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FINAL REPORT

Six-laning of Kozhikode Bypass (i.e., Vengalam Jn. to Ramanattukara Jn.) from km 230.400 to km 258.800 (approx. 28.400 km) of NH-66 in the State of Kerala executed on design, build, operate and transfer (the "DBOT Annuity" or "Hybrid Annuity)

SAMARTH INFRAENGG Technocrats Private Limited

SAMARTH
committed competence

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Table of Contents

List of Tables

LIST OF APPENDICES

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
CA	-Concession Agreement
CBR	-Californian 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
MR	-Resilient Modulus
MSA	-Million Standard Axle
NDT	-Non-Destructive Testing
NHAI	- National Highways Authority of India
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 Under pass
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, “National Highways Authority of India” for the development, maintenance and management of National Highway No. 66 including the section from km 230.400 to km 258.800 (Design Chainage) (approx. 28.400 km). The Authority had resolved to augment the existing Kozhikode Bypass (i.e., Vengalam Jn. To Ramanattukara Jn.) from km 230.400 to km 258.800 (approximately 28.400 km) on the section of National Highway No. 66 ("NH 66") in the State of Kerala by Six-Laning thereof (the "Project") on design, build, operate and transfer (the "DBOT Annuity" or "Hybrid Annuity") basis. Accordingly, Authority has invited tenders and awarded the Project to the successful bidder, M/s KMC Constructions Limited on 26.02.2018 (LOA).

Consequent to this, M/s KMC Constructions Limited, formed a Special Purpose Vehicle (SPV) in the name M/s Calicut Expressway Private Limited (CEPL), as the Concessionaire for implementing/execution of the project. The Concession Agreement was signed between Authority and the Concessionaire on 18.04.2018. However, Concessionaire could not submit Performance Security Bank Guarantee (PSBG) within the scheduled time (30 days) from the date of signing of the Concession Agreement stating the main reason for delay is stringent conditions being imposed by the Bank due to mounting NPAs.

Further Settlement Agreement made on 11.01.2021 to resolve and amicably settle the dispute of declaration of Appointed Date. Concessionaire agreed for the amount of Rs. 27.97 Cr.as damages for delays on the part of Concessionaire shall be recovered in two equal instalments of 50% each from the payment to be made in respect of the 1st & 2nd Payments Milestone of the Concessionaire along with interest rate of 9% with effect from the date of signing of Settlement Agreement.

M/s INKEL Ltd., a PPP initiative of the Government of Kerala, has entered the project both as an EPC partner and part shareholder, at 24.44% of the equity to implement the Project. Based on revised policy circulars, the Concessionaire vide letter dt: 06.03.2019 submitted the proposal for further transfer of 24.56% of the Company M/s Calicut Expressway Pvt. Ltd. (CEPL) to M/s INKEL Infrastructure Development Projects Limited (IIDPL) and changing the EPC contractor from M/s KMC to M/s KMC-INKEL Ltd. (JV) and sought approval of Competent Authority. Subsequent to detailed deliberation, Authority on 13.12.2019 approved "In-Principal" for acquisition of 49% equity in CEPL by IIDPL.

Accordingly Financial Close has been declared by Authority on 22.02.2021. Presently, the Project is still under Construction stage, Concessionaire has applied PCOD on 24.12.2024 for a completed length of 17.138 km of Main Carriageway and 16.172 km BHS of Service Road out of 28.400km.

M/s Actis GP LLP intends to acquire this project from the present Concessionaire and thus, engaged M/s Samarth Infraengg Technocrats to undertake a technical due diligence study for the said project.

This report highlights the findings of technical diligence undertaken by consultants on the project.

1.2 PROJECT AT A GLANCE

The site of the Six-lane divided Project Highway comprises the section of National Highway NH-66, including section from Km 230.400 to Km 258.800 in the State of Kerala.

National Highway 66, commonly referred as “NH 66” is a 1640 km long busy National Highway that runs from north to south along the western coast of India, parallel to the Western Ghats. It connects Mumbai in Maharashtra and Kanyakumari in Tamil Nadu, passing through the states of Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu.

NH-66 connects many Cities like Panvel, Mangaon, Mahad, Poladpur, Khed, Chiplun, Sangameshwar, Ratnagiri, Rajapur, Kankavli, Kudal, and Sawantwadi in the state of Maharashtra. Panaji and Margao in the state of Goa. Karwar, Ankola, Honnavar, Murudeshwar, Bhatkal, Udupi, Surathkal, Mangaluru, Thokottu, Kotekar, and Talapady in the state of Karnataka. Kasaragod, Kannur, Thalassery, Kozhikode, Ramanattukara, Kottakkal, Valanchery, Kuttippuram, Vadanappally, Varapuzha, Kochi, Alappuzha, Ambalapuzha, Kollam, Kottiyam, Thiruvananthapuram and Neyyattinkara in the State of Kerala and Marthandam, Nagercoil and Kanyakumari in the state of Tamil Nadu.

The project road starts at km 230.400, Kozhikode (formerly known as Calicut) Bypass i.e., Vengalam Jn. and terminates at km 258.800, near Ramanattukara Jn. in the state of Kerala traversing over a length of 28.400 kms. The project road is situated in Kozhikode district.

The location map of the project corridor is shown below.

Map Showing the Project Corridor

The following table highlights the Chainage system as per CA vs. Site.

Table 1: Project Corridor Chainage System

Referencing system	Project Corridor Start Point (km)	Project Corridor End Point (km)	Length (km)
CA Chainage	230.400	258.800	28.400
As per Site	230.400	258.800	28.400

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

Start Point of project at km 230.400

End Point of project at km 258.800

Following Table highlights the total project at a glance:

Table 2: Project Details

Client (Authority)	National Highways Authority of India, New Delhi
Concessionaire	Calicut Expressways Pvt. Ltd. (CEPL)
Independent Engineer	M/s SA Infrastructure Consultants Private Ltd. Noida, UP.
EPC Contractor	M/s KMC-INKEL (JV)
Length of The Project	28.4 kms
Estimated Project Cost	Rs.1288.56 Crores
Bid Project Cost/ Adjusted Bid Project Cost	Rs.1710 Crores/ Rs.1611.38 Crores
Letter of Award (LOA)	26.02.2018
Date of Signing Concession Agreement	18.04.2018
Date of Signing Settlement Agreement- I	11.01.2021
Appointed Date (AD)	22.02.2021
Scheduled Project completion (730 days from Appointment Date)	21.02.2023
EOT -1, for 225 days	04.10.2023
EOT -2, for 106 days	18.01.2024
Date of Signing Settlement Agreement- II	08.12.2023
As per Settlement Agreement, EOT-3 for 17.138 km MCW, SR (LHS) 16.172 km, SR (RHS) 16.172 km EOT-4 remaining 11.262 km including COS	30.06.2024 (expected PCC, for EOT-3) 25.12.2024 (expected FCC, for EOT-4)
O&M Period	15 years from COD
PCOD/FCC	-Not Achieved- Concessionaire applied for PCOD on 24.12.2024 for a completed length of MCW:17.138 km & SR-road (BHS): 16.172 km BHS out of 28.400km

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, GFC drawings of highway and structures, design reports and 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 (6-Lane section @ 7 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 6 nos)
  - ✓ Collection and Testing of Borrow Areas for Earthwork and few samples of Aggregates and Sand from quarries (Approximately 4nos)
  - ✓ Axle load survey considered at 1 location 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 6nos).
  - ✓ 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.
- Risk & opportunity analysis of the projects for the concession period.

