintaining due attention to budgetary constraints. They also include Operational Procedures for Resettlement Management and Implementation by the RHD Social Circle.

However, these guidelines have not yet been approved or put into practice and so the problem continues. In order to deal with this issue effectively, the Government of Bangladesh must finalise and approve the guidelines so that RHD staff can implement them.

18.2. Traffic Management

Physical protection measures need to be provided around schools and markets on busy roads, in particular the national and regional highways. Roadside barriers have been used in some locations to prevent encroachment of roadside activities onto the main carriageway, and this should be encouraged in all locations. New markets and schools should include protective barriers as part of the design process.

Off-road parking areas should be provided. A thorough needs analysis of all road users should be made to ensure the location and access to these areas meets the needs of the users and measures put in place to ensure they are used. This may be supported by bans on on-street parking, with effective enforcement measures put in place. This could be managed by the Market Committees as part of the development and maintenance of the market place.

During the design phase, consideration also needs to be made for the provision of safe pedestrian crossing facilities and areas where it is safe to wait for public transport services. A range of design options are available depending on traffic volumes and market size, and should be included as part of the wider Road Safety Audit process.

A road safety awareness campaign is also needed to improve pedestrian and driver behaviour. Such a campaign could be included in the national curriculum under the 'life skills' umbrella. Awareness raising for adults could be done through the market committees. Road safety awareness of commercial vehicle drivers should be conducted through the major road transport associations and companies.

Many organisations have implemented various road safety programmes and conferences over the past few years, but these efforts are rarely coordinated or followed up in a systematic way that proves effective at the national level. Whilst RHD can take responsibility for putting in place certain physical protection measures as part of highway improvement measures at known safety black-spots, the national organisations responsible for road safety (National Road Safety Council, Road Safety Cell at BRTA, etc) must develop and implement a national strategy for addressing the major causes of Bangladesh's poor road safety record.

During the preparation of the Road Sector Master Plan, discussions on road safety led to the preparation of a concept note on a Road Safety Pilot, whereby a section or sections of road are improved to incorporate best practice in physical and non-physical road safety measures. The impacts of this model section of road could then be used to quantify costs and benefits to road users, roadside communities and the impact on economic growth and poverty reduction efforts.

The pilot could also be used to promote implementation of an effective national Road Safety Campaign, through the design and testing of road safety awareness materials and dissemination mechanisms.

18.3. Non-motorised vehicles

There have been suggestions, including in the National Land Transport Policy, to ban NMVs on major highway routes. The idea being that these roads are designed to serve strategic long distance traffic, not local traffic and NMVs. However, these national highways often provide the only road access for rural people to their nearest market, school or other social and economic facilities. Therefore a balance needs to be found to ensure that access restrictions for NMVs does not have a negative impact on the livelihoods of the poor and vulnerable.

Bans on the use of NMVs on the main carriageways of national highways should only be put into practice if an alternative lane is provided for NMV use. All highways should have a hard strip / shoulder for NMV use, at the same level as the carriageway (no step) to ensure that NMVs can easily pull off the carriageway to allow faster traffic by as necessary.

18.4. Civil Participation

International experience has shown that involving local communities in the planning, design and implementation of road works can improve the quality of works, the sense of ownership and therefore protection of the road asset, and can improve the take up of the benefits and socio-economic opportunities that road improvements can bring. Civil participation in road management improves the efficiency and effectiveness of the investments made.

In Bangladesh, there is little evidence of effective civil participation in road sector management for the RHD road network, except on some of the larger donor funded projects. There is a lack of community consultation and participatory processes, and social assessments. In addition, more effort could be made to utilise local labour in contract implementation and to implement equitable labour practices.

18.5. Employment

Whilst contractors may utilise local labour, especially for activities that require unskilled labour, there is no obligation to do so, and little effort is made to make sure employment conditions are fair and equitable. Most jobs are given to men, and where women are employed they are often not paid the same wage rate as men. Whilst there are social and cultural barriers to women's participation in the labour force, these can be reduced through effective management and civil participation, as has been proven by the LGED practice in Labour Contracting Societies for rural road maintenance and roadside tree planting.

The promotion of youth employment, especially with an associated training programme, to encourage development of a local skilled labour force would make a significant contribution towards improving the economic potential of rural communities, and can be implemented through large (longer duration) construction contracts or through term maintenance contracts.

Construction and maintenance contracts should include social protection clauses that include targets for employment of local labour including specific targets for women, youths and the poor. Employment terms and conditions should be on an 'equal pay for equal work' basis, regardless of gender, age, disability, or ethnic / social group. For development of youths and local skills, contract evaluation criteria could include additional marks for local skills development programmes, similar to the evaluation for 'knowledge transfer' found in many of the World Bank's international contracts.

Contracts should also include conditions for minimum ages for different types of work in the construction sector, based on the ILO standards. Whilst it is difficult for contractors to manage the employment conditions of their suppliers, it is possible to include additional marks in the contract evaluation criteria for firms that propose methods for managing child labour on their contracts and from their suppliers.

