

## CHAPTER 1: INTRODUCTION

### 1.1 Overview

RHD is the road authority in Bangladesh which is responsible for the management of major road network that includes National Highways, Regional Highways and Zilla Roads. Total RHD paved road network is around 19,387 km (91 % of total length) of which 3,759 km is National Highway, 4,043 km is Regional Highway and the rest 11,584 km is Zilla Roads. Proper Maintenance and management of these assets is a fundamental requirement which is vital to the national economy. For optimization of the fund disbursement to maintain this road network RHD has been using the Highway Development and Management (HDM-4) Model (HDM-4 software) as an economic tool since 1999-2000. Since then, a Road Maintenance and Rehabilitation Needs Report (MRNR) is published every year to assess 5-year investment plan to meet acceptable levels of service provision for the RHD road network. The current Maintenance and Rehabilitation Needs Report of 2015 is a continuation of the process.

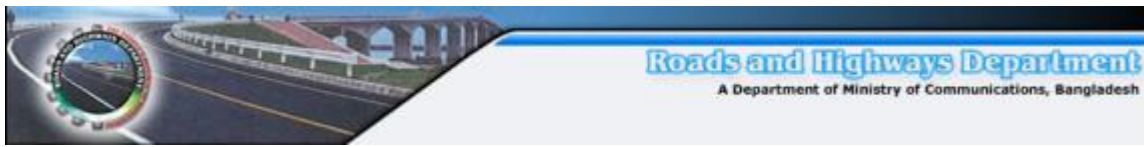
This year's analysis has been carried out on about 14,342.17 km of paved road of National, Regional and Zilla roads. All roads have been analysed to assess the overall long-term maintenance need of the RHD road network. Ongoing projects, have been excluded from the HDM analysis to project the immediate maintenance requirement. However few segments either completed or ongoing may appear in the HDM outputs because they were not reported by the field offices before the HDM analysis.

The outputs from HDM-4 are based on the Road Maintenance and Management System (RMMS) database of RHD. This report provides recommendations for Managers and Engineers in RHD to improve the road network in a cost effective manner.

### 1.2 Objectives of the analysis:

The main objectives of this analysis are:

- To project the total maintenance need of RHD Road network.
- To select and prioritize the maintenance works based on NPV over financial cost ratio.
- To develop a 5-year investment plan to meet acceptable levels of service provision for the RHD network.
- To provide a database for preparing RAMS map that combines all relevant information and shows decision makers where they can most effectively allocate funds for maintenance and rehabilitation.
- To provide recommendations for Managers and Engineers in RHD to improve the road network in a cost effective manner.



### **1.3 Methodology:**

Data required for the analysis are mainly primary in nature and obtained from field survey method.

#### **1.3.1 The data of RMMS Database:**

The data of RMMS database is the fundamental input to HDM 4 analysis.

In 2004 RHD undertook a major survey of its network covering around 15,000 km of roads. The survey was comprehensive and included a full inventory, current condition (including deflection measurements), pavement structure and traffic flows. In 2006 further surveys were undertaken, originally intended to complete the remaining 5,000 kilometres that were not surveyed in 2004. Only around 2,000 km of Zilla Roads omitted in 2004 were surveyed and around 1,500 km of National Roads were re-surveyed. In late 2007 further road condition surveys commenced and were completed in May 2008. In 2010-11 a comprehensive Road Condition Survey was conducted by the HDM Circle. These surveys undertook road condition assessment, traffic flows and deflection measurements (for national and Regional Roads only) but, most critically, did not update information on pavement structure. In 2013 HDM Circle again conducted comprehensive survey which included Pavement Inventory, Road Condition Assessment and Test Pit Survey. Most recently, in 2014 HDM circle conducted only roughness survey of most of the paved roads. This year's HDM run was conducted with the updated database of this survey result.

As like previous year this year the Roughness Survey was conducted by HDM Circle with its own officers. This roughness data is one of the critical input of HDM-4 analysis. Roughometer III was used to obtain roughness data.

#### **1.3.2 Road User Cost Data:**

The Road User Cost (RUC) data were provided by the Economic Circle of RHD. This year only the Vehicle Operating Cost (VOC) data has been updated.

#### **1.3.3 Unit cost of work and maintenance standard:**

The same maintenance standard set previously was used in the analysis. The unit cost of work was obtained from RHD Schedule of Rates, 2014.

#### **1.3.4 HDM 4 Export Tool:**

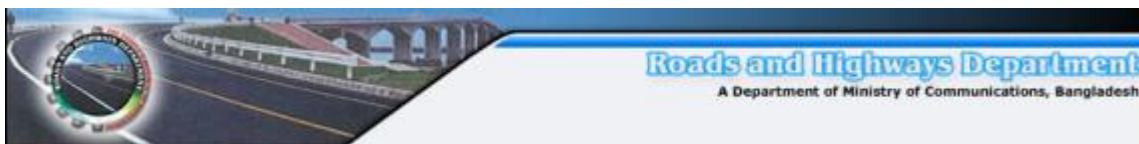
The HDM 4 export tool, mainly a software used to make the data of RMMS database useable by the Highway Development and Management Software (HDM 4).

#### **1.3.5 Analysis and presentation:**

After analysis of data by HDM 4 software, the result obtained is presented in tabular and graphical form.

### **1.4 Scope and Limitation:**

All the unpaved roads were excluded from the analysis. Besides, the present version of the HDM 4 software that RHD has been using for a long time (Version- 1.3) is not capable of doing the socio-economic analysis and hence the socio-economic variables are excluded from the analysis.



## **1.5 Road and Bridge Asset Management System:**

Since 2005-06 maintenance programme RHD introduced a new procedure, which streamlined the planning of its maintenance and rehabilitation works, as a critical tool to support their responsibility to actively manage the nation's network of roads and bridges. Each year this system is being further improved and developed in order to improve the selection and prioritisation of maintenance works.

Called "RAMS", short for Road and Bridge Asset Management System, the system brings together all RHD's current databases and analytical procedures. The final output of RAMS is the **RAMS Map**: a single GIS-based map for each Division which combines all relevant information and shows decision makers where they can most effectively allocate funds for maintenance and rehabilitation.

The strength of the RAMS Map is its simplicity. It presents information in a highly visual, graphical format and uses a minimal set of symbols and colours.

RAMS relies on output from the Bridge Maintenance Management System (BMMS), HDM, and therefore the data in RMMS. The quality of the RAMS Output is therefore heavily dependent on the quality of the data included in these databases. It should be noted that this Maintenance Needs Report deals only with the needs of roads and road pavements and does not address needs for bridges and structures.

## **1.6 Needs Report Output:**

This report presents the results of HDM-4 analysis for National, Regional and Zilla road networks. None of this work is improvement or development work – it is simply the work required to restore the existing road network to its original condition. It should therefore be classified as maintenance work and funded 100% through the Revenue Budget.