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:26.02.2018 Agreement Signed Date: 18.04.2018
2	Clause 3.1 of CA	Concession Period: 15 years from COD
3	Clause 4.1.2 of CA	The Conditions Precedent required to be satisfied by the Concessionaire within, unless specifically stated, a period of 120 days from the date of this Agreement or on an earlier day acceptable to the Authority
4	Clause 4.2 of CA (Delay by Authority)	Authority shall pay to the Concessionaire, damages in an amount calculated at the rate of 0.2% performance Security for each day's delay until the fulfilment of such Condition precedent, subjected to the maximum limit equal to the amount of the bid security and upon reaching such limit.
5	Clause 5.3 of CA (obligation relating to change in ownership)	The Concessionaire shall not undertake or permit any Change in Ownership, except with the prior written approval of the Authority.
6	Clause 9.1 of CA	Performance Guarantee: 85.50 Crores
7	Clause 10.3.4 of CA (Right of way)	In the event, the Authority is unable to provide the remaining Site within 180 days from the Appointed Date, the remaining Site of the Project Highway shall be removed from the scope of the work under the provision of Change of Scope.
8	Clause 12.3.1 of CA	Construction Period: 730 days from the Appointed Date
9	Clause 14.3 of CA (Provisional Certificate)	Provisional Certificate can be given to Concessionaire for part of the project highway (if the concessionaire has completed 100% of site made available to the Concessionaire up to 146 days from the Appointed Date).
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.
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 receive Annuity from the Authority in accordance with the provisions this agreement.
12	Clause 15.2 of CA	COD shall be achieved within 91 days from the scheduled completion date. In the event of delay, damages for delay of COD, 0.2% of the performance security for delay of each day until COD is achieved.
13	Clause 16.3.2 of CA	Within 7 (seven) days of issuing a Change of Scope Order, the Authority shall make an advance payment to the Concessionaire in a sum equal to 20% (twenty per cent) of the cost of Change of Scope as agreed hereunder, and in the event of a Dispute, 20% (twenty per cent) of the cost assessed by the Independent Engineer.

S. No	Relevant Clause	Description
14	Clause 17.3 of CA	Not later than 90 days prior to the scheduled completion date, the Concessionaire shall provide Maintenance Manual. The Maintenance Manual shall be revised and updated once in every 3 (three) years.
15	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.
16	Clause 17.5.2 of CA	Concessionaire has to maintain and operate round the clock rescue post with equipment in accordance with good industry practice.
17	Clause 17.8.1 of CA (Maintenance obligations)	Damages for breach of maintenance obligations: Damages shall be calculated for each day of delay at higher of (a) 2% of Performance Security (b) 0.1% of the Cost of such repair or rectification.
18	Clause 17.15 of CA	Installation and operation of CC TV The Concessionaire shall install and operate a closed-circuit television system to monitor such parts of the project as may be necessary and expedient for a safe and secure and smooth operation thereof
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 undertaken and funded in accordance with the provisions article 16.
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 of 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.
24	Clause 20.5 CA	Building for Medical Aid post: Construct an Aid post and 2 residential quarters and handover to Authority not later than 30 days prior to Scheduled completion date
25	Clause 20.7 CA	Recurring expenditure on Police Assistance: 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.
26	Clause 20.8 CA	Recurring expenditure on Medical Aid Posts: On or before COD, the Concessionaire shall provide one ambulance in good working

S. No	Relevant Clause	Description
		condition along with chauffeurs for the round-the-clock ambulance services shall meet operation cost of ambulance including the salaries and allowances of chauffeurs. The concessionaire shall also reimburse to the state medical department, the actual expenditure incurred by it in each accounting year on the medical equipment and the pay and allowance of up to two medical personals deployed exclusively for Medical Aid post.
27	Clause 21.3 CA	Remuneration of IE: Subject to the limits set in Schedule-M, One half of the IE Fee shall be borne by Concessionaire.
28	Clause 22.1 of CA	Financial Close: The Concessionaire agrees and undertakes the, it shall achieve Financial Close within 150 days from the date of signing of the agreement. In the event of delay, another 120 days extension will be given subjected to payment of damages to the Authority at 0.05% of Performance Security for each day of delay. In the event of further delay, another 95 days extension will be given subjected to payment of damages to the Authority at 0.1% of Performance Security for each day of delay.
29	Clause 23.1 of CA	Bid Project Cost: 1710 Crores.
30	Clause 23.3 of CA	Payment of Bid Project Cost 40% of BPC, adjusted for the price index multiple shall be due and payable to the Concessionaire in 5 equal instalment, 8% each during the construction period as per Clause 23.4. The remaining BPC adjusted for the price index multiple, shall be due and payable in 30 biannual instalments commencing from the 180th day of COD as per Clause 23.6.
31	Clause 23.5 of CA	Bonus on Early Completion: on before 30days at 0.5% of 60% of BPC for the first 30 days by which COD shall precede the schedule Completion date. Thereafter on pro-rata basis.
32	Clause 23.7 of CA	First Year O&M Cost: 6.30 Crores.
	Clause 23.8 of CA	Mobilisation Advance: The Authority upon request of the Concessionaire, can make an advance payment in a sum not exceeding 10% of the Bid Project Cost in 2 equal instalments.
33	Clause 26.1 of CA	Insurance during Concession Period: The Concessionaire shall affect 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.
34	Clause 27.2.1 of CA	All fee and expenses of the Statutory Auditors shall be borne by the Concessionaire.
35	Clause 32.5 of CA	The Concessionaire shall bear and pay all cost incidental to Divestment except stamp duties which shall be payable by Authority.
36	Clause 33.1 of CA	Concessionaire responsible for all defects and deficiencies for a period of 120 days from termination.
37	Clause 35.1 of CA	for increase in Cost or reduction in net after tax return due to change in Law, the aggregate financial effect of which exceeds the

S. No	Relevant Clause	Description
		higher of Rs. 2.58 crore and 2.0% of Total Annuity payment in any accounting Year, Authority has to compensate.
38	Clause 35.2 of CA	reduction in Cost or increase in net after tax return, the aggregate financial effect of which exceeds the higher of Rs. 2.58 crore and 2.0% of Total Annuity Payment in any accounting year. Concessionaire has to pay back to Authority.
39	Clause 38.3 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 Society for Affordable Redressal of Disputes ("SAROD"), New Delhi and shall be subject to provisions 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.

The Applicable Manual for this Project Road is IRC: SP: 87-2013, for Six-Lane roads. The relevant schedule for Operations and Maintenance (O&M) activities is Schedule K of the Concession Agreement.

Schedule K of CA species that Roughness values exceeding 2750 mm/km in a km-length, needs to be corrected within 180 days. Based on the manual, clause 5.8 for structural evaluation of the pavement deflection measurements shall be taken every 5 years interval. Clause 5.9.6 indicates the strengthening overlay thickness shall not be less than 50mm bituminous concrete.