All local employment targets and minimum age criteria should be agreed following consultation with the local communities. Acceptable standards will vary depending on the socio-economic

situation and cultural traditions of the local communities, and their attitudes towards women and youths.

At present, maintenance contracts tend to be for particular road sections and for works at a discrete point in time. In the future, RHD may move towards Term Maintenance Contracts, and perhaps even Performance Based Maintenance Contracts. These have many advantages in terms of reducing the administrative and management burden on RHD staff, but also provide a mechanism for promoting local employment and skills development programmes.

Labour based maintenance contracts for roads and highways should be encouraged for off-road maintenance activities and roadside vegetation management, including tree planting where appropriate, especially on the Zila road network. These could target poor women from the local communities by following the LGED model. The responsibility for implementing such a programme could be transferred to the Contractor should term maintenance contracts be introduced.

18.6. Stakeholder Participation

It is recommended that all projects and contracts include some form of stakeholder participation process that incorporates the above points where applicable. The Project Appraisal Framework (PAF) includes a limited participation process to extract local information for use in decision-making, but does not take it the next step to improve design, implementation and management of the road network. The extent of consultation required will depend upon the size and nature of the project / contract. In addition, all projects should undergo some form of Social and Environmental Assessment, in accordance with current regulations. The Environmental Management Guidelines for RHD have been approved and are being implemented. The Social Assessment Guidelines are only in draft form for further discussion within RHD. Some form of Social Assessment Guidelines need to be prepared, approved and implemented. These need to include for consultation processes and needs analysis to support improved traffic management, environmental management and local employment management processes as discussed in the relevant sections.

The Road Masterplan was developed with stakeholder consultation at three workshops on:

- Inception Stage
- Draft Policies and Planning
- Draft Road Masterplan proposals

18.7. Environmental Protection

18.7.1. Water Management

Water management is a key feature of life in Bangladesh and impacts on all parts of society. Because of a lack of coping mechanisms, the poor often suffer the most when their water supply is cut-off or polluted. Roads inevitably cut across natural drainage systems and / or irrigation channels. There are many examples where surveys done during the dry season do not capture the full extent or correct flood and drainage patterns, leading to poorly designed cross drainage systems. The road therefore prevents effective drainage of floodwaters and causes wider flooding, crop damage and contamination of the local water supply. Spillages on roads, especially from traffic accidents, can also cause contamination of local water supplies.

All projects must include initial Environmental Assessments during feasibility and preliminary design stages. Projects where potential negative impacts are identified and trigger the requirement for full Environmental Impact Assessment to be carried out, this should be done in consultation with local communities. Commitment from Senior Managers to implementing effective environmental management systems and accommodating this in road sector budgets is essential. The capacity of RHD to implement the Environmental Management Guidelines also needs to be increased.

All new road construction and rehabilitation works will be subjected to a full hydrological and morphological study. It is important that hydrology studies and environmental impact assessments take into account local knowledge of typical water flows and flood levels, and recent

historical patterns, and that these are used to improve detailed design to ensure adequate drainage measures and water management systems are put in place. Where accident data suggests a particular contamination hazard, pollution control measures should be introduced to protect local water supplies.

It is recommended that costs for full hydrological and morphological studies be required as part of all new major project preparations be included when DPP's are prepared.

Road development and rehabilitation projects should follow the recommendations of the National Workshop on Options for Flood Risk and Damage Reduction in Bangladesh.[47]

RHD is recommended to develop an asset database with formation levels related to national datum to allow engineers to forecast flloding of the road network. This should be linked to existing flood forecasting capabilities.

RHD is also recommended to create a Morphology and Hydrology Unit in its Technical Services Wing, in order to aid implementation of the above recommendations.

18.7.2. Use of Bricks

There is widespread practice in Bangladesh of using crushed bricks as an alternative to stone aggregate. Whilst this seems a sensible and cost effective measure to address the lack of suitable gravel aggregate naturally available in Bangladesh, brick making factories do cause environmental damage. The use of crushed brick aggregate on major highways is not a preferred solution on technical grounds, as studies suggest that its strength deteriorates too rapidly hence reducing the life of structural pavements. However, its use on Zila roads and rural roads is often accepted.

The use of crushed brick is not an environmental hazard in itself, but brick making factories are a major cause of environmental damage. Not only through the visible atmospheric pollution, that can lead to respiratory health problems among workers and local communities, but they can dramatically alter the topography and drainage patterns of the locality, causing serious water management problems that negatively impact on the local communities.

Where the use of crushed bricks as aggregate is acceptable in contract specifications, contractors should be encouraged to work with their suppliers to ensure that the bricks used have been made in without undue damage to the environment. This may lead to slight increases in cost, but this should not be substantial. Proposal evaluation criteria could include additional marks as an incentive to improve environmental management on site and through the supply chain for contracts.