Rehabilitation is referred to as "backlog maintenance" as it is the result of under-investment in maintenance in the past. Separate budget sub-codes should be assigned for routine maintenance, periodic maintenance and rehabilitation in order that monitoring of expenditure can be effectively carried out. The road network maintenance and rehabilitation needs for National, Regional and Zilla Road Networks are presented in Appendix A and B. Recurrent costs of the whole road network has been shown in Appendix-C.

It must be stressed, however, that HDM-4 is not a design tool. The Road Asset Management System (RAMS) approach emphasizes that the nominal treatment recommended in the output must be confirmed and detailed through a more comprehensive survey, investigation and design process.

## CHAPTER 2: CURRENT NETWORK CONDITION.

### 2.1 The RHD Road Network:

Table 2.1 shows the extent of the roads covered by the roughness surveys carried during 2014-2015. In total about, 12,005 km paved roads were surveyed.

**Table 2.1: Road Networks Lengths Surveyed for Roughness (Survey Year 2014) Survey Conducted from December 2014-September 2015**

Road Zone	National Highways	Regional Highways	Zilla Roads	Total
Barisal	126.12	257.00	461.28	844.40
Chittagong	435.05	401.97	354.90	1191.91
Comilla	287.05	235.65	933.28	1455.98
Dhaka	391.23	445.92	269.04	1105.07
Mymensingh	249.15	334.76	451.38	1035.28
Gopalganj	251.95	158.91	373.85	784.71
Khulna	417.04	551.73	983.09	1951.87
Rajshahi	381.46	377.66	757.66	1516.78
Rangpur	581.52	352.03	400.02	1333.57
Sylhet	346.38	385.79	52.79	784.97
	3466.94	3501.42	5037.29	12005.65

The road condition can be grossly categorized into descriptive bands based on roughness. These categories are shown in table 2.2. Different ranges are adopted for each road class to reflect their relative importance and the level of service that should be expected from each road class.

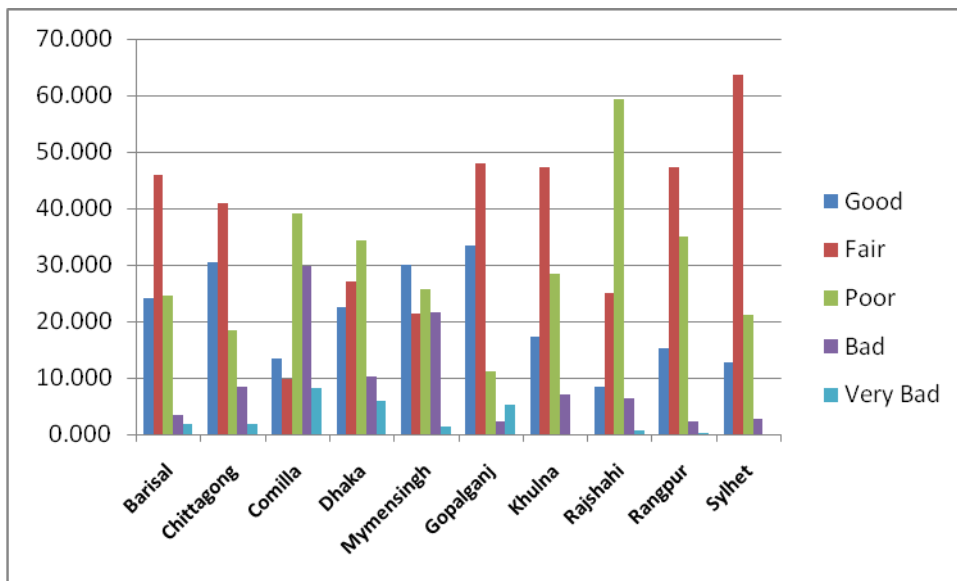
**Table 2.2: Qualitative descriptors of IRI values**

	National Highway	Regional Highway	Zila Road
<b>IRI Values</b>			
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
Bad	8.0 – 9.9	9.0 – 10.9	10.0 – 11.9
Very Bad	≥10.0	≥11.0	≥12.0

Based on the above categories, following tables and figures show the network condition by Zone and road classes.

**Table 2.3: Overall RHD Road Network Condition (Survey Year 2014) Survey Conducted from December 2014-September 2015**

Road	Good		Fair		Poor		Bad		Very Bad		Total Surveyed
	Length (Km)	%	Length (Km)	%	Length (Km)	%	Length (Km)	%	Length (Km)	%	
National	854.40	24.64	1618.11	46.67	794.19	22.91	123.55	3.56	76.71	2.21	3466.94
Regional	719.72	20.56	1513.12	43.21	915.26	26.14	287.54	8.21	65.78	1.88	3501.42
Zilla Road	761.75	15.12	1367.46	27.15	2068.86	41.07	747.29	14.84	91.94	1.83	5037.29
Total	2335.87	19.46	4498.68	37.47	3778.30	31.47	1158.37	9.65	234.43	1.95	12005.65

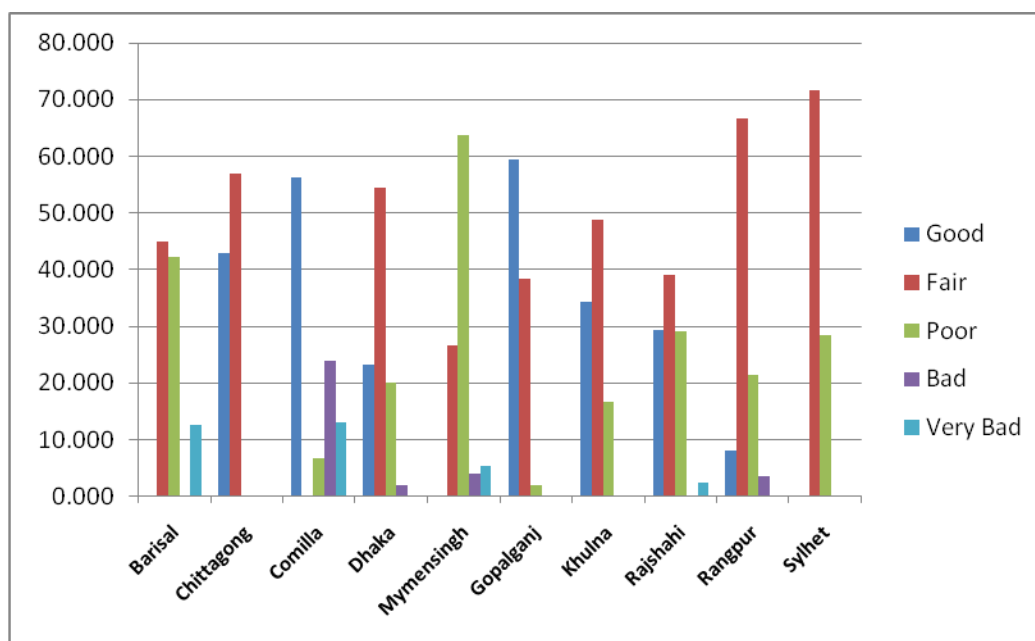


**Figure 2.2: Network Condition of All Roads**

**Table 2.4: Road Condition of National Highways based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015(data in km)**