1.5 REVIEW OF SETTLEMENT AGREEMENT

I) SETTLEMENT Agreement Dt. 11.01.2021

Concessionaire could not submit Performance Security Bank Guarantee (PSBG) within the scheduled time (30 days) from the date of signing of the Concession Agreement stating the main reason for delay is stringent conditions being imposed by the Bank due to mounting NPAs

D. The Concessionaire vide letter dt:20.12.2018 informed that M/s INKEL Ltd., a PPP initiative of the Government of Kerala, is joining them both as an EPC partner and part-shareholder, at 24.4% (subsequently changed to 24.44%) of the equity, to implement the Calicut Bypass project. The action of Concessionaire for transfer of

24.44% of equity shares does not require prior approval of the Competent Authority as per Clause 5.3.2 of Concession Agreement however, subsequent transfer of equity shares will require prior approval of Competent Authority.

E. The Concessionaire vide letter dt: 09.02.2019 submitted the PSBG, with a delay of 267 days, bearing BG No. 0406219BG0000012, dt: 18.01.2019 for an amount of Rs.85, 50, 00,000/- which was issued on application of INKEL Limited on behalf of Calicut Expressway Pvt. Ltd. However, in view of Policy Guidelines No.3.1.23/2018 dt: 10.09.2018 the PSBG couldn't be accepted and accordingly the Concessionaire was informed by Authority vide letter dt: 23.04.2019. The Concessionaire represented the matter vide letter dt: 02.05.2019.

However, pursuant to the Revised Policy circular no.3.1.25/2019; dt: 04.09.2019 issued by Authority for acceptance of PSBG, the Concessionaire submitted the PSBG in terms thereof on 19.09.2019 which has been accepted by the Authority.

F. The Concessionaire vide letter dt: 06.03.2019 submitted the proposal for further transfer of 24.56% of the Company M/s Calicut Expressway Pvt. Ltd. (CEPL) to M/s INKEL Infrastructure Development Projects Limited (IIDPL) and changing the EPC contractor from M/s KMC to M/s KMC-INKEL Ltd. (JV) and sought approval of Competent Authority. Subsequent to detailed deliberation, Authority on 13.12.2019 approved "In-Principal" for acquisition of 49% equity in CEPL by IIDPL.

T. The Concessionaire finally submitted the Financial Closure documents on 15.09.2020. The Authority decided to consider declaration of Appointed Date upon signing of a Settlement Agreement between the Parties.

W. Based on the suggestions, the matter was again placed by the Technical Division before the Executive Committee of NHAI in its 450th Meeting held on 10.12.2020 and the Executive Committee of NHAI approved the Revised proposal to recover the amount of Rs. 27.97 Crores as damages/penalty on the Concessionaire for the delays on his part in 2 instalments of 50% each from 1st and 2nd Payment Milestone alongwith interest @ 9 % from the date of Settlement Agreement and subject to above, to revive the Concession Agreement of 6 laning of Kozhikode Bypass as recommended.

THE AMOUNT OF FULL AND FINAL SETTLEMENT

The Parties hereby agree that the Concession Agreement shall not be deemed as terminated as contemplated in Clause 4.5, 9.1 & 22.2 of the Concession Agreement. The Concessionaire acknowledges, undertakes and agrees that NHAI shall recover an amount of Rs.27.97 crore as penalty for delays on his part in two instalments as mentioned below in clause 3(i) hereinafter.

Parties hereby agree that recovery of the amount in the sum of Rs. 27.97 crore shall be full and final settlement with respect to the issues related to declaration of the Appointed Date as mentioned above. For avoidance of doubt, apart from above, there are no past, present or outstanding liability, claims or counter claims including for delay in achievement of Financial Close / Appointed Date made by either Party.

II) Settlement Agreement Dt. 08.12.2023

For completion of the project, EOT-2 was granted up to 18.01.2024. but the Concessionaire achieved around 52% progress as on 31.10.2023. To complete the balance works, this agreement is executed.

The status of works are as follows.

- Length of the Project is 28.40 Km. SR on LHS is 27.306 Km and SR on RHS is 27.306 Km. The status of land handing over to the Concessionaire as on the Appointed Date+20% of Construction Period is as under:

Sr. No.	Particulars	Length of Main Carriageway		Length of Service Road			
				LHS		RHS	
		Made Available	Completed	Made Available	Completed	Made Available	Completed
1	Land made available upto AD+180 days i.e. upto 21.08.2021	28.4 Km	9.40 Km (DBM upto 31.10.2023)	27.276 Km	12.11 Km (DBM upto 31.10.2023)	27.246 Km	13.46 Km (DBM upto 31.10.2023)
2	Land made available after AD + 180 days.	Nil		Nil		Nil	
3	Land yet to be made available.	Nil		0.03 Km		0.06 Km	
	Total	28.4 Km	9.40 Km		12.11 Km		13.46 Km

- In-principle, approval of COS for a net cost of about Rs. (-) 29 Cr. (Including GST) is under consideration of the Authority for the following items.

Table 3: COS Summary

Sr. No.	COS Provision	Cost (Rs. in Cr.)
1	Widening of culverts 30 Nos.	4.13
2	Construction/widening of LVUP/PUP at Km. 239.755, 242.283, 247.210, 241.603	11.95
3	Shifting of Na!a 2.40 km (increase in width of drain)	9.74
4	FOB at Ch: 257+380 and Ch: 256+860	3.39
5	Standardization of Service Road	-6.09
6	Reduction in median width from 1.50m to 0.50m	-6.36
7	Deletion of span of LVUP at 238+300 from 2x12 to 1x12	-1.04
8	To descope remaining work of LHS Major Bridge at Ch. 232+836, 235+389, 250.723& 254+887 duly accounting for the works executed (except the cost of 16 PSC Girders which have already been casted be utilised by Concessionaire on its own at no cost to NHAI) and bringing the executed work to safe position as proposed by IE.	-40
	Total Net COS amount (including GST)	-29

Both the parties agreed to the following.

(i) In-principle approval of COS-1 for a net cost of about Rs. (-) 29 Cr. (Refer details at Recital-F) has been granted by the Authority. Independent Engineer based on the details being submitted by the Concessionaire will work out the net cost on the following principles & submit to NHAI who in turn shall examine, approve such cost and issue an order (COS order):

(ii) Out of total project length of 28.4 Km, hindrances in the form of COS are in 3.377 km and 9.02 km length was affected due to delay in approval of revised estimates for utility shifting upto 24.06.2023. However, the net affected length is 11.262 Km after excluding overlapping length. Concessionaire agreed to complete the entire project as under:

(a) All works in the Project Length of 17.138 km [17.138 Km. Main Carriageway; SR (LHS) 16.172 Km.; SR (RHS) 16.172 Km.] by 30.06.2024;

(b) All works in remaining Project Length of 11.262 km including COS works in this reach by 25.12.2024.

(iv) After completion of all works in 17.138 Km, Provisional Completion Certificate (PCC) would be issued and the Annuity, Interest and O&M Payments would be made based on the proportionate BPC for 17.138 Km.

PCC	Likely date	Likely Completed Length of Reaches	BPC corresponding to completed length
PCC	30.06.2024	17.138 km	BPC-1
Final Completion	25.12.2024 (within 180 days of 30.06.2024 i.e first annuity payment date)	11.262 km	BPC-2

Annuity	Due date	Annuity Payment	Interest Payment	O&M Payment
1st Annuity	27.12.2024 (30.06.2024 + 180 days)	BPC-1+BPC-2 (if final completion is before 27.12.2024)	BPC-1	BPC-1
2nd Annuity	27.06.2025	BPC-1+BPC-2	BPC-1+BPC-2	BPC-1+BPC-2

1.6 REVIEW OF PROJECT MILESTONE

Competent Authority has accorded 2nd EOT for 106 days vide e-office File No: 12395/NHAI/PIU-Kozhikode/KozhikodeBypass/EOT up to 18.01.2024 and details of revised mile stones are as presented below.

Sl. No	Description	Scheduled Milestone Date as per CA	Milestone Date as per approved 1st EOT (225 Days)	Milestone Date as per approved 2nd EOT (106 Days)
1	Project Milestone-I (20%)	20-08-2021	02-04-2022	17-07-2022
2	Project Milestone-II (35%)	21-02-2022	04-10-2022	18-01-2023
3	Project Milestone-III (75%)	25-08-2022	07-04-2023	22-07-2023
4	Scheduled Completion Date (100%)	21-02-2023	04-10-2023	18-01-2024

Milestone-1 & 2 are already achieved and settlement agreement made on 08.12.2023 to complete the balance works for 17.138 Km of Main Carriageway and 16.172 kms of Service Road on 30.06.2024 and remaining project length of 11.262 km including COS works to complete by 25.12.2024.

Further, Concessionaire requested for revised proposal as per delay period of 448days i.e.,

- ✓ 30.06.2024 to extend up to 21.09.2025 and
- ✓ 25.12.2024 to extend up to 18.03.2026

1.7 REVIEW OF IE MPR

Based on the latest available IE MPR for the month of Jan-2025 following items are presented below.

Table 4: Project Milestones

Project Milestone	Description (Days from Appointed Date)	Planned		Actual		Revised Date (As per EOT for 331 days approved by Authority)	Delay (No. of months)	Current Status
		Physical Progress (%)	Scheduled Date	Physical Progress (%)	Achieved Date			
Milestone 1	180 days	20	21-08-2021	20.00	16.10.2022	17.07.2022	2.2	Achieved within the grace period
Milestone II	365 days	35	22-02-2022	35.00	31.03.2023	18-01-2023	NA	Achieved within the grace period
Milestone III	550 days	75	26-08-2022	84.45% as on 31.01.2025	NA	As per Settlement Agreement completion date for 17.138 Km of Main carriageway and Service Road on 18.06.2024 and balance length by 25.12.2024	NA	To be achieved
Scheduled Completion	730 days	100	22-02-2023	-	NA	As per Settlement Agreement completion date for 17.138 Km of Main carriageway and Service Road on 18.06.2024 and balance length by 25.12.2024	NA	To be achieved

- Status of Construction Progress as on Jan-2025

S No	Key reporting metrics	Value/%/Amount
1	Scheduled Physical Progress	100 %
2	Cumulative Physical Progress up to current month (%)	83.066 %
3	Physical Progress during current month (%)	1.416 %
4	Financial progress (%)	83.00 %
5	Cumulative Expenditure till date (Rs Cr)	1380.48 Cr
6	Tests passed as % of total tests witnessed by IE (Nos)	Sheet Attached
7	Tests passed as % of total tests conducted by IE (Nos)	Sheet Attached
8	Number of pending COS proposals	Nil
9	Amount for pending COS (Rs Cr)	Nil

- Total length of the project is **28.400 Km** from Design chainage Km 230+400 to Km 258+800 and the total project cost is **Rs. 1710 Crores**.
- Cumulative physical progress **83.066 %** Scheduled Physical Progress is as per the work program submitted by the Concessionaire, which is based on the EOT.

- Physical Progress as on Jan-2025

Component	% Weightage	Physical Progress (During Current Month)	Physical Progress (During Previous Month)	Physical Progress (Cumulative, Up to Current Month)
Road Works	46.92%	0.765%	40.501%	41.266%
Major Bridge works and ROB/ RUB	11.41%	0.001%	8.22%	8.22%
Other works	41.67%	0.65%	32.93%	33.58%
Physical Progress	100.00%	**1.416%**	**81.65%**	**83.066%**

1.8 REVIEW OF DRAWINGS

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

Elements	Criteria	Details
Horizontal alignment	Length, km	28.400
	No. of Horizontal Curves	60
	Deflection angle Criteria Deficiencies	
	Total no's	14
	Flat curves(R>1850)	Out of 60, at 37 location R>1850
	Broken Back curves not satisfying design requirement	
	Total no's	4
	Flat curves(R>2000)	Out of 60, at 36 location R>2000
	Curves < 400m	1
	Minimum/Maximum Radius	385/10000
	Design Speed	100(51), 80(9)
Vertical alignment	Vertical Curve details	Details are given for the entire stretch
	Maximum gradient	3.4%
	Summit Curves Minimum/Maximum K value	Out of 99 curves ISD - 100(55), ISD - 80(6), <ISD -100(36), - 80 (2) with minimum K as 27
	Majority section 'K'value designed for	ISD-100
TCS	No. 0f TCS types proposed	9
	Builtup/Approach TCS	4
	Rural	5
	CW width rural/urban/Approach	12.75
	SR width	5.25+1.0=6.25 (including RCC Cover Drain top)
	Drains	Footpath cum box drain of 1.0m width Provided at SR outer edge
	Side slope-- MCW/SR	-
Miscellaneous	Entry/Exit type	As per Schedule D
	Safety measures in MCW median/Separator	CCB is proposed for the median & in between MCW & Service Roads for the entire length on both side except flyover locations.
	Junctions	drawings are not provided.
	Bus bays/Shelters	drawings are not provided
	Street lighting	As per Schedule C.
	Highmast	As per Schedule C.

1.9 REVIEW OF PAVEMENT DESIGN

Referring to Schedule-B, clause 5 (i) indicates, Design of Flexible pavement shall be carried out in accordance with Section 5 of the Manual for minimum design traffic of 23.31 MSA for section from km 230+400 to km 258+800 for main carriageway and 10 million standard axles for Service roads and Slip roads.

Further in the recent NHAI invited tenders for the adjacent project stretch "Six laning of Ramanattukara Junction to start of Valanchery bypass Section of NH-66 (Old NH-17) from Design Ch.258+818 to Design Ch.298+500 in the state of Kerala on Hybrid Annuity Mode under Bharatmala Pariyojana" and in this awarded the contract, the pavement design, the design traffic suggested for the design period of 20 years was 70 MSA. Considering this, the Authority desired the design the pavement for 70MSA traffic for the Kozhikode bypass as well. Subgrade CBR of 10% shall be maintained.

Design MSA

Upon review of Approved Pavement Design Report indicates that the Flexible Pavement designed for 70 MSA for Main Carriageway and 10 MSA for Service Roads considering minimum 10% effective CBR for subgrade material.

Pavement Crust Main carriageway

Design of New construction is carried out in accordance with IRC 37 2018.

For Main Carriageway (Design Traffic 70 MSA)

S No.	Description	Thickness (mm)	Remarks
1	Bituminous concrete (BC)	50	BC with VG-40 At Va =3.5%. Vbe =10.5%
2	DBM with VG40	80	At Va=3.5%, Vbe =10.5%.
3	WMM	150	Crushed aggregates
4	CTSB	200	Gradation IV to be adopted
5	Subgrade	500	During execution of work a minimum of 10% Effective CBR is to be ensured

For Service Road (Design Traffic 10 MSA)

S No.	Description	Thickness (mm)	Remarks
1	Bituminous concrete (BC)	40	BC with VG-40 At Va -3.5%, Vbe -10.75%
2	WMM	150	Crushed aggregates
3	CTSB	200	Gradation IV to be adopted
4	Subgrade	500	During execution of work a minimum of 10% Effective CBR is to be ensured

At service road locations, it is observed that 50mm DBM has been provided between BC (40mm) and WMM (150mm)

1.10 REVIEW OF EPC AGREEMENT

- Review of EPC agreement reveals that the Concessionaire (CEPL) and EPC Contractor (KMC-INKEL JV & KMC Construction Ltd) entered into an EPC agreement on 05.11.2021 on fixed price lumpsum turnkey basis.
- As per EPC agreement, the Contractor also acknowledges that the Concession agreement between NHAI 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 7.1, EPC Contractor to furnish performance security for an amount 5% of Contract price. And is valid until 60days after DLP period,
- As per Clause 7.5 (retention money), Employer shall deduct 6% as guarantee money towards performance obligations during construction period and this should not exceed 5% of the contract price. Within 15 days of issue of completion certificate, employer shall refund the balance retention money.
- 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 19.1 of EPC Agreement, contract Price is Rs.1450 crores as lumpsum price. Contract price includes all duties, taxes, royalty and other fee.
- As per Clause 19.2 of EPC Agreement, Employer shall make an interest-free advance payment of 10% on contract price towards mobilization expenses in 2 equal instalments

1.11 BALANCE WORKS

The status of balance works observed as on 31.03.2025.

S.No	Item	Balance Length, mts			
		LHS- MCW	RHS- MCW	LHS- SR	RHS- SR
1	BC	3140	6345	8153	8414
2	DBM	1235	1309	5083	3254
3	WMM	968	1005	4105	2579
4	CTSB	968	1005	3825	2459
5	SG	718	920	2275	1171
6	EMB	115	920	2135	1171
7	C&G	0	0	0	0

Note: Total Length, MCW: 28.4km, LHS: 28.4km, RHS: 28.4km,

Major part of all structures is completed. However, miscellaneous items such pitching. Painting. Wearing coat, crash barrier, expansion joints etc are to be completed. In regard to the Toll Plaza, works are in progress for staggered plaza.

1.12 REVIEW OF SCHEDULES

- **Schedule-A Provisions:**

The existing width of carriageway is standard 2LPS with Flexible pavement for the entire project

Description	As per Schedules-A
Length of Project	28.4 km
Existing ROW for 2LPS	30m to 45m
Service Road/Slip-road	Nil
Major Bridges	4 Nos.
ROB	Nil
Grade Separator	2 Nos.
Underpasses	16 Nos.
Minor Bridges	1 Nos.
Pipe Culverts	9 Nos.
Box/Slab Culverts	36 Nos.
Bus Shelters (includes both sides)	36 Nos.
Truck Lay byes	Nil
Toll Plaza	Nil
Major Junction	8 Nos.
Minor Junctions	27 Nos.

- **Schedule-B/C Provisions:**

The existing 2LPS should be widened to 6-lane carriageway of varying configurations of paved carriageway widths (2x 11.75m), (2x 13.5m) and (1x13.5m+1x11m) including paved shoulder.

Description	As per Schedules-B&C
Length of Project	28.4 km
Service Road/Slip-road (including both sides)	54.612 km
Major Bridges	4 Nos.
ROB	Nil
Flyover	7 Nos.
LVUP	4 Nos.
VOP	2 Nos.
PUP	16 Nos.
FOB	1 Nos.
Minor Bridges	1 Nos.
Pipe Culverts	7 Nos.
Box/Slab Culverts	22 Nos.
Bus Shelters (includes both sides)	34 Nos.
Truck Lay byes	-
Toll Plaza (8+1)	1 Nos.
Major Junction	1 Nos.
Minor Junctions	26 Nos.
Rainwater Harvesting Structure	12 Nos.
Overhead Signs	Min. 18 Nos
Traffic Aid Post	25sqm
Patrol Vehicle	2 Nos
Medical Aid-Post	Required
Vehicle Resue Post	2 Nos
ATMS	To be provided
O&M Centre	To be provided

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 and to understand the present condition of the various elements of the project road and 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
- Visual Pavement Condition
- FWD Surveys
- Roughness Surveys using NSV
- Pavement Composition surveys (Test Pits)
- Material Investigations
- Core Cutting
- Axle Load Survey
- Structure Inventory and Condition Surveys

The above said surveys were performed in the month of March-2025.

2.2 ROAD INVENTORY

The project corridor features a 6-lane divided carriageway for most of its length. Generally, the carriageway width of flexible pavement is 10.5 meters wide, with 0.5m shyness, and is flanked by 2.5m paved shoulders on each side of the median. These widths vary at structure locations and approaches to major junctions.

The median is typically 0.5 meters wide for the majority of the corridor as project stretch passing through built-up section. In general, entire road constructed in confined area with elevated structures and Underpasses with RE/Retaining wall at approaches. Whereas, Gabion facia walls are provided at Major Bridge approaches.

The bypass runs along coastal belt through predominantly flat to gently undulating terrain, with land use along the project corridor characterized by a diverse mix of residential and commercial zones, interspersed with patches of agricultural land.

Typical view of project road is shown below:

View of the Project corridor at Km. 231+400 with a 6-lane configuration in the main carriageway (MCW) with Segmental Arm Lights on Shoulders and provided with CCB on Median.

View of the Project corridor at Km. 234.600 with a 6-lane configuration in the main carriageway (MCW) with CCB on median

A view of the Project Corridor with 5.5m wide Slip Road at Km 242.060 RHS

A View of Project Corridor with 5m wide Slip Road @ Km 245.700 LHS

The Project Road has both Major and Minor junctions. Photographs showing the Major Junctions and minor junctions are presented below:

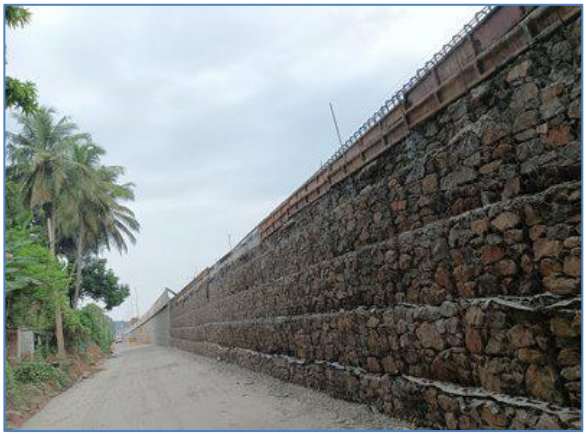
Minor Junction @ km 234.900 RHS

Minor Junction @ Km 244.338 LHS

Major Junction @ Km 248.230 LHS

Minor Junction @ Km 255.520 RHS

Approaches to the Grade-Separator structures are provided with RE-wall and at other High embankments sections. The sample photos are presented below:

	
RCC Wall at km. 232.300 - RHS	**Gabion Wall at km. 254.500 - RHS**

RCC- cover drains are provided in the project road at built-up locations adjacent to service roads:

	
RCC closed drain at Km 247+200 RHS	**RCC drain cum Footpath at km. 258+793 RHS**

Highway lighting in the form of single/segmental/double arms is observed. Sample photos showing highway lighting are presented below:

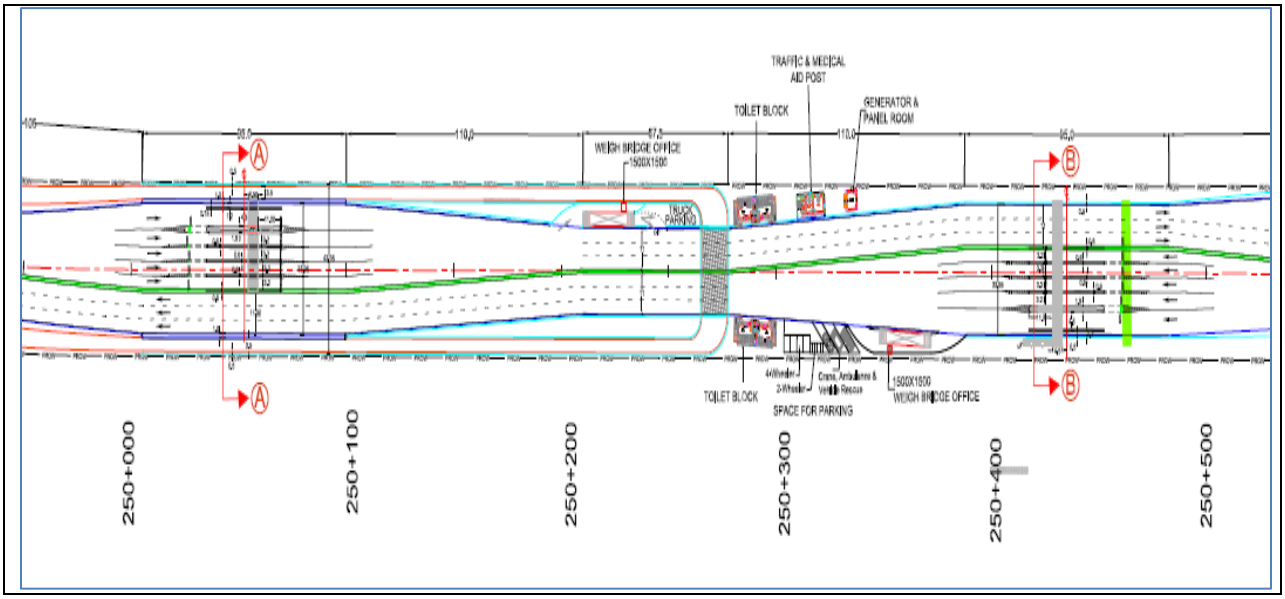
Segmental Lighting @ Km 231.155 Median

Solar Single arm @ Km 232.830 LHS

Single Arm lighting on Service Road @ Km 234.551 RHS

Single Arm lighting @ Km 246.600 RHS

Toll Plaza at km. 250+300, is to be constructed as per Schedule-C with 8+1 Toll-lanes in each direction. Presently, there are no works started yet. Based on the discussions with the Concessionaire, it is noted that due to the land constraint Concessionaire sought approval from Authority for staggered Toll Plaza with 4+1 Toll-lanes in each direction at same location. The submitted revised layout drawing for the staggered Toll Plaza is presented below.



Service Road/slip roads have been observed almost entire length on either side of the project corridor with flexible pavement of 5.0m to 7.0m wide attached with covered Drain. Sample photos of Service Road locations are presented below.

5.5m wide Slip road @ Km 235.160 RHS

5.5m wide Slip Road at Km 242.280 LHS

The collected Road Inventory Data is presented in **Appendix 1** of this Report

2.3 PAVEMENT CONDITION SURVEYS

The collected Pavement Condition Data using NSV surveys for main carriageway is presented in **Appendix 2** of this Report. The project corridor involves construction of 6-lane divided highway with flexible pavement.

The existing pavement condition ranges from excellent to good. Certain stretches of the project are still under construction and have not yet been opened to traffic.

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

Fair pavement condition @ Km 238.300 LHS

Fair pavement condition @ Km 247.000 LHS

Fair pavement condition @ Km 256.180 RHS

Fair pavement condition @ Km 258.800 RHS

2.4 FALLING WEIGHT DEFLECTOMETERS (FWD) SURVEY

In order to evaluate the structural strength of the existing pavement, Falling Weight Deflectometer (FWD) survey has been carried out along the project road in line with IRC: 115-2014.

- ✓ Prior to the start the surveys, Load repeatability tests are performed on each day
- ✓ The target Peak Load of 40 KN (+/- 4 KN) is maintained during survey
- ✓ At Regular intervals of time Pavement temperature is noted
- ✓ For every 1 Km of stretch 7 test Points (2 pts-Outer, 2 pts-Middle, 3 pts-inner) were taken on Main Carriageway in each direction.
- ✓ Temperature correction equation is applied for back calculated modulus of BT and Summer seasonal correction factor is applied for the back calculated modulus of granular and Subgrade considering the Summer Season (March Month).

The collected FWD Data and Analysis is presented in **Appendix 3** of this Report.

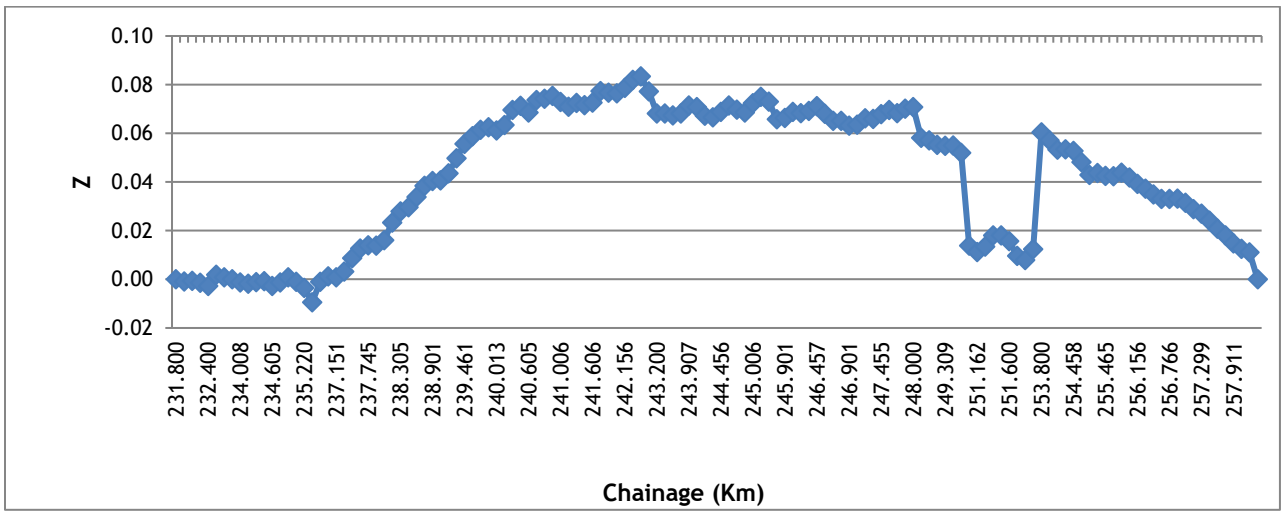
Few photos taken during the progress of FWD Surveys are presented below:

Deflection Measurement in progress

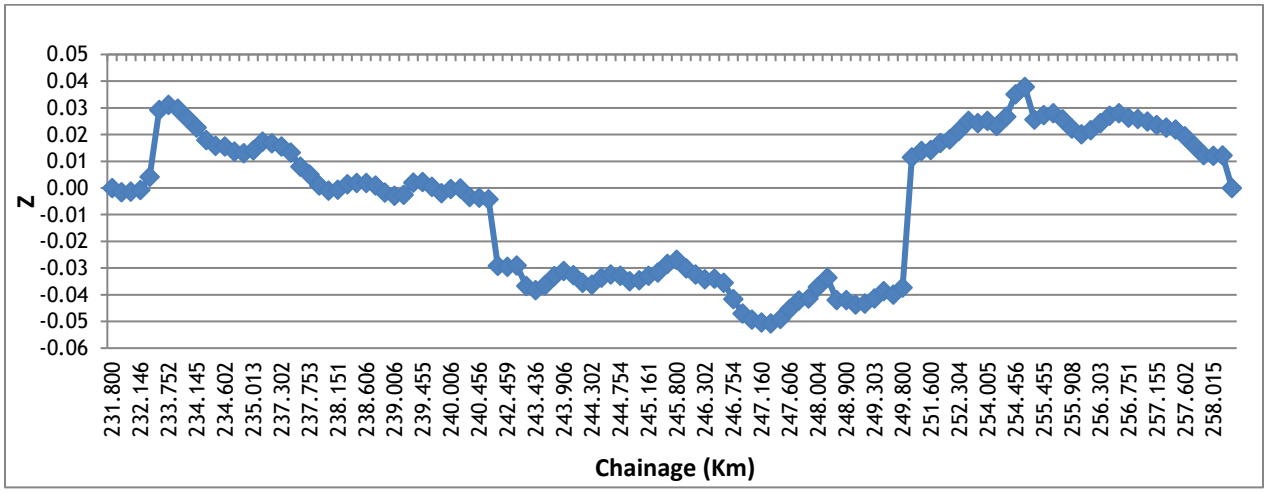
Temperature Measurement in progress

The 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 for Main carriageway is presented in graphical representation of followed by tables.



Delineation of Homogeneous Section – LHS



Delineation of Homogeneous Section - RHS

Based on the above graphs, the flexible pavement section has been sub-divided into homogeneous sections for LHS and RHS direction as given below.

Table 5: FWD Data -Homogenous Section of MCW – LHS

Homo Sections	From (Km)	To (Km)	Length (Km)	Remarks
1	230.400	231.800	1.40	U/C & Diversion
2	231.800	232.400	0.60	
	232.400	233.530	1.13	U/C & Diversion
	233.530	235.220	1.69	
3	235.220	236.600	1.38	U/C & Diversion
4	236.600	238.447	1.85	
5	238.447	240.155	1.71	
6	240.155	242.700	2.54	
7	242.700	243.200	0.50	U/C & Diversion
8	243.200	245.300	2.10	
9	245.300	245.800	0.50	Flyover
	245.800	248.000	2.20	
	248.000	248.950	0.95	Flyover
10	248.950	249.750	0.80	
	249.750	251.050	1.30	U/C & Diversion
	251.050	251.600	0.55	
	251.600	252.000	0.40	Flyover
	252.000	252.300	0.30	
11	252.300	253.800	1.50	U/C & Diversion
12	253.800	254.660	0.86	
	254.660	255.140	0.48	U/C & Diversion
	255.140	256.003	0.86	
13	256.003	258.100	2.10	
	258.100	258.750	0.65	Flyover
	258.750	258.800	0.05	
Total Length (Km)			28.40	

Table 6: FWD Data -Homogenous Section of MCW – RHS

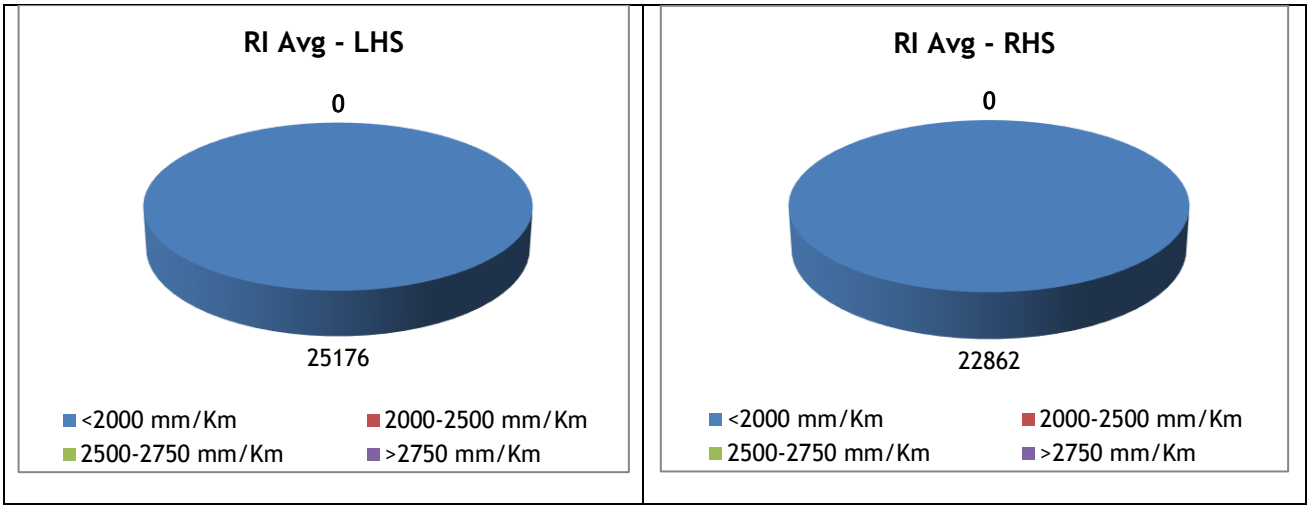
Homo Sections	From (Km)	To (Km)	Length (Km)	Remarks
1	230.400	231.800	1.40	U/C & Diversion
2	231.800	232.400	0.60	
	232.400	233.530	1.13	U/C & Diversion
	233.530	235.200	1.67	
3	235.200	237.140	1.94	U/C & Diversion
4	237.140	238.751	1.61	
5	238.751	239.550	0.80	
	239.550	239.900	0.35	Diversion (VOP U/C)
	239.900	240.700	0.80	
6	240.700	242.230	1.53	U/C & Diversion
7	242.230	242.700	0.47	
	242.700	243.200	0.50	U/C & Diversion
	243.200	245.450	2.25	
8	245.450	245.800	0.35	Flyover
9	245.800	248.100	2.30	
10	248.100	248.900	0.80	Flyover
11	248.900	249.800	0.90	
	249.800	251.300	1.50	Diversion (VUP U/C)
	251.300	251.600	0.30	
	251.600	252.000	0.40	Flyover
	252.000	252.580	0.58	
	252.580	253.800	1.22	U/C & Diversion
	253.800	254.144	0.34	
12	254.144	254.600	0.46	
	254.600	255.140	0.54	U/C & Diversion
	255.140	256.606	1.47	
15	256.606	258.100	1.49	
	258.100	258.750	0.65	Flyover
	258.750	258.800	0.05	
Total Length (Km)			28.40	

2.5 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. Pavement Roughness data collection and computation of IRI for each km length in each direction is presented in **Appendix 4** of this Report.

As per Schedule-K, the roughness values exceeding 2750mm/km are warranted for resurfacing.

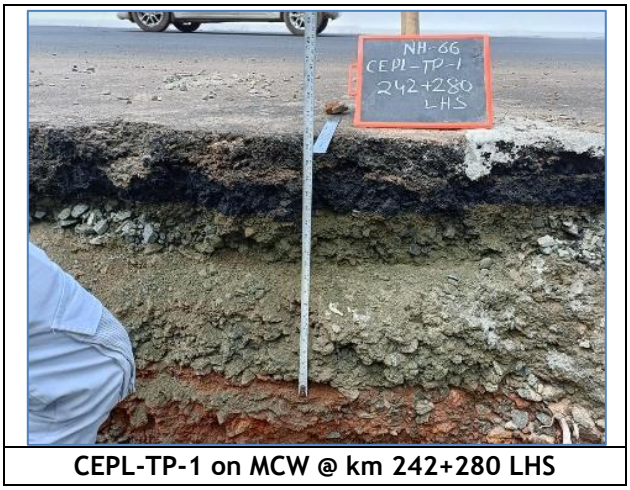
Average Roughness Index (RI) values along the corridor were grouped in to four categories, Pie chart showing the range of RI values in each carriageway of the project road have been presented below:



It can be seen from the above pie charts, that entire the length of the Project Road has good riding quality (RI<2000 mm/km).

2.6 PAVEMENT COMPOSITION TEST

The composition of the existing pavement structure shall be determined through test pit surveys. Since the project is newly constructed, not yet opened to traffic, and only small sections are still under construction, a single test pit was excavated to identify the pavement layer types and their thicknesses.



CEPL-TP-1 on MCW @ km 242+280 LHS

It is noted from pit that the Main Carriageway consists of granular base, sub-base and asphalt wearing course with the thicknesses of Cement Treated Sub Base (CTSB): 200 mm, Base course (WMM): 150 mm and that of asphalt layers is 130 mm. The total Crust Thickness is around 480mm. This is in line with approved pavement design thickness for 70MSA traffic.

2.7 MATERIAL INVESTIGATIONS

2.7.1 BORROW AREAS

Potential borrows areas identified at 6 Nos. of locations within the vicinity of the project corridor for sub-grade/ embankment within economic haulage leads have been identified. The soil samples collected have been tested for the following properties.

- Sieve analysis
- Atterberg limits

- Heavy compaction
- Four (4) days soaked CBR as per IS standards at 97% of MDD as applicable for sub-grade (Heavy Compaction)
- Free swelling index

The sources identified as potential borrow sources are shown in Table below.

Table 7: Details of Borrow Soils

Sl.No	Borrow Area No	Chainage	Side	Offset	Village and contact person	Quantity	Rate	Remarks	Co-ordinate
1	CEPL-BP-1	236+800	LHS	4.0 KM	Vill-Olopara Owner-Abhilash Mob no- 9946176326	5 Acres*5 feet	Govt. Permission	Pvt. Land	11.340967 75.786458
2	CEPL-BP-2	241+070	LHS	4.8 KM	Vill-Chalilthazam Owner- Srinivash Nair Mob no-	3 Acres*5 feet	Govt. Permission	Pvt. Land	11.322974 75.820448
3	CEPL-BP-3	251+780	RHS	1.0 KM	Vill- Pantheerankave	10 Acres*5 feet	Govt. Permission	Govt. Land	11.226803 75.846100
4	CEPL-BP-4	255+540	LHS	6.4 KM	Vill- Vazhayur Town Name- Abdul Mob no- 9526073085	10 Acres*5 feet	Govt. Permission	Pvt. Land	11.217.097 75.908981
5	CEPL-BP-5	258+320	LHS	5.2 KM	Vill- Kunderi Alungal Name- V. Koya Mob no- 9072510938	10 Acres*5 feet	Govt. Permission	Govt/Pvt. Land	11.174171 75.912998
6	CEPL-BP-6	258+320	LHS	13.4 kM	Vill- Aroor	10 Acres*5 feet	Govt. Permission	Pvt. Land	11.218225 75.936703

Soil samples from these borrow sources have been collected in bulk by excavating test pits down up to 1.0m depth from the existing ground surface. The top organic soil layer of approximately 150mm thickness was removed before sampling. The samples collected from these identified borrow pits/ gravel quarries have been tested for the suitability of utilizing them as embankment fill/ sub-grade. The sample photos of borrow area locations are as presented below.

CEPL-BP-1

CEPL-BP-2

CEPL-BP-3

CEPL -BP-4

CEPL -BP-5

CEPL -BP-6

2.7.2 AGGREGATE SAMPLES

The aggregate materials useful for sub-base, base, surface courses and concrete works have been collected from the crushers/quarry under operation in the existing quarries. The locations, estimated quantity, basic cost of material and the approximate distance from each source to the nearest point on the project corridor are presented in following table.

CEPL-AQ-1

Table 8: Details of Aggregate Samples

S No	sample No.	Ex.Chainage (Km.)	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	CEPL-AQ-1	258+320 LHS	Mini Ooty	Hi-Tech Metals Owner-Suniyyappa Contract No-8304949177	21.5 KM	Plenty	40mm-Rs 30/- per cft 20mm-Rs 35/- per cft 12mm - Rs 35/- per cft 6mm -Rs 35/- per cft Dust - Rs 27/- per cft M-Sand - Rs 45/- Per Cft	Royalty & GST After Discussion	11.100839 76.014124

2.7.3 SAND SAMPLES

Crushed Sand samples of 1 Nos. have been collected from the above said aggregate source and tested. The location of this sand quarry along with lead to the Project Road and its cost is presented in the following table

Table 9: Details of Sand Sample

Sl No	**sample No.**	**Ex.Chainage (Km.)**	**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	CEPL-M-Sand-1	258+320 LHS	Mini Ooty	Hi-Tech Metals Owner-Suniyyappa Contract No-8304949177	21.5.0 KM	Plenty	M-Sand - Rs 45/- Per Cft	Royalty & GST After Discussion	11.100839 76.014124

2.8 CORE INVESTIGATION

The objective of the core cutting is examining the engineering properties of the materials relevant to the project as per specification. Core are taken in the following locations.

I. Main Carriage way
   - A. On LHS Side - 4 Nos.
   - B. On RHS Side - 3 Nos.

The Core samples collected from these identified locations have been tested for the following properties.

- Density of Core
- Theoretