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FINAL REPORT

Periodic Studies for 4-Lane, Rewa- MP/UP Border (Hanumana) Section from km 229/800 to km 140/600 (Length 89.3 km) of NH-7 (new NH-135 & NH-30) in the state of Madhya Pradesh on BOT Basis- VEPL

SAMARTH INFRAENGG Technocrats Private Limited

SAMARTH
committed competence

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ABBREVIATIONS AND SYMBOLS

AADT	-Average Annual Daily Traffic
AE	-Authority Engineer
AMC	-Annual Maintenance Contract
ATMS	-Advanced Traffic Management System
BC	-Bituminous Concrete
BOQ	-Bill of Quantities
BOT	-Build, Operate & Transfer
BPC	-Bid Project Cost
CA	-Concession Agreement
CBR	-California Bearing Ratio
CCB	-Concrete Crash Barrier
CCR	-Cement Concrete Railing
COD	-Commercial Operation Date
COS	-Change of scope
CPI	-Consumer Price Index
CUP	-Cattle Underpass
CVC	-Classified Volume Count
CVPD	-Commercial Vehicles per Day
DBM	-Dense Bituminous Concrete
DPR	-Detailed Project Report
ECB	-Emergency Call Box
EPC	-Engineering, Procurement and Construction
ESI	- Employees' State Insurance
FDD	-Filed Dry Density
FOB	-Foot Over Bridge

FRL	-Finished Road Level
FSI	-Free Swell Index
FWD	-Falling Weight Deflectometer
FY	-Financial Year
GOI	- Government of India
GR	-Growth Rates
GS	-Grade Separated
GSB	-Granular Sub Base
GST	-Goods and Services Tax
HCPT	-Half cell Potential Test
HPC	-Hume Pipe Culvert
HR	- Human Resources
HTMS	-Highway Traffic Management Systems
IE	-Independent Engineer
IRC	- Indian Roads Congress
IRC SP	- Indian Roads Congress Special Publications
IRI	-International Roughness Index
Km	-kilometer
LHS	-Left Hand Side
LL	-Liquid Limit
LS	-Lumpsum
m	-Meter
MBIU	-Mobile Bridge Inspection Unit
MCB	-Metal Beam Crash Barrier
MCS	-Micro Surfacing
MCW	-Main Carriageway
MDD	-Maximum Dry Density
MHR	-Metallic Hand Rail
MJB	-Major Bridge
mm	-Millimeter
MM	-Major Maintenance
MNB	-Minor Bridge
MoRTH	- Ministry of Road Transport & Highways
Mpa	-Mega Pascal
MPRDCL	-Madhya Pradesh Road Development Corporation Ltd.
MR	-Resilient Modulus
MSA	-Million Standard Axle
NDT	-Non-Destructive Testing
NHAI	- National Highways Authority of India
NPA	- Nonperforming Asset
NSV	- Network survey Vehicle

O&M	- Operation and Maintenance
OL	-Overlay
PF	-Provident Fund
PGR	-Pedestrian Guard Rail
PI	-Plasticity Index
PL	-Plastic Limit
PM	-Periodic Maintenance
PUP	-Pedestrian Underpass
R&R	-Repair and Rehabilitation
RCC	-Reinforced Cement Concrete
RE Wall	-Reinforced Earth Wall
RHS	-Right Hand Side
RHT	-Rebound Hammer Test
RM	-Routine Maintenance
ROB	-Road Over Bridge
RPO	-Route Patrol Officer
RUB	-Road Under Bridge
SDBC	-Semi-Dense Bituminous Concrete
SPV	-Special Purpose Vehicle
SR	-Service Road
SWB	-Static Weigh Bridge
TCS	-Typical cross Section
TDRT	-Transient Dynamic Response test
TMS	-Toll Management System
UI	-Unevenness Index
UPVT	-Ultra Pulse Velocity test
VDF	-Vehicle Damage Factor
VG	-Viscosity Grade
VUP	-Vehicular Underpass
WBM	-Water Bound Macadam
WMM	-Wet Mix Macadam
WPI	-Wholesale Price Index

CHAPTER 1.INTRODUCTION

1.1 INTRODUCTION

The Government of India had entrusted to the "Authority", Madhya Pradesh Road Development Corporation Limited (MPRDC) to develop existing road to 4-lane from km 229+800 to km 140+600 (approx. 89.3 km), Rewa to MP/UP Border (Hanumana) section of National Highway 7 (presently New NH-135 & NH30) in the state of Madhya Pradesh to be executed design, built, finance, operate and transfer (DBFOT) basis. Accordingly, MPRDC has invited tenders and awarded the Project to the successful bidder, M/s JMC Projects (India) Ltd on 19.12.2011(LOA).

Consequent to this, M/s JMC Projects (India) Ltd., formed a Special Purpose Vehicle (SPV) in the name M/s **Vindhyachal Expressway Private Limited (VEPL),** as the Concessionaire for implementing/execution of the project. The Concession Agreement was signed between MPRDC and the Concessionaire on 25.01.2012.

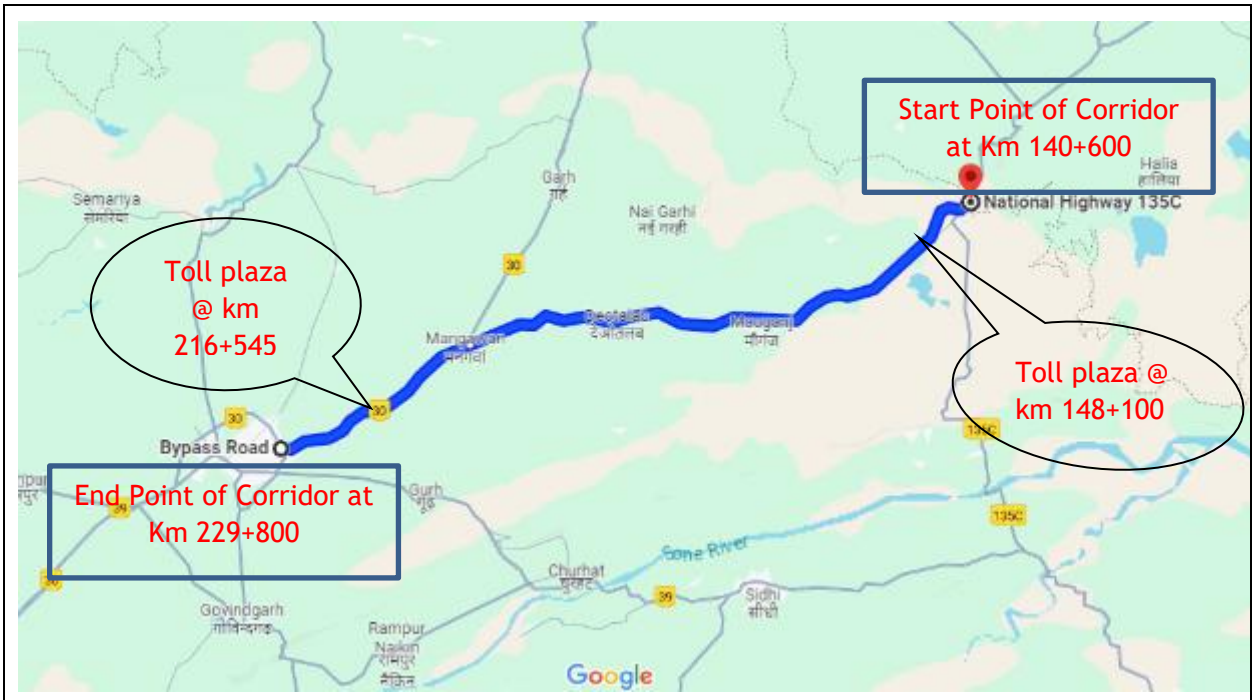
The Concessionaire obtained Provisional Completion certificate (PCC), PCOD-1 for a length of 49.629 km on 07.02.2015 from km 180.200 to km 229.829 and PCOD-2, for a length of 39.600 km on 28.03.2016 from km 140.600 to km 180.200 with a punch list of items to be completed within 90-days of the issuance of PCC. Further, Final Completion certificate obtained for a length of 89.229 km on 14.07.2021 with a condition note that Concessionaire will complete the balance works related to highway items such as service road, drain and PGR etc. as whenever the said land is made available by MPRDC. The project is presently under operation and maintenance by Concessionaire.

The Actis GP LLP Ltd has engaged M/s Samarth Infraengg Technocrats to undertake a periodic study for the said project. This report highlights the findings of study undertaken by consultants to estimate initial improvement cost (EPC) including immediate requirements for repair & rehabilitation of various elements and make an assessment of Operation & Maintenance costs for entire concession period.

1.2 PROJECT AT A GLANCE

The Project Road was a part of National Highway 7 at the time of bidding process which connects Varanasi and Kanyakumari. In the recent past, Government of India, MORTH has initiated the rationalization of numbering systems of National Highways. Thus, the Project stretch falling in new NH-135 from km 140.600 to km 205.400 and balance length from km 205.400 to km 229.800 is falling under NH-30.

The project road starts at km 140.600 MP/UP Border (Hanumana) and terminates at end of Rewa bypass 229.800 in the state of Madhya Pradesh. The project road is situated in Rewa district touching the outskirts of Raipur, Mangawan, Ragunathganj, Devtalab, Mauganj, Hanumana towns/villages.



Map Showing the Project Corridor

The project road starts from MP/UP Border near Hanumana at km 140.600 of NH-135 and terminates at Rewa city bypass at km 229.800 of NH-30 having the total existing length of 89.229 Kms.

Table 1: Project Corridor Chainage System

Referencing system	Project Corridor Start Point (km)	Project Corridor End Point (km)	Length (km)
CA Chainage	140.600	229.800	89.200
As per Site	140.600	229.829	89.229

Photograph showing the start and end point of the project road are presented below:

Start Point of project at km 140.600

End Point of project at km 229.829

Following Table highlights the total project at a glance:

Table 2: Project Details

S No.	Description	Date
1.	Letter of Award (LOA)	19.12.2011
1.	Date of Signing the Concession Agreement	25.01.2012
2.	Appointed Date (AD)	20.02.2013
3.	Scheduled Project completion (730days from Appointment Date)	19.02.2015
4.	Date of issue of Provisional Completion Certificate PCOD-1: Km 180.200- Km 229.829 PCOD-2: Km 140.600- Km 180.200	07.02.2015 (for 49.629 km) 28.03.2016 (for 39.600 km)
5.	Date of Issue of Final Completion Certificate	14.07.2021
6.	Scheduled End of Concession (30 years from Appointed date)	19.02.2043
7.	Extension of End of Concession (89 days based on traffic and revenue of toll collection)	19.05.2043
8.	Anticipated End of Concession (6 years, due to shortfall traffic)	19.02.2049

1.3 OBJECTIVE AND SCOPE OF SERVICES

The main objective of the study is to review the current status of project corridor including details pertaining to its construction and maintenance and to provide requisite technical information for processing the acquisition of said project by client.

The scope of services as defined in the "terms of reference" for consultants is as below:

- Desktop review of project documents such as CA, project schedules, latest MPR's, COS works, As-built drawings of highway and structures, any other technical documents pertaining to project.
- Undertaking detailed reconnaissance, inventory of Highway & Structures, preparation of O&M cost.
- Following field investigations are considered as per the scope mentioned in your ToR.
  - FWD survey along the Main carriage way (4-Lane section @ 5 points per KM in each direction).
  - Pavement condition survey and Roughness survey using Network Survey Vehicle (NSV) along main carriageway
  - Collection and Testing of existing Sub grade and Granular Material (GSB/WMM) characteristics using Test Pits @ one pit for every 5Kms (approximately 18 nos.)
  - Collection and Testing of Borrow Areas for Earthwork and few samples of Aggregates and Sand from quarries (Approximately 5nos)

- Axle load survey considered at 2 locations for 24hrs and based on CVC supplied by client direction wise MSA along project highway shall be estimated.
- Undertaking bituminous cores along the existing pavement (approximately 9nos).
- Inspection of structures (bearings) using MBIU is not included in present quote.

- Pavement life evaluation with the use of FWD survey as per relevant IRC codes.
- Assessment Major Maintenance schedule subjected to the requirement of CA and Schedules for the balance concession period based on the results of above investigations and using HDM analysis for each homogeneous section.
- Conducting Visual inspection of all the existing structure for the assessment of residual life of structures & rehabilitation measures requirement if any other than mentioned in schedules, costing as per applicable Manual & IRC.
- Based on preliminary visual observation of structures, if required detailed inspection of structures using MBIU along with necessary tests such as NDT testing, UPV etc., shall be taken up upon confirmation from client at mutually agreed quantity and price.
- Review of TMS equipment and functionality at all the toll plaza locations, and also ATMS along the project highway if any. A detailed cost estimate shall be presented w.r.to any deficiencies in TMS & ATMS in comparison with Schedules requirements.
- Verification of balance works, punch list items, etc. (if any) and preparation of an estimate of the cost/ time required to complete the balance works
- Preparation of details O&M cost estimate.

1.4 REVIEW OF CONCESSION AGREEMENT

Few important contract clauses of the project road are as presented below

S. No	Relevant Clause	Description
1	Initial 2 pages of CA	LOA:19.12.2011 Agreement Signed Date: 25.01.2012
2	Clause 3.1 of CA	Concession Period: 30 years from Appointed Date
3	Clause 4.1.2 of CA	The Conditions Precedent required to be satisfied by the Concessionaire within, unless specifically stated, a period of 180 days from the date of this Agreement or within any extended date agreed by the Authority, and in any case prior to the Appointed Date
4	Clause 4.2 of CA (Delay by Authority)	Authority shall pay to the Concessionaire, damages in an amount calculated at the rate of 0.1% performance Security for each day's delay until the fulfilment of such Condition precedent, subjected to the maximum limit equal to 20% of Performance Security.

S. No	Relevant Clause	Description
5	Clause 6.3 of CA (obligation relating to Competing Roads)	Neither Authority nor any Govt, shall not construct competing road any time before 10th Anniversary of the Appointed Date. The restriction shall not apply if the average traffic in any year exceeds 90% of design capacity specified in clause 29.2.3
6	Clause 9.1 of CA	Performance Guarantee:33.55 Crores
	Clause 10.3 of CA (Right of way)	The land granted within 90days of appointed date shall be completed before Completion Date.
7	Clause 12.4.1 of CA	Construction Period: 730 days from the Appointed Date
8	Clause 12.7 of CA	Authority may any time after 12th Anniversary of the Appointed date may construct service lanes at its costs. Concessionaire has obligation to maintain these service lanes also in accordance with the specifications and standards applicable to other district roads (ODRs) in the state.
9	Clause 14.3 of CA (Provisional Certificate)	Provisional Certificate can be given to Concessionaire for part of the project highway with the Punch list items, if at least 75% of total length of the Project Highway has been completed.
10	Clause 14.4 of CA	All items in the punch List shall be completed by the Concessionaire within 90 days of the date of issue of the Provisional Certificate. For the delays Authority shall be entitled to recover damages from as per clause 14.4.1.
11	Clause 15.1 of CA	On issuance of PCC or Completion Certificate, the date can be considered as COD. The Concessionaire shall be entitled to demand and collect Fee in accordance with the provisions of Article 27.
12	Clause 15.2 of CA	COD should occur prior to 91 days after the date of Schedule Four Laning Date. Damages for delay of COD, shall be 0.1% of the Performance Security for delay of each day until COD is achieved.
13	Clause 16.3.2 of CA	COS issued during Construction period: up to 0.25% of the Total Project Cost shall be borne by Concessionaire and anything in excess shall be reimbursed to Concessionaire by Authority. If COS is less than 0.25% of total project Cost, then the difference there shall be credited by the Concessionaire to the Safety Fund within 180 days of project completion date.
14	Clause 16.6 of CA	Reduction in scope of work: If the Concessionaire failed to complete any construction work on account of Force Majeure or any other reasons attributable to Authority then Authority may ask Concessionaire to pay 80% of the sum saved therefrom. Upon doing the above, the obligation of the Concessionaire deemed to have been fulfilled.
15	Clause 17.3 of CA	Not later than180 days prior to the scheduled 4-laning date, the Concessionaire shall provide Maintenance Manual. The Maintenance Manual shall be revised and updated once in every 3 (three) years.

S. No	Relevant Clause	Description
16	Clause 17.4 of CA	Not later than 45 days prior to the beginning of each Accounting Year during the Operation Period, the Concessionaire shall provide to the Authority and the IE, its proposed annual maintenance programme.
17	Clause 17.5.2 of CA	Concessionaire has to maintain and operate a round-the-clock vehicle rescue post with one mobile crane of having capacity to lift a truck with a Gross Vehicle Weight of 30,000 kilograms;
18	Clause 17.8 of CA (Maintenance obligations)	Damages for breach of maintenance obligations: Damages shall be calculated for each day of delay at higher of (a) 0.5% of average daily fee and (b) 0.1% of the Cost of such repair or rectification.
19	Clause 18.2 of CA	All Costs relating to safety requirement shall be borne by the Concessionaire to the extent that such costs and expenses form part of the scope and costs not forming part of the scope shall be borne from safety fund to be managed and operated by the Authority
20	Clause 19.1 of CA	Monthly status Report: The Concessionaire shall submit a detailed monthly status Report no later than 7 days after the close of each month
21	Clause 19.2 of CA	O&M Inspection Report: The IE Shall inspect the Project Highway at least once in a month and send a detailed Report to Authority/ Concessionaire within 7 days of such inspection.
22	Clause 19.3 of CA (Tests)	For determining that the project highway confirms to the maintenance requirements, IE may ask the Concessionaire to perform certain test and the one of the costs incurred for performing such test to the extent certified by IE will be reimbursed by Authority
23	Clause 20.3 and 20.4 CA	Building for Traffic Aid Post: 25 square meter of plinth area for each of the traffic aid post and shall hand over to Authority within 60 days prior to SCOD. One Jeep or similar vehicle in good working condition shall be provided to state police department along with chauffeurs for the round-the-clock patrolling and shall meet operation cost of vehicles including the salaries and allowances of chauffeurs.
24	Clause 21.2 and 21.3 CA	Medical Aid post: Construct an aid post and 2 residential quarters and handover to Government within 30 days prior to SCOD Towards recurring expenditure, one ambulance in good working condition along with chauffeurs for the round-the-clock ambulance services shall meet operating cost of ambulance including the salaries and allowances of chauffeurs and two medical personals exclusively deployed for Medical Aid post
25	Clause 23.3 of CA	Remuneration of IE: One half of the IE Fee shall be borne by Concessionaire.
26	Clause 25.4 & 26.2 of CA	Concessionaire to pay Authority for each year of Concession Period on the COD date, a “Premium” in the form of an additional Concession Fee a sum of Rs.1 per annum

S. No	Relevant Clause	Description
27	Clause 26.2 of CA (addl. Concession fee)	Additional Concession Fee: Rs. 3.6 Cr. per annum. And for each subsequent year shall be increased by an additional 5% as compared to the immediately preceding year.
28	Clause 27.2.1 of CA (user fee)	Revision of Fee shall be annually on April 1.
29	Clause 27.6 of CA (Re-appropriation of excess fee)	If the average daily traffic of PCUs in any Accounting year exceeding 120% of designed capacity "Traffic Cap", the Fee levied and collected exceeding Traffic cap shall be deemed to be due and payable to Authority.
30	Clause 27.10 of CA (additional Fee)	Additional fee for overloaded vehicles: Concessionaire may recover fee for overloaded vehicle at the rate applicable to the next higher category of Vehicles.
31	Clause 28.1.1 of CA (Revenue shortfall loan)	If Realisable Fee in any Accounting Year shall fall short, Concessionaire shall be eligible for "Revenue shortfall loan" at an interest rate equal to 2% above the Bank Rate.
32	Clause 29.1 of CA (effect of variation in traffic)	Target date: 01.10.2035. Target Traffic: 42,473 PCUs per day Actual Traffic shall have fallen short of the Target Traffic by more than 2.5% thereof or exceeded the Target Traffic by more than 2.5% Concession Period shall be deemed to be modified
33	Clause 29.2.1 of CA (in case of shortfall of traffic)	in the event the actual traffic is fallen short of target traffic, then for every 1% short fall as compared to target traffic, the concession period shall be increased by 1.5% thereof; provided that the increase in Concession Period shall not be more than 20% of Concession Period.
34	Clause 29.2.2 of CA (in case of exceeded traffic traffic)	in the event the actual traffic exceeded the target traffic, then for every 1% excess as compared to target traffic, the concession period shall be reduced by 0.75% thereof; provided that the reduction in Concession Period shall not in any case exceed 10% of thereof.
35	Clause 29.2.3 of CA	Designed Capacity of the Four Lane: 60,000 PCUs (Average Daily Traffic). In case the traffic exceeds the design capacity, then the Authority may terminate the project by paying termination payment.
36	Clause 30.1 of CA	Restriction on construction of Additional Toll way: Authority shall not construct any additional road before the 18th Anniversary of Appointed date. If the length of the new road exceeds above 20% the project length, then it is not a "Additional Toll way".

S. No	Relevant Clause	Description
37	Clause 30.2 of CA	Modification in Concession period due to Additional Toll way: additional concession period shall be equal in duration period between the opening of the additional toll way and the 30th anniversary. If additional Toll way is opened on the 27th anniversary, the Concession Period shall be deemed to be 33 years.
38	Clause 32.1 of CA	Insurance during Concession Period: The Concessionaire shall effect and maintain at its own cost, during the Construction period and the operation period, such insurances for such maximum sums as may be required under the Financing Agreements, and the Applicable Laws and in accordance with Good Industry Practice.
39	Clause 33.2.1 of CA	All fee and expenses of the Statutory Auditors shall be borne by the Concessionaire
40	Clause 37.3 of CA	**Termination on account of Concessionaire default during O&M period:** Authority shall pay Termination Payment, an amount equal to 90% of the Debt Due less Insurance Cover **Termination on account of Authority default:** Authority shall pay an amount equal to Debt Due and 150% of the Adjusted Equity.
41	Clause 38.6 of CA	The Concessionaire shall bear and pay all cost incidental to Divestment except stamp duties
42	Clause 39.1 of CA	Concessionaire responsible for all defects and deficiencies for a period of 120 days after termination.
43	Clause 41.1 of CA (Change in Law)	Increase in Cost due to Change in Law for increase in Cost or reduction in net after-tax return due to change in Law, the aggregate financial effect of which exceeds the higher of Rs. 1.0 crore and 0.5% realisable fee in any accounting year. Authority has to compensate the Concessionaire.
44	Clause 41.2 of CA (Change in Law)	Reduction in Cost due to Change in Law reduction in Cost or increase in net after-tax return, the aggregate financial effect of which exceeds the higher of Rs. 1.0 crore and 0.5% realisable fee in any accounting year. Concessionaire has to pay back to Authority.
45	Clause 44.3 of CA	Arbitration: Any dispute shall be resolved amicably by way of conciliation. If not resolved shall be decided by reference to Arbitration, in accordance with rules of Arbitration of the International Centre for Alternative Dispute Resolution, New Delhi (the "Rules"), or such other rules as may be mutually agreed by the Parties, and shall be subject to the provisions of the Arbitration and Conciliation Act

S. No	Relevant Clause	Description
46	Clause 47.1 of CA	Governing Law: Agreement shall be construed and interpreted in accordance with and governed by the laws of India, and the courts at Bhopal (MP) shall have exclusive jurisdiction over matters arising out of or relating to this Agreement

The Applicable manual for this project is IRC: SP:84-2009, for Four-Lane roads and applicable Schedule for O&M activities is Schedule K of the Concession Agreement.

Schedule K of CA species that Roughness value exceeds 2500 mm/km in a length of KM, needs to be corrected within 180 days.

1.5 REVIEW OF DRAWINGS AND DESIGNS

Drawing made available have been reviewed and has been categorized mainly into 3 groups as:

1. Highway Drawings
2. Structural Drawings
3. Pavement Design Reports

- **Highway plan & profile drawings**

Following is the summary from review of Highway drawings of the project:

Table 3: Review of Highway Drawings

Elements	Criteria	Details
Horizontal alignment	Length, km	89.229
	No. of Horizontal Curves	107
	Deflection angle Criteria Deficiencies	
	Total no's	25
	Flat curves(R>2000)	Out of 25, at 11 location R>2000
	Broken Back curves	
	Total no's	6
	Flat curves(R>2000)	Out of 6, at 1 location R>2000
	Curves < 400m	
	Minimum/Maximum Radius	400/25000
	Design Speed	100(97), 80(9), 60(1)
Vertical alignment	Vertical Curve details	Details are given for the entire stretch
	Maximum gradient	4.4%
	Summit Curves Minimum/Maximum K value	Out of 92 curves ISD - 100(70), ISD - 80(16), <ISD - 80 (6) with minimum K as 27
	Majority section 'K'value designed for	ISD-100
TCS	No. 0f TCS types proposed	14

Elements	Criteria	Details
	Built-up/Approach TCS	10
	Rural	4
	CW width rural/urban/Approach	8.75/9.25/9.25
	SR width	5.5
	Drains	Footpath cum box drain of 2m width Provided at SR outer edge
	Side slope-- MCW/SR	1:1.5
Miscellaneous	Entry/Exit type	As per Schedule D
	Safety measures in MCW median/Separator	MCB is proposed in both sides of the median. PGR was proposed in separator for length of 1.95km as minimum and at every bus bay/bus shelter location for 200m length.
	Junctions	Junction drawings are not provided.
	Truck lay bye	Truck lay bye drawings not provided
	Bus bays	Bus bay dwgs are not provided
	Street lighting	As per Schedule C.
	Highmast	As per Schedule C.

S. No	Description	Approved Drawing	As Built P&P Drawings
1	P&P Drawing	Available	Not Available
2	TCS	Available	Not Available
3	Service Road Drawings	Available	Not Available
4	Toll Plaza Drawings	Available	Not Available
5	Bus Bays	Available	Not Available
6	Truck Lay byes	Available	Not Available
7	Junction	Available	Not Available
8	Drains	Not Available	Not Available

➢ REVIEW OF PAVEMENT DESIGN

Design CBR

As per the approved Pavement design report, the Subgrade material having CBR value of 10 % used in the pavement design.

Summary of VDFs

VDFs adopted in Pavement Design Report						
Section	Chainage	Direction	LCV	2 Axle	3 Axle	MAV
Section-I	Km 140+572 to Km 203+650	UP	0.69	2.72	2.4	1.55
		DN	1.4	3.15	7.23	5.34
Section-II	Km 203+650 to Km 229+800	UP	0.69	2.72	2.4	1.55
		DN	1.4	3.15	7.23	5.34

Design MSA

The Design traffic for the project road in term of cumulative number of standard axles has been computed for a design life of 10 years and for end of the concession period of Main carriageway as given below:

Design traffic loading (MSA)				
Section	Chainage	Direction	10 years	30 years
Section-I	Km 140+572 to Km 203+650	UP	7	34
		DN	18	88
Section-II	Km 203+650 to Km 229+800	UP	14	67
		DN	39	192

Pavement Crust Main carriageway

Design of New construction is carried out in accordance with IRC 37 2001. The Bituminous layers are designed for 10 years for 4 lane road. Base and sub base layers are designed for 30 years.