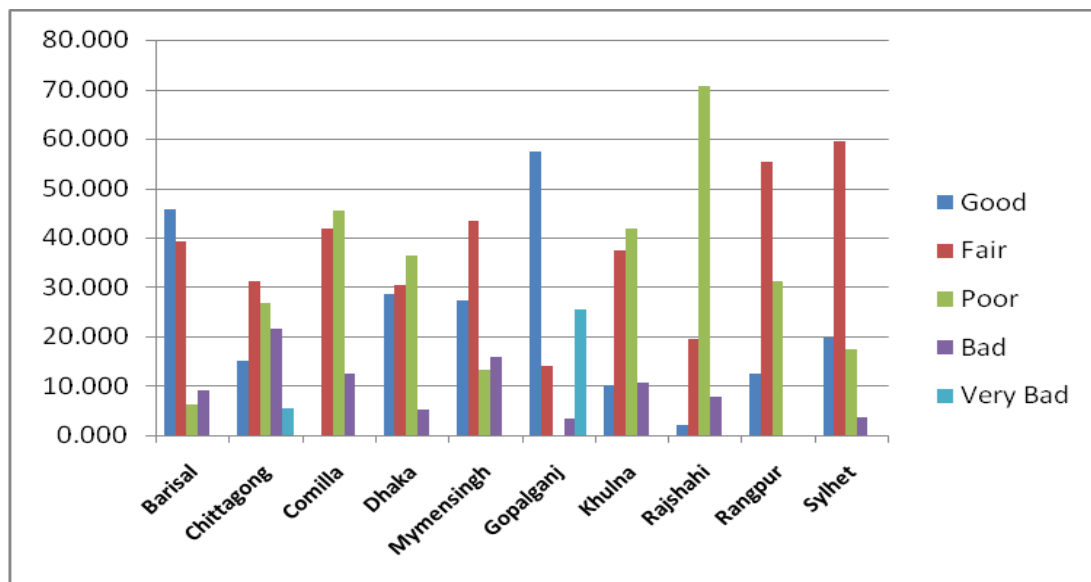
Road Zone	Good	Fair	Poor	Bad	Very Bad	Total
Barisal	0.000	56.627	53.410	0.000	16.080	126.117
Chittagong	168.286	223.352	43.410	0.000	0.000	435.048
Comilla	161.326	0.000	19.200	68.639	37.880	287.045
Dhaka	91.416	212.781	79.028	8.000	0.000	391.225
Mymensingh	0.000	66.718	159.010	10.121	13.300	249.149
Gopalganj	149.755	96.899	5.300	0.000	0.000	251.954
Khulna	123.923	176.743	100.533	15.845	0.000	417.044
Rajshahi	111.969	148.854	111.188	0.000	9.450	381.461
Rangpur	47.722	388.141	124.721	20.940	0.000	581.524
Sylhet	0.000	247.992	98.385	0.000	0.000	346.377

**Figure 2.3: Road condition of National Highways based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015**



**Table 2.5: Road Condition of Regional Highways based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015**

Road Zone	Good	Fair	Poor	Bad	Very Bad	Total
Barisal	117.334	100.553	15.845	23.269	0.000	257.001
Chittagong	60.252	125.483	107.987	86.486	21.760	401.968
Comilla	0.000	98.790	107.356	29.508	0.000	235.654
Dhaka	124.445	135.413	162.440	23.173	0.000	445.471
Mymensingh	92.765	144.790	44.572	52.629	0.000	334.756
Gopalganj	91.042	22.276	0.000	5.200	40.390	158.908
Khulna	113.191	377.196	45.365	15.980	0.000	551.732
Rajshahi	0.000	84.778	255.204	37.674	0.000	377.656
Rangpur	44.231	194.512	109.656	0.000	3.630	352.029
Sylhet	76.014	229.324	66.836	13.620	0.000	385.794



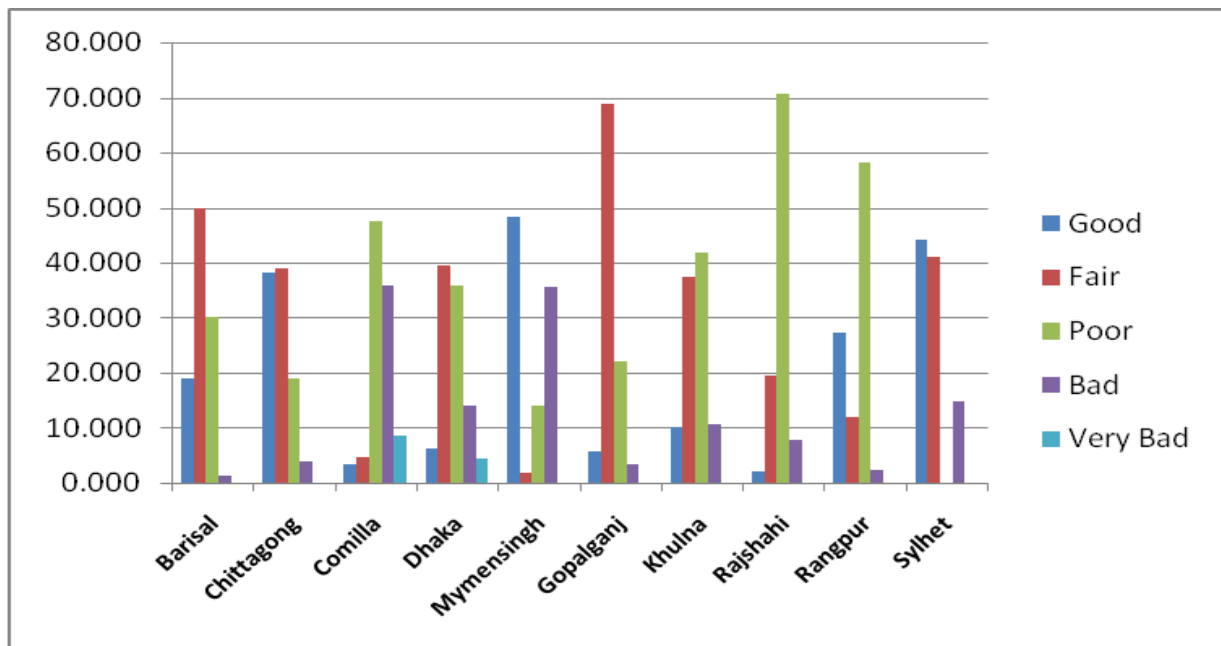
**Figure 2.4: Road Condition of Regional Highways based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015**