18.7.3. Temporary Works

Often negative environmental impacts of road works are not a result of the road itself, but of the temporary works involved in construction. For example:

- dust and traffic pollution from heavy plant on temporarily unpaved roads or access roads;
- poor risk management of storage depots and chemicals leading to potential contamination of water supplies;
- extraction of water from local sources for construction activities limiting access to safe water by the local community;
- poor management and restoration of quarries and borrow pits;
- negative environmental and social impacts of poorly managed labour camps.

Contract clauses should include environmental protection measures to be implemented during construction works, covering all aspects of temporary works as well as the final product.

[47] 7-8 September 2004, organised by the Prime Minister's Office, Government of Bangladesh

18.8. HIV or AIDS

Social Impact Assessments should include an analysis of the risk of the spread of HIV or AIDS and develop protection measures for construction workers and local communities in consultation and partnership with local health service providers. Implementation of the protection measures can be included in contract clauses.

18.9. Human Trafficking

The cause of continued and extensive human trafficking in Bangladesh is related to a range of cultural and poverty issues, and the low value placed on women and children in Bangladeshi society. The impact of the Road investment programme proposed in the Road Master Plan will have little impact on this issue, and there is little that an organisation such as RHD can do to address this issue. It is the responsibility of the Ministry of Women and Children Affairs to identify and implement a national response to the problem.

19. INSTITUTIONAL CONSEQUENCES

19.1. Capacity

RHD will need to have the capacity to absorb expenditure of over 68,000 Crore Taka over the next 20 years on capital and maintenance projects. The overall programme requires a great deal of that expenditure in the first five years. Experience of the Periodic Maintenance Programme (PMP) to date means that RHD needs continued assistance in institutional development and capacity building.

As a Government Department, RHD does not have sufficient authority to deliver the programmes efficiently, and in the long term, reform and change will be necessary.

The starting point for that reform might have been the World Bank's IDAP programme of institutional change and capacity building. But such has been the slow pace of securing the necessary loan, that IDAP itself is now woefully out of date. In such a circumstance, it may be prudent to look for a more visionary view of the shape and role of RHD in 20 years time.

As part of this study, 4 RHD officers and 2 Ministry of Communications officials undertook a study tour of the institutional arrangements for road building and management in Kolkata, India. It was decided, as a result, that video filming of the construction of major projects should be done to record the processes for sharing experiences.

19.2. Private Sector Involvement

Representatives on the study tour also concluded that RHD should make more use of public-private-partnerships in funding and implementing road and bridge projects.

Much greater use can be made of the private sector in financing the capital costs of road development than has hitherto been the case.

RHD, or its successor, will need to have in place dedicated and sufficient human resources to deal with the various types of private sector participation in roads and bridges in the future.

19.3. Reform Agenda

In many countries, both developed and developing, a new relationship is emerging between Government and the agency responsible for developing and managing the government's road assets. New road agencies are being created with a different relationship between themselves and their respective Government Ministries. In particular, greater levels of authority are being granted, with a parallel deal of responsibility to meet targets, standards and deadlines.

Such a change in Bangladesh should not affect RHD alone; the Ministry of Communications would need to alter to adopt a policy-based role, with an accent on setting targets and standards and ensuring that procedures are in place for its road agency(ies) to adhere to these. The recommendations are in line with the World Bank's ORA.

20. IMPLEMENTATION

20.1. Programmes

This Road Master Plan is an investment programme for the next twenty years, of which the first five years are the most critical. Within this period the following programmes need urgent attention for implementation:

- National and Regional road Recovery Programme
- Zila Road Recovery Programme
- Bridge Recovery and Maintenance

20.2. Annual Development Programme (ADP)

RHD should bring forward the Road Master Plan programmes by cost and year as proposals for the Annual Development Programme on an annual basis. This Master Plan has ben approved by the Minstry of Communications and the Planning Commission, and hence there is already 'in principle' agreement to the ADP submissions so long as they follow the Master Plan.

20.3. Projects

Within the above programmes projects are grouped in priority order, but it will be for RHD to bring forward the projects from the ADP (in the form of DPP's) in the order that is appropriate at the time.

20.4. Implementing Agencies

The implementing agency for the bulk of physical work proposed in this Masterplan will be the Roads and Highways Department. In some cases, within major cities, implementation may be assisted by the relvant City Corporation, and in the case of Dhaka, by the Dhaka Transportation Co-ordination Board (DTCB).

Other areas of the plan, such as Road Sector Policy Implementation, axle load control, many road safety initiatives, reform of the Anunal Development Programme, and greater private sector participation should be led by the Ministry of Communications.

20.5. Improving the Quality of Construction

RHD should take measures to improve the quality of construction through better supervision. The TSMR Project has brought in a number of improvements, and these should be fully implemented and sustained.

20.6. Monitoring and Review

RHD should monitor the physical implementation of the Road Masterplan, and report on this annually. The Masteprlan should be reviewed every 3 years, at which time amendments may be made in the light of prevailing circumstances. Between reviews no road project should be brought forward outside of the Masterplan proposals, unless such a project is deemed to address a national emergency.

The implementation of the Road Sector Policy should be monitored through Performance Measures, to be development by the Transport Sector Coordination Wing of the Planning Commission.