The Pavement layer thickness adopted for Section-I (Km 140+600 to Km 203+650):

S No.	Pavement layer	Hanumana - Mangawan		Mangawan - Hanumana	
1	Bituminous Concrete (BC)	40	7 msa	40	18 msa
2	Dense Bituminous Macadam (DBM)	50		70	
3	Wet Mix Macadam (WMM)	250		250	
4	Granular Sub-base	200		200	

The Pavement layer thickness adopted for Section-II (Km 203+650 to Km 229+800):

S No.	Pavement layer	Mangawan - Rewa		Rewa - Mangawan	
1	Bituminous Concrete (BC)	40	14 msa	40	39 msa
2	Dense Bituminous Macadam (DBM)	75		100	
3	Wet Mix Macadam (WMM)	250		250	
4	Granular Sub-base	200		200	

Further IE has reviewed the proposal, revised the crust with additional DBM thickness as mentioned in table below and further mentioned that COS for the increased DBM is not acceptable. The following revised thicknesses is finally adopted along the project road.

S No.	Pavement layer	Km 140.600 to Km 203.650 (for both carriageways)	Km 203.650 to Km 229.800 (for both carriageways)
1	Bituminous Concrete (BC)	40	40
2	Dense Bituminous Macadam (DBM)	80	100
3	Wet Mix Macadam (WMM)	250	250
4	Granular Sub-base	200	200

For Rigid Pavement

For the Rigid Pavement following thicknesses have been considered

PQC: 300mm

DLC: 150mm

GSB: 150mm

Service Road Design

The Service Road has to be designed for design traffic of 5 MSA as per manual clause 5.5.5.

As per Pavement Design Report and P&P drawings, the service road has been designed for 5MSA & CBR-10%. The Pavement layer adopted for service road as given below:

Pavement Layer	Thickness (mm)
Semi Dense Bituminous Concrete (SDBC)	25
Dense Bituminous Macadam (DBM)	50
Wet Mix Macadam	250
Granular Sub-base	150

1.6 REVIEW OF EPC AGREEMENT

- Review of EPC agreement reveals that the Concessionaire (VEPL) and EPC Contractor (JMC) entered into an EPC agreement on 30.01.2012.
- As per EPC agreement, the Contractor also acknowledges that the Concession agreement between MPRDC and the Concessionaire is always binding on a back-to-back basis on the EPC Contractor and in case of discrepancy in whatsoever matter, the clauses and conditions of the CA shall prevail over this EPC Contract.
- As per Clause 3.4, EPC Contractor is responsible for complying the CA provisions and shall be responsible for Safety and stability works and all project operation etc,
- EPC Contractor shall pay all taxes and duties including import fee and customs duties.
- EPC Contract shall comply with all Quality system and shall maintain all records of all tests
- EPC Contractor is responsible for all designs and execution of the work; he is also responsible for maintaining the Construction documents and shall arrange all the test certificates including the third-party material.
- As per Clause 4.1 of EPC Agreement, the Contact price is Rs.603.00 crores including all taxes and duties, being the fixed and lump sum.
- As per Clause 4.6.1 to 4.6.3 of EPC Agreement, 1st trench interest free advance payment up to 7,5% of contract price upon signing of the agreement and submitting Corporate Indemnity. 2nd trench interest free advance payment up to 7,5% of contract price upon on mobilization of key equipment and upon submission of Corporate Indemnity. The advance payment shall be recovered from RA bills when the progress of work reaches 10% of Contract price. And to be finish before the works reaches 80% of Contract Price.
- As per Clause 13.4 of EPC Agreement, Contractor to provide Performance Security in the form of BG equal to Rs.33.55 Crores upon signing the EPC agreement.

Turnkey EPC agreement

- EPC Turnkey agreement made between JMC Projects (India) Ltd and M/s Dilip Buildcon Ltd on 31.01.2012
- Defect Notification Period considered as 5 years from the date of Provisional Completion.

1.7 REVIEW OF O&M CONTRACTS

Annual Maintenance and Service Level Contract (AMSLC) for Toll Management, Electronic Toll Collection and Weigh in Motion Systems and Static Weigh Bridges has been awarded to M/s Techsture Technologies for providing non-comprehensive maintenance services for the Toll Management, Electronic Toll Collection and Weigh in Motion Systems and Static Weigh Bridges, installed at Toll Plaza located at Km 216+545 and 148+100 having 2 toll plaza consisting 18 Toll Lanes, comprising of 14 normal tolling lanes and 4 reversible tolling lanes.

Contract Value: The annual contract value is Rs. 14,80,000 /- excluding all applicable taxes, duties, charges, fees, Service Tax, which shall be paid extra as per the applicable law. The price quoted

shall remain firm for entire Contract Period. i.e. from 1st November 2022 to 31st October 2023. In the next year. i.e. from 1st November 2023 to 31st October 2024, the contract value shall be revised to Rs. 15,68,800 /-. i.e. 6% increment, excluding all applicable taxes, duties, charges, fees, service tax, which shall be paid extra as per applicable law. Both amounts mentioned the salary of Service engineer at site. i.e. Rs. 2.5 lacs per annum per engineer. After the above said period, the price would be mutually decided, however yearly escalation will be discussed and communicated by mutual consent of parties to this contract.

1.8 CHANGE OF SCOPE DETAILS

MPRDC letter dated…/10/2015 indicates +ve as 4.766 Cr (Rewa Flyover @ 229+829, PUP@ 142.470, PC@ km168.584 and Foot-path @km206428) and -ve COS 4.827 Cr (Hanumana bypass VUP @ km141.700 and Pipe/Slab Culverts @ 4-locations) with overall net negative COS of -Rs. 6.1 Lacs agreed by VEPL on account of non-execution of certain works. In addition to this, as per article 16.3.2, 0.25% of Total Project Cost (TPC Rs.670.82 Cr) i.e., Rs 1.677 Crs. Shall be recoverable from the Concessionaire for safety fund

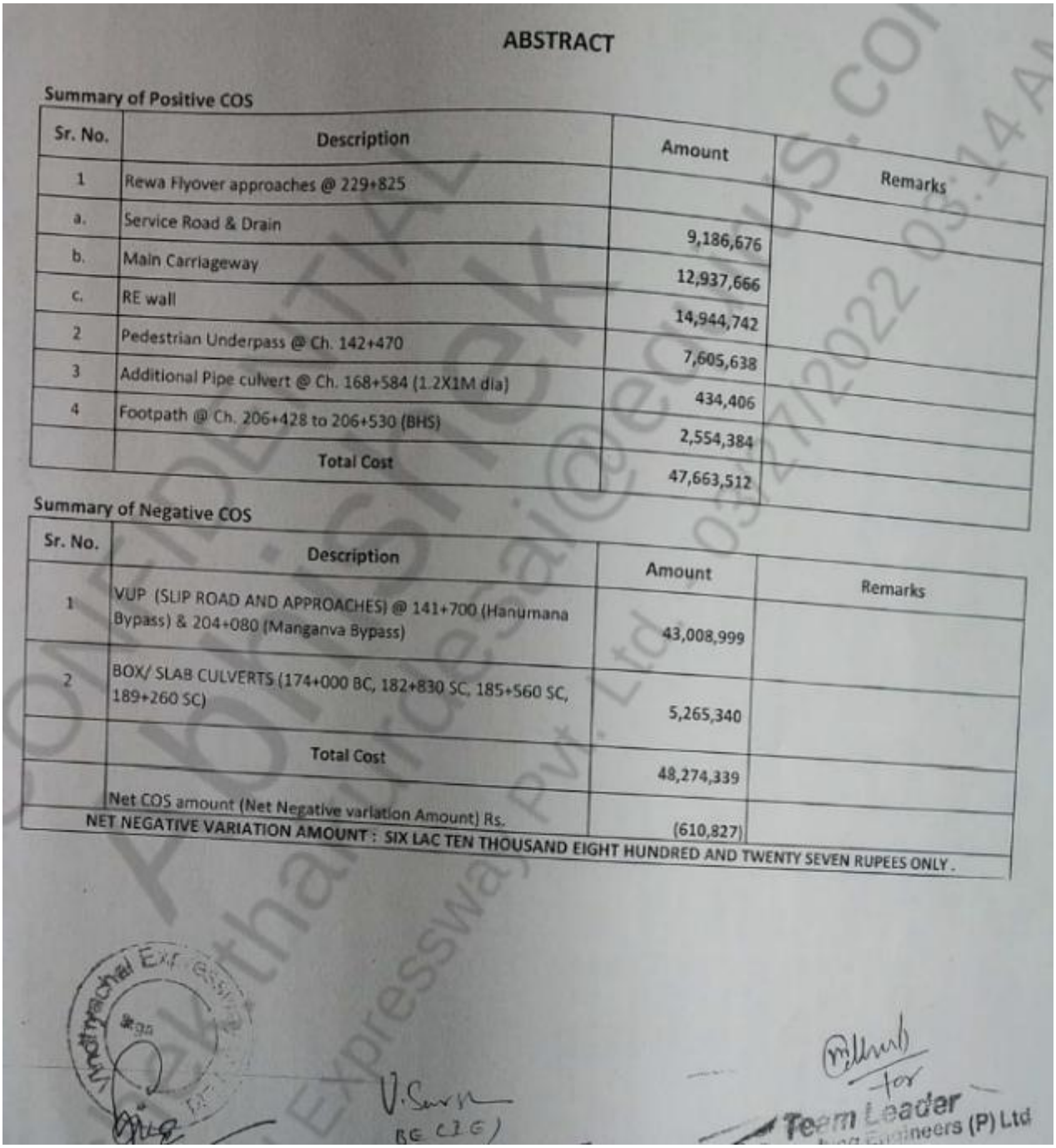
Change of Scope Proposal Dt:- 11-03-2015

Four Laning with Paved Shoulders Between Km. 229/10 at Rewa City to Km. 140/6 at MP/UP Border in the State of Madhya Pradesh (NH-7) on Design, Build, Finance, Operate and Transfer basis.

CLIENT : Madhya Pradesh Road Development Corporation Ltd
CONCESSIONAIRE : Vindhyachal Expressway Private Limited
INDEPENDENT ENGINEER : M.C. Consulting Engineers(P) Ltd

SR. NO.	CHAINAGE		EXISTING DETAILS AS PER SCHEDULE A	PROVISION AS PER SCHEDULE B	CONSTRUCTION PROPOSED BY CONCESSIONAIRE AS PER SITE CONDITION	REASONS & RECOMMENDATION BY INDEPENDENT ENGINEER	DECISION OF COMMITTEE
	EXISTING	DESIGN					
1	NA	141+700	NA	1X12 m VUP at Hanumana Byepass end point	There exists an integrated Border check post near the loaction of VUP and it is not possible to have a VUP at this location. This is mainly due to site constraint wrt ROW and land availability for approaches, if this is constructed will have major safety issue to the peoples working in 'Border Check Post Project. The issue was internally discussed in between IE & Concessionaire with respect to the plan and profile drawing of this area and it was decided to delete the VUP from this location. Hence this comes under a **Negative Change of Scope** of the project.	Because of MP/UP Border Check post the proposed VUP is Deleted. If this VUP is constructed will have major safety issue to the peoples working in 'Border Check Post Project. Also the topography of the chainage having ridge & adjacent check post construction, if constructed the border check post will be affected due to long aproach construction of this VUP. Hence it is recommended to consider the cost of VUP for **Negative Change of Scope.**	Committee has agreed with the reasons and recommendation given by Independent Engineer. Hence it is recommended to consider the cost of VUP for **Negative Change of Scope.**
2	NA	204+080	NA	1X12 m VUP at Mangawaan Byepass Hanumana end point	There is a Minor Bridge within the approch of the VUP on Hanumana end of Mangawan bypass and it is not possible to construct VUP at this location due to this design issue. The same was discussed internally in between IE and Concessionaire wrt plan and profile drawings of the project at this location and it was decided to delete this VUP. Hence it comes under **Negative Change of Scope** of the project.	Due to Minor Bridge at KM.203+764, the proposed VUP is Deleted. No any safety issue will arise after deleting this VUP. Hence it is recommended to consider the cost of VUP for **Negative Change of Scope.**	Committee has agreed with the reasons and recommendation given by Independent Engineer. Hence it is recommended to consider the cost of VUP for **Negative Change of Scope.**
3		a) 189+280 b) 185+560 c) 182+830 d) 174+000	a) 1x1 b) 1x1 c) 1x2 d) 1x3	Box culverts (4nos)	In the Concession Agreement construction of widening of slab culverts had been considered at these chainages (S No. a,b & c) . The culverts at these locations have not been widened since there was no existing slab culvert at these locations. In case of S No. (d) 174+000, Box Culvert at this location is deleted due (a) there was no water stream at this location and (b) due to a pipe culvert was proposed at location @173+940 (1x1.2m dia) & also another one Box Culvert was proposed at location @ 175+700 (1x6m), hence these 4nos of Culverts omes under **Negative Change of Scope.**	Existing 3nos of Slab Culverts were not available at site for widening and 1no Box Culvert was deleted due to 2nos of nearby Culverts. Hence come under **Negative change of scope.**	Committee has agreed with the reasons and recommendation given by Independent Engineer. Hence it is recommended to consider the cost of 3nos of Slab Culverts for widening and 1no Box Culvert for new construction for **Negative Change of Scope.**
4	NA	142+470 Provision of PUP	NA	No provition	Honorable MLA of Mauganj, Sh. Sukendra Singh Banna has requsted to construst an additional Underpass in Hanumana Byepass to ensure safe crossing of public, animals and agricultural tractors . There have been public representaions and agitations for the provition on Underpass at this location. Concessionaire submitted detail drawing and design for construction of a PUP at this location. IE inspected the site and reviewed submission and recommended the construction of a PUP at this location to improve safety of road users and cattle crossing. Since there was no provision of Underpass at this location in the CA, same comes under **Positive Change of Scope.**	Local Public demand and same was also necessary to ensure safe crossing of highway by pedestrians and cattles. Hence it is recommended to consider the cost of PUP for **Positive Change of Scope.**	Committee has agreed with the reasons and recommendation given by Independent Engineer. Hence it is recommended to consider the cost of PUP for **Positive Change of Scope.**

Further to the above the overall +ve & -ve COS works are as follows



ABSTRACT

Summary of Positive COS

Sr. No.	Description	Amount	Remarks
1	Rewa Flyover approaches @ 229+825		
a.	Service Road & Drain	9,186,676	
b.	Main Carriageway	12,937,666	
c.	RE wall	14,944,742	
2	Pedestrian Underpass @ Ch. 142+470	7,605,638	
3	Additional Pipe culvert @ Ch. 168+584 (1.2X1M dia)	434,406	
4	Footpath @ Ch. 206+428 to 206+530 (BHS)	2,554,384	
	Total Cost	47,663,512	

Summary of Negative COS

Sr. No.	Description	Amount	Remarks
1	VUP (SLIP ROAD AND APPROACHES) @ 141+700 (Hanumana Bypass) & 204+080 (Manganva Bypass)	43,008,999	
2	BOX/ SLAB CULVERTS (174+000 BC, 182+830 SC, 185+560 SC, 189+260 SC)	5,265,340	
	Total Cost	48,274,339	
	Net COS amount (Net Negative variation Amount) Rs.	(610,827)	

NET NEGATIVE VARIATION AMOUNT : SIX LAC TEN THOUSAND EIGHT HUNDRED AND TWENTY SEVEN RUPEES ONLY .

Madhyanchal Expressway Pvt. Ltd.

for Team Leader

Engineers (P) Ltd

1.9 REVIEW OF INSURANCES:

As per Sub Clause 32.1 of Concession Agreement, Concessionaire shall obtain and maintain at no cost to NHAI during Operation Period in respect of the Project Highway and its operations such insurance as may be required under any of the Financing Documents, Applicable Laws and such insurance as the Concessionaire may reasonably consider necessary or desirable in accordance with Good Industry Practice. The following insurance are maintained:

1.10 KEY FINDINGS:

- The Project Road Starts at Km 229.829 near Rewa City and ends at Km 140.600 @ MP/UP Boarder near Hanumana Village.
- Balance works as per site in terms of length: Service Roads of 2.860 kms; RCC Cover Drains of 1.210 kms; PGR of 2.650 kms & Side Kerb of 3.270 kms.
- It is observed from the site that about 60-70% of the Traffic is being diverting from the Junction at Km 205.400 (NH-30) towards Prayagraj.
- From the site, it is understood that from the overloaded trucks, Concessionaire is collecting (3X Fare) as penalty instead of 10XFare as per CA with intention that Heavy penalty (10XFare) may further reduce traffic on project road.
- Inner-lane rutting associated with cracking is observed in full length of the corridor which is more when compare with that on outer-lane carriageway. It seems only maintenance works are ongoing by attending surface defects in the form of crack sealing, mill and overlay and MCS works either in inner-lane or outer-lane. Full width overlay has not been done on project road thus far.
- As the pavement design is done for stage-construction, considering 10 year of design life, the expected overlay is warranted in FY 2025/FY2026.
- At km 192+000, irrigation canal crossing works are in progress by other EPC Contractor and about 50m length of main carriageway is tackled by this EPC contractor.
- The distresses like gaps/cracks/misaligned RE-blocks were observed at RE-wall portion of VUP @ km 152+840, VUP @ km 159+500 are attended by Concessionaire on temporary basis by filling with grout. However, cost provision shall be considered to rectification of these defects in MMR cycles.
- Based on Road safety Audit Reports, at two locations Black spots are identified as below

Safety Audit report	Recommendations	Work status
For the month Nov-2020	Km 200.320: Provision of service road 750m on each side of Highway including fixing of PGR and Street lighting. Estimate: 249.04 Lakhs	Not started on ground.
For the month: Jun-2021	Km 206.420: Provision of VUP with service road with drain on each side of Highway. Estimate: 14.46 Crores	Work started by other EPC Contractor: M/S Ram Sajjan Sukla agency

Note: DLP period for on-going work and expected completion date is to be ascertained.

- Change of Scope Works: MPRDC letter dated…/10/2015 indicates +ve as 4.766 Cr (Rewa Flyover @ 229+829, PUP@ 142.470, PC@ km168.584 and Foot-path @km206428) and -ve COS 4.827 Cr (Hanumana bypass VUP @ km141.700 and Pipe/Slab Culverts @ 4-locations) with

overall net negative COS of -Rs. 6.1 Lacs agreed by VEPL on account of non-execution of certain works. In addition to this, as per article 16.3.2, 0.25% of Total Project Cost (TPC Rs.670.82 Cr) i.e., Rs 1.677 Crs. Shall be recoverable from the Concessionaire for safety fund.

- Concession period extended by 89 days i.e., Scheduled End of Concession (19.02.2043) has been revised to 19.05.2043.
- Maintenance Requirements, Schedule K: CA species that Roughness values exceeding 2500 mm/km in a length of KM, needs to be corrected within 180 days. There is no mention of Allowable Characteristic deflection & BBD survey test in Schedule K. However,4-lane manual, clause 5.8 suggests that deflection measurement shall be taken in every 5 years as per IRC:81.
- No specific Handing Over (Divestment) requirements are mentioned under CA. Clause 7 of Schedule K specifies that, all defects and deficiencies specified in this schedule-K shall be repaired and rectified by the Concessionaire so that the Project conforms to the Maintenance Requirements on the Transfer Date.

CHAPTER 2. SURVEYS AND INVESTIGATIONS

2.1 INTRODUCTION

The main objective of undertaking Surveys and Investigations is to:

- appreciate the existing engineering features along the project corridor
- to understand the present condition of the various elements of the project road
- to prepare required inputs for various rehabilitation and maintenance strategies.

Following Survey and Investigations have been undertaken as a part of study with an objective to understand the present condition of the road and there by access the quality of construction and as well to prepare requisite rehabilitation/corrective designs where necessary.

- Road Inventory Surveys
- Pavement Condition using NSV
- FWD Surveys
- Roughness Surveys using NSV
- Pavement Composition surveys (Test Pits)
- Subgrade Investigations & Laboratory testing
- Material Investigations
- Core Investigations
- Axle Load Survey
- Structure Inventory and Condition Surveys

The above said surveys are conducted in the month of December 2023. Further again, only NSV surveys and Cores tests are conducted in the month of March 2025.

2.2 ROAD INVENTORY

The project corridor has 4-lane divided carriageway with Flexible pavement in the entire length of project corridor except at Toll Plaza locations it has rigid pavement. In general, the cross-sectional elements are as 7.0m wide carriageway, 0.5m shyness, 1.5m paved shoulder plus 1m to 2m earthen shoulder on either side of the median. In general, the median width is 4.0m in rural & 1.5m in urban reach. The project corridor generally runs in plain terrain:

In general, road embankments are in the range of 1.0m-2.0m height in urban limits and in bypass/realignment 2m to 3.5m embankments are observed. High embankment above 3.5m are observed in the approaches of Cross Drainage (CD) structures and Underpass locations. The collected Road Inventory Data is presented in **Appendix 1** of this Report.

Typical view of project road is shown below:

A View of Project Corridor with 4.5m wide Median @ Km 214.200

A view of the Project Corridor with Double arm lighting in the 2 m wide Median & PGR on separators on BHS at Km 159.000

A view of the Project Corridor with 9.5m wide carriageway on both sides of 1m wide Median at Km 158.000

Service Road/slip roads have been observed at village/settlement locations accounting to a length of 52.330km with flexible pavement of varying carriageway with from 5.0m to 7.0m. Sample photos of Service Road locations are presented below.

7m wide Service Road at Km 205.700 RHS

5.5m Wide service road @ Km 182.500 LHS

There are 2 Nos. of major junctions and 84 Nos. of minor junctions are observed along project corridor.

Sample photos of the Junction locations are presented below.

Major Junction @ Km 229.850 LHS

Minor Junction @ Km 222.490 LHS

Minor Junction @ km 227.140 RHS

Minor Junction @ Km 226.400 LHS

High mast lighting of 4 Nos. have been provided in project road at Toll Plaza locations. Highway lighting in the form of double arm is provided at built-up sections on median and single arm lighting provided at slip road/service roads. Sample photos of Highway lighting are presented below.

Single Arm lighting on Service Road @ Km 161.000 RHS

Double Arm Lighting @ Km 182.600 Median

High-mast @ Km 216.500 LHS TP-1

Double Arm lighting @ Km 230.000 Median

The Project Road has two Toll Plaza at km 148.100 Masuriha Toll Plaza and at km 216.545, Joginihal Toll Plaza. Rigid pavement is provided in toll plaza locations including its tapering portion. The condition of Toll Plaza appears to be fair. Details of Toll Plaza are presented in the table below.

Table 4: Toll Plaza Details

S No	Chainage	Toll Plaza	Pavement Type	Width on one side (m)	No of Lanes	Office	Toilets
1	216.545	Joginihal	Rigid	47	8	Yes	Yes
2	148.100	Masuriha	Rigid	47	6	Yes	Yes

Few photos taken at toll plaza locations are presented below:

A view of Toll Plaza at km 216.545 (TP-2)

A view of Toll Plaza at km 148.100 (TP-1)

Toll Plaza admin building @ Km 216.545 TP-2

Toll Plaza admin building @ Km 148.100 TP-1

There are 8no. of Truck lay-bye and 51 nos. of Busbays with shelter. Truck lay-byes with toilet blocks. Flexible pavement is provided in both truck lay byes and Busbays. Sample photos are presented below.

Truck lay-bye @ km173.400 LHS

Truck lay-bye @ km 221.700 RHS

damaged Bus shelter @ km 170.900 RHS

Bus-bay with shelter @ km 218.920 RHS

2.3 PAVEMENT CONDITION SURVEYS

The present Pavement condition data has been collected in the month of March-2025 using Network Survey Vehicle (NSV). The Pavement Condition data collected in each lane and in each direction has been presented in **Appendix 2** of this Report.

Inner-lane rutting associated with cracking is a common phenomenon observed in full length of the corridor in either carriageway. Even outer-lane carriageway also has hungry surface cracks associated with raveling, patching and rutting, but it is less when compared with inner-lane. It seems only maintenance works are ongoing by attending surface defects in the form of mill & overlay, MCS works and fog-seal to maintain the riding surface, either in inner-lane or outer-lane. No full-width overlay done in the project road thus far. Presently, pavement condition is average to poor.

The photographs showing the pavement condition of the Project Road is presented below:

Rutting @ Km 157.000 RHS

Rutting & Alligator Cracking @ Km 168.00 RHS

Rutting & Alligator Cracking @ Km 191.100 RHS

Alligator Cracking @ Km 194.800 RHS

Rutting & Alligator Cracking @ Km 198.000 LHS

Rutting & Alligator Cracking @ Km 200.400 LHS

Rutting & Alligator Cracking @ Km 202.000 LHS

Rutting & Alligator Cracking @ Km 210.000 RHS

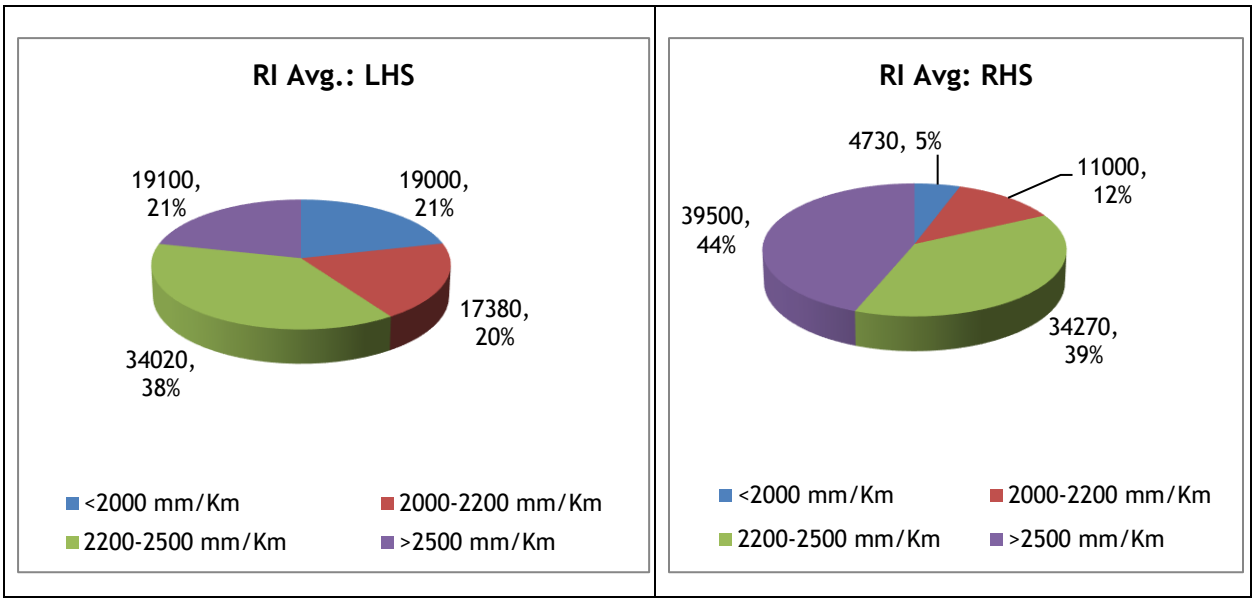
Rutting & Alligator Cracking @ Km 221.500 LHS

Poor Condition @ Km 222.500 RHS-SR

2.4 ROUGHNESS SURVEYS

The Roughness data has been collected using **Network survey vehicle** and analyzed in terms of International Roughness Index (IRI), separately for each lane, for both direction of travel. Computation of IRI for each km length in each direction is presented in **Appendix 3** of this Report.