**Table 2.6: Road condition of Zilla Roads based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015(data in km)**

Road Zone	Good	Fair	Poor	Bad	Very Bad
Barisal	18.870	49.770	30.080	1.280	0.000
Chittagong	38.210	38.990	18.910	3.870	0.000
Comilla	3.460	4.670	47.450	35.820	8.500
Dhaka	38.610	73.694	108.520	39.74	5.150
Mymensingh	48.420	1.910	14.020	35.630	0.000
Gopalganj	5.750	68.770	22.070	3.370	0.000
Khulna	10.100	37.400	41.790	10.690	0.000
Rajshahi	2.120	19.380	70.580	7.900	0.000
Rangpur	27.250	11.860	58.110	2.260	0.000
Sylhet	44.130	41.090	0.000	14.770	0.000

**Figure 2.5: Road condition of Zilla Roads based on IRI (Survey Year 2014) Survey Conducted from December 2014-September 2015**





## CHAPTER 3: HDM-4 PROGRAMME ANALYSIS

### 3.1 Principles of Life Cycle Analysis.

The life cycle analysis in HDM-4 predicts the pavement conditions (performance), the required treatments and costs and benefits over a specified period (in this case 20 years) under a user-defined maintenance strategy. The costs used in this analysis include cost of capital investment, maintenance costs and vehicle operating costs.

The costs of two scenarios are compared:

- The “do minimum maintenance” scenario (either routine maintenance or a “holding strategy”).
- The “with maintenance” scenario.

Details of treatments considered in Bangladesh can be seen in Table 3.1. Maintenance strategies were set for these treatments based on road condition, traffic and roughness data for different classes of roads (see Table 3.2). Holding strategy has been included (see Table 3.2), which means that DBST / carpeting has to be provided instead of going for higher treatment if there is shortage of funds to keep the roads at maintainable condition. DBST was considered for National and Regional roads and carpeting for Zilla roads.

The benefits and costs of the above scenarios are compared for a HDM-4 life cycle analysis of 20 years. The Net Present Value (NPV)/costs were utilized to prioritize treatment options at a 12% discount rate. NPV/cost was chosen to obtain maximum benefits as it produces highest benefits when there is crisis in funding.

### 3.2 Description of Treatments:

The HDM analysis considers a number of treatments representing the most commonly used types of maintenance work items in Bangladesh. Table 3.1 provides details of these treatments and the assumptions made for HDM.

**Table 3.1: Maintenance and rehabilitation treatments and assumptions used in HDM**

Routine Maintenance:	Off-pavement works:	Includes all regular works along a road such as maintaining shoulders, roadside vegetation control, cleaning side drains and pipe culverts, maintenance of signs and signals.
	Patching	Repair of potholes based on a standard pothole unit of 0.01m <sup>3</sup> per pothole. The quantity of pothole repairing shall not be more than 1% of the total surface.
	Crack Sealing	Sealing to cracks using Seal Coat/Fog Seal. It assumes a maximum in any one kilometre of 5% area affected.

Periodic Maintenance:	Preparatory Patching	Patching potholes and regulating surface irregularities prior to undertaking the treatments like DBST or DBS Overlay. Should not be more than 2% of the total quantity of overlay for National roads and maximum of 5% for Regional roads.
	Preparatory Edge Repair	Allows for restoring pavement edges that have been damaged by vehicles leaving the road to drive onto the shoulder prior to undertaking the treatments like DBST or DBS Overlay.
	DBST	Applying two layers of surface treatments on the prepared road surface. The total thickness has been specified as 25mm. This is applied in medium to highly trafficked road. Life expectancy assumed to be 3 years.
	Bituminous Carpeting	This is a 40 mm thick manual overlay used in low trafficked roads in place of dense bituminous overlay. Life expectancy has been taken as 2 to 4 years.
	Overlay	Machine laid premixed dense bituminous surfacing overlay 40 – 80 mm thick used in medium to highly trafficked roads. Carefully controlled overlay may be applied in response to badly damaged road surface or high roughness so as to obtain a predefined roughness level (2.5 to 3 IRI). Life expectancy assumed to be 5 years.
Rehabilitation	Partial Reconstruction	Reconstruction of the upper pavement layers following scarification of the existing damaged surface and re-compaction. Normally a 150-200 mm crushed aggregate base with a dense bituminous surfacing of between 75 and 195mm, depending on traffic level. This is a treatment to overcome higher roughness or higher levels of surface cracking resulting from delayed maintenance. Life expectancy should be 10 years prior to major periodic maintenance. Full design of the pavement must be undertaken prior to treatment. Shoulder rehabilitation would also be provided where necessary.
	Complete Reconstruction	A major reconstruction on the existing alignment and within the same overall dimension limits. The road is not widened. The pavement must be fully designed prior to construction and shoulder rehabilitation provided where necessary. Life expectancy should be 10 years before major periodic maintenance. Applied where there are extremely high levels of roughness and extensive cracking.
Holding Treatment		DBST triggered when rehabilitation is required but budget constraints do not permit the preferred treatment. Expected to last for 3 years

### 3.3 Maintenance Strategies:

Table 3.2 shows the compound maintenance standards adopted for HDM analysis for the different classes of roads. These standards are based on experience and analysis of road conditions in Bangladesh, and are considered to be a reliable basis for HDM-4 to estimate economic performance of the network. Final treatment designs must be separately established.

Compound maintenance standards have been modified slightly, but are similar to the previous years' standards. The slight modification relates to the introduction of a DBST in the holding strategy of National and Regional roads when the roughness will exceed 12 IRI. Similarly carpeting was introduced in the holding strategy of Zilla roads for roughness greater than 12 IRI.

Corridor roads (N1, N2, N3, N4, N5, N6, N7 and N8) were given high priority and hence they were analyzed separately as they cover the major traffic and will be the part of the Asian Highway Network in the near future. Hence, periodic maintenance was considered at 4 IRI. The other National highways, Regional highways and Zilla roads were considered for periodic maintenance at 5, 5.5 and 6 IRI respectively. "Holding maintenance strategy" was considered to maintain roads using DBST when funding is limited and higher treatments cannot be provided. Application of DBST can then delay further road deterioration.

**Table 3.2 : Compound maintenance standards for HDM-4 programme analysis in 2015-16**

Holding Standard without Reconstruction for National and Regional Roads						
Roughness Range (IRI)	All Damage (%)	Traffic Range (MT-AADT)				
		100 - 1999	2000 - 3999	4000 - 5999	6000 - 9999	> 10000
<12	<5%	Routine				
	5 - 10%	Routine				DBST 25mm
	10 - 20%	Routine	Routine	DBST 25mm		
	20 - 30%	Routine	DBST 25mm			
	> 30%	DBST 25mm				
> 12.00	All	DBST 25mm				

Holding Standard with Reconstruction for National and Regional Roads						
Roughness Range (IRI)	All Damage (%)	Traffic Range (MT-AADT)				
		100 - 1999	2000 - 3999	4000 - 5999	6000 - 9999	> 10000
<12	<5%	Routine				
	5 - 10%	Routine				DBST 25mm
	10 - 20%	Routine		DBST 25mm		
	20 - 30%	Routine	DBST 25mm			
	> 30%	DBST 25mm				
> 12.00	All	Full Recon 110mm	Full Recon 135mm	Full Recon 150mm	Full Recon 180mm	Full Recon 195mm

Holding Standard with Reconstruction for Zilla Roads						
Roughness Range (IRI)	All Damage (%)	Traffic Range (MT-AADT)				
		100 - 999	1000-1999	2000-2999	3000-3999	>4000
<12	0 -10%	Routine	Routine	Routine	Routine	Routine
	10-20%	Routine	Routine	Overlay 40mm		
	20-30%	Routine	Overlay 40mm			
	>30%	Overlay 40mm				
> 12.00	All	Full Rec 75mm				

Compound Maintenance Standards for National Corridor Roads						
Roughness Range (IRI)	Cracking Range (%)	Traffic Range (MT-AADT)				
		100 - 1999	2000 - 3999	4000 - 5999	6000 - 9999	> 10000
< 4.0	< 25%	Routine				
	>= 25%	DBST 25mm				Overlay 50mm
4.00 - < 7.00	All	Overlay 50mm			Overlay 50mm	Overlay 80mm
7.00 - < 9.00	All				Overlay 60mm	Overlay 80mm
9.00 - < 12.00	All	Rehab 120mm	Rehab 140mm	Rehab 150mm	Rehab 180	Rehab 195mm
> 12.00	All	Full Rec 120mm	Full Rec 140mm	Full Recon 150mm	Full Recon 180mm	Full Recon 195mm

Compound Maintenance Standards for Other National Roads						
Roughness Range (IRI)	Cracking Range (%)	Traffic Range (MT-AADT)				
		100 - 1999	2000 - 3999	4000 - 5999	6000 - 9999	> 10000
< 5.0	< 25%	Routine				
	>= 25%	DBST 25mm				Overlay 50mm
5.00 - < 7.00	All	Overlay 50mm			Overlay 50mm	Overlay 80mm
7.00 - < 9.00	All				Overlay 60mm	
9.00 - < 12.00	All	Rehab 110mm	Rehab 135mm	Rehab 150mm	Rehab 180 mm	Rehab 195mm
> 12.00	All	Full Recon 110mm	Full Recon 135mm	Full Recon 150mm	Full Recon 180mm	Full Recon 195mm

Compound Maintenance Standards for Regional Roads					
Roughness Range (IRI)	Cracking Range (%)	Traffic Range (MT-AADT)			
		100 - 1999	2000 - 2999	3000 - 3999	4000 - 4999
< 5.5.0	< 25%	Routine			
	>= 25%	DBST 25mm			
5.50 - < 7.00	All	Overlay 50mm			Overlay 60mm
7.00 - < 9.00	All	Overlay 50mm		Overlay 60mm	
9.00 - < 12.00	All	Rehab 110mm	Rehab 135mm	Rehab 150mm	
> 12.00	All	Full Recon 110mm	Full Recon 135mm	Full Recon 150mm	

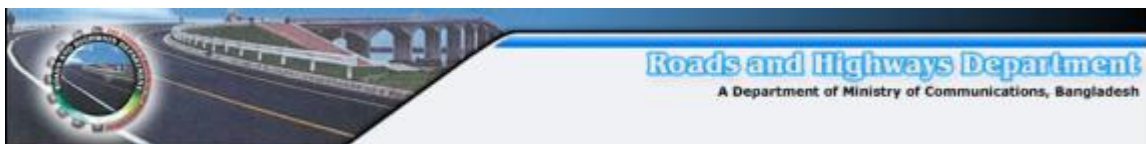
Compound Maintenance Standards for Zilla Roads					
Roughness Range (IRI)	Cracking Range (%)	Traffic Range (MT-AADT)			
		100-999	1000-1999	2000-2999	3000-3999
< 6.0	< 25%	Routine			
	>= 25%	Seal 15mm		Overlay 40mm	Overlay 50mm
6.0 - < 7.00	All	Overlay 40mm			Overlay 50mm
7.00 - < 9.00	All				
9.00 - < 12.00	All	Rehab- 75mm			
> 12.00	All	Full Rec 75mm			

### 3.4 Unit Costs.

Table 3.3 shows the unit cost of different work prepared in accordance with the RHD Schedule of Rates 2014.

**Table 4.3` Unit costs of Treatment.**

Work Type	Work Class	Work Description	Financia Costs (Tk)
<b>Routine</b>	Routine Maintenance	Routine	80,000
		Patching	1,573
		Edge Repair	1,573
		Crack Sealing	252
<b>Periodic</b>	Resurfacing	Seal Coat	252
		DBST 25 mm	494
	Ashphalt Mix Resurfacing	Overlay 40mm	849
		Overlay 50mm	1,050
		Overlay 60mm	1,251
		Overlay 80mm	1,653



		Overlay 100mm	2,056
		Overlay 120mm	2,458
<b>Rehabilitation</b>	Partial Reconstruction	Partial Recon 75mm	2,993
		Partial Recon 100mm	3,496
		Partial Recon 110mm	3,697
		Partial Recon 120mm	3,898
		Partial Recon 135mm	4,528
		Partial Recon 140mm	4,629
		Partial Recon 150mm	4,830
		Partial Recon 180mm	5,762
		Partial Recon 195mm	6,064
		<b>Reconstruction</b>	Full Reconstruction
Full Recon 100mm	4,733		
Full Recon 110mm	4,934		
Full Recon 120mm	5,136		
Full Recon 135mm	5,464		
Full Recon 140mm	5,866		
Full Recon 150mm	6,068		
Full Recon 180mm	6,999		
Full Recon 195mm	7,301		

## CHAPTER 4: RESULTS OF HDM-4 ANALYSIS.

### 4.1 Analysis Procedure:

The analysis was carried out in the following sequences.

- Run all roads to obtain the overall funding needs. This will also allow a comparison between last years results to get a picture of overall changes in network condition.
- Remove all segments currently ongoing and run HDM-4 to get the immediate funding needs for the year 2015.

### 4.2 Network Result:

Like the previous years, HDM-4 analysis was carried out for all road networks to get the overall picture of needs. This has produced a detailed work programme for the full 20-years analysis period. However, only the first five years should be considered when estimating the future funding needs due to the uncertainty about future conditions and availability of funds.