Average RI values along the corridor were grouped in to four categories, Pie chart showing the range of RI values in each carriageway of the project road have been presented below:



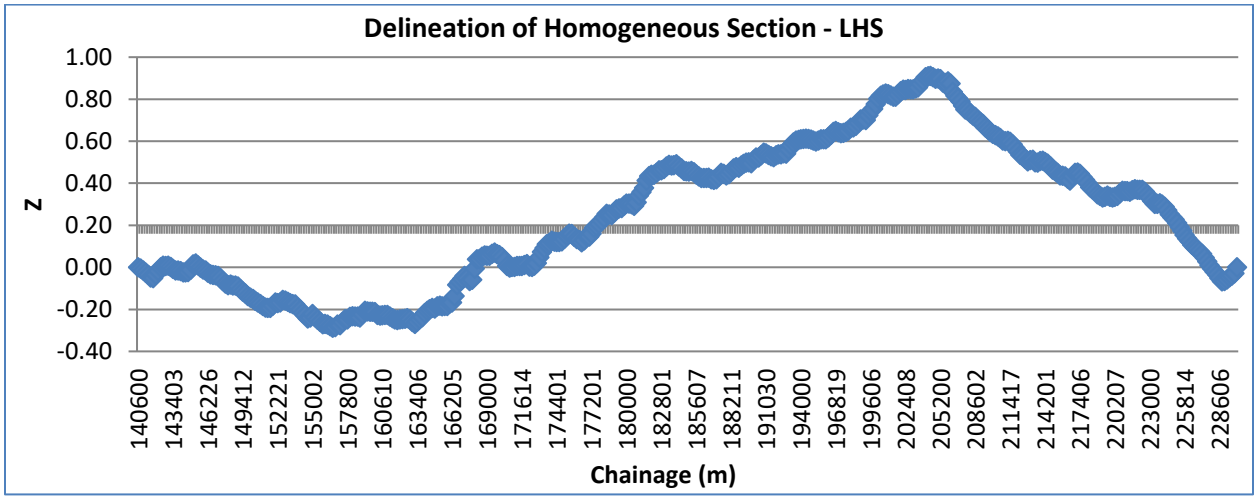
It can be seen from the above pie charts about 79% of the length in LHS carriageway and 56% of the length in RHS carriageway of the Project Road has RI values less than 2500mm/km.

2.5 FALLING WEIGHT DEFLECTOMETERS (FWD) SURVEY

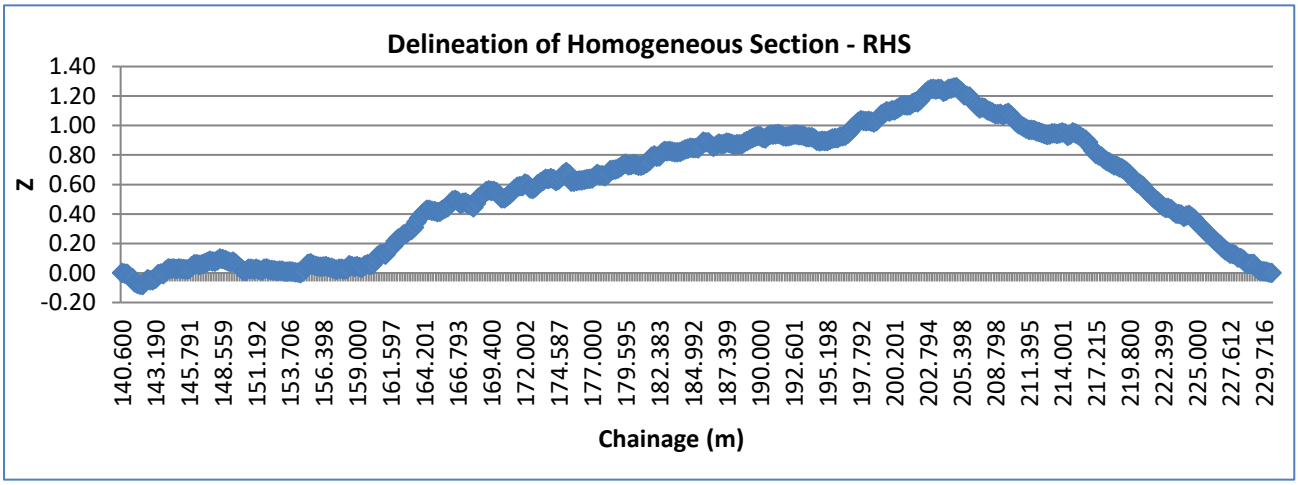
Falling Weight Deflectometer (FWD) analysis is considered from previous studies.

Cumulative Difference Approach (CDA) has been used for the identification of homogeneous sections on the basis of Surface Curvature Index (SCI). SCI is calculated as the difference between D_0 and D_{300}, where D_0 and D_{300} are the peak deflections (mm) measured at the center of loading plate and at a radial distance of 300mm.

The homogenous sections in each direction of traffic (i.e. LHS & RHS) for the project stretch have been identified by graphical representation followed by table are given as below.



Delineation of Homogeneous Section - LHS



Delineation of Homogeneous Section - RHS

Table 5: FWD Data -Summary of Homogenous Section - LHS & RHS

S No	From	To	Length (km)	Remarks
LHS				
1	140.600	144.413	3.81	
2	144.413	148.000	3.59	
3	148.000	148.270	0.27	Toll Plaza 1
4	148.270	151.000	2.73	
5	151.000	154.432	3.43	
6	154.432	156.810	2.38	
7	156.810	159.203	2.39	
8	159.203	163.000	3.80	
9	163.000	166.001	3.00	
10	166.001	168.805	2.80	
11	168.805	171.995	3.19	
12	171.995	175.258	3.26	
13	175.258	178.201	2.94	
14	178.201	180.816	2.62	
15	180.816	183.203	2.39	
16	183.203	186.810	3.61	
17	186.810	190.601	3.79	
18	190.601	192.900	2.30	
	192.900	193.100	0.20	Canal under construction
	193.100	196.403	3.30	
19	196.403	200.210	3.81	
20	200.210	202.804	2.59	
21	202.804	205.200	2.40	
22	205.200	206.200	1.00	
	206.200	206.700	0.50	VUP under construction
	206.700	209.206	2.51	
23	209.206	212.604	3.40	
24	212.604	216.380	3.78	
25	216.380	216.720	0.34	Toll Plaza 2

S No	From	To	Length (km)	Remarks
26	216.720	219.205	2.49	
27	219.205	223.210	4.01	
28	223.210	227.199	3.99	
29	227.199	230.100	2.90	
RHS				
1	140.600	143.993	3.393	
2	143.993	148.000	4.007	
3	148.000	148.270	0.270	Toll plaza 1
4	148.270	150.590	2.320	
5	150.590	153.087	2.497	
6	153.087	155.396	2.309	
7	155.396	158.692	3.296	
8	158.692	161.791	3.099	
9	161.791	164.201	2.410	
10	164.201	166.601	2.400	
11	166.601	169.195	2.594	
12	169.195	172.002	2.807	
13	172.002	175.000	2.998	
14	175.000	177.396	2.396	
15	177.396	180.000	2.604	
16	180.000	182.601	2.601	
17	182.601	185.799	3.198	
18	185.799	188.000	2.201	
19	188.000	190.387	2.387	
20	190.387	192.900	2.513	
21	192.900	193.100	0.200	Canal Under Construction
22	193.100	195.401	2.301	
23	195.401	197.792	2.391	
24	197.792	200.200	2.408	
25	200.200	202.794	2.594	
26	202.794	205.200	2.406	
27	205.200	206.200	1.000	
28	206.200	206.700	0.500	VUP Under Construction
29	206.700	209.600	2.900	
30	209.600	212.191	2.591	
31	212.191	214.796	2.605	
32	214.796	216.380	1.584	
33	216.380	216.720	0.340	
34	216.720	218.200	1.480	Toll plaza 2
35	218.200	221.200	3.000	
36	221.200	224.187	2.987	
37	224.187	227.398	3.211	
38	227.398	230.100	2.702	

2.6 PAVEMENT COMPOSITION SURVEYS (TEST PITS)

The composition of the existing pavement crust has been considered from the previous studies and its details are as follows:

Table 6: Pavement Composition along Project Road

S No	Test Pit Number	Design Chainage, km	Direction	BT (mm)	WMM (mm)	GSB (mm)	Total(mm)
1	HR-TP-1	142+700	LHS	130	230	250	610
2	HR-TP-2	146+950	RHS	130	250	200	580
3	HR-TP-3	153+650	LHS	120	230	200	550
4	HR-TP-4	156+000	RHS	170	200	150	520
5	HR-TP-5	162+300	LHS	120	290	200	610
6	HR-TP-6	168+650	RHS	130	250	200	580
7	HR-TP-7	172+700	LHS	110	250	250	610
8	HR-TP-8	176+650	RHS	120	250	180	550
9	HR-TP-9	182+800	LHS	130	230	160	520
10	HR-TP-10	186+600	RHS	120	220	200	540
11	HR-TP-11	192+300	LHS	120	230	200	550
12	HR-TP-12	196+200	RHS	120	230	200	550
13	HR-TP-13	202+000	LHS	120	250	150	520
14	HR-TP-14	207+050	RHS	160	250	200	610
15	HR-TP-15	212+300	LHS	140	250	160	550
16	HR-TP-16	215+800	RHS	150	240	200	590
17	HR-TP-17	223+400	LHS	120	230	200	550
18	HR-TP-18	226+450	RHS	150	240	200	590
19	HR-SR-TP-1	205+100	RHS	90	200	160	450
20	HR-SR-TP-2	147+600	RHS	120	150	130	400
21	HR-SR-TP-3	189+050	LHS	80	130	360	570
22	HR-SR-TP-4	218+650	LHS	80	230	160	470

Total crust thickness of the MCW pavement varying from 520mm to 610mm. The thickness of bituminous layer varying between 110mm to 170mm. Granular layers (GSB+WMM) varying between 350mm to 500mm.

Total crust thickness of the Service Road varying from 400mm to 570mm. The thickness of bituminous layer varying between 80mm to 120mm. Granular layers (GSB+WMM) varying between 280mm to 490mm.

2.7 SUBGRADE & BORROW AREA INVESTIGATION

Subgrade and Borrow area related test results are considered from previous DD studies and presented in Chapter-4 of this report.

2.8 BORROW AREAS

The location details of the borrow areas are as follows:

Table 7: Details of Borrow Soils

Sl. No	Borrow Area No	Chainage	Side	Offset	Village and contact person	Quantity	Rate	Remarks
1	HR-BP-1	215+250	RHS	2.8 km	Vill- Bhudiya Owner-Ragavendra Pratap singh Mob no- 9131514292	2 Acres*5 feet	Rs - 1200/- per 600 cft	Pvt. Land
2	HR-BP-2	205+600	RHS	17.2 km	Vill-Parasi Owner- Satyanarayan Mishra Mob no- 7694926119, 9424624033	5 Acres*5 feet	Rs - 1200/- per 600 cft	Pvt. Land
3	HR-BP-3	198+500	RHS	3.2 km	Vill-Mangawari Tikuri Name-Phusparaj Yadav	20 Acres*5 feet	Only Royalty	Govt. Land
4	HR-BP-4	189+050	RHS	7.0 km	Vill-Judmaniya Owner- Kamal Prasad Patel Mob no- 7697257172	3 Acres*5 feet	Not told	Pvt. Land
5	HR-BP-5	184+150	RHS	0.1 km	Vill-Ghoraha Name- Deven Prasad Mishra Mob-7697238900	2 Acres*5 feet	Not told	Pvt. Land
6	HR-BP-6	175+500	LHS	1.6 km	Vill-Jamuhara Owner- Ramji Mishra Mob no- 8827045628	5 Acres*5 feet	Not told	Pvt. Land
7	HR-BP-7	171+600	LHS	0.1 Km	Vill-Mauganj Owner- Neeraj Tripath Mob no- 9630149888	2 Acres*5 feet	Not told	Pvt. Land
8	HR-BP-8	167+700	LHS	8.0 km	Vill- Atarital (Ghurehata)	30 Acres*5 feet	Only Royalty	Govt. Land
9	HR-BP-9	162+000	RHS	6.0 km	Vill-Bichrahata Owner- Rajan Singh Mob no- 9131646181	45 Acres*5 feet	Rs - 1200/- per 600 cft	Pvt. Land
10	HR-BP-10	155+400	RHS	Road Side	Vill-Khatakeri Owner- Rajan Singh Mob no- 9131646181	45 Acres*5 feet	Rs - 1200/- per 600 cft	Pvt. Land
11	HR-BP-11	151+500	RHS	6.0 km	Vill- Agrahi (Pratapganj) Sarpanch-Krishna Pratap SinghMob no-9200258683	10 Acres*5 feet	Only Royalty	Govt. Land
12	HR-BP-12	145+900	RHS	1.8 km	Vill- Arjunpur Paikan Owner- Shasi Bhushan Singh Mob-8085633672	5 Acres*5 feet	Not told	Pvt. Land
13	HR-BP-13	142+600	LHS	0.2 km	Vill- Hanumana Owner- Sunil Mishra Mob-7049685373	10 Acres*5 feet	Not told	Pvt. Land
14	HR-BP-14	221+200	LHS	9.4 km	Vill- Guduwa (Gorgaon) Owner- Anand Singh Mob-9753375721 Owner- Lalbahadur Singh Mob-9039997456	42 Acres*10 feet	Not told	Pvt. Land
15	HR-BP-15	223+700	LHS	0.5 km	Vill- Ramnai Owner- Pritraj Sharma Mob-98936635056	45 Acres*10 feet	Not told	Govt. Land

2.9 AGGREGATE SAMPLES

From previous DD studies, the aggregate source identified in the project corridor are presented in following table.

Table 8: Details of Aggregate Samples

Sl No	sample No.	Ex.Chainage (Km.)	Left/ Right	Name of Village	Name of Source/ Crusher	Lead from Nearest Ex.Chainage (Km.)	Approximate Quantity (ton)	Basic cost of the material (Rs.)	Remarks	Co-ordinate
1	HR-AQ-1	141+900	LHS	Hardi (Piparahi)	Mahadev Stone Crusher & MCC Stone Crusher Owner- Vijaypratap Singh Contract no-831877677	27.0 km	Plenty	40mm-Rs 700/- per ton 20mm-Rs 910/- per ton 10mm - Rs 680/- per ton 6mm -Rs 340/- per ton dust - Rs 320/- per ton including Royalty & loading **(VSI Aggregate)**	Extra GST 5% Royalty -2% Extra Total Amount	24.593668 82.077275
2	HR-AQ-2	141+900	LHS	Hardi (Piparahi)	Mahalaxmi Stone Crusher Owner- Sanjay Kumar Contract no-9094557000	27.0 km	Plenty	20mm-Rs 750/- per ton 10mm - Rs 200/- per ton 6mm -Rs 200/- per ton dust - Rs 50/- per ton including loading **(Non- VSI Aggregate)**	Royalty per ton Rs 125/-Extra GST 5% Total Amount	24.592722 82.069374
3	HR-AQ-3	230+100	RHS	Bela (Baijnath)	Bhundavan Stone Crusher Owner- Devraj Singh Contract no-9131493268	24.3 km	Plenty	20mm-Rs 650/- per ton 10mm - Rs 180/- per ton 6mm -Rs 70/- per ton dust - Rs 40/- per ton including loading **(Non- VSI Aggregate)**	Royalty per ton Rs 180/-Extra GST 5% Total Amount	24.508732 81.186012
4	HR-AQ-4	230+100	RHS	Bela (Baijnath)	Trimuthy Stone Crusher Owner- Babulu Pandey Contract no-8770910711	24.3 km	Plenty	20mm-Rs 680/- per ton 10mm - Rs 200/- per ton 6mm -Rs 70/- per ton dust - Rs 80/- per ton including loading **(Non- VSI Aggregate)**	Royalty per ton Rs 170/-Extra GST 5% Total Amount	24.510639 81.184667
5	HR-AQ-5	230+100	RHS	Bankuia	Maa Saradha Stone Crusher Owner- Narmada Prasad Pandey Contract no-6266457971	19.4 km	Plenty	20mm-Rs 35/- per cft 10mm - Rs 12/- per cft 6mm - Rs 5/- Per cft dust - Rs 5/- per cft including loading	Royalty -Rs 160/- per Cub meter Extra GST 5% Total Amount	24.604675 81.207016
6	HR-AQ-6	177+700	LHS	Harraha	Bansal Stone Crusher Owner- Gourav Singh Contract no-8982147047	24.5km	Plenty	40mm-Rs 450/- per ton 20mm-Rs 650/- per ton 10mm - Rs 200/- per ton dust - Rs 40/- per ton including Royalty & loading **(Non- VSI Aggregate)**	Royalty -Rs 160/- per Cub meter Extra GST 5% Total Amount	24.552740 81.870121
7	HR-AQ-7	177+700	LHS	Harraha	Singh InfrastructureOwner- Sujith SinghContract no-6307354243	24.5km	Plenty	40mm-Rs 200/- per ton20mm-Rs 750/- per ton10mm - Rs300/- per tondust - Rs 70/- per tonincluding Royalty & loading **(VSI Aggregate)**	Royalty -Rs 110/- per tonExtra GST 5% Total Amount	24.5516848 1.868208

2.10 SAND SAMPLES

From previous DD studies, River Sand source locations from the Project Road is presented in the following table

Table 9: Details of Sand Sample

S No	Sand Source	Village & Name	Name of river	Chainage	side	Offset	Rate
1	HR-SQ-1	Vill- Sidhi Distt- Sidhi Supplier Name- Satyam Shukla (Hanummana) Mob- 9685292561	Sone	141+900	LHS	75.0 km	Rs- 3500 /- per 100 cft including GST & loading Transporting at Hanumana
2	HR-SQ-2	Vill-Sidhi Distt- sidhi Supplier Name- Akash Patel (Koshla) Mob-9516464940	Sone	229+800	LHS	140.0 km	Rs-30,000/-Per 500 Cft including GST & loading Transporting at Rewa

2.11 CORE INVESTIGATIONS

The objective of the core cutting is examining the engineering properties of the materials relevant to the project as per specification. The locations have been identified with the help of Visual observation of existing Road condition and past history of pavement. Thereafter the location has been identified for core cutting. Accordingly, 21 cores were cut on Main carriageway and 3 cores on service road. After noting the condition such as location, cracks, depth of core etc. The core samples were properly packed and sent for laboratory testing for its properties. Core results are presented in **Appendix-4** of this report.

Location and Details of the core cutting are given below.

Table 10: Core details

Core Cutting Details of VEPL Site												
S. no	**Sample No**	**Chainage**	**Side**	**Carriageway lane**	**MCW /SR**	**Distance from Kerb**	**Distance from Paved Shoulder**	**Pavement Condition**	**Total Core Thickness (mm)**	**Cracks On Core Depth (mm)**	**Cracks in Core hole depth(mm)**	**Remarks**
1	VE-C-1	226+350	RHS	Outer	MCW		2.5	Aligator Cracking	160	150	150	2-Parts
2	VE-C-2	217+870	RHS	Outer	MCW		2.5	Aligator Cracking	160	120	120	1-Pieces
3	VE-C-3	211+700	RHS	Inner	MCW	6.5		Major Rutting	135	No	No	1-Pieces of Core Good Condition (Median Opening)
4	VE-C-4	205+500	RHS	Outer	SR			Service Road Poor Condition Aligator Cracking,Rutting	120	No	No	Cracks are Not Fromed to the below layers

Core Cutting Details of VEPL Site												
S. no	Sample No	Chainage	Side	Carriagew ay lane	MCW /SR	Distance from Kerb	Distance from Paved Shoulder	Pavement Condition	Total Core Thickness (mm)	Cracks On Core Depth (mm)	Cracks in Core hole depth(mm)	Remarks
5	VE-C-5	204+280	RHS	Inner	MCW	1.1		Rutting, Aligator Cracking	80	70	70	1-Piece
6	VE-C-6	192+400	RHS	Outer	MCW		2.5	Rutting,Aligator Cracking	145	135	135	1-Piece good Core
7	VE-C-7	182+760	RHS	Inner	MCW	1.6		Rutting,Aligator Cracking	180	80	80	Top-135mm,Bottom-45mm
8	VE-C-8	178+530	RHS	Inner	SR	1.1		Aligator Cracking	85	65	65	1-Piece 85mm,(Offset 1.1m MCW Side)
9	VE-C-9	175+570	RHS	Outer	MCW		2.5	Rutting,Aligator Cracking	150	150	150	1-Piece good Core
10	VE-C-10	165+760	RHS	Inner	MCW	6.5		Rutting,Minor Cracking	110	60	60	1-Piece good Core,Crashed Aggregate, Rutting 25mm,Core at M.O
11	VE-C-11	157+550	RHS	Outer	MCW		3	Rutting,Aligator Cracking	120	40	40	1 Piece Good Condition,Crack Depth 40 mm
12	VE-C-12	146+340	RHS	Inner	MCW	2.8		Major Rutting	135	No	No	1-Piece good Core
13	VE-C-13	142+220	LHS	Outer	MCW		2.5	Cracking,Major Ravelling	100	90	90	1 Piece Good Condition,Crashed Aggregate
14	VE-C-14	154+400	LHS	Inner	MCW	1.3		Rutting,Aligator Cracking	100	100	100	1-Piece of Core good Condition
15	VE-C-15	164+680	LHS	Outer	MCW		2.5	Cracking,Ravelling	115	115	115	1-Piece of Core good Condition
16	VE-C-16	171+900	LHS	Inner	SR	1.8		Rutting,Aligator Cracking	55	55	55	Full break Crashed Aggregates (offset MCW Side)
17	VE-C-17	173+050	LHS	Inner	MCW	3.5		Rutting,Aligator Cracking	130	No	No	Core Sample got 130mm done,Cracks are not formed to the BC layer and DBM layer
18	VE-C-18	182+250	LHS	Outer	MCW		1.8	Cracking	130	25	25	1-Piece of Cracks going to the 25mm only
19	VE-C-19	190+600	LHS	Inner	MCW	3.5		Rutting,Aligator Cracking	130	55	55	1-Piece of core 130 remaining Crashed Aggregate
20	VE-C-20	200+280	LHS	Outer	MCW		2.5	Poor,Aligated Cracking	135	135	135	Core Sample got 2Pieces 55mm Top 80mm Bottom
21	VE-C-21	214+500	LHS	Inner	MCW	3.5		Major Rutting	150	No	No	1-Piece of Core good Condition,Ruttin g-15mm

Core Cutting Details of VEPL Site												
S. no	**Sample No**	**Chainage**	**Side**	**Carriagew ay lane**	**MCW /SR**	**Distance from Kerb**	**Distance from Paved Shoulder**	**Pavement Condition**	**Total Core Thickness (mm)**	**Cracks On Core Depth (mm)**	**Cracks in Core hole depth(mm)**	**Remarks**
22	VE-C-22	223+450	LHS	Outer	MCW		2.3	Aligator Cracking	140	140	140	1-Piece of Core It is breaking Vertical Direction
23	VE-C-23	227+650	LHS	Inner	MCW	1.8		Rutting,Aligator Cracking	150	150	150	WMM got 85mm,Cracking going to the up to DBM
24	VE-C-24	229+550	LHS	Inner	SR	1.1		Aligator Cracking	100	95	95	Cracks up to DBM layer

The core sample photos are as presented below.

VE-C-1

HR-C-2

HR-C-3

HR-C-4

HR-C-5

HR-C-6

HR-C-7

HR-C-8

HR-C-9

HR-C-10

HR-C-11

HR-C-12

VE-C-13

VE-C-14

VE-C-15

VE-C-16

VE-C-17

VE-C-18

VE-C-19

VE-C-20

VE-C-21

VE-C-22

VE-C-23

VE-C-24

2.12 AXLE LOAD SURVEYS

From the previous DD studies, the direction-wise VDF for each mode of commercial traffic are presented in the following table.

Table 11: Estimated VDF Values

Mode Type	TP1 @ km 148+100		TP2 @ km 216+545	
	UP	DOWN	UP	DOWN
LCV	1.21	1.69	0.64	1.76
2 Axle Truck/Buses	2.78	3.61	3.55	4.36
3 Axle Truck	6.21	**5.73**	5.41	**7.33**
MAV (4-6 Axle)	13.35	21.88	10.28	21.68

It is observed in LHS direction, the VDF of 3-Axle & MAV were on lower side when compared with the RHS direction in both the locations. Higher VDFs are due to loaded trucks carrying aggregates, clinker and other construction materials

CHAPTER 3. VALIDATION OF EXECUTED WORKS

The project road has been closely inspected to verify the executed works on ground. The scope works to be executed by the Concessionaire/Contractor as envisaged in CA is compared with the executed work on the Ground. As a part of the validation, the available as-built drawings and the inventory data received from the Concessionaire were also referred. Each structure has been inspected to note down its structural configuration and condition. The following table highlights the scope comparison of the executed works on ground.

3.1 ROAD WORKS

Table 12: Scope Comparison of executed works

S. No.	Particulars	Length/ Nos.	As per CA	As per Site	Remarks
1	Start Chainage (Km)	Km	229.800	229.829	
2	End chainage (Km)	Km	140.600	140.600	
3	Length of the Project Corridor	Kms	89.200	89.229	
4	Service Road / Slip Road	Kms	31.240/21.09	52.330	
5	Toll Plaza	Nos.	2	2	
6	No.of Lanes (Both side)	Nos.	14	14	
7	Flyovers	Nos.	2	2	
8	VUPs	Nos.	20	18	2 nos of VUP's Descoped
9	Minor Bridges	Nos.	20	20	
10	Culverts (Pipe)	Nos.	82	83	1nos extra found
11	Culvert (Box)	Nos.	-	33	CA proposed Slab culverts are constructed as Box Culverts & 4 Nos Descoped
12	Culvert (Slab)	Nos.	43	6	
13	Major Junctions	Nos.	2	2	
14	Minor junctions	Nos.	39	84	Extra junctions are found at ground
15	High Embankments	Kms		19.330	
16	RCC Wall	Kms		0.480	
17	Full Height RE Wall	Kms		3.030	
18	Bus Bays with Shelter	Nos.	52	51	
19	Truck Lay bye	Nos.	8	8	
20	High Mast Lights	Nos.		4	
21	Highway Lighting (length only)	Kms		16.150	
22	Single Arm Lightnings	Nos.		190	
23	Double Arm Lightnings	Nos.		382	
24	Solar Blinkers	Nos.		60	
25	RCC Cover Drain	Kms		30.640	
26	Median drain	Kms		0.150	
27	Median Cuts	Nos.		1628	
28	Chutes	Nos.		502	
29	Median Opening	Nos.		30	
30	Median Plantation Functional	Kms		73.300	
31	Median Plantation Non-Functional	Kms		12.180	
32	Road Markings	Kms		179.000	
33	W-Beam Safety Barriers	Kms		22.785	
34	Rigid Concrete Barriers	Kms		12.185	
35	Concrete Railing	Kms		1.980	
36	Pedestrian Guard Rails	Kms		13.425	
37	Kilometer Stones	Nos.		194	
38	Hectometer Stones	Nos.		384	

S. No.	Particulars	Length/ Nos.	As per CA	As per Site	Remarks
39	Road Signs	Nos.		883	
40	Gantry Sign Boards	Nos.		6	
41	Cantilever Sign Boards	Nos.		20	

Service roads/Slip roads are provided in most of the length of the Project. In total the service/slip road length on both side of Main Carriageway accounts to 52.330 Km. Location wise details of service roads and slip roads are presented in **Appendix 5** of this report.