The unconstrained capital cost of initial 5 years for all analyzed road lengths are given in figure 4.1 below. Here, the total five years cost for capital works; i.e. periodic maintenance, partial and full reconstruction, is 252,881 million taka wherein the average demand per year is around 50,557 million taka. The figure depicts that if major portion (192,052 out of 252,881 million taka) of the Total Capital Works demand is fulfilled in the 1<sup>st</sup> year then this demand will be substantially below the average demand per year in the subsequent years.

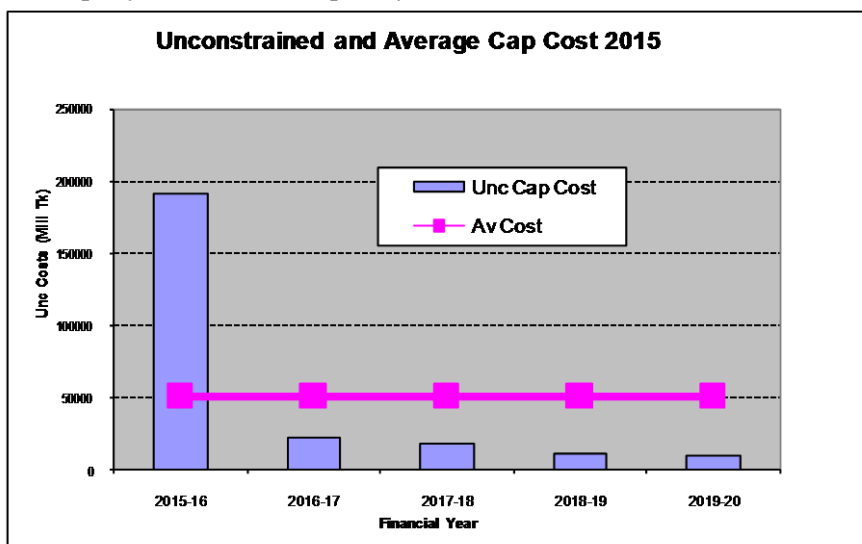


Figure 1:1-Total unconstrained and average demand of capital works (2015-2020)



**Table 4.1: Total Capital Works Demand for the next five years (in Million Taka)**

Road Class	2015-16	2016-17	2017-18	2018-19	2019-20	Total
National	74256.24	4674.65	1206.99	847.52	1070.07	82055.46
Regional	32369.89	4161.88	2911.75	2486.64	3096.13	45026.29
Zilla	85426.46	12820.85	13949.46	8367.41	5235.68	125799.86
<b>Total</b>	<b>192052.59</b>	<b>21657.38</b>	<b>18068.20</b>	<b>11701.57</b>	<b>9401.88</b>	<b>252881.62</b>

**Table 4.2: Periodic Maintenance Demand (in Million Taka) for the next five years**

Road Class	2015-16	2016-17	2017-18	2018-19	2019-20	Total
National	16411.21	4186.36	1181.85	837.88	1070.07	23687.36
Regional	13320.24	3383.51	2690.62	1520.44	2913.24	23828.05
Zilla	16206.91	5310.67	9275.69	5755.71	3931.85	40480.83
<b>Total</b>	<b>45938.40</b>	<b>12880.54</b>	<b>13148.2</b>	<b>8114.03</b>	<b>7915.16</b>	<b>87996.20</b>

**Table 4.3: Partial Reconstruction Demand (in Million Taka) for the next five years**

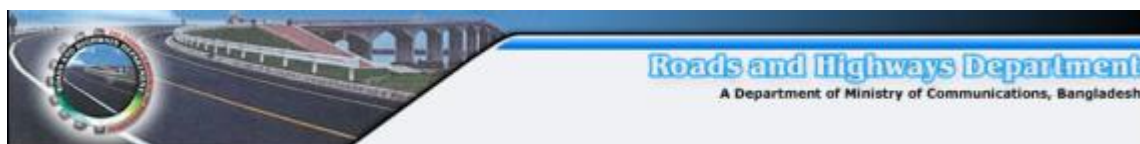
Road Class	2015-16	2016-17	2017-18	2018-19	2019-20	Total
National	34243.03	134.86	25.10	9.63	0.00	34412.63
Regional	4343.48	770.45	221.13	966.2	182.89	6484.16
Zilla	23491.88	5948.46	4221.95	2485.64	1303.83	37451.77
<b>Total</b>	<b>62078.39</b>	<b>6853.77</b>	<b>4468.18</b>	<b>3461.47</b>	<b>1486.72</b>	<b>78348.56</b>

**Table 4.4: Full Reconstruction Demand (in Million Taka) for the next five years**

Road Class	2015-16	2016-17	2017-18	2018-19	2019-20	Total
National	23602.00	353.42	0.05	0.00	0.00	23955.47
Regional	14706.16	7.92	0.00	0.00	0.00	14714.09
Zilla	45727.66	1561.73	451.82	126.06	0.00	47867.27
<b>Total</b>	<b>84035.82</b>	<b>1923.07</b>	<b>451.87</b>	<b>126.06</b>	<b>0.00</b>	<b>86536.83</b>

**Table 4.5: Routine Maintenance Demand (in Million Taka) for the next five years**

Road Class	2015-16	2016-17	2017-18	2018-19	2019-20	Total
National	541.29	739.64	725.75	782.06	846.48	3635.22
Regional	822.17	1481.84	1430.67	1515.70	1610.59	6860.96
Zilla	3101.43	5716.72	6075.53	6162.99	6709.28	27766.51
<b>Total</b>	<b>4465.43</b>	<b>7938.21</b>	<b>8231.95</b>	<b>8460.75</b>	<b>9166.35</b>	<b>38262.69</b>



Tables 4.2 to 4.6 shows the class wise (Capital works and Routine Maintenance cost) demand required for the first five years of analysis. Figure 4.2 gives a comparison of this year's analysis with the previous year in respect to demand per km of analyzed length. Analyzed length for 2015 analysis is 14,342.17 km against 14,637.83 km in 2013-14, 17,494.33 km in 2012-13, 18,177 km in 2011-12, 17,482 km in 2010-11 and 16,821 km in 2009-10 analysis. All sets of figures are from analyses including ongoing projects.

**Table 4.6: Length of different work category in all classes of roads (Km)**

Road Class	Treatment Type	2015-16	2016-17	2017-18	2018-19	2019-20
<b>National Highways</b>	Periodic Maintenance	2007.49	452.88	159.01	141.36	154.84
	Partial Reconstruction	675.36	3.21	6.6	0.21	0
	Full Reconstruction	505.37	14.51	7.33	7.33	7.33
	<b>Total</b>	<b>3188.22</b>	<b>470.6</b>	<b>166.94</b>	<b>148.9</b>	<b>162.17</b>
<b>Regional Highways</b>	Periodic Maintenance	2202.34	576.6	486.1	267.2	328.06
	Partial Reconstruction	177.17	35.18	10.44	40.51	7.77
	Full Reconstruction	474.96	0.4	0	0	0
	<b>Total</b>	<b>2854.47</b>	<b>612.18</b>	<b>496.54</b>	<b>307.71</b>	<b>335.83</b>
<b>Zilla Roads</b>	Periodic Maintenance	4231.89	1360.54	2298.04	1594.53	1091.43
	Partial Reconstruction	1742.96	475.43	335.39	206.14	103.83
	Full Reconstruction	2324.63	89.12	23.7	8	0
	<b>Total</b>	<b>8299.48</b>	<b>1926.09</b>	<b>2657.13</b>	<b>1808.67</b>	<b>1195.26</b>
<b>Grand Total</b>		<b>14342.17</b>	<b>3007.87</b>	<b>3320.61</b>	<b>2265.28</b>	<b>1693.26</b>

### 4.3 Demand excluding ongoing projects

List of ongoing projects were collected from various projects and fields and also the list of ongoing works of the previous year was collected. Ongoing segments were then excluded from HDM run and remaining sections were analysed separately. This was done to avoid duplication of the current year's maintenance programme and to ascertain the actual immediate need of capital budget.

**Table 4.7: Capital Demand of National and Regional Roads 2015(Excluding on-going projects)**

(million taka)

Zone	Periodic	Partial Reconstruction/ Rehabilitation	Full Construction	Total
Barisal	1233.65	614.92	448.59	2297.16
Chittagong	3170.84	825.14	595.89	4591.87
Comilla	1910.72	525.28	2468.15	4904.15
Dhaka	5231.11	6398.75	4908.94	16538.8
Gopalganj	1369.9	517.34	1028.76	2916
Khulna	2756.04	809.36	8673.15	12238.55
Mymensingh	1825.27	374.16	236.78	2436.21
Rajshahi	2797.68	3723.15	5514.71	12035.54
Rangpur	2536.93	1702.19	6793.48	11032.6
Sylhet	2360.12	62.28	49.96	2472.36
<b>Total</b>	<b>25192.3</b>	<b>15552.6</b>	<b>30718.4</b>	<b>71463.2</b>

**Table 4.8: Funding Needs of Zilla Roads Networks for 2015( Excluding Ongoing Projects)**

(million taka)

Zone	Periodic	Partial Reconstruction/ Rehabilitation	Full Construction	Total
Barisal	831.05	596.03	119.62	1546.70
Chittagong	1318.12	1812.86	1101.41	4232.39
Comilla	1796.28	2596.44	2762.57	7155.29
Dhaka	361.97	1254.78	502.79	2119.54
Gopalganj	303.74	428.32	76.13	808.19
Khulna	1283.24	1306.63	2732.18	5322.05
Mymensingh	1239.16	3455.26	794.69	5489.11
Rajshahi	1179.00	915.46	1986.1	4335.12
Rangpur	2019.14	1310.76	12372.11	15702.01
Sylhet	227.530	2083.24	139.14	2449.91
<b>Total</b>	<b>10559.23</b>	<b>15759.78</b>	<b>22586.74</b>	<b>48905.75</b>

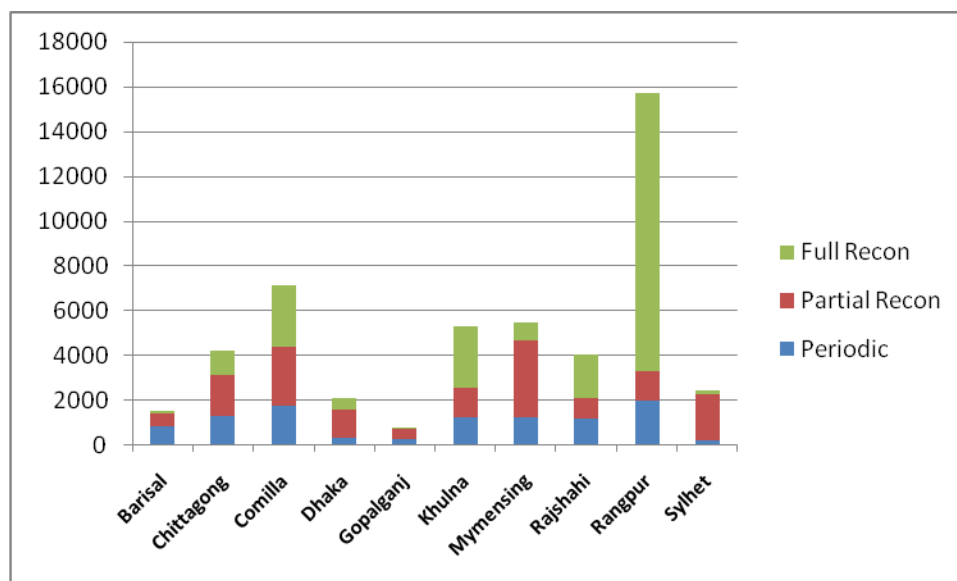
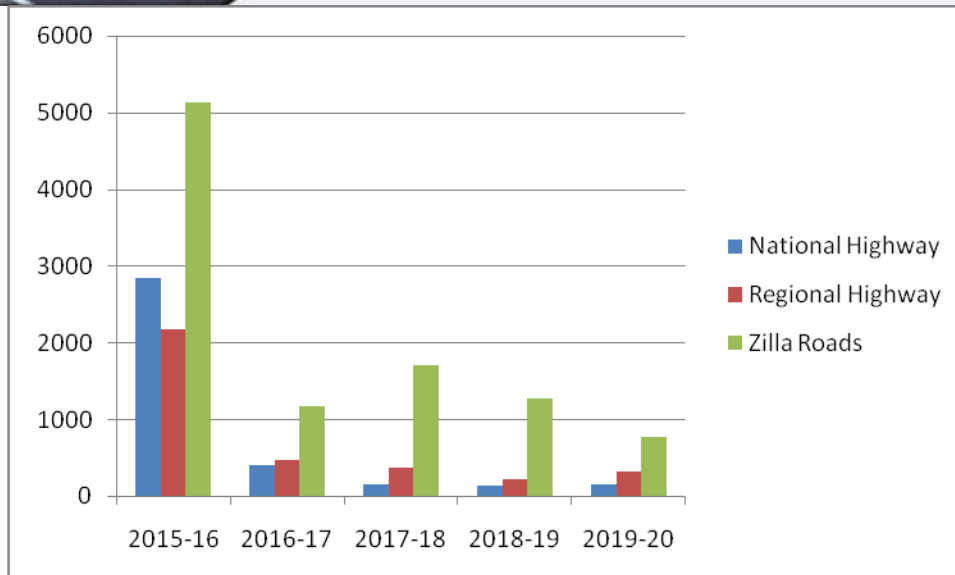


Figure 1.3-Zonewise Capital Needs (Million Taka) of National and Regional Highways in the Year 2015

Table 4.9: Required Length of different road classes for Capital works in next five years (Excluding Ongoing Projects)

(in Km)

Road Class	Treatment Type	2015-16	2016-17	2017-18	2018-19	2019-20
National Highways	Periodic Total	1795.96	389.02	140.35	122.51	138.82
	Rehabilitation Total	605.53	3.01	0.60	0.21	0.00
	Reconstruction Total	436.99	14.51	7.33	7.33	7.33
	<b>Total</b>	<b>2838.48</b>	<b>406.54</b>	<b>148.28</b>	<b>130.05</b>	<b>146.15</b>
Regional Highways	Periodic Total	1724.76	441.83	365.18	182.29	312.01
	Rehabilitation Total	127.86	27.30	7.76	34.25	5.29
	Reconstruction Total	323.93	0.40	0.00	0.00	0.00
	<b>Total</b>	<b>2176.55</b>	<b>469.53</b>	<b>372.94</b>	<b>216.54</b>	<b>317.30</b>
Zilla Roads	Periodic Total	2438.54	937.01	1533.80	1185.43	734.55
	Rehabilitation Total	1094.46	220.16	173.42	80.39	39.47
	Reconstruction Total	1110.03	6.40	2.10	2.80	0.00
	<b>Total</b>	<b>4645.18</b>	<b>1165.57</b>	<b>1709.32</b>	<b>1268.62</b>	<b>774.02</b>
<b>Total</b>		<b>9658.06</b>	<b>2041.64</b>	<b>2230.54</b>	<b>1615.21</b>	<b>1237.47</b>



*Figure 1:4-Trend of length of roads requiring treatment (in Km)*

#### 4.4 Overall Needs

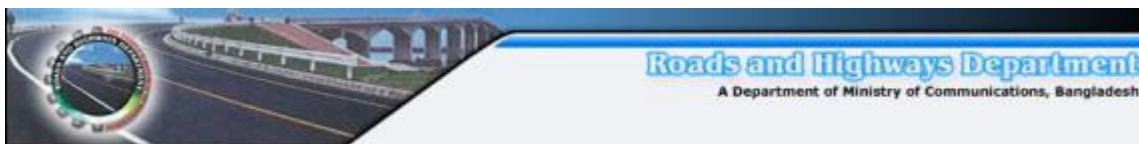
The initial run of HDM, including ongoing projects, is indicative of the longer-term needs of the network. Roads excluded from the run on the ground works on them are currently in progress or recently completed, will require periodic maintenance before the end of the five year period and thus the five-year plan should be based on the “All Roads” HDM Output.

**Table 4.10: Overall Maintenance Needs by Work Category (Million Taka )**

Work Type	2015-16	2016-17	2017-18	2018-19	2019-20	Total
Routine Maintenance	4465.43	7938.19	8231.94	8460.73	9166.34	<b>38262.63</b>
Periodic Maintenance	45938.36	12880.54	13148.16	8114.03	7915.16	<b>87996.25</b>
Partial Reconstruction	62078.39	6853.77	4468.18	3461.47	1486.72	<b>78348.56</b>
Full Reconstruction	84035.82	1923.07	451.87	126.06	0.00	<b>86536.83</b>
<b>Total</b>	<b>196518</b>	<b>29595.57</b>	<b>26300.15</b>	<b>20162.29</b>	<b>18568.22</b>	<b>291144.30</b>

The Road Master Plan makes a strong case for separating the assessment of Zilla roads from that of National and Regional Roads. It can be seen from Tables 4.11 and 4.12 that the needs of Zilla Roads are predominantly rehabilitation and reconstruction, hence the proposal in RMP for a “Zilla Road Recovery Programme”. In the past two years, no Zilla roads have featured in the PMP because the prioritization using NPV/C favours more heavily trafficked roads. It is therefore important that a separate prioritization process is adopted for Zilla Roads.

The results of the HDM analysis show that, in the first five years, the budget demand for Zilla Roads is higher than that for National and Regional Roads. The overall figures translate into a need to invest more in Zilla Roads over the next five years. It is therefore strongly recommended that separate budget provision is made for Zilla Roads for the next five years.



**Table 4.11: Overall Maintenance Needs by Work Category for National and Regional Roads (Million Taka)**

Work Type	2015-16	2016-17	2017-18	2018-19	2019-20	Total
Routine Maintenance	1363.45	2221.47	2156.41	2297.74	2457.06	10496.13
Periodic Maintenance	29731.45	7569.87	3872.47	2358.32	3983.31	47515.42
Partial Reconstruction	38586.51	905.31	246.23	975.83	182.89	40896.79
Full Reconstruction	38308.16	361.34	0.05	0.00	0.00	38669.56
<b>Total</b>	<b>107989.60</b>	<b>11057.99</b>	<b>6275.16</b>	<b>5631.89</b>	<b>6623.26</b>	<b>137577.90</b>

**Table 4.12: Overall Maintenance Needs by Work Category for Zilla Roads (Million Taka)**

Work Type	2015-16	2016-17	2017-18	2018-19	2019-20	Total
Routine Maintenance	3101.98	5716.72	6075.53	6162.99	6709.28	27766.50
Periodic Maintenance	16206.91	5310.67	9275.69	5755.71	3931.85	40480.83
Partial Reconstruction	23491.88	5948.46	4221.95	2485.64	1303.83	37451.77
Full Reconstruction	45727.66	1561.73	451.82	126.06	0.00	47867.27
<b>Total</b>	<b>88528.43</b>	<b>18537.58</b>	<b>20024.99</b>	<b>14530.40</b>	<b>11944.96</b>	<b>153566.40</b>

## CHAPTER 5: FINDING AND RECOMMENDATIONS

### 5.1 Major Findings:

The overall or total maintenance needs for the coming five years are:

**Table 5.1: Overall Maintenance Needs 2015-16 (Mill Taka)**

Year	2015-16	2016-17	2017-18	2018-19	2019-20	Total
<b>Total</b>	196518.00	29595.57	26300.15	20162.29	18568.22	291144.30

The immediate maintenance need for the year 2015-16 is:

**Table 5.2: Immediate Maintenance Needs 2015-16 (Mill Taka)**

Routine Maintenance	Periodic Maintenance	Maintenance Backlog		Total Need
		Partial Reconstruction	Full Reconstruction	
3014.73	35751.49	31312.35	53305.15	123383.72

### 5.2 Recommendations:

- Since HDM-4 is basically an economic tool for selection and prioritisation of road maintenance options, Field visits and design verification must be undertaken before finalising treatment option.
- Routine maintenance has to be done properly and should be the first budget priority.
- Since the prioritisation of projects using NPV/Cost favours the more highly trafficked roads, adoption of a separate prioritisation process for zilla road is recommended.
- Small contracts (up to 30 million taka) should be avoided in the maintenance programme to improve quality of works.
- Separate budget provision is necessary to address backlog clear up.