Lined Covered drains are provided adjacent to service road locations. Length of lined Covered drain is 30.640 kms. Median Drain of 0.150kms length and median cuts of 1628 Nos. are provided in super elevation location and median drains.

Table 13: Summary of Lined Covered & Median Drain

Summary	Units	Length		Total
		LHS	RHS	
Covered Drain	Kms	15.130	15.510	30.640
Median Drain	Kms	-	0.150	0.150

All Approaches have been provided with normal slope except at three locations, where RE Walls were provided. Detail locations are listed in the **Appendix 5** of this report.

Table 14: Summary of Type of Slope Details

Type of slope Protection	Length (km)
RE Blocks	3.030
High Embankment	19.330
RCC Wall	0.480
Total Length	**22.840**

Median width of 4m was generally observed along the project road. There are 30 nos. of Median openings with shelter lane. These median openings provided are for facilitating the U-turn traffic. The Junction are developed by giving an access to the service road.

Table 15: Summary of Median Opening

Type of Opening	Nos.
Median Opening with Standing Lane	24
Median Opening without Standing Lane	6
Total	**30**

The Solar blinkers, 60 nos. are provided in the Project Corridor at median opening location. The location wise details of Median opening and solar blinkers are presented in **Appendix 5.**

Safety barriers have been provided along the project road at high embankment, sharp curve locations and on the approaches of grade separated and cross drainage structures. The summary of safety barriers provided along the corridor are presented in the following table and the location wise details are presented in **Appendix 5.**

Table 16: Summary of Safety Barriers along Project Road

Safety Barrier	Length (km)	Damage (km)
Metal Beam Crash Barrier	22.785	0.186
Concrete Crash Barrier	12.185	0.001
Pedestrian Guard Rail	13.425	0.107
Concrete Railing	1.980	-

2 nos of Major junctions and 84nos of Minor Junctions are developed along the Project corridor summary are presented in the table below and details are provided in **Appendix 5** of this report.

Table 17: Summary of Junctions

Summary of Junctions				
	LHS	RHS	Total	Remarks
Major Junctions	2	-	2	
Minor Junctions	40	44	84	

Road furniture in the form of Signboards (Information, Gantry, Cantilever signs and Toll Boards) Pavement Markings and Highway Lighting have been provided along the project road. The Tables below depict the particular details of the Road Furniture. Details are presented in **Appendix 5** of this report.

Table 18: Details of Road Signs along Project Road

Summary				
	LHS	RHS	Junction	Total
As per Site	444	429	36	909
Damage	15	25	-	40
Washed out	4	29	-	33
Cantilever	8	8	4	20
Gantry	1	2	3	6
Chevron	127	53	-	180

High mast lighting of 4 Nos. have been provided in project road at Toll Plaza locations. Highway lighting in the form of double arm and single arm is provided in the project corridor at built-up and Slip/Service Road sections. The summary of the highway lighting is presented in the below table and the details are presented in the **Appendix 5** of this report.

Table 19: Summary of High Mast & Lighting along Project Road

Description	Units	High mast	Low mast	Single Arm	Double Arm
As Per Site	Nos	4	-	190	382

The Project Road has about 51 Bus bays with shelters. The details of the same are given in **Appendix 5** of this report.

3.2 STRUCTURES

List of Structures found during the inventory surveys along the corridor are as follows:

Table 20: Summary of Structures as per CA & Site

S. No	Type of Structure	No. of Structures As per Sch-B	As per site					Remarks
			No. of Structures			Total No.of Str's	Total No.of Locations	
			LHS	RHS	BHS			
1	Minor Bridge	20	20	20	-	40	20	
2	Flyover	2	2	2	-	4	2	
3	Vehicular Underpass	20	18	18	-	36	18	2 No's Descoped
4	Box Culverts	-	-	-	33	33	33	CA proposed Slab culverts are constructed as Box Culverts & 4 Nos Descoped
5	Slab Culverts	43	-	-	6	6	6	Widened with Slab Culverts
6	Pipe Culverts	82	-	-	83	83	83	Additional culvert-1No.

Table 21: Age of structures

S.No	Type of Structure	LHS		RHS		BHS		Total (Nos)		Total no. of Str's
		Old	New	Old	New	Old	New	Old	New	
1	Minor Bridge	7	13	-	20	-	-	7	33	40
2	Flyover	-	2	-	2	-	-	-	4	4
3	Vehicular Underpass	-	18	-	18	-	-	-	36	36
4	Box Culverts	-	-	-	-	-	33	-	33	33
5	Slab Culverts	-	-	-	-	6	-	6	-	6
6	Pipe Culverts	-	-	-	-	29	54	29	54	83
Total Nos								**43**	**159**	**202**

Table 22: Summary of expansion joints and bearing

S. No	Type of Structure	Expansion joints		Bearings			
				Pot PTFE		Elastomeric	
		Old	New	Old	New	Old	New
1	Minor Bridge	3	46	-	-	18	252
2	Flyover	-	14	-	32	-	48
3	Vehicular Underpass	-	-	-	-	-	-
Total Nos		**3**	**60**	**-**	**32**	**18**	**300**
		63		**32**		**318**	
				350			

Table 23: Summary of Superstructure

S. No	Type of Structure	RCC Slab	RCC Box	RCC Girder	Stone Masonry Arch Type	PSC Girder	Total no. of Structures
1	Minor Bridge	5	13	9	3	10	40
2	Flyover	-	-	-	-	4	4
3	Vehicular Underpass	10	26	-	-	-	36
Total		**15**	**39**	**9**	**3**	**14**	**80**

Table 24: Summary of Substructure

S.No	Type of Structure	ABUTMENT				PIER	
		RE Abutment	RCC Box	RCC Wall Type	Stone Masonry Wall Type	RCC Wall Type	Stone Masonry Wall Type
1	Minor Bridge	-	12	25	3	19	3
2	Flyover	-	-	4	-	4	-
3	Vehicular Underpass	10	26	-	-	-	-
Total		**10**	**38**	**29**	**3**	**23**	**3**

Table 25: Details of CD & Other Structures along Project Road

Sl. No.	Chainage (Km)	Type of Str.	Side	Age of Str	Skew	Span Arrangement (No x Length)	No. of Span	Span length	Deck width	Remarks
1	205+415	Flyover	LHS	New	Yes	2 x 43.988	2	43.988	12	-
2	205+415	Flyover	RHS	New	Yes	2 x 43.988	2	43.988	12	-
3	229+825	Flyover	LHS	New	No	3 x 30.00	3	30	12	-
4	229+825	Flyover	RHS	New	No	3 x 30.00	3	30	12	-
5	148+553	MNB	LHS	New	No	2 x 25	2	25	12	-
6	148+553	MNB	RHS	New	No	2 x 25	2	25	12	-
7	150+694	MNB	LHS	New	No	1 x 20	1	20	12	-
8	150+694	MNB	RHS	New	No	1 x 20	1	20	12	-
9	151+759	MNB	LHS	Old	No	5 x 6.60	5	6.6	12	-
10	151+759	MNB	RHS	New	No	5 x 6.60	5	6.6	12	-
11	155+274	MNB	LHS	New	No	1 x 20	1	20	12	-
12	155+274	MNB	RHS	New	No	1 x 20	1	20	12	-
13	158+877	MNB	LHS	New	No	2 x 10	2	10	20.75	-
14	158+877	MNB	RHS	New	No	2 x 10	2	10	20.75	-
15	162+513	MNB	LHS	New	Yes	2 x 28	2	28	12	-
16	162+513	MNB	RHS	New	Yes	2 x 28	2	28	12	-
17	165+035	MNB	LHS	Old	No	2 x 12.55	2	12.55	12	-
18	165+035	MNB	RHS	New	No	2 x 12.55	2	12.55	12	-
19	165+978	MNB	LHS	New	No	2 x 10	2	10	13.75	-
20	165+978	MNB	RHS	New	No	2 x 10	2	10	13.75	-
21	167+563	MNB	LHS	New	No	2 x 25	2	25	12	-
22	167+563	MNB	RHS	New	No	2 x 25	2	25	12	-
23	171+034	MNB	LHS	New	Yes	3 x 10	3	10	13.75	-
24	171+034	MNB	RHS	New	Yes	3 x 10	3	10	13.75	-
25	175+282	MNB	LHS	Old	No	2 x 26.50	2	26.5	12	-
26	175+282	MNB	RHS	New	No	2 x 26.50	2	26.5	12	-
27	180+745	MNB	LHS	Old	No	3 x 7.2	3	7.2	12	-
28	180+745	MNB	RHS	New	No	3 x 7.2	3	7.2	12	-
29	180+983	MNB	LHS	New	No	2 x 5	2	5	13.75	-
30	180+983	MNB	RHS	New	No	2 x 5	2	5	13.75	-
31	196+780	MNB	LHS	New	No	2 x 20	2	20	12	-
32	196+780	MNB	RHS	New	No	2 x 20	2	20	12	-
33	203+764	MNB	LHS	New	Yes	2 x 28	2	28	12	-
34	203+764	MNB	RHS	New	Yes	2 x 28	2	28	12	-
35	207+374	MNB	LHS	New	No	4 x 7.50	4	7.5	13.75	-
36	207+374	MNB	RHS	New	No	4 x 7.50	4	7.5	13.75	-
37	211+293	MNB	LHS	New	Yes	4 x 12.208	4	12.208	13.75	-

Sl. No.	Chainage (Km)	Type of Str.	Side	Age of Str	Skew	Span Arrangement (No x Length)	No. of Span	Span length	Deck width	Remarks
38	211+293	MNB	RHS	New	Yes	4 x 12.208	4	12.208	13.75	-
39	213+825	MNB	LHS	Old	No	3 x 8.885	3	8.885	12	-
40	213+825	MNB	RHS	New	No	3 x 8.885	3	8.885	12	-
41	215+050	MNB	LHS	Old	No	1 x 13.10	1	13.1	12	-
42	215+050	MNB	RHS	New	No	1 x 13.10	1	13.1	12	-
43	218+282	MNB	LHS	Old	No	2 x 13.80	2	13.8	12	-
44	218+282	MNB	RHS	New	Yes	2 x 13.80	2	13.8	12	-
45	147+420	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
46	147+420	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
47	152+840	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
48	152+840	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
49	159+500	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
50	159+500	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
51	163+659	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
52	163+659	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
53	166+730	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
54	166+730	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
55	167+980	VUP	LHS	New	No	1 x 12.00	1	12	13.75	-
56	167+980	VUP	RHS	New	No	1 x 12.00	1	12	13.75	-
57	172+117	VUP	LHS	New	Yes	1 x 12.77	1	12.77	13.75	-
58	172+117	VUP	RHS	New	Yes	1 x 12.77	1	12.77	13.75	-
59	174+220	VUP	LHS	New	No	1 x 12.00	1	12	13.75	-
60	174+220	VUP	RHS	New	No	1 x 12.00	1	12	13.75	-
61	177+910	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
62	177+910	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
63	181+900	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
64	181+900	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
65	186+030	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
66	186+030	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
67	187+172	VUP	LHS	New	Yes	1 x 12.77	1	12.77	13.75	-
68	187+172	VUP	RHS	New	Yes	1 x 12.77	1	12.77	13.75	-
69	189+280	VUP	LHS	New	No	1 x 12.00	1	12	13.75	-
70	189+280	VUP	RHS	New	No	1 x 12.00	1	12	13.75	-
71	193+350	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
72	193+350	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
73	197+210	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
74	197+210	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
75	207+810	VUP	LHS	New	No	1 x 12.00	1	12	13.75	-
76	207+810	VUP	RHS	New	No	1 x 12.00	1	12	13.75	-
77	218+790	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
78	218+790	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-
79	222+490	VUP	LHS	New	No	1 x 12.00	1	12	12.5	-
80	222+490	VUP	RHS	New	No	1 x 12.00	1	12	12.5	-

3.3 PENDING & MISSING WORKS

The Final COD for the project is received with conditional approval to complete the balance works by Concessionaire as and when the land is made available..

Service Roads, RCC Covered drain & PGR are missing on the ground its summary is given below.

Table 26: Details of Pending works along Project Road

Summary	LHS (kms)	RHS (kms)	Total (kms)
Service Roads	1.640	1.220	2.860
RCC Drain	0.720	0.490	1.210
Kerb	1.770	1.500	3.270
PGR	1.420	1.230	2.650

4.1 SUBGRADE & BORROW AREA TESTS

➢ **SUBGRADE**

Subgrade test results are considered from previous DD studies are as follows:

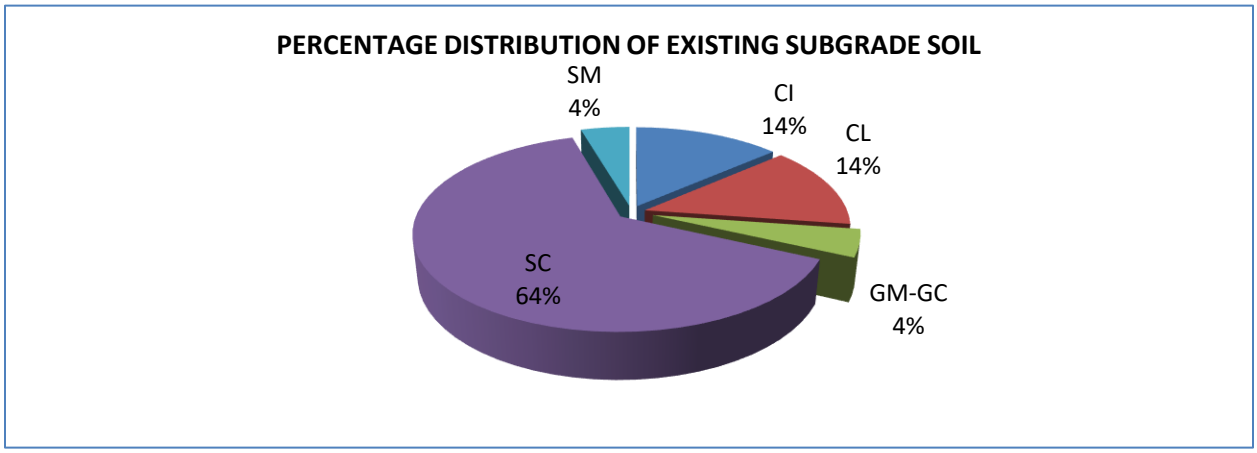


Table 27: Test Results of Subgrade Soils

Lab Sample No	Site Identification		Grain Size Analysis					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Saoked CBR 97% AVERAGE	FDD (gm/cc)	Free Swelling Index (%)
	Location (km)	Up/Dn	Percentage passing from					LL	PL	PI						
			4.75 mm IS Sieve	425 mic IS Sieve	75 mic IS Sieve	Gravel %	Sand %									
HR-TP-1	142+700	LHS	51.7	28.8	23.62	48.3	28.08	20	14	6	GM-GC	2.23	8.40	21.90	2.034	10
HR-TP-2	146+950	RHS	89.6	74.76	38.04	10.4	51.56	-	NP	NP	SM	2.02	12.20	16.46	1.851	5
HR-TP-3	153+650	LHS	73.49	47.09	38.85	26.51	34.64	35	18	17	SC	2.08	10.80	16.57	2.020	24
HR-TP-4	156+000	RHS	64.33	37.59	23.31	35.67	41.02	32	20	12	SC	2.10	11.30	18.77	1.895	24
HR-TP-5	162+300	LHS	78.06	46.56	43.96	21.94	34.1	42	21	21	SC	2.04	14.20	21.32	1.877	31
HR-TP-6	168+650	RHS	96.85	86.1	82.34	3.15	14.51	34	20	14	CL	1.94	12.80	8.1	1.753	22
HR-TP-7	172+700	LHS	87.3	72.38	71.51	12.7	15.79	40	22	18	CI	2.00	10.80	5.26	1.850	38
HR-TP-8	176+650	RHS	78.44	43.4	37.48	21.56	40.96	28	18	10	SC	2.02	11.20	14.31	1.952	18
HR-TP-9	182+800	LHS	75.41	48.19	39.75	24.59	35.66	45	24	21	SC	2.12	10.00	23.17	1.982	33
HR-TP-10	186+600	RHS	63.68	32.04	23.29	36.32	40.39	41	21	20	SC	2.08	10.30	16.57	1.975	25
HR-TP-11	192+300	LHS	81.69	46.09	28.9	18.31	52.79	43	24	19	SC	2.10	9.80	18.77	1.915	38
HR-TP-12	196+200	RHS	96.92	84.43	81.1	3.08	15.82	41	25	16	CI	1.87	13.00	4.56	1.746	31
HR-TP-13	202+000	LHS	92.43	85.26	82.55	7.57	9.88	30	20	10	CL	1.94	10.30	8.1	1.759	22
HR-TP-14	207+050	RHS	71.52	49.83	41.74	28.48	29.78	25	17	8	SC	2.02	13.70	14.31	1.836	19
HR-TP-15	212+300	LHS	65.62	30.24	20.43	34.38	45.19	28	17	11	SC	2.04	10.00	21.32	1.854	13
HR-TP-16	215+800	RHS	71.2	44.32	38.06	28.8	33.14	28	17	11	SC	2.03	10.70	14.31	1.834	13
HR-TP-17	223+400	LHS	78.7	53.34	45.07	21.3	33.63	27	17	10	SC	2.13	8.00	23.17	2.028	17
HR-TP-18	226+450	RHS	74.95	52.43	45.39	25.05	29.56	32	21	11	SC	1.85	14.50	9.02	1.730	23

Lab Sample No	Site Identification		Grain Size Analysis					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Saoked CBR 97% AVERAGE	FDD (gm/cc)	Free Swelling Index (%)
	Location (km)	Up/Dn	Percentage passing from					LL	PL	PI						
			4.75 mm IS Sieve	425 mic IS Sieve	75 mic IS Sieve	Gravel %	Sand %									
HR-SR-TP-1	205+100	RHS	69.64	41.64	33.93	30.36	35.71	31	18	13	SC	1.94	10.20	9.20	1.740	14
HR-SR-TP-2	147+600	RHS	98.07	91.75	87.52	1.93	10.55	37	19	18	CI	1.81	11.90	3.65	1.667	25
HR-SR-TP-3	189+050	LHS	95.13	79.91	75.66	4.87	19.47	33	21	12	CL	1.90	11.60	8.1	1.733	27
HR-SR-TP-4	218+650	LHS	76.45	52.78	43.77	23.55	32.68	28	17	11	SC	2.04	11.00	21.32	1.946	13

- Liquid limit for existing subgrade samples varies between 20% and 45%. All the samples satisfying the liquid limit criterion (LL<=50).
- Plasticity Index for 22 out of 21 samples Subgrade samples varies between 6% and 21% and one is non-plastic. All samples satisfying the Plasticity Index criterion (PI<=25%).
- Maximum Dry Density for all subgrade samples varies between 1.81 gm/cc and 2.23 gm/cc. All the samples satisfying the MDD criterion (MDD>=1.75 gm/cc).
- OMC for existing subgrade samples varies between 8 %to 14.5
- Free Swelling Index for existing subgrade samples varies between 5% and 38%. All samples satisfying the FSI criterion (FSI<=50%).

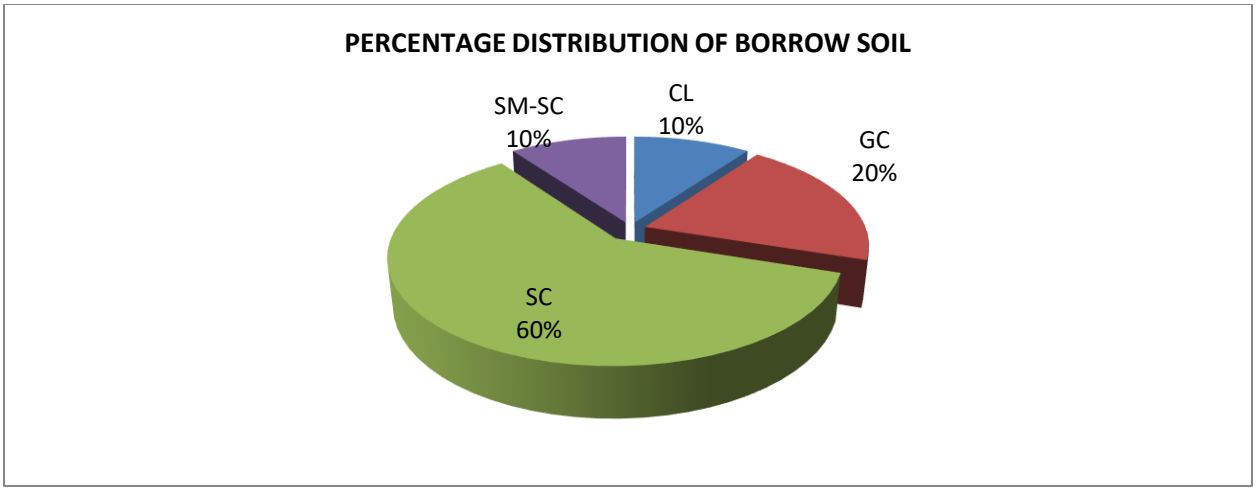
➢ BORROW AREA

Borrow area test results are considered from previous DD studies are as follows.

Table 28: Test Results of Borrow Soils

Lab Sample No	Site Identification		Grain Size Analysis					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Saoked CBR 97% Average	Free Swelling Index (%)
	Location (km)	Up/Dn	Percentage passing from					LL	PL	PI					
			4.75 mm IS Sieve	425 mic IS Sieve	75 mic IS Sieve	Gravel %	Sand %								
HR-BP-1	215+250	RHS	73.69	51.16	44.95	26.31	28.74	31	21	10	SC	1.97	11.60	17.61	13
HR-BP-2	205+600	RHS	58.96	27.06	25.24	41.04	33.72	44	23	21	GC	2.12	10.20	23.02	11
HR-BP-3	198+500	RHS	87.67	35.88	30.03	12.33	57.64	28	17	11	SC	2.12	9.30	26.21	15
HR-BP-4	189+050	RHS	58.17	18.34	18.00	41.83	40.17	45	28	17	GC	2.21	10.50	41.26	19
HR-BP-6	175+500	LHS	69.07	32.16	29.9	30.93	39.17	35	18	17	SC	2.13	9.20	23.17	14
HR-BP-8	167+700	LHS	94.76	75.29	61.54	5.24	33.22	29	17	12	CL	2.04	11.00	10.74	20
HR-BP-10	155+400	RHS	69.35	24.70	22.62	30.65	46.73	37	23	14	SC	2.14	9.60	34.19	19
HR-BP-11	151+500	RHS	76.74	46.48	34.35	23.26	42.39	30	18	12	SC	2.18	10.60	24.82	10
HR-BP-13	142+600	LHS	79.53	40.79	34.86	20.47	44.67	31	20	11	SC	2.16	9.40	24.82	14
HR-BP-15	223+700	LHS	72.29	39.89	31.93	27.71	40.36	25	18	7	SM-SC	2.06	11.80	15.73	19

Pie Chart showing the percentage distribution of soil classification of Borrow area sample is presented below:



- **AGGREGATE**

From Previous DD studies, the extracted test results of aggregate are as follows

Table 29: Results of Aggregate Samples

S. No	Sample	Location (km)	Up/Dn	A.I.V (%)	Water Absorption (%)	Specific Gravity	Remark
1	HR-AQ-1	141+900	LHS	19	0.45	2.64	
2	HR-AQ-2	141+900	LHS	19	0.51	2.64	
3	HR-AQ-3	230+100	RHS	22	0.31	2.71	
4	HR-AQ-4	230+100	RHS	22	0.29	2.71	
5	HR-AQ-5	230+100	RHS	22	0.54	2.70	
6	HR-AQ-6	177+700	LHS	20	0.30	2.62	
7	HR-AQ-7	177+700	LHS	15	0.32	2.63	

Note: All samples meeting specification requirements AIV <24% and WA<2%,

- **SAND**

From Previous DD studies, the extracted test results of M-Sand are as follows

Table 30: Results of Sand Samples

Sl No	Sample No	CHAINAGE (KM)	SIDE	10 mm Passing %	4.75 mm Passing %	2.36 mm Passing %	1.18mm Passing %	600mic Passing %	300mic Passing %	150mic Passing %	FM	ZONE
1	HR-SQ-1	141+900	LHS	100	98	95	88	72	32	1	**2.14**	**ZONE-III**
2	HR-SQ-2	229+800	LHS	100	99	98	92	71	5	2	**2.12**	**ZONE-III**

Note: Sand Samples meeting the requirement of Zone-III criteria.

4.2 CORE TEST ANALYSIS

Based on the extracted core samples obtained from the designated Flexible pavement locations, a detailed assessment of the in-situ material properties of few selective cores were determined in accordance with relevant test procedures and standards. The results of BC/DBM materials are as presented below.

Table 31: Core results of BC Samples

Sl. No.	Name of Material	Core No.	Chainage	Direction	Carriage way lane	Distance from kerb (mm)	Distance from Paved shoulder	Depth of core in mm	Condition of Road	% of Bitumen Obtained (by extraction of core)		% Agg by Wt. of total Mix	Thickness of Specimen mm	DENSITY %	Maximum Theoretical Sp.Gr. of Mix (GMM) %	% of Air Voids	Filler Asphalt Ratio (%)	% compaction	Gradation as per Morth
										BC	Limits						0.075 mm		
1	BC	VE-C-1	226+350	RHS	Outer Lane		2.5	150	Alligator Cracks	5.18	As per MORTH 5th Revision Table no 500-17 &18, Bitumen Content for BC Gr.- 1 is 5.2+3 %	94.82	40	2.369	2.464	3.86	1	96	Grade-I
10	BC	VE-C-10	165+760	RHS	Inner Lane	6.5		60	Rutting Minor cracking	5.13		94.87	30	2.438	2.451	0.53	0.75	99	Grade-I
17	BC	VE-C-17	173+050	LHS	Inner Lane	3.5		NO	Rutting, Alligator Cracks	5.28		94.72	37	2.475	2.569	3.66	0.93	96	Grade-I
21	BC	VE-C-21	214+500	LHS	Inner Lane	3.5		NO	Major Rutting	5.27		94.73	55	2.448	2.495	1.88	0.47	98	Grade No Match
24	BC	VE-C-24	229+550	LHS	Inner Lane	1.1		95	Alligator Cracks	5.31		94.69	38	2.318	2.435	4.80	0.85	95	Grade-I

- Majority of the cores are taken on the distressed surface and hence many are broken. However, few cores tested indicates that the mix gradation belongs to BC-Grade-1.
- MORTH 5th Revision Table 500-17 specifies Bitumen percentage should be 5.2 % ± 0.3%.

- Air Voids For BC– varying between 0.53 % and 4.8 %.
- Compaction –Most of locations of more than 95%.
- Filler Asphalt Ratio–The specified limit (0.6-1.2) as per MORTH 505.3 OR as per MS-2 (5.10)).

Table 32: Core results of DBM Samples

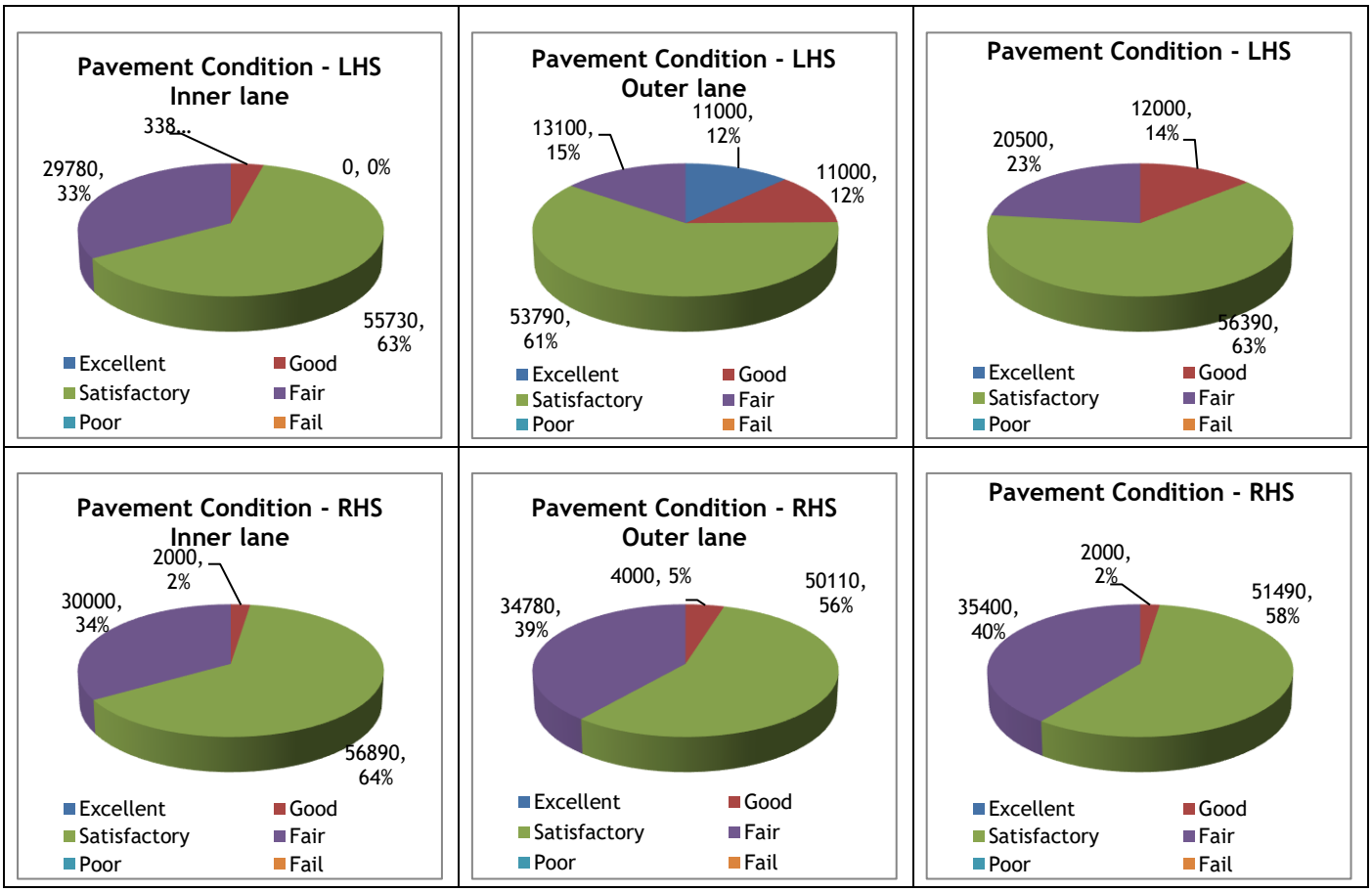
Sl. No.	Name of Material	Core No.	Chainage	Direction	Carriage way lane	Distance from kerb (mm)	Distance from Paved shoulder	Depth of core in mm	Condition of Road	% of Bitumen Obtained (by extraction of core)		% Agg by Wt. of total Mix	Thickness of Specimen mm	DENSITY %	Maximum Theoretical Sp. Gr. of Mix (GMM) %	% of Air Voids	Filler Asphalt Ratio (%)	% compaction	Gradation as per Morth
										DBM	Limits						0.075 mm		
1	DBM	VE-C-1	226+350	RHS	Outer Lane		2.5	150	Alligator Cracks	4.06	As per MORTH 5th Revision Table no 500-10 &18, Bitumen Content for DBM Gr-2 is Min 4.5±3 %	95.94	110	2.418	2.536	4.65	0.49	95	Grade-II
10	DBM	VE-C-10	165+760	RHS	Inner Lane	6.5		60	Rutting Minor cracking	4.11		95.89	55	2.410	2.496	3.45	1.05	97	Grade-II
21	DBM	VE-C-21	214+500	LHS	Inner Lane	3.5		NO	Major Rutting	4.09		95.91	95	2.433	2.445	0.49	0.44	100	Grade-II
24	DBM	VE-C-24	229+550	LHS	Inner Lane	1.1		95	Alligator Cracks	4.20		95.8	60	2.408	2.491	3.33	1.77	97	Grade-II

- Majority of the cores are taken on the distressed surface and hence many are broken. However, few cores tested indicates that the mix gradation belongs to DBM-Grade-II.
- Binder content for DBM - varying between 4.06% and 4.20%. For DBM Grade II mix, as per MORTH Table 500-10 Bitumen is 4.5% ± 0.3%. The bitumen % observed is less than the specified values. This may be due to aging of the bitumen might have oxidized.
- Air Voids for DBM- varying between 0.49% and 4.65%.
- Compaction –it is observed more than 95% of Compaction
- Filler Asphalt Ratio– The specified limit 0.6 to 1.2 as per MORTH 505.3 OR as per MS-2 (5.10).

4.3 PAVEMENT CONDITION

The distress in bituminous surface have been captured on the project corridor for each lane separately by using Network survey vehicle (NSV).

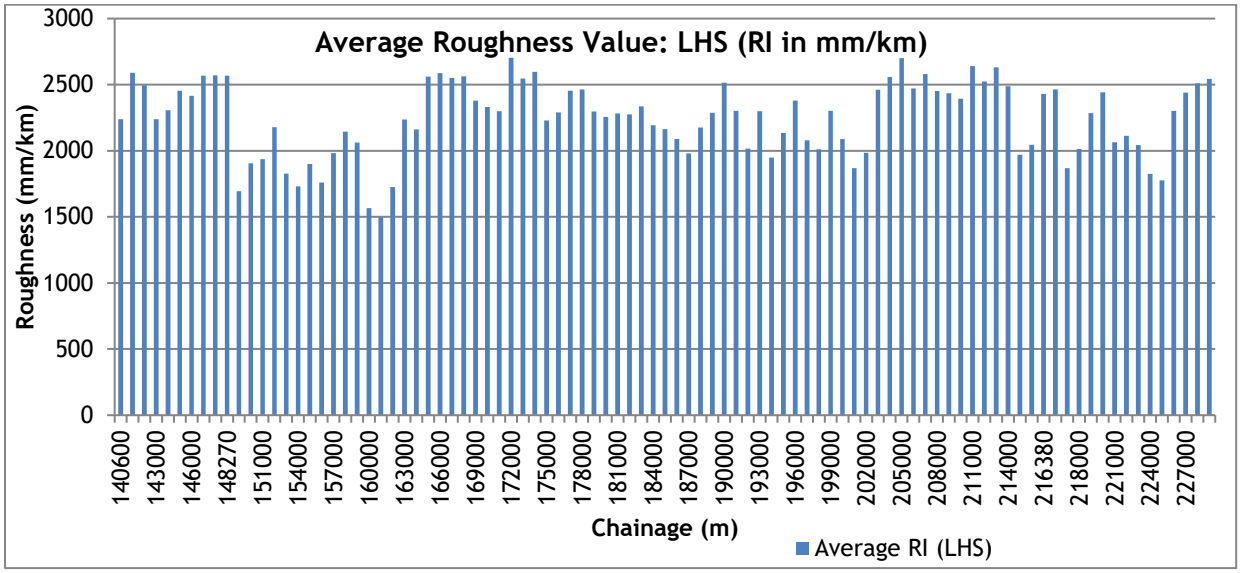
The project corridor has been provided with flexible pavement over entire length and even on service roads also. Rigid pavement is provided at Toll Plaza including tapering section. Condition of flexible pavement of main carriageway appears to be fair. Cracking and Patching and rutting are observed. Pie chat of the distress observed is presented below:



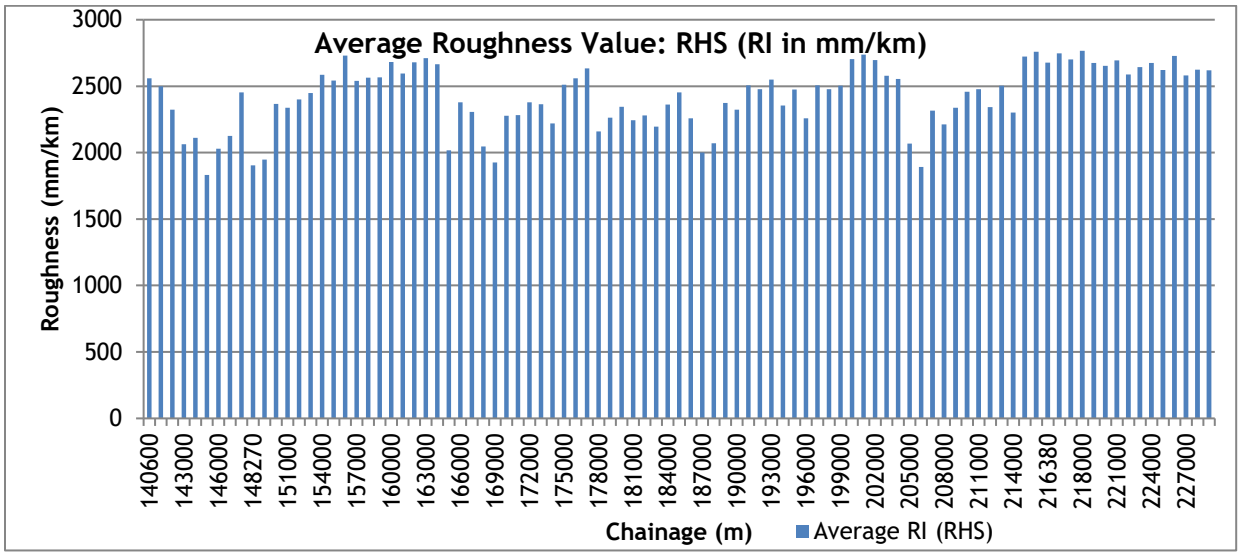
RHS carriageway is experiencing higher traffic loads compared to the LHS. Resulting greater distress observed on the RHS.

4.4 ROUGHNESS

The Roughness represented in Bar charts for the main carriageway are as presented below:



LHS Carriageway



RHS Carriageway

Based on the above, considering the Km-stone reference system the summary of Lane-Km having varying roughness values are as presented below.

RI (mm/Km)		Length (Km)			
>=	<	LHS Inner Lane	LHS Outer Lane	RHS Inner Lane	RHS Outer Lane
	2000	17.380	24.000	7.730	11.730
2000	2200	12.000	12.400	18.000	7.000
2200	2500	31.290	24.820	23.670	23.270
2500		**28.830**	**28.280**	**40.100**	**47.500**

From the above charts, it is evident that roughness Index (RI) greater than 2500 mm/km is warranted for functional overlay. RHS-side is showing more distressed than LHS due to heavy loads plying in RHS.

4.5 FWD ANALYSIS AND ASSESSMENT OF OVERLAY REQUIREMENT

The FWD data collected has been analyzed as per IRC-115 guidelines with the suggested ranges for in-service pavements

- Subgrade Modulus---------- 5 CBR to 20 CBR
- Granular Layer Modulus---------- 100 Mpa to 500 MPa
- Bituminous Layers –Thick without distress------ 750 Mpa to 3000 MPa
- Bituminous Layers in distressed condition------ 400 Mpa to 1500 MPa

The above suggested ranges for guidance only and pavement engineer shall use his judgment based on available data while fixing the above ranges. By looking at the age and condition and performance of the pavement following different set of ranges have been used while finalizing the modulus values:

Layer	Bituminous Layers	Granular Layer Modulus	Subgrade
Modulus Value (MPa)	400-1500	100-500	50-75

Bituminous layer Moduli obtained from back calculations shall be corrected for a standard pavement temperature of 35°C using given equations. However, in the present case no temperature correction is applied considering back-calculated MR-values of BT-layer have observed to be in the same range with various temperatures. Whereas, for back calculated moduli values obtained for granular and subgrade layer are corrected for seasonal variations (using winter and summer equations). As FWD tests, performed, during the winter seasonal correction factor winter is applied for granular and subgrade layer. The design moduli (15^{th} percentile moduli) of in-service layers for each homogenous section are given in table below.

The FWD data collected has been analyzed as per IRC guidelines and presented in the tables below.

Table 33: Summary of Design Moduli of different layers – LHS

S.No	Side	From (km)	To (km)	Length (Km)	15th Percentile MR values (Mpa)		
					MR for BT	MR for Granular	MR for Subgrade
1	LHS	140.60	144.41	3.81	1475	382	64
2	LHS	144.41	148.00	3.59	1428	391	64
3	LHS	148.00	148.27	0.27	Toll Plaza		
4	LHS	148.27	151.00	2.73	1469	390	64
5	LHS	151.00	154.43	3.43	1468	296	64
6	LHS	154.43	156.81	2.38	1474	391	64
7	LHS	156.81	159.20	2.39	1444	236	64
8	LHS	159.20	163.00	3.80	1462	359	64
9	LHS	163.00	166.00	3.00	1336	179	64
10	LHS	166.00	168.81	2.80	1487	180	54
11	LHS	168.81	172.00	3.19	1453	312	64
12	LHS	172.00	175.26	3.26	1461	192	59
13	LHS	175.26	178.20	2.94	1426	224	57
14	LHS	178.20	180.82	2.62	1457	232	64
15	LHS	180.82	183.20	2.39	1453	263	64
16	LHS	183.20	186.81	3.61	1461	287	64

S.No	Side	From (km)	To (km)	Length (Km)	15th Percentile MR values (Mpa)		
					MR for BT	MR for Granular	MR for Subgrade
17	LHS	186.81	190.60	3.79	1420	218	64
18	LHS	190.60	192.90	2.30	1465	310	64
19	LHS	192.90	193.10	0.20			
20	LHS	193.10	196.40	3.30			
21	LHS	196.40	200.21	3.81	1459	178	64
22	LHS	200.21	202.80	2.59	1458	184	64
23	LHS	202.80	205.20	2.40	1410	220	64
24	LHS	205.20	206.20	1.00	1461	320	64
25	LHS	206.20	206.70	0.50			
26	LHS	206.70	209.21	2.51			
27	LHS	209.21	212.60	3.40	1481	388	64
28	LHS	212.60	216.38	3.78	1472	376	64
29	LHS	216.38	216.72	0.34	Toll Plaza		
30	LHS	216.72	219.21	2.49	1473	375	64
31	LHS	219.21	223.21	4.01	1453	368	64
32	LHS	223.21	227.20	3.99	1461	392	64
33	LHS	227.20	230.10	2.90	1439	369	64

Table 34: Summary of Design Moduli of different layers - RHS

S.No	Side	From	To	Length (Km)	15th Percentile MR values (Mpa)		
					MR for BT	MR for Granular	MR for Subgrade
1	RHS	140.60	143.99	3.39	1413	205	64
2	RHS	143.99	148.00	4.007	1446	202	64
3	RHS	148.00	148.27	0.27	Toll plaza		
4	RHS	148.27	150.59	2.320	1462	389	64
5	RHS	150.59	153.09	2.50	1429	269	64
6	RHS	153.09	155.40	2.31	1472	360	64
7	RHS	155.40	158.69	3.30	1200	226	64
8	RHS	158.69	161.79	3.10	1261	245	64
9	RHS	161.79	164.20	2.410	1238	107	64
10	RHS	164.20	166.60	2.400	1118	135	61
11	RHS	166.60	169.20	2.594	902	257	63
12	RHS	169.20	172.00	2.807	1351	228	64
13	RHS	172.00	175.00	2.998	1184	137	64
14	RHS	175.00	177.40	2.396	1409	239	64
15	RHS	177.40	180.00	2.604	1452	230	62
16	RHS	180.00	182.60	2.60	1464	235	64
17	RHS	182.60	185.80	3.198	1439	139	64
18	RHS	185.80	188.00	2.201	1403	260	64
19	RHS	188.00	190.39	2.387	1425	228	64
20	RHS	190.39	192.90	2.513	1446	262	64
21	RHS	192.90	193.10	0.20	Canal works in progress		
22	RHS	193.10	195.40	2.301	1431	224	64
23	RHS	195.40	197.79	2.391	1395	137	64
24	RHS	197.79	200.20	2.408	1412	139	64
25	RHS	200.20	202.79	2.594	1463	325	63
26	RHS	202.79	205.20	2.406	1417	143	64
27	RHS	205.20	206.20	1.000	1449	305	64
28	RHS	206.20	206.70	0.500			
29	RHS	206.70	209.60	2.900			
30	RHS	209.60	212.19	2.59	1459	365	64

S.No	Side	From	To	Length (Km)	15th Percentile MR values (Mpa)		
					MR for BT	MR for Granular	MR for Subgrade
31	RHS	212.19	214.80	2.60	1456	369	64
32	RHS	214.80	216.38	1.58	1465	391	64
33	RHS	216.38	216.72	0.34			
34	RHS	216.72	218.20	1.48			
35	RHS	218.20	221.20	3.00	1460	391	64
36	RHS	221.20	224.19	2.99	1453	388	64
37	RHS	224.19	227.40	3.21	1460	392	64
38	RHS	227.40	230.10	2.702	1457	329	64

Observation of FWD Results

It can be noticed from the above table that the layer moduli for the three layers are varying along the length and direction. The MR value for BT layer is 1336Mpa to 1487Mpa in LHS & 902Mpa to 1472Mpa in RHS Carriageway. The MR value for Granular Layers is 178Mpa to 392Mpa in LHS &107Mpa to 392Mpa in RHS Carriageway. Similarly, the MR value for Subgrade Layer is 54Mpa to 64Mpa in LHS & 61Mpa to 64Mpa in RHS Carriageway.

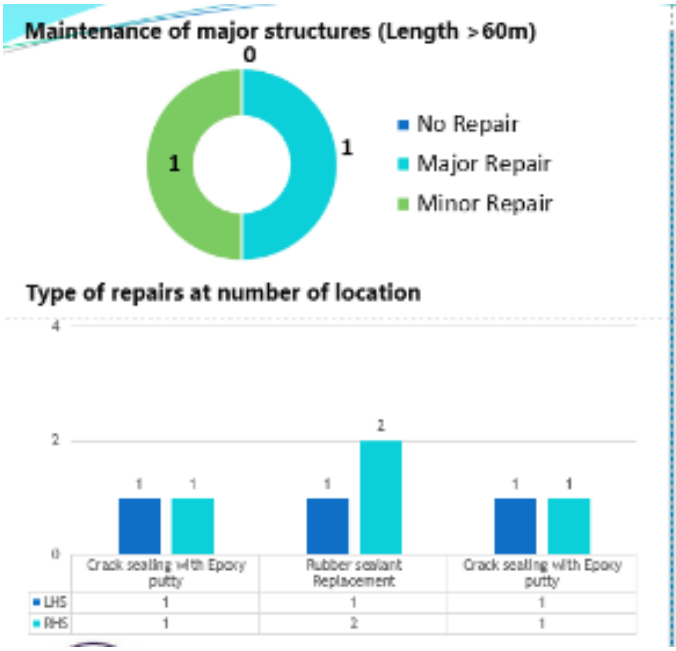
Out-layered values obtained in back calculation at isolated sections have been removed while finalizing the Modulus of resilience for each homogeneous section. Such out layered locations have been considered to be provided with additional provisions such as glass-grids exogenously to account for abnormal value obtained during survey.

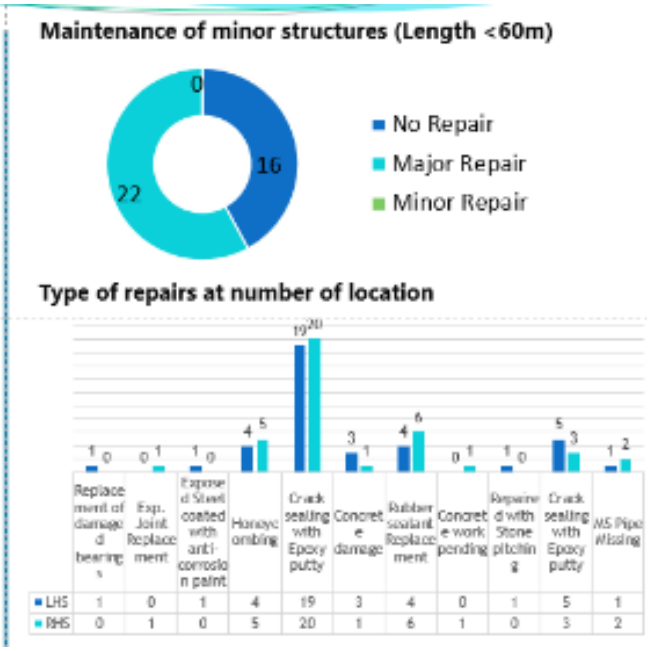
4.6 STRUCTURES

From previous DD studies, Inventory and asset condition of all the existing structures falling within project road have been verified as per IRC: SP-35 procedures and guidelines with following field surveys

- Inventory of existing highway bridges / structures
- Visual condition survey of existing highway bridges / structures

Based on these surveys following structural rehabilitation measures have been considered.





Inventory and condition of all the structures is presented as below.

Chainage: 205+415
General Description
LHS MCW (New)

- Type of Structure : Flyover
- Span Arrangement : 2 x 43.988 m
- Total length of Structure : 87.976 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Pot PTFE
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged on Exp.Joint P-1. (1No)
- Drainage spouts were clogged.
- Structure is in fair condition.

Chainage: 205+415
General Description
RHS MCW (New)

- Type of Structure : Flyover
- Span Arrangement : 2 x 43.988 m
- Total length of Structure : 87.976 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Pot PTFE
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in Exp. Joint on A-1. (1No)
- Drainage spouts were clogged.
- Structure is in fair condition.

Chainage: 229+825
General Description
LHS MCW (New)

- Type of Structure : Flyover
- Span Arrangement : 3 x 30.00 m
- Total length of Structure : 90 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints were buried with debris and channel buried with bitumen.
- Drainage spouts clogged at some locations.
- Minor Cracks observed on RE blocks at some locations.




Chainage: 229+825
General Description
RHS MCW (New)

- Type of Structure : Flyover
- Span Arrangement : 3 x 30.00 m
- Total length of Structure : 90 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged (minor) in Exp.Joint on both abutments. (2No)
- Minor Cracks observed on RE blocks at some locations.
- Friction slab crash barrier damaged on A-2 shoulder side dirt wall.

Chainage: 148+553
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 25 m
- Total length of Structure : 50 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in expansion joint on A-1. (1 No)
- Cracks observed on soffit of deck slab in both spans & Abutment 1.
- Friction slab crash barrier damaged on A-1 shoulder side dirt wall.

Chainage: 148+553
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 25 m
- Total length of Structure : 50 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in all Expansion joints. (3 Nos)
- Honeycomb and steel exposed on Cantilever portion of deck slab.
- Cracks observed on soffit of deck slab in both spans & Abutment 1.
- Median crash barrier damaged on A2 side.




Chainage: 150+694
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 1 x 20 m
- Total length of Structure : 20 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in Exp.Joints on both abutments. (2 Nos)
- Drainage spouts were clogged with debris.
- Silt and Debris observed on Abutment caps.
- Cracks observed on girders at some locations.

Chainage: 150+694
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 1 x 20 m
- Total length of Structure : 20 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in Exp.Joints on both abutments. (2 Nos)
- Drainage spouts were clogged with debris.
- Silt and Debris observed on Abutment caps.
- Cracks observed on both abutments.




Chainage: 151+759
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 5 x 6.60 m
- Total length of Structure : 33 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : Stone Masonry Wall Type
- Type of Superstructure : Stone Masonry Arch Type
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Quadrant Slope protection partially damaged at A-1.
- Gaps observed between stones at some locations on Structure.
- Hand Railing missing about 1m on A2 side.

Chainage: 151+759
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 5 x 6.60 m
- Total length of Structure : 33 m
- Total deck width of Structure : 12 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 155+274
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 1 x 20 m
- Total length of Structure : 20 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints are buried with wearing coat.
- Cracks observed on girders at some locations and also soffit of deck slab between girders G-1, 2 & G-3 from median side & on Abutment 2.
- Hand Railing missing about 4m on A1 & A2 side.

Chainage: 155+274
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 1 x 20 m
- Total length of Structure : 20 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged on both abutments. (2 Nos)
- Honeycomb observed on soffit of Girder G2 from median side.
- Cracks observed on girders at some locations and also soffit of deck slab between girders G-2, 3 & G-4 from shoulder side.




Chainage: 158+877
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 10 m
- Total length of Structure : 20 m
- Total deck width of Structure : 20.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 158+877
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 10 m
- Total length of Structure : 20 m
- Total deck width of Structure : 20.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 162+513
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 28 m
- Total length of Structure : 56 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in expansion joint on A-1. (1 No)
- Minor Cracks observed on soffit of deck slab between girders G-2 & 3.
- On pier P-1 expansion joint buried with wearing coat and also debris.
- Cracks observed on A-2 and also soffit of girder G-1 near A-2 in span-2 from median.









Chainage: 162+513
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 28 m
- Total length of Structure : 56 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor damage on Hand Railing at A-1 approach.
- Expansion joint are buried with BT Layers.
- Concrete portion damaged near Exp.Joint on A-1.
- MS Pipe railing missing on median Crash barrier about 28m in Sapn-1.




Chainage: 165+035
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 2 x 12.55 m
- Total length of Structure : 25.1 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Steel exposed on pier-1 at median side.
- Concrete surface damaged due to water leakage through expansion gap on Pier-1.
- Structure is in fair condition.

Chainage: 165+035
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 12.55 m
- Total length of Structure : 25.1 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Slab
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.




Chainage: 165+978
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 10 m
- Total length of Structure : 20 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 165+978
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 10 m
- Total length of Structure : 20 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 167+563
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 25 m
- Total length of Structure : 50 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in expansion joint on pier P-1. (1 No)
- Cracks observed on both abutments.
- Honeycomb & Reinforcement exposed on soffit of deck near joint location.

Chainage: 167+563
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 25 m
- Total length of Structure : 50 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in expansion joint on pier P-1. (1 No)
- Cracks observed on both abutment and also on soffit of deck slab between girders G-1, 2, & 3 near Pier P-1.
- Honeycomb on deck soffit of cantilever portion from shoulder side near A-1.




Chainage: 171+034
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 3 x 10 m
- Total length of Structure : 30 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 171+034
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 3 x 10 m
- Total length of Structure : 30 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on wearing coat at Exp.joint gap location.
- Structure is in fair condition.

Chainage: 175+282
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 2 x 26.50 m
- Total length of Structure : 53 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints buried under BT layers.
- Cracks observed on both abutments.
- Minor damage observed on Hand Railing.
- Drainage spouts clogged at some locations.




Chainage: 175+282
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 26.50 m
- Total length of Structure : 53 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Rubber Sealant damaged in expansion joint on pier P-1. (1 No)
- Cracks observed on abutment wall both abutments.
- Expansion joints were buried under BT Layers.
- Drainage spouts clogged at some locations.




Chainage: 180+745
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 3 x 7.2 m
- Total length of Structure : 21.6 m
- Total deck width of Structure : 12 m
- Type of Foundation :
- Type of Substructure (Abutment & Pier) : Stone Masonry Wall Type
- Type of Superstructure : Stone Masonry Arch Type
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Old Stone masonry Arch Bridge widened with RCC Structure.
- Vegetation growth observed on super structure.
- Gaps observed between stones at some locations on the Structure.

Chainage: 180+745
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 3 x 7.2 m
- Total length of Structure : 21.6 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion gaps buried under BT Layer.
- Steel Exposed on bottom of median wall.
- Drainage spouts clogged at some locations.
- Structure is in fair condition.




Chainage: 180+983
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 5 m
- Total length of Structure : 10 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Drainage spouts clogged.
- Structure is in fair condition.

Chainage: 180+983
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 5 m
- Total length of Structure : 10 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Drainage spouts clogged.
- Structure is in fair condition.




Chainage: 196+780
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 20 m
- Total length of Structure : 40 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints were partially buried under bituminous layer on both abutments.
- Cracks observed on abutment wall A-2 & on web portion all girder in both spans.
- Cracks on deck soffit between G1 & G2 from median side & G2 & G3 from shoulder side.
- Drainage spouts clogged at some locations




3

Chainage: 196+780
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 20 m
- Total length of Structure : 40 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints were buried under bituminous layer on both abutments.
- Cracks observed on abutment wall A-2.
- Cracks observed on web portion of all girders in span-2 and Girder G-1 from median side in span-1.




Chainage: 203+764
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 28 m
- Total length of Structure : 56 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- MS Pipe railing damaged about 15m on median crash barrier.
- Cracks observed on both abutments.
- Expansion joints were buried under bituminous layer on both abutments.




Chainage: 203+764
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 28 m
- Total length of Structure : 56 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : PSC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints are buried with debris.
- MS Pipe railing damaged about 40m on median crash barrier.
- Cracks observed on both abutments.

Chainage: 207+374
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 4 x 7.50 m
- Total length of Structure : 30 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 207+374
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 4 x 7.50 m
- Total length of Structure : 30 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 211+293
General Description
LHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 4 x 12.208 m
- Total length of Structure : 48.832 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Drainage spouts clogged at some locations.
- Structure is in fair condition.




Chainage: 211+293
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 4 x 12.208 m
- Total length of Structure : 48.832 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Honeycombing observed on return wall at A-2.
- Drainage spouts clogged at some locations.
- Structure is in fair condition.




Chainage: 213+825
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 3 x 8.885 m
- Total length of Structure : 26.655 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Honeycombing & reinforcement exposed on bottom of A-2 wall at shoulder side.
- Drainage spouts clogged at some locations.




Chainage: 213+825
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 3 x 8.885 m
- Total length of Structure : 26.655 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 215+050
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 1 x 13.10 m
- Total length of Structure : 13.1 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Crash Barrier missing on A-1 Approach.
- Cracks observed on girders at some locations.
- Bearings distress(Cracks) observed on A-1 Bearing no. B-1 &3 from median side.

Chainage: 215+050
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 1 x 13.10 m
- Total length of Structure : 13.1 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joints were partially buried with debris.
- Cracks observed on deck soffit between girders G1, G2 & G3 from median.

Chainage: 218+282
General Description
LHS MCW (Old)

- Type of Structure : MNB
- Span Arrangement : 2 x 13.80 m
- Total length of Structure : 27.6 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : Stone Masonry Wall Type
- Type of Superstructure : Stone Masonry Arch Type
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Gaps observed between stones at some locations on Structure.

Chainage: 218+282
General Description
RHS MCW (New)

- Type of Structure : MNB
- Span Arrangement : 2 x 13.80 m
- Total length of Structure : 27.6 m
- Total deck width of Structure : 12 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RCC Wall Type
- Type of Superstructure : RCC Girder
- Type of Bearing : Elastomeric
- Type of Railing / Crash Barrier : Hand Railing & Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Expansion joint damaged on A-2. (1 No)
- Rubber Sealant damaged in Expansion joint on P1 & A-1. (2 Nos)
- Honeycombing observed on soffit of girder G1 from median side in span-2.
- Drainage spouts clogged at some locations.




Chainage: 147+420
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 147+420
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 152+840
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Gap observed in between side wall and RE wall on A1 side.
- Gaps observed b/w RE Blocks on A-2 Approach RE Wall.

Chainage: 152+840
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on RE blocks.




Chainage: 159+500
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on RE Wall Blocks at some locations.




Chainage: 159+500
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Gap and Settlement observed on RE Wall (Blocks) at Abutment-1 approach.




Chainage: 163+659
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on side wall at A-1 and soffit of deck slab.




Chainage: 163+659
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on both side walls and soffit of deck slab.

Chainage: 166+730
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on both side walls and soffit of deck slab.




Chainage: 166+730
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on both side walls and soffit of deck slab.




Chainage: 167+980
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on side wall A-2 and soffit of deck slab.
- Minor Honeycomb observed on soffit of deck slab.

Chainage: 167+980
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on both side walls and soffit of deck slab.

Chainage: 172+117
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.77 m
- Total length of Structure : 12.77 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 172+117
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.77 m
- Total length of Structure : 12.77 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 174+220
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.

Chainage: 174+220
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.

Chainage: 177+910
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks and Honeycomb observed on soffit of deck slab.

Chainage: 177+910
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on soffit slab.

Chainage: 181+900
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.

Chainage: 181+900
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.




Chainage: 186+030
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Crash barrier settlement observed on A-1 approach.
- Cracks observed on soffit of deck slab.
- Median side wall damaged.

Chainage: 186+030
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Cracks observed on soffit of deck slab.

Chainage: 187+172
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.77 m
- Total length of Structure : 12.77 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on haunch portion.

Chainage: 187+172
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.77 m
- Total length of Structure : 12.77 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.




Chainage: 189+280
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on soffit of deck slab.

Chainage: 189+280
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on soffit of deck slab.

Chainage: 193+350
General Description
BHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 197+210
General Description
BHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 207+810
General Description
LHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 207+810
General Description
RHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 13.75 m
- Type of Foundation : Raft
- Type of Substructure (Abutment & Pier) : RCC Box
- Type of Superstructure : RCC Box
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Minor Cracks observed on soffit of deck slab.

Chainage: 218+790
General Description
BHS MCW (New)

- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Chainage: 222+490
General Description
BHS MCW (New)

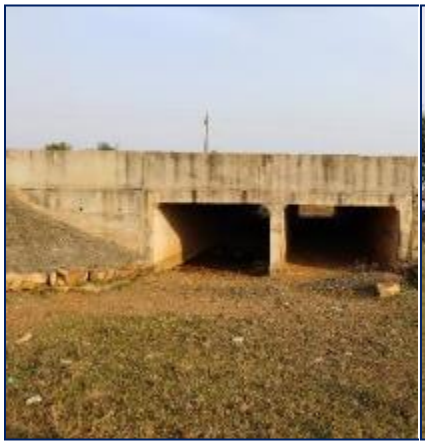
- Type of Structure : VUP
- Span Arrangement : 1 x 12.00 m
- Total length of Structure : 12 m
- Total deck width of Structure : 12.5 m
- Type of Foundation : Open
- Type of Substructure (Abutment & Pier) : RE Abutment
- Type of Superstructure : RCC Slab
- Type of Bearing : Not Applicable
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

Visual Observations on condition of the structure are as below:

- Structure is in fair condition.

Photos depicting the existing culverts are presented below



Box Culvert at Km 146+240

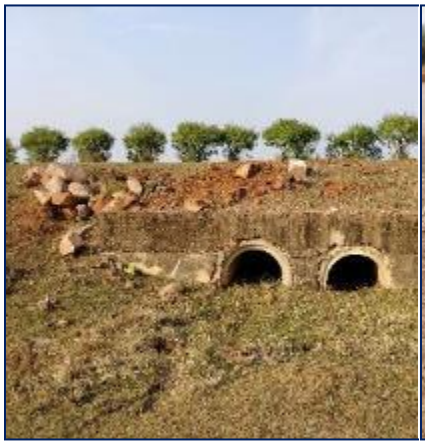
Box Culvert at Km 172+380

Box Culvert at Km 173+700

Box Culvert at Km 187+810

Box Culvert at Km 195+630

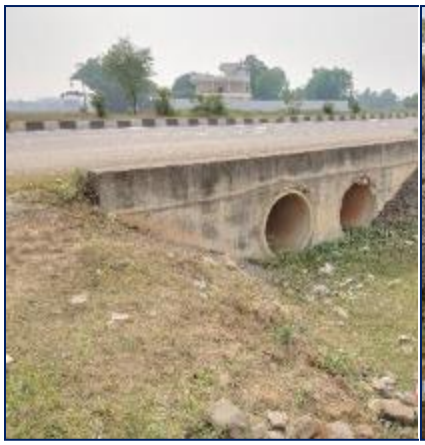
Box Culvert at Km 223+733



Pipe Culvert at Km 143+150

Pipe Culvert at Km 153+785

Pipe Culvert at Km 157+727



Pipe Culvert at Km 169+770

Pipe Culvert at Km 170+550

Pipe Culvert at Km 193+900

4.7 DRAINAGE AND SLOPE PROTECTION

- *Lined Covered drains observed Urban locations and Toll Plaza Location along the corridor.*
- *Median drains are observed at only one location where they need cleaning.*
- *Slope protection in the form of Embankment and RE blocks has been provided along the corridor*. At two locations RE blocks dislocated and cracks observed. Grouting has been done.

4.8 TRAFFIC SAFETY AND ROAD FURNITURE

- *Metal beam crash barriers provided along the project road appear to be intact over entire length except for few locations where it got damaged.*
- *Pedestrian guard rails installed at Urban Locations between MCW and Service Road appear to be in good condition.*
- *Traffic blinkers established along the corridor and street lighting observed at Toll Plaza location and in Urban areas and high mast lighting are all functioning well.*

4.9 ROAD USER FACILITIES

- *There are 51 nos. of bus bays with shelters (1 shelter damaged) and 8 no's truck lay byes observed along the corridor and appear in fair condition.*

CHAPTER 5. REHABILITATION PLANS AND DESIGNS

5.1 DESIGN TRAFFIC LOADING

From the previous DD-studies, Year-2023, the considered AADT and Traffic Loading are as follows:

Table 35: AADT

Vehicle/Mode	Toll plaza, km148+100	Toll Plaza, km 216+545
Car	1666	5244
LCV	114	336
2A truck/Buses	418	678
3A truck	172	270
MAV truck	1448	2508

Table 36: Estimated Design traffic loading

Year	Design MSA			
	TP1 @ km 148+100		TP2 @ km 216+545	
	UP	DN	UP	DN
5 Years	17	27	24	48
10 Years	39	62	54	108
15 Years	67	107	93	186
20 years	103	163	142	285

5.2 PAVEMENT REHABILITATION AND STRENGTHENING

For Design the Overlay Thickness the following method as suggested in IRC: 115 has been used

- The existing pavement is considered as a 3-layer system consisting of subgrade, granular and bituminous layer. The remaining life of exiting pavement in terms of Fatigue and Rutting life (MSA) are estimated
- The remaining life is compared with design traffic loading. An overlay with assumed thickness is considered on exiting pavement where required.
- The Total system including the proposed Overlay (Trial thickness) is assumed as a four-layer system and considered the relevant MR values for all the four layers namely New BT layer, existing Bituminous surface, Total existing Granular layers and Subgrade layers.
- The MR value for the New BT is assumed as 3000 MPA (considering VG40 Bituminous grade) and for all the remaining three layers, the MR Values derived and finalized from the FWD Analysis are considered
- Critical Tensile strains and Vertical strains are found out by using the IIT PAVE Software at the bottom of existing bituminous layer and at the top of the subgrade layer respectively.
- The Fatigue and Rutting equations given in the IRC: 37, applicable for 80% reliability have been used to estimate the Fatigue and Rutting Life of The Pavement system.

- The Obtained Fatigue and Rutting Life are compared with the required life for the assumed trial overlay thickness.
- Analysis is carried out for individual homogeneous sections as well for minimum and Average Modulus Values on each direction separately.

Remaining life of the existing pavement from the above analysis is presented in the following tables:

Table 37: Remaining life of the existing pavement on Both Carriageways

S.No	Side	From	To	Length (Km)	15th Percentile MR values			Average Existing Crust		Total Crust (mm)	Remaining Life as per IRC 37-2012 equation for 80% Reliability			
					MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)	BT (mm)	Granular (mm)		Nf-Fatigue life, mSA	Rutting life,mSA	Target MSA	Remarks
1	LHS	140.60	144.41	3.81	1475	382	64	130	480	610	125	492	39	No Overlay
2	LHS	144.41	148.00	3.59	1428	391	64	130	480	610	133	506	39	No Overlay
3	LHS	148.00	148.27	0.27										Toll Plaza
4	LHS	148.27	151.00	2.73	1469	390	64	120	430	550	108	232	39	No Overlay
5	LHS	151.00	154.43	3.43	1468	296	64	120	430	550	49	138	39	No Overlay
6	LHS	154.43	156.81	2.38	1474	391	64	120	430	550	109	233	39	No Overlay
7	LHS	156.81	159.20	2.39	1444	236	64	120	465	585	27	141	39	Overlay
8	LHS	159.20	163.00	3.80	1462	359	64	120	490	610	86	412	39	No Overlay
9	LHS	163.00	166.00	3.00	1336	179	64	120	490	610	13	116	39	Overlay
10	LHS	166.00	168.81	2.80	1487	180	54	115	495	610	13	80	39	Overlay
11	LHS	168.81	172.00	3.19	1453	312	64	110	500	610	47	295	39	No Overlay
12	LHS	172.00	175.26	3.26	1461	192	59	110	500	610	13	103	39	Overlay
13	LHS	175.26	178.20	2.94	1426	224	57	114	480	594	21	105	39	Overlay
14	LHS	178.20	180.82	2.62	1457	232	64	130	400	530	31	77	39	Overlay
15	LHS	180.82	183.20	2.39	1453	263	64	130	400	530	43	94	39	No Overlay
16	LHS	183.20	186.81	3.61	1461	287	64	130	400	530	54	109	39	No Overlay
17	LHS	186.81	190.60	3.79	1420	218	64	122	425	547	23	79	39	Overlay
18	LHS	190.60	192.90	2.30	1465	310	64	120	430	550	55	150	39	No Overlay
19	LHS	192.90	193.10	0.20										Under Construction
20	LHS	193.10	196.40	3.30										No Overlay
21	LHS	196.40	200.21	3.81	1459	178	64	120	405	525	14	46	39	Overlay
22	LHS	200.21	202.80	2.59	1458	184	64	120	400	520	15	45	39	Overlay
23	LHS	202.80	205.20	2.40	1410	220	64	120	400	520	22	56	39	Overlay
24	LHS	205.20	206.20	1.00	1461	320	64	133	406	539	77	150	54	No Overlay
25	LHS	206.20	206.70	0.50										Under Construction
26	LHS	206.70	209.21	2.51										No Overlay
27	LHS	209.21	212.60	3.40	1481	388	64	140	410	550	154	257	54	No Overlay
28	LHS	212.60	216.38	3.78	1472	376	64	140	410	550	141	242	54	No Overlay
29	LHS	216.38	216.72	0.34										Toll Plaza
30	LHS	216.72	219.21	2.49	1473	375	64	129	421	550	113	226	54	No Overlay
31	LHS	219.21	223.21	4.01	1453	368	64	120	430	550	90	205	54	No Overlay
32	LHS	223.21	227.20	3.99	1461	392	64	120	430	550	110	233	54	No Overlay
33	LHS	227.20	230.10	2.90	1439	369	64	120	430	550	91	205	54	No Overlay

S.No	Side	From	To	Length (Km)	15th Percentile MR values			Average Existing Crust		Total Crust (mm)	Remaining Life as per IRC 37-2012 equation for 80% Reliability			
					MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)	BT (mm)	Granular (mm)		Nf-Fatigue life, mSA	Rutting life,mSA	Target MSA	Remarks
1	RHS	140.60	143.99	3.39	1413	205	64	130	450	580	24	114	62	Overlay
2	RHS	143.99	148.00	4.007	1446	202	64	130	450	580	23	113	62	Overlay
3	RHS	148.00	148.27	0.27										Toll Plaza
4	RHS	148.27	150.59	2.320	1462	389	64	130	450	580	130	353	62	No Overlay
5	RHS	150.59	153.09	2.50	1429	269	64	157	417	573	82	201	62	No Overlay
6	RHS	153.09	155.40	2.31	1472	360	64	170	400	570	226	343	62	No Overlay
7	RHS	155.40	158.69	3.30	1200	226	64	170	400	570	64	143	62	No Overlay
8	RHS	158.69	161.79	3.10	1261	245	64	170	400	570	80	166	62	No Overlay
9	RHS	161.79	164.20	2.410	1238	107	64	137	442	578	7	53	62	Overlay
10	RHS	164.20	166.60	2.400	1118	135	61	130	450	580	8	50	62	Overlay
11	RHS	166.60	169.20	2.594	902	257	63	130	450	580	35	119	62	Overlay
12	RHS	169.20	172.00	2.807	1351	228	64	130	450	580	30	130	62	Overlay
13	RHS	172.00	175.00	2.998	1184	137	64	122	434	556	7	42	62	Overlay
14	RHS	175.00	177.40	2.396	1409	239	64	120	430	550	27	93	62	Overlay
15	RHS	177.40	180.00	2.604	1452	230	62	120	430	550	25	83	62	Overlay
16	RHS	180.00	182.60	2.60	1464	235	64	120	426	546	26	88	62	Overlay
17	RHS	182.60	185.80	3.198	1439	139	64	120	420	540	8	40	62	Overlay
18	RHS	185.80	188.00	2.201	1403	260	64	120	420	540	34	94	62	Overlay
19	RHS	188.00	190.39	2.387	1425	228	64	120	420	540	19	66	62	Overlay
20	RHS	190.39	192.90	2.513	1446	262	64	120	426	546	35	105	62	Overlay
21	RHS	192.90	193.10	0.20										Under Construction
22	RHS	193.10	195.40	2.301	1431	224	64	120	430	550	23	85	62	Overlay
23	RHS	195.40	197.79	2.391	1395	137	64	120	430	550	8	43	62	Overlay
24	RHS	197.79	200.20	2.408	1412	139	64	120	430	550	8	44	62	Overlay
25	RHS	200.20	202.79	2.594	1463	325	63	137	439	576	90	242	62	No Overlay
26	RHS	202.79	205.20	2.406	1417	143	64	160	450	610	23	138	62	Overlay
27	RHS	205.20	206.20	1.000	1449	305	64	160	450	610	123	383	108	No Overlay
28	RHS	206.20	206.70	0.500										Under Construction
29	RHS	206.70	209.60	2.900										No Overlay
30	RHS	209.60	212.19	2.59	1459	365	64	157	447	604	186	483	108	No Overlay
31	RHS	212.19	214.80	2.60	1456	369	64	150	440	590	164	400	109	No Overlay
32	RHS	214.80	216.38	1.58	1465	391	64	150	440	590	193	448	108	No Overlay
33	RHS	216.38	216.72	0.34										Toll Plaza
34	RHS	216.72	218.20	1.48										No Overlay
35	RHS	218.20	221.20	3.00	1460	391	64	150	440	590	193	447	108	No Overlay
36	RHS	221.20	224.19	2.99	1453	388	64	150	440	590	189	439	108	No Overlay
37	RHS	224.19	227.40	3.21	1460	392	64	150	440	590	195	449	108	No Overlay
38	RHS	227.40	230.10	2.702	1457	329	64	150	440	590	120	326	108	No Overlay

Hence, from the above analysis it can be noted that length of 29.61 Km in LHS and 48.015 Km in RHS required Strengthening Overlay on existing Pavement from the FWD analysis.

Overlay with 40mm BC in LHS and 40mm to 90mm in RHS is proposed as it is satisfying the requirement of design life. Its details are presented as below.

Table 38: Summary of Pavement life with Overlay

Sl. No	From (km)	To (km)	Length (km)	MR for BT(Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)	BT (mm)	Granular (mm)	Proposed BT (mm)	Total Crust (mm)	MR for BT (Mpa)	Nf-Fatigue life, mSA	Rutting life,mSA
LHS													
7	156.81	159.20	2.39	1444	236	64	120	465	40	625	1444	75	415
9	163.00	166.00	3.00	1336	179	64	120	490	40	650	1336	40	362
10	166.00	168.81	2.80	1487	180	54	115	495	40	650	1487	39	242
12	172.00	175.26	3.26	1461	192	59	110	500	40	650	1461	40	307
13	175.26	178.20	2.94	1426	224	57	114	480	40	634	1426	59	309
14	178.20	180.82	2.62	1457	232	64	130	400	40	570	1457	85	247
17	186.81	190.60	3.79	1420	218	64	122	425	40	587	1420	63	252
21	196.40	200.21	3.81	1459	178	64	120	405	40	565	1459	40	157
22	200.21	202.80	2.59	1458	184	64	120	400	40	560	1458	43	154
23	202.80	205.20	2.40	1410	220	64	120	400	40	560	1410	61	186
RHS													
1	140.60	143.99	3.39	1413	205	64	130	450	40	620	1413	67	355
2	143.99	148.00	4.007	1446	202	64	130	450	40	620	1446	66	353
9	161.79	164.20	2.410	1238	107	64	137	442	80	658	1238	62	544
10	164.20	166.60	2.400	1118	135	61	130	450	80	660	1118	69	459
11	166.60	169.20	2.594	902	257	63	130	450	40	620	902	90	373
12	169.20	172.00	2.807	1351	228	64	130	450	40	620	1351	81	396
13	172.00	175.00	2.998	1184	137	64	122	434	80	636	1184	63	405
14	175.00	177.40	2.396	1409	239	64	120	430	40	590	1409	75	287
15	177.40	180.00	2.604	1452	230	62	120	430	40	590	1452	70	257
16	180.00	182.60	2.60	1464	235	64	120	426	40	586	1464	73	273
17	182.60	185.80	3.198	1439	139	64	120	420	80	620	1439	71	393
18	185.80	188.00	2.201	1403	260	64	120	420	40	580	1403	90	288
19	188.00	190.39	2.387	1425	228	64	120	420	40	580	1425	67	243
20	190.39	192.90	2.513	1446	262	64	120	426	40	586	1446	93	316
22	193.10	195.40	2.301	1431	224	64	120	430	40	590	1431	65	265
23	195.40	197.79	2.391	1395	137	64	120	430	80	630	1395	69	418
24	197.79	200.20	2.408	1412	139	64	120	430	80	630	1412	71	425
26	202.79	205.20	2.406	1417	143	64	160	450	40	650	1417	65	460

5.3 STRUCTURAL REHABILITATION

All the structure found to be in good condition except little minor treatment like crack repairs, repair of stone pitching, cleaning of drainage spouts, cleaning of vegetation etc. may be required. Detailed structural rehabilitation quantities have been worked out based on the prevailing condition of existing structures. This methodology describes in detail the procedure for the execution of each item of rehabilitation work of the Existing Bridges of the project.

The scope of this methodology covers the items mentioned below for rehabilitation work of all the existing Bridges.

- Repair of RE-panels/blocks
- Repair/ Replacement of Existing Bearings
- Repair / Replacement of Existing Expansion Joints
- Repair / Replacement of Existing Wearing Coat
- Profile Correction for Existing Deck Slab by Cement Concrete
- Sealing of Cracks for Bridges by Epoxy Resin
- Replacement of Spalled Concrete of ECW by Epoxy Mortar
- Cement Grouting for Repair of Existing Bridges
- Guniting / Shotcreting for Repair of Existing Bridges
- Providing & Fixing of Drainage Spouts
- Repair of Substructure Component
- Repair / Replacement of Railing & Crash Barrier
- Epoxy Bonding between New and Old Concrete.

CHAPTER 6. OPERATION AND MAINTENANCE

6.1 INTRODUCTION

Looking at the contractual requirements of maintaining project road under specified level of roughness it is felt that roughness is the most important criterion for finalizing the O&M schedule for the project. Accordingly, the methodology adopted by present consultants includes predicting the roughness year by year under the traffic using a well acknowledged HDH-4 model developed for developing countries like India after lot of research by World Bank. The said model is widely prescribed by MORTH and NHAI during the preparation of detailed project reports for several projects in doing economic analysis for the projects. The economic analysis mainly consists of two parts:

1. Predicting the road deterioration and estimating VOC
2. Estimating Benefits

Considering its importance and present use in India, consultants felt prudent to use the first part, i.e. estimating road deterioration and predicting roughness in HDM 4 model to finalize the O&M schedule for the project. This approach is more scientific and includes main criterion of maintaining roughness at 2500mm/Km as per Schedule K.

6.2 CA SPECIFICATIONS FOR MAJOR MAINTENANCE

- *Schedule-K of CA species that Roughness values should not exceed 2500mm/km in a length of Km*

6.3 INPUTS FOR M&M SCHEDULE

6.3.1 Project Sections

Based on traffic pattern, the Total Project Road is divided into two Homogeneous Section.

- Section 1: From Km 140+600 to km 205+200
- Section 2: From Km 205+200 to km 229+829

Based on the Initial Overlay requirement from FWD Consideration, each section is further divided into following sub-sections

- No-Overlay Section (these are converted to overlay section as stage construction due in FY25/26) and
- Overlay Sections.

However, since the project road condition is fair to poor and no major maintenance in the form of fullwidth overlay is done on project road since inception it is felt prudent to consider overlay over the entire length irrespective of FWD requirement. This will also serve the purpose of stage construction strengthening all along the corridor which is due in 2025/2026.

Since roughness is the main criterion for major maintenance, each section has been divided into various cases depending the present roughness values:

- Case 1: Roughness value <2000 mm/km
- Case 2: Roughness values >2000<2200 mm/km
- Case 3: Roughness>2200<2500 mm/km
- Case 4: Roughness>2500 mm/km

Direction wise analysis has been done separately for LHS (UP)/RHS (DN) and each direction length has been divided into sections based on above.

6.3.2 Traffic (AADT)

The following traffic data has been used in the analysis is as below:

Vehicle/Mode	Toll Plaza 148+100	Toll Plaza 216+545
Car	5244	1666
LCV	336	114
2A truck/Bus	678	418
3A truck	270	172
MAV truck	2508	1448

Note: 50:50 directional distributions are considered.

6.3.3 Vehicle Damage Factor (VDF)

VDF values as obtained from axle load surveys are used for various sections are as given below:

Toll Plaza, km 148+100		
Mode Type	**UP**	**DOWN**
LCV	1.21	1.69
2 Axle Truck/Bus	2.78	3.61
3 Axle Truck	6.21	5.73
MAV (4-6 Axle)	13.35	21.88

Toll Plaza, km 216+545		
Mode Type	**UP**	**DOWN**
LCV	0.64	1.76
2 Axle Truck/Bus	3.55	4.36
3 Axle Truck	5.41	7.33
MAV (4-6 Axle)	10.28	21.68

6.3.4 HDM Inputs

FWD and Roughness values are used as obtained from surveys and investigations as below:

Section 1: From Km 140+600 to km 205+200

LHS-1 40mm OL				
	Case-1	Case-2	Case-3	Case-4
Length, km	32.18	13.22	14.4	4.8
Roughness, mm/km	1808	2092	2343	2617
IRI	2.56	2.92	3.23	3.57
Deflection, mm	0.54	0.66	0.66	0.69
Cracking, %	14.38	15.89	14.49	7.35
Reveling, %	0.35	0.64	1.59	2.51
Rut Depth, mm	7.53	7.97	7.66	6.97
Patching, %	0.41	0.68	1.21	1.95
Potholes, %	0.00	0.00	0.00	0.00
BT Crust, mm	121	123	123	117
Granular Crust, mm	451	439	441	456

RHS-1 40mm OL				
	Case-1	Case-2	Case-3	Case-4
Length, km	2.2	10.9	22.28	13.41
Roughness, mm/km	1918	2098	2314	2843
IRI	2.70	2.93	3.19	3.84
Deflection, mm	0.49	0.69	0.70	0.65
Cracking, %	4.601	7.961	6.193	8.900
Reveling, %	1.344	0.867	0.870	1.084
Rut Depth, mm	0.011	0.317	0.526	0.723
Patching, %	0.007	0.000	0.000	0.000
Potholes, %	7.08	7.51	7.27	7.37
BT Crust, mm	153	135	138	132
Granular Crust, mm	433	441	424	435

RHS-1 80mm OL				
	Case-1	Case-2	Case-3	Case-4
Length, km	1	0	8.81	6
Roughness, mm/km	1987	0	2355	2807
IRI	2.79	0.00	3.25	3.79
Deflection, mm	0.81	0.00	0.80	0.86
Cracking, %	0.493	0.000	3.715	11.335
Reveling, %	0.040	0.000	1.033	0.956
Rut Depth, mm	0.167	0.000	0.805	1.451
Patching, %	0.000	0.000	0.004	0.003
Potholes, %	6.71	0.00	7.21	7.55
BT Crust, mm	130	0	128	124
Granular Crust, mm	450	0	428	434

Section 2: From Km 205+200 to km 229+829

LHS-2 40mm OL				
	Case-1	Case-2	Case-3	Case-4
Length, km	7	7.10	5.00	5.80
Roughness, mm/km	1928	2106	2299	2894
IRI	2.71	2.94	3.18	3.90
Deflection, mm	0.40	0.45	0.46	0.49
Cracking, %	5.01	8.88	9.57	6.72
Reveling, %	0.18	0.91	1.01	3.49
Rut Depth, mm	7.78	7.62	8.02	7.94
Patching, %	2.18	0.56	3.01	0.66
Potholes, %	0.00	0.00	0.00	0.00
BT Crust, mm	131	130	120	129
Granular Crust, mm	419	420	430	410

RHS-2 40mm OL				
	Case-1	Case-2	Case-3	Case-4
Length, km	0	1	6	17.9
Roughness, mm/km	0	2174	2341	2813
IRI	0.00	3.02	3.23	3.80
Deflection, mm	0.00	0.40	0.49	0.49
Cracking, %	0.000	0.185	6.659	5.398
Reveling, %	0.000	0.098	0.208	0.671
Rut Depth, mm	0.000	3.881	1.188	0.887
Patching, %	0.000	0.000	0.000	0.000
Potholes, %	0.00	6.54	7.40	7.44
BT Crust, mm	0	150	150	153
Granular Crust, mm	0	440	440	443

6.3.5 Options for MM Schedule

Based on the requirements of CA, various options have been considered to be used as responsive overlays triggered at specified level of roughness of 2500mm/km. Micro surfacing has also been considered to examine its feasibility for major maintenance.

- ✓ Base Case: MCS at Roughness of 2500mm/Km with regular maintenance
- ✓ Opt-1: Responsive Overlay of 30mm BC whenever roughness is >2500mm/KM with regular maintenance
- ✓ Opt-2: Responsive Overlay of 40mm BC whenever roughness is >2500mm/KM with regular maintenance

6.4 ROUGHNESS PROGRESSION

Roughness progression for each section under each alternative maintenance option has been done using the deterioration models in HDM-4. Following Sample graphs represents the roughness progression for each alternative:

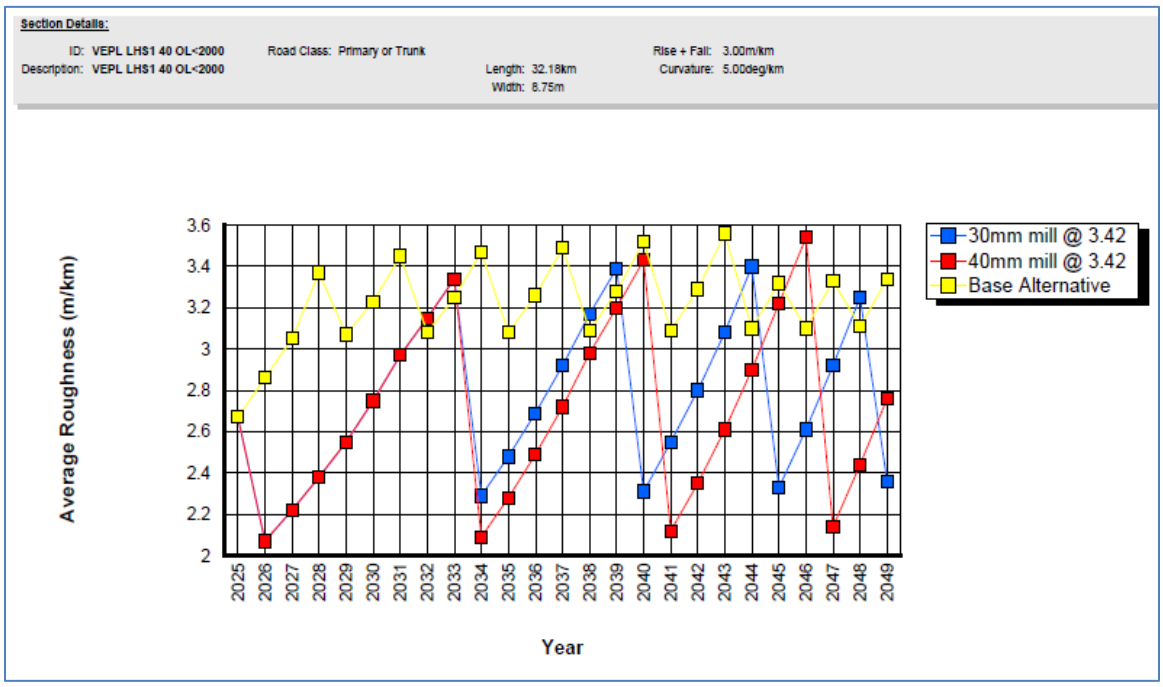


Figure 1: Average Roughness in LHS (UP) Carriageway (Section-1 40mm OL<2000mm/Km)

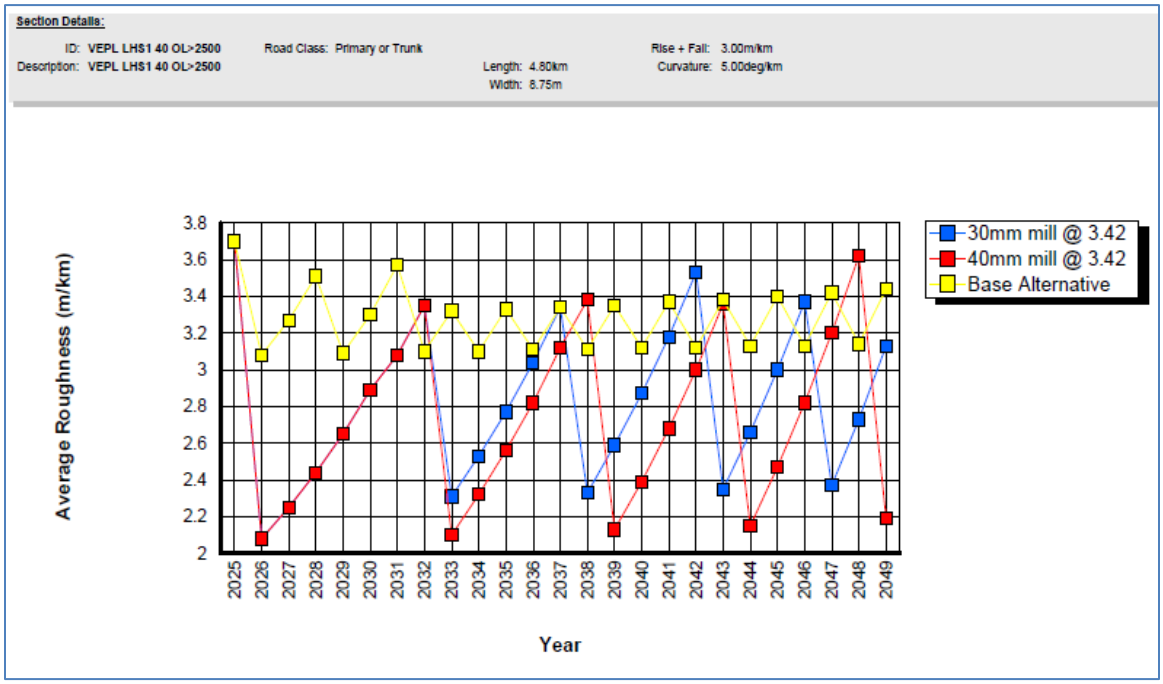


Figure 2: Average Roughness in LHS (UP) Carriageway (Section-1 40mm OL >2500mm/Km)

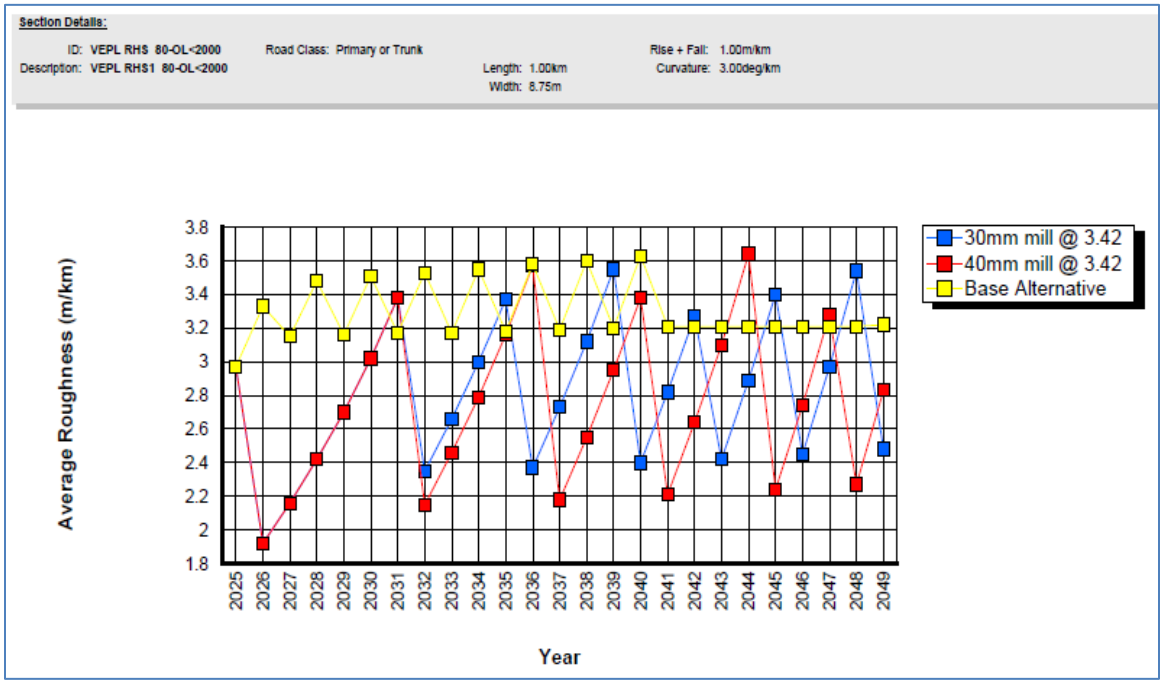


Figure 3: Average Roughness in RHS (DN) Carriageway (Section-1 80mm OL<2000mm/Km)

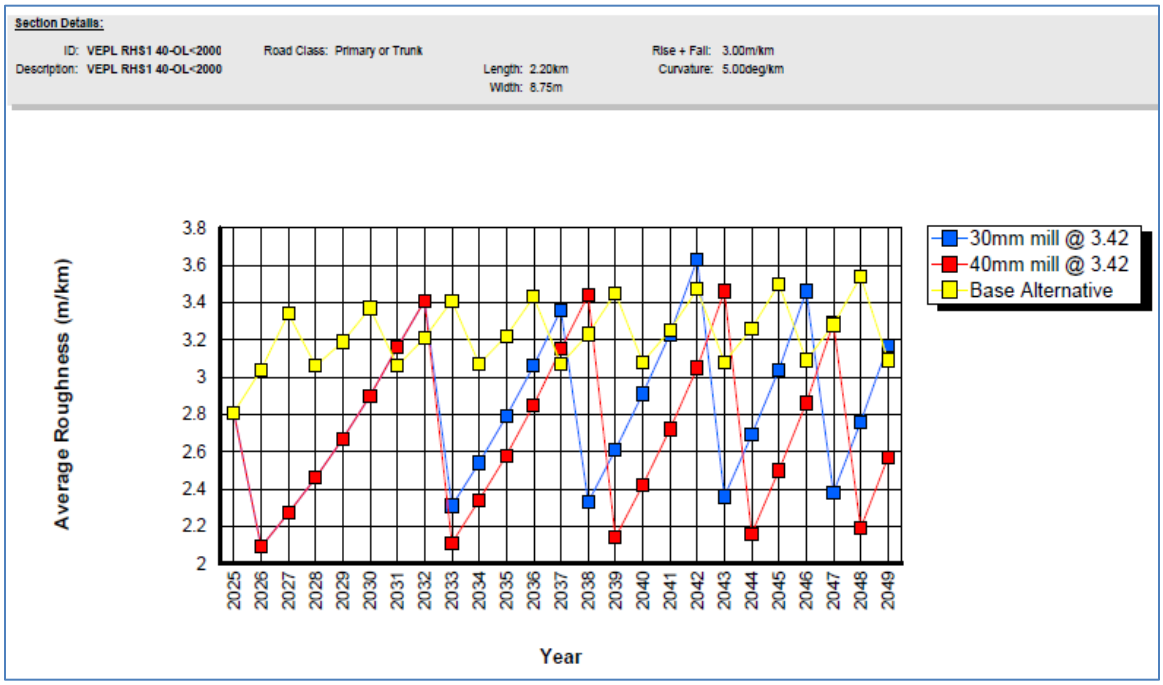


Figure 4: Average Roughness in RHS (DN) Carriageway (Section-1 40mm OL<2000mm/Km)

6.5 M&M SCHEDULE FY-2049

Considering the 6-yrs extension of concession period due to traffic variation, the adopted MM schedule for the project is as below:

HDM Output LHS: Section-1 40mm Overlay

Obtained					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	32.18	13.22	14.40	4.80
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	40
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032			1	1
11	2033	1	1		
12	2034				
13	2035				
14	2036				
15	2037				
16	2038			1	1
17	2039		1		
18	2040	1			
19	2041				
20	2042				
21	2043			1	1
22	2044		1		
23	2045				
24	2046	1			
25	2047				
26	2048			1	1
27	2049		1		

Adjusted					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	32.18	13.22	14.40	4.80
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	40
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032				
11	2033	30	30	30	30
12	2034				
13	2035				
14	2036				
15	2037				
16	2038				
17	2039	40	40	40	40
18	2040				
19	2041				
20	2042				
21	2043				
22	2044				
23	2045	40	40	40	40
24	2046				
25	2047				
26	2048				
27	2049	40mm for 20% length only			

HDM Output LHS: Section-2 40mm Overlay

Obtained					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	7.00	7.10	5.00	5.80
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	40
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032		1	1	1
11	2033	1			
12	2034				
13	2035				
14	2036				
15	2037				
16	2038		1	1	1
17	2039	1			
18	2040				
19	2041				
20	2042				
21	2043		1	1	1
22	2044	1			
23	2045				
24	2046				
25	2047		1	1	1
26	2048	1			
27	2049				

Adjusted					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	7.00	7.10	5.00	5.80
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	50
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032				
11	2033	30	30	30	30
12	2034				
13	2035				
14	2036				
15	2037				
16	2038				
17	2039	40	40	40	40
18	2040				
19	2041				
20	2042				
21	2043				
22	2044				
23	2045	40	40	40	40
24	2046				
25	2047				
26	2048				
27	2049	40mm for 20% length only			

HDM Output RHS: Section-1 40mm Overlay

Obtained					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	2.20	10.90	22.28	13.41
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	40
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031		1	1	1
10	2032	1			
11	2033				
12	2034				
13	2035				
14	2036		1	1	1
15	2037				
16	2038	1			
17	2039				
18	2040		1	1	1
19	2041				
20	2042				
21	2043	1			
22	2044		1	1	1
23	2045				
24	2046				
25	2047	1	1	1	
26	2048				1
27	2049				

Adjusted					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	2.20	10.90	22.28	13.41
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	40	40	40	40
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032	50	50	50	50
11	2033				
12	2034				
13	2035				
14	2036				
15	2037				
16	2038				
17	2039	50	50	50	50
18	2040				
19	2041				
20	2042				
21	2043				
22	2044				
23	2045	40	40	40	40
24	2046				
25	2047				
26	2048				
27	2049	30	30	30	30

HDM Output RHS: Section-1 80mm Overlay

Obtained					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	1.00	0.00	8.81	6.00
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	80	80	80	80
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031	1		1	1
10	2032				
11	2033				
12	2034				
13	2035				
14	2036	1		1	1
15	2037				
16	2038				
17	2039				
18	2040	1		1	1
19	2041				
20	2042				
21	2043				
22	2044	1		1	1
23	2045				
24	2046				
25	2047	1		1	1
26	2048				
27	2049				

Adjusted					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	1.00	0.00	8.81	6.00
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025	80		80	80
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032	40		40	40
11	2033				
12	2034				
13	2035				
14	2036	MCS		MCS	MCS
15	2037				
16	2038				
17	2039	50		50	50
18	2040				
19	2041				
20	2042				
21	2043				
22	2044				
23	2045	40		40	40
24	2046				
25	2047				
26	2048				
27	2049	30		30	30

HDM Output RHS: Section-2 40mm Overlay

Obtained					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	0.0	1.00	6.00	17.90
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025		90	90	90
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031		1	1	1
10	2032				
11	2033				
12	2034				
13	2035		1	1	1
14	2036				
15	2037				
16	2038				
17	2039		1	1	1
18	2040				
19	2041				
20	2042		1	1	1
21	2043				
22	2044				
23	2045		1	1	1
24	2046				
25	2047				
26	2048		1	1	1
27	2049				

Adjusted					
Base Year	Option-1 (Responsive 40mm)				
	Criteria:	<2000	>=2000 and <2300	>=2300 and <2500mm	>=2500
	Length:	0.0	1.00	6.00	17.90
	Financial Year	Case-1	Case-2	Case-3	Case-4
1	2023				
2	2024				
3	2025		90	90	90
4	2026				
5	2027				
6	2028				
7	2029				
8	2030				
9	2031				
10	2032		50	50	50
11	2033				
12	2034				
13	2035				
14	2036				
15	2037				
16	2038				
17	2039		50	50	50
18	2040				
19	2041				
20	2042		MCS	MCS	MCS
21	2043				
22	2044				
23	2045		40	40	40
24	2046				
25	2047				
26	2048				
27	2049		30	30	30

6.6 STRUTURAL PERIODIC MAINTENACE

Expansion joints:

- Visual inspection is carried out to check for seal breakages, Armor angle, Weld failures, cracks between deck & Expansion joints concrete and Joints filled with debris. Such joints replaced immediately.
- Joint buried with debris shall be inspected for any distress, if any distress is shown it shall be replaced immediately.
- In the absence of records pertaining to Expansion joint replacements it is highly difficult to predict the date of replacement needed for compliance to IRC codal requirements. Balance joints which are not replaced initially will be replaced as on when defects are shown in the joints. This aspect is considered in BOQ.

Bearings:

- All types of Bearings are considered for periodic maintenance.

Wearing Coat:

- Wearing coat is a very weak component on the bridge structure which is subjected to severe deterioration due to Loading, Environment etc. This requires periodic maintenance and is considered in BOQ.

Periodic Maintenance of RE-wall

The distresses like gaps/cracks/misaligned RE-blocks were observed at RE-wall portion of VUP @ km 152+840, VUP @ km 159+500. Cost for rectification of these defects have been considered in O&M cost.

Periodic Maintenance strategy for Replacement of Bearings & Expansion joint:

Below strategy has been considered for periodic major maintenance of the structures.

S no	Description	Bridge components
1	Old structure	Structures retained at the time of 4-laning
2	New Structure	Structures newly constructed during 4-laning works

Age	Description	Item	structures-Assumption-MMR				
			% of Replacement of Major components				
			2025	2031	2037	2043	2047
New	Super structure lifting with Pot bearings	Pot	10%	50%	40%	20%	20%
New	Super structure lifting with Elastomeric bearings	Ela	10%	50%	40%	20%	20%
New	Super structure lifting with Rocker bearings	Rocker	0%	0%	0%	0%	0%
Old	Super structure lifting with Pot bearings	Pot	10%	50%	40%	20%	20%
Old	Super structure lifting with Elastomeric bearings	Ela	10%	50%	40%	20%	20%
Old	Super structure lifting with Rocker bearings	Rocker	0%	0%	0%	0%	0%
New	Pot bearing cost	Pot	10%	50%	40%	20%	20%
New	Elastomeric bearing cost	Ela	10%	50%	40%	20%	20%
New	Rocker bearing cost	Rocker	0%	0%	0%	0%	0%
Old	Pot bearing cost	Pot	10%	50%	40%	20%	20%
Old	Elastomeric bearing cost	Ela	10%	50%	40%	20%	20%
Old	Rocker bearing cost	Rocker	0%	0%	0%	0%	0%
New	Expansion joint Replacement	Rm	23%	63%	50%	25%	25%
Old	Expansion joint Replacement	Rm	23%	63%	50%	25%	25%
New	Others	LS	23%	63%	50%	25%	25%
Old	Others	LS	23%	63%	50%	25%	25%

Cost Component for various items and activities have been worked out by considering the Best Industry practice and most appropriate methods. Detailed quantities for work items have been estimated based on the details presented in previous chapters for various heads.

The gist of the cost components considered are presented below:

- Immediate Repair's Cost
- Routine Maintenance Cost
- Incident Management Cost
- Periodic Maintenance Cost
- Operations Cost
- Year by Year total O&M Costs

7.1 RATE ANALYSIS

Detailed rate analysis has been carried out based on MORTH guidelines to arrive at the unit rates of various items. Material rates and their leads from the project corridor are considered as per the material investigations done on the project road. Summary of unit rates arrived at are presented in table below:

Table 39: Basic Material Cost

Sl.no	Description	Units	Source	Basic rate excluding Transportation & GST	Lead in Kms
1	Good earth	Cum	BA	57	6.80
2	40 mm	Cum	Crusher	686	30.01
3	20 mm	Cum	Crusher	1,156	30.01
4	12 mm	Cum	Crusher	316	30.01
5	6 mm	Cum	Crusher	180	30.01
6	Dust	Cum	Crusher	123	30.01
7	M sand	Cum	Crusher	148	30.01
8	Flyash	Cum	Nearest Plant	-	190.70
9	Boulders	Cum	Quarry	199	6.00
10	Sand source to Plant	Cum	River	1,704	109.00
11	Sand source to working site	Cum	Stock yard	1,704	108.00
12	Bitumen 60/70	MT	Mathura	44281	722.00
13	Bitumen 80/100	MT	Mathura	42096	722.00
14	VG-40	MT	Mathura	46647	722.00
15	CRMB-55	MT	Mathura	47612	722.00
16	PMB	MT	Mathura	57102	722.00
17	SS1	MT	Mathura	45000	722.00
18	Steel	MT	Rewa	52000	47.00
19	HTS Strands	MT	Rewa	75000	47.00
20	Cement	MT	Rewa	7000	47.00
21	Structural Steel	MT	Rewa	64000	47.00

Table 40: Major Material cost

S.no	Item	Unit	Rate (INR) Excluding GST
1	Embankment - borrow	Cum	324
2	Embankment - Excavation	Cum	84
3	SG	Cum	331
4	GSB G-2	Cum	1,605
5	WMM	Cum	1,765
6	Prime Coat	Sqm	51
7	Tack coat on granular	Sqm	17
8	DBM G-1	Cum	8,340
9	Tack coat on bituminous surface	Sqm	16
10	BC - G1	Cum	10,094
11	Road Marking	Sqm	538
12	RE wall	Sqm	3214
13	Select Fill	Cum	365
14	Filter Media	Cum	1460
15	M15	Cum	7594
16	M20	Cum	8361
17	M25	Cum	9010
18	M30	Cum	8921
19	M35	Cum	9230
20	M40	Cum	9371
21	PSC M45	Cum	11199
22	HYSD	MT	76379
23	HT strand	MT	162653

NOTE: 1. Item rates are considered for small projects

2. Labour: Central Minimum Wages as on April'2025 for "C Area" Category of construction workers

7.2 BALANCE WORK COST

At the time of issuance of completion certificate, conditional approval given to complete the balance works for service road, drain and PGR as and when the land is made available. The cost worked as shown below.

Table 41: Summary of Balance work cost

S No	Item	Unit	SR	HW Misc Works	Total Qty	Rate in Rs	Amount in Rs	Amount in Cr.
1	C&G	Hec	2	-	2	53,638	89,258	0.01
3	EMB Fill	Cum	16,641	-	16,641	324	53,91,684	0.54
4	SG	Cum	8,238	17	8,255	331	27,35,682	0.27
5	GSB	Cum	2,496	-	2,496	1,605	40,05,996	0.40
7	WMM	Cum	4,160	-	4,160	1,765	73,40,844	0.73
9	PC	Sqm	16,641	-	16,641	50	8,39,206	0.08
10	TC	Sqm	15,730	-	15,730	17	2,69,140	0.03
11	DBM	Cum	787	-	787	8,272	65,05,802	0.65
12	TC	Sqm	15,730	-	15,730	16	2,46,804	0.02
13	BC	Cum	393	-	393	9,705	38,16,554	0.38
17	Kerb	Rm	2,860	420	3,280	281	9,21,680	0.09
18	Kerb Painting	Sq.m	1,073	157	1,230	180	2,21,400	0.02
20	Covered drain	Rm	1,640	630	2,270	17,386	3,94,65,861	3.95
21	Road Marking	Sqm	1,576	-	1,576	538	8,47,673	0.08
22	Road Studs	Nos	984	-	984	264	2,59,776	0.03
25	PGR	Rm	2,300	110	2,410	2,250	54,22,500	1
32	Light Single Arm	Nos	40	-	40	64,133	25,65,300	0.26
40	Road Furniture	Km	3	-	3	20,00,000	57,20,000	1
75	PCC-M15	Cum	-	34	34	7,540	2,53,328	0.03
175	Km Stones	Nos	1	-	1	4,461	4,461	0.00
176	Hm Stones	Nos	13	-	13	1,237	16,081	0.00
Total Cost							8,69,39,031	8.69
Cont @						5%	43,46,952	0.43
Sub Total							9,12,85,983	9.13
GST						18%	1,64,31,477	1.64
Grand Total							**10,77,17,460**	**10.77**

7.3 IMMEDIATE REPAIRS COSTS

Costs associated with immediate repairs are estimated based on the detailed asset inventory and condition assessment surveys, Pavement condition and structural condition assessment surveys. Items which are not executed as part of scope or in damaged condition have been considered for immediate costs as a part of 1-year capex. Following items are mainly considered for immediate costs:

- Scope which is not executed
- Road work items
- Bridge Work Items
- Pavement Rehabilitation works
- Structural Rehabilitation works

- Drainage Works
- Slope Protection works
- Safety Works

Summary of Immediate costs are included in table below:

Table 42: Summary of immediate Repairs Cost

S.no	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.)	Remarks
1	Immediate Repair's - Misc	LS	1	15608976	1,56,08,976	
2	Immediate Repair's - Pavement rectification from FWD	LS	-	22120000	-	Considered in FY26 MMR
3	Immediate Repair's - Structures	LS	1	5360800	53,60,800	Repair cost w.r.to completed structures
4	TMS	LS	-	8345363	-	Full replacement is considered in MMR
5	Lighting Replacement with LED bulbs	Nos	1106	8400	92,90,400	One time cost - as per market price
6	Balance Work	LS	1	107717459	10,77,17,460	Service road balance work as and when land is handed over to Concessionaire
Total immediate repair Cost					13,79,77,635	
Total cost including 18% GST					**16,28,13,610**	
Total cost in Crs					**16.28**	

Table 43: Summary of immediate Repairs Cost-Highways

S.no	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.)	Remarks
1	Crack Sealing	Sqm	78470	-	0	Cracking Area - Full Overlay in FY25
2	Fog Sealing	Sqm	3185	-	0	Raveling Area - Full Overlay in FY25
3	Potholes	Cum	5	-	0	Potholes Filling - Full Overlay in FY25
4	Rutting	Cum	725	-	0	Rutting - Full Overlay in FY25
5	Bus Shelter - GI Sheet	Sqm	30	900	27000	Damaged
6	Bus Shelter-Roof	No	3	5,000	15000	Damaged
7	RCC Cover Drain	Sqm	648	2,267	1468886	Covered sheet Damaged
8	RCC Cover Drain	m	30640	90	2760664	Cleaning Required
9	RCC Cover Drain/ Open lined Drain	m	169	10,300	1740700	Full Drain Damage
10	Median Drain	m	150	100	15000	Cleaning Required
11	Median Cuts	m	220	323	71060	Damaged
12	Median Cuts	No	1628		0	Cleaning Required, covered under RM
13	Median Kerb Damages	m	203	323	65569	Unauthorized openings
14	Side Kerb Damages	m	17	323	5491	
15	Median Plantation- Non-Functional	Km	12	68,422	833380	Non-Functional

S.no	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.)	Remarks
16	Road Markings	Sqm	10134	-	0	Poor/ No marking - Full Overlay in FY25
17	Kerb Painting	Sqm	28455	180	5121900	Poor
18	Pedestrian Crossing	Sqm	288	538	154944	Poor
19	W-Beam Crash Barriers	m	186	2,967	551862	Missing/Damaged
20	Concrete Crash Barriers	m	1	5,109	5109	Damaged
21	Pedestrian Guard Railing(PGR)	m	405	5,020	2033100	Missing/Damaged
22	Kilometre Stones	No	4	4,461	17844	Missing/Damaged
23	Kilometre Stones	No	1	186	186	Paint Damaged/ No Paint
24	5th Kilometre Stones	No	2	7,825	15650	Missing/Damaged
25	Hectometre Stones	No	332	1,237	410684	Missing/Damaged
26	Hectometre Stones	No	12	186	2227	Paint Damaged/ No Paint
27	Road Signs	No	40	6,328	253120	Missing/Damaged
28	Road Signs	Nos	33	1,200	39600	Paint Washed-out/ Paint Damaged
Total cost (RS)					**1,56,08,976**	

Table 44: Summary of immediate Repairs Cost-Structures

S.No.	Description	Units	Quantity	Rate (Rs.)	Amount (Rs)
1	Replacement of existing damaged Expansion joints by providing and laying of Strip Seal Expansion Joint System, including removal of existing damaged expansion joints by dismantling of deck slab, wearing coat etc. and back filling of the recess up to final finish level with **Micro conc**, complete as per M.O.R. T&H specification.	Rm	49	16797	8,16,629
2	Providing and fixing in position 20 mm thick pre-moulded joint filler in expansion joint for fixed ends of simply supported spans not exceeding 10 m.	RM	12	130	1,560
3	Cleaning and adding rubber sealant near expansion joints	s	242	91	21,992
4	Replacement of Damaged Concrete Railing all complete as per technical specifications and as directed by the Engineer	Rm	21	3357	70,497
5	Provision of an RCC crash barrier (0.35sqm cross sectional area) constructed with M-40 grade concrete including reinforcement	cum	5.2	12182	62,737
6	Cutting of groove of 15 mm x 15 mm along crack and sealing the same with epoxy putty including cost of material, labour etc.	RM	322	312	1,00,464
7	Weed removal (Vegetation)	Man days	91	2075	1,88,825
8	Anti-corrosion paint for Steel 45 microns primer with Zinc bonding coat	Lit	2	525	788
9	Micro Concrete	Cum	0.26	60480	15,725
10	Concrete	Cum	0.21	10496	2,204
11	HYSD Bars	MT	0.02	79644	1,497
12	Cement Mortar (1:1) Grouting	Kg	50	566	28,300
13	Patching of damaged concrete surface with polymer Modified mortar up to maximum thickness of 45mm thickness in layer not exceeding 15mm and curing compounds, available in present formulations, to be applied including bond coat.	sqm	14	2474	34,636
14	Providing and laying Plain cement concrete M20 grade, mechanically mixed and compacted, including centering and shuttering all complete.	cum	0.4	8541	3,075
15	Steel pipe	Rm	30	726	21,780
16	Dry pack with mortar (1 :3)	Cum	13	6741	87,633
17	Pointing with cement mortar (1:3) on brick work in substructure as per technical specifications	Sqm	1170	901	10,54,170
18	Soil Nailing for RE walls	Sqm	687	4149	28,48,289
Total					**53,60,800**

7.4 ROUTINE MAINTENANCE & INCIDENT MANAGEMENT COSTS

Routine maintenance costs include general maintenance costs of road elements, bridge elements and road furniture and appurtenances. This can be mainly divided into two parts as:

- ✓ General Maintenance of Works
- ✓ Repairs to Highway & Bridge Elements

7.4.1 General Routine Maintenance

General Routine Maintenance of Roads generally include following items:

- Cleaning of Project facilities
- Structures cleaning,
- Cleaning of ROW
- Cleaning and Maintenance of Toll Plaza
- Unlined Drain Maintenance
- Lined Drain Maintenance
- Maintenance of Highway Lighting at Toll Plaza and other project locations
- Median Plantation maintenance & Avenue plantation maintenance:
- Maintenance of Road Furniture
- Maintenance of Road Safety Items

The above items are estimated by considering the detailed break-up of following items:

- Manpower including Managers/Labour etc
- Vehicles for Labour Transport/Water Tankers/Sweeping Machines Etc
- Resources/Equipment's such as grass cutters, tools, jet sprayers, hydraulic trimmers etc

7.4.2 Repairs to Highway & Bridge Works

Repairs to highway and bridge works have been estimated based on the assumed quantities (Percentage basis) of execution for every year.

These items include the following:

1	Providing treatment for sealing of road surface / isolated cracks at scattered locations
	i) covered with 6.7 mm size stone chipping @ 0.1 cum/ 10 sqm.
	ii) covered with dry coarse sand passing through 2.36 mm sieve and retained on 180-micron sieve @ 0.03 cum/10 sqm heated to 600 C
	iii) filling discrete cracks with slow curing bitumen emulsion as per Technical Specification Clause 3004.3.3
2	Providing treatment to bleeding bituminous surface at scattered locations
3	Providing localized repair to rutted portion and edge breaking of bituminous surface
4	Providing treatment and repair to pot-holes and patch work

5	Providing and laying dense bituminous macadam using bitumen grade VG 40 complete as per Technical Specification Clause 507
6	Proving and laying bituminous concrete (asphaltic concrete)
	(a) Using bitumen (VG-40) as per IRC: SP: 53
7	Road Roughness survey
8	Turfing on embankment slopes and at all other Project Facilities
9	Providing repair to stone pitching/apron at scattered locations
10	Rain Cuts Maintenance: Restoration of rain cuts soil, moorum, gravel or a mixture of these
11	Providing and laying apron/ stone pitching on slopes of guide bunds/ road embankment / other location
12	Providing and laying stone aggregate filter material (150 mm compacted thickness) underneath pitching
13	Unlined drain
14	Filling in median island with approved materials with all leads and lifts complete as per TS Clause No. 407
15	Replacing damaged / broken railing with new pre-cast / cast-in-situ, concrete railing to match with existing design and pattern.
24	Carrying out repair to road signs including strengthening resetting or otherwise repairing signs and delineators
	a) Road sign board mounted on single post
	b) Road sign board mounted on double post
	c) Overhead/ Gantry Sign boards
	d) Delineator
25	Supplying and fixing at site retro-reflectorised type **sign boards/signs**
	90cm Equilateral triangle
	60cm circular
	90 cm circular
	90cm high octagon
	80cm x 60cm rectangle
	Chevron signs 60cm x 45cm
	Place identification signs (Fig 15.7 of IRC 67)
	Providing and fixing Object Markers
	Providing and fixing of retro-reflectorized Route Marker signs (size 450mm x 600mm)
26	**Hazard Marker Sign :**
	a) size 90 x 30 cm
	b) size 30cm triangular side cluster of red reflectors (screen printed)
27	Cats Eyes/Raised pavement marker (NMC Nails Less)
28	Painting two coats on old surface after minor repairs to give an even and smooth surface and printing letters and figures with synthetic enamel paint
	a) Hectometer stones
	b) Kilometer Stone
	c) 5 Kilometer stone
	d) Boundary stone
	e) Guard stone
29	Providing painting lettering and fixing of distance measurement stones including dismantling of old damaged/ broken ones, confirming to TS Clause 804
	a) Hectometer stones
	b) Kilometer Stone
	c) 5 Kilometer stone
	d) Boundary stone

	e) Guard stone
30	Providing and fixing road delineators conforming to TS Clause No. 805 as directed by the Engineer.
31	Repainting the kerb stones and separation barrier with first quality synthetic enamel paint of approved brand
32	Painting all types of pavement markings including lines, dashes, arrows etc. on roads as per relevant IRC/MOST standards after cleaning the surface complete in all respects as directed by the Engineer.
	a) Hot applied Thermoplastic compound
	(i) Lane / Centre Line / Edge Line
	(ii) Direction Arrows
	(iii) Diagonal Chevrons Markings
33	Supplying and laying cast-in-situ cement concrete kerb without channel section
	a) by Manual/machine including formwork
34	Major repair / replacement of metal beam crash barrier (W profile guard rails)
35	Providing and fixing chain link/ welded mesh fencing / square bars fencing
36	Dismantling the old damaged chain link/welded mesh / square bars fencing and replacing it with new chain link/ welded mesh/square bars fencing
37	Provision of rumble strips
38	Shoulder Maintenance:
39	synthetic enamel paint of approved brand on metal pedestrian guard rail
40	Dismantling of wearing course

B. BRIDGES

1. Wearing coat comprising of 50 mm thick BC.
2. Cleaning and adding rubber sealant near expansion joints.
3. Modular Expansion joints.
4. Replacement of Damaged Concrete Railing all complete as per Technical specifications and as directed by the Engineer
5. Provision of an RCC crash barrier (0.35sqm cross sectional area) constructed with M-40 grade concrete including reinforcement
6. Cleaning of rocker & roller bearing using high pressure water jet, free from rust scales, re-setting & greasing the bearings using graphite grease including cost of materials, labour etc., complete.
7. POT PTF Bearings greasing and maintaining (sand plastering).
8. Elastomeric Bearings and maintaining.
9. Cutting of groove of 15 mm x 15 mm along crack and sealing the same with epoxy putty including cost of material, labour etc.
10. Carrying out 50 to 60 mm thick shortcreting using a mix proportion of 1:2:2 (cement: sand:6 mm down aggregate) added with Polypropylene fibers at a dosage rate of 125 gms/bag of cement including cost of labour, material, scaffolding, equipment etc complete.

11. Repair of Floor Aprons, pitching and other protection works
12. Cleaning of Drainage Spouts
13. M-25 Concrete
14. Providing and filling joint sealing compound as per drawings of pourable grade, (Bitumastic sealant in the gap b/w Abutment & Approach slab. As per Technical specifications
15. Providing and laying Filter material underneath pitching in slopes.
16. Providing and laying Pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankments.
17. Test s UPV, RHT and Load test for span 15m and above as per Schedule I.
18. Vegetation cleaning before and after monsoon.
19. Repair of damaged structure portion due accidents and any others.
20. Level of Service if applicable.

7.4.3 Incident Management Cost

Incident Management & Safety items include the following:

- ✓ Regular patrolling & reaching accident/incident site,
- ✓ providing relief to injured persons including taking them to nearest hospital and attending to the safety requirements at the location (putting cones, safely guide & manage the traffic using signs, safety barricades, etc.),
- ✓ removal of accident /breakdown vehicles, removing of dead animals/birds lying on the highway and loading, unloading, transportation & disposal of surplus material left over by accidental vehicle or otherwise lying on road (on carriageway) and
- ✓ Encroachment prevention & removal with all lead & lifts complete with proper communication equipment,
- ✓ consumables, materials, suitable Towing vehicles, Ambulance, patrolling vehicles and manpower like drivers, helpers, para-medical staff, labours including deployment of crane and all works shall be done as per requirement and as directed by Client representative and as per Relevant Specifications as applicable.

7.5 PERIODIC MAINTENANCE COSTS

Cost towards major maintenance include following:

- ✓ Cost of Periodic maintenance of Pavement based on Finalized MM schedule
- ✓ Cost of Periodic Maintenance of Structures
- ✓ Cost of Periodic replacement of Toll Equipment's & Software

Table 45: Periodic Maintenance Cost

YEAR	Functional +Structural overlay MCW+ S/R	Major Maintenance of Rigid Pavement	Replacement of ATMS @ every 7 Years	Replacement of TMS @ every 5 years	Structure specified repairs
2025-2026	173.97 *	-		5.26	0.71
2026-2027	-	-			-
2027-2028	1.36	0.34			-
2028-2029	-	-			-
2029-2030	-	-			-
2030-2031	-	1.36		2.63	5.00
2031-2032	68.43	-	-		-
2032-2033	47.99	-			-
2033-2034	-	-			-
2034-2035	-	0.34			-
2035-2036	7.74	-			-
2036-2037	-	-		3.94	4.52
2037-2038	-	1.36	-		-
2038-2039	133.80	-			-
2039-2040	-	-			-
2040-2041	-	0.34			-
2041-2042	6.37	-			-
2042-2043	-	-	-	2.63	1.21
2043-2044	-	1.36			-
2044-2045	108.83	-			-
2045-2046	-	-			-
2046-2047	-	-			-
2047-2048	-	-	-	2.63	1.69
2048-2049	63.22	1.36			-
TOTAL	**611.70**	**6.44**	**0.00**	**17.08**	**13.13**

Note: 1. The amount is Crores inclusive of GST (18%) and without escalation, considering FY2026 rates

2. No Capacity Augmentation is envisaged and Concession end date is 18-05-2049

3. * The workout for 1st year MMR(FY2026) for pavement rehabilitation is presented as below

Based on the NSV surveys and FWD surveys, the required overlay sections have been quantified to derive major maintenance cost. The following key considerations have been taken into account:

- 40mm BC Overlay is proposed for the entire length in both directions of the main carriageway.
- Based on FWD analysis, at locations where overlay requirements exceed 40mm BC, additional 50mm DBM layer is proposed.
- From FWD analysis, few abnormal deflection points have been omitted, at such locations glass-grids are proposed over an area of size 100m x 7m.
- In the sections where PCI index is less than 60%, an additional 50mm DBM is proposed and ensuring that no overlapping with FWD, DBM overlay lengths.
- For the service roads and Truck layby areas, a 30mm BC overlay is proposed for its entire length.

Thus, the overlay lengths considered for the main carriageway are as follows:

Section	LHS- carriageway
	Length, km
40mm BC	**88.890**
+ 50mm DBM	**18.611**

RHS- carriageway
Length, km
88.890
30.255

The Final Quantities for both main carriageway and service road are as follows:

BOQ Item	**Unit**	**MCW**			**S/R**	**Total (MCW+ S/R)**	**Additional 5% for Junctions & Median openings**	**Total (MCW+ S/R)**
		LHS	**RHS**	**Total**	**Total**			
		Qty (Cum)	**Qty (Cum)**					
BC	Cum	32580	32303	64883	9133	74,016	3,701	**77,717**
TC	Sqm	814500	807565	1622065	304445	19,26,510	96,325	**24,84,626**
DBM	Cum	8375	13615	21990	0	21,990	1,100	**23,090**
TC	Sqm	167500	272300	439800	0	4,39,800	21,990	-
Glass Grid	Sqm	39900	70700	110600		1,10,600	16,590	**1,27,190**
Crack Sealing	Sqm			78470		78,470		**78,470**
Fog Sealing	Sqm			3185		3,185		**3,185**
WMM	Cum			2188		2,625		**4,813**
Shoulder	Sqm			178400		1,78,400		**1,78,400**
Pot holes	Sqm	133.5	133.5	267		267		**267**

Note:

- *The quantities arrived for main carriageway and service road are increased by 5% to accommodate the quantities of Junctions and median openings.*
- *Glass-grid quantity has been increased by 15% to account for future pavement deterioration and to address any additional distress that may be identified after milling of surface, prior to overlay.*
- *These quantities are based on NSV & FWD studies and are indicative. Final quantities may vary at the time of execution, depending on site conditions and results of detailed investigations at the time of implementation.*

Based on the above, Bill of Quantities have been worked out and presented below.

Item No.	Item Description	Unit	Qty	Rate	Amount in INR Rs	Amount in INR Cr.
1	Providing and laying **Wet Mix Macadam** using a hydrostatic paver/Grader, using crushed aggregates, transporting the mix to work site, laying spreading and compacting to the required grade, level and alignment, rolling with soil compactor to achieve the desired compaction as per MORTH (Fifth Revision) Technical specifications as per Section 400 and relevant IRC codes etc. including premixing of the Material with water at OMC in mechanical mix plant complete in all respects.	Cum	4,813	2320	1,11,64,139	1.12
2	Providing and applying **Prime coat** with cationic bitumen emulsion (SS-1) using emulsion pressure distributor at the rate of 0.60 to 0.90 kg per sqm on the prepared aggregate surface and cleaned with mechanical broomer and as per relevant clauses of MORTH (Fifth Revision) Technical specifications.	Sqm	19,250	60	1156155	0.12
3	**Milling of existing bituminous pavement** surface by using milling machine with automatic grade and slope controls machine, capable of cold milling existing asphalt pavement to an accurate depth of cut, profile and cross slope and shall be capable of loading the milled material directly into trucks. Including all lead, lift & disposal of unserviceable material as per the direction of Client.				0	-
a.	Milling up to 40mm depth	Sqm	12,19,388	80	97551040	9.76
b.	Milling for depth more than 40mm and less than 90mm	Sqm	4,83,780	100	48378000	4.84
5	Providing and applying **Tack coat** with cationic bitumen emulsion (RS-1) using emulsion pressure distributor at the rate of 0.25 to 0.30 kg per sqm on the prepared bituminous/milled surface and cleaned with mechanical broomer and as per relevant clauses of section-503 of MORTH (Fifth Revision) Technical specifications.@ 0.25 kg per sqm (normal bituminous surfaces) and @ 0.30 kg per sqm (milled surfaces)	Sqm	24,84,626.50	18.33	45543203.75	4.55
6	Providing and laying **Dense Graded Bituminous macadam** using Higher Capacity batch type Hot Mix Plant using crushed aggregates of size (Table 500-10, Grading-2), premixed with VG-40 Grade of Bitumen binder @ 4.5% (minimum) mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers, Pneumatic Tyre Rollers to achieve the desired compaction as per MORTH (Fifth Revision) Technical specification clause No. 501 and 505 and relevant IRC codes. etc. complete in all respects.	Cum	23,090	10333	238579041	23.86
7	Application / Laying of **Paving grid / Glass Fiber Grid** (in-built self - tacking AIC – like RAPID from Saint Gobain) composite on top of DBM/milled surface including material as per IRC 59 – 2019 and supplier specification requirements. Complete in all respects.	Sqm	1,27,190	233	29635270	2.96
8	Providing and laying **Bituminous Concrete** of using higher capacity batch type Hot Mix Plant using crushed aggregates of size (table 500-17, Grading-2), premixed with VG-40 Grade Bitumen binder @ 5.4% (minimum) of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers, Pneumatic Tyre Rollers to achieve the desired compaction as per MORTH (Fifth Revision) Technical specification clause No. 501 and 507 and relevant IRC codes. etc. complete in all respects.	Cum	77,717	11916	926095201	92.61
9	Construction of **earthen shoulders** with approved material obtained from milled material/ borrow pits and /or quarries with all lifts & leads, transporting to site, loosening of existing shoulder, spreading, grading to required slope and compacted (up to BC top) to meet	Sqm	1,78,400	24	4320848	0.43

Item No.	Item Description	Unit	Qty	Rate	Amount in INR Rs	Amount in INR Cr.
	requirement of table No. 300-2, Ref. to MORTH (Fifth Revision) Technical specification 305 and 408.					
10	Providing and laying **Slurry Seal** of Type-III (Table 500-25 0f MoRTH) consisting of a mixture of fine aggregates, portland cement filler, bituminous emulsion and water on a road surface including cleaning of surface, mixing of slurry seal in a suitable mobile plant, laying and compacting to provide even riding surface as per clause 512 of MORTH (Fifth Revision) Technical specifications.	Sqm	78,470	68	5299863.8	0.53
11	**Fog Sealing:** Providing and applying low viscosity emulsion for sealing fine hair cracks less than 3mm or for rejuvenating bituminous surface or for disintegration in an existing bituminous surface, with emulsion pressure distributor @ 0.5 to 1.0 litre per sqm as per clause 3004.3.2 MORTH (Fifth Revision) Technical specifications.	Sqm	3,185	71	225784.65	0.02
12	Filling **Pot- holes and Patch Repairs** with DBM, (Removal of all failed material, trimming of completed excavation to provide firm vertical faces, cleaning of surface, painting of tack coat on the sides and base of excavation as per clause 503, back filling the pot holes with hot bituminous material as per clause 505, compacting, trimming and finishing the surface to form a smooth continuous surface, all as per clause 3004.2)	Sqm	267	161	42987	0.00
13	**Road Marking with Hot Applied Thermoplastic** Compound with Reflectorising Glass Beads on Bituminous Surface (Providing and laying of hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35 .The finished surface to be level, uniform and free from streaks and holes.)	Sqm	80,425	558	44877150	4.49
14	**Kerb Height raising** with M20 Concrete - Removal & Disposal of damaged concrete, removal of earth, roughening the old concrete surface with chiselling / hammering, supply & applying Epoxy Bonding agent between old & new concrete. Supplying, pouring & compacting M20 concrete, cutting & applying curing compound complete in all respect etc. with reinforcement (Fe 500) work - cutting, bending, binding of steel reinforcement (vertical 8mm dia. 225mm long @ 300mm c/c and 8mm binding -1 No over existing kerb top by providing DG & drilling as per requirement & cement grouting etc. complete in all respects along with work zone safety.	Rm	2,000	530	1060000	0.11
	Net Amount in Rs:				**1,45,39,28,683**	**145.39**
	Supervision Charges (@ 1.4%)				**2,03,55,001**	
	Total Amount in Rs:				**1,47,42,83,676**	**147.43**
	Total Amount in Rs: (including GST @ 18%)				**1,73,96,54,737**	**173.97**

7.6 OPERATIONS COSTS

Cost towards Operations include the following:

- Electricity Bill of lighting
- ATMS & Toll Plaza Operation cost
- Operation and management costs of rest areas and lay byes
- Operation and management costs of Traffic & medical aid posts
- SPV Costs
- Survey Costs
- Insurance
- IE Fee
- Audit Charges
- Administrative Cost

Table 46: O&M Cost for FY 2026

S No	Description	Amount in Crs. (including GST)
	SPV - Expenditure	
1	SPV staff	3.33
2	Highway lighting	1.34
3	Tolling AMC/ Spare Parts	0.39
4	Surveys & Investigations (BBD, Roughness)	0.31
5	IE fees	0.77
6	Insurance Charges	1.34
7	Audit Charges	0.44
8	Admin cost - Board Meeting Expenses, valuation etc.	0.34
	Agency - Expenditure	
9	Toll Operation - Agency	5.37
10	Route patrolling	2.92
11	TAP & MAP	-
12	Routine maintenance	5.28
13	Repair of Road - Boq Items	2.35
14	Repair of Structures	0.27
	Total Amount in CRs	**24.46**

Note: 1. The amount is Crores inclusive of GST (18%) and without escalation, considering FY2026 rates

2. No Capacity Augmentation is envisaged and Concession end date is 18-05-2049

7.7 TOTAL OPERATION & MAINTENANCE COSTS

Year on year operation cost is summation of following:

- ✓ Immediate Costs
- ✓ Routine Maintenance & Incident Management
- ✓ Periodic Maintenance
- ✓ Operations Cost

Following table presents the summary of Operations & Maintenance cost for the project

Table 47: Abstract Cost

FY year	Initial EPC cost	Operation cost	Routine Maintenance cost	Periodic Maintenance. cost	Total Cost in Crore
2025-2026	16.28	13.24	11.22	179.93	220.67
2026-2027	-	13.24	11.22	-	24.46
2027-2028		13.24	11.22	1.70	26.16
2028-2029		13.24	11.22	-	24.46
2029-2030		13.24	11.22	-	24.46
2030-2031		13.24	11.22	8.99	33.44
2031-2032		13.24	11.22	68.43	92.88
2032-2033		13.24	11.22	47.99	72.44
2033-2034		13.24	11.22	-	24.46
2034-2035		13.24	11.22	0.34	24.79
2035-2036		13.24	11.22	7.74	32.19
2036-2037		13.24	11.22	8.46	32.92
2037-2038		13.24	11.22	1.36	25.81
2038-2039		13.24	11.22	133.80	158.26
2039-2040		13.24	11.22	-	24.46
2040-2041		13.24	11.22	0.34	24.79
2041-2042		13.24	11.22	6.37	30.83
2042-2043		13.24	11.22	3.84	28.29
2043-2044		13.24	11.22	1.36	25.81
2044-2045		13.24	11.22	108.83	133.29
2045-2046		13.24	11.22	-	24.46
2046-2047		13.24	11.22	-	24.46
2047-2048		13.24	11.22	4.32	28.77
2048-2049		14.86	12.71	64.58	92.14
Total	**16.28**	**319.39**	**270.65**	**648.36**	**1,254.68**

Note: 1. The amount is Crores inclusive of GST (18%) and without escalation, considering FY2026 rates

2. No Capacity Augmentation is envisaged and Concession end date is 18-05-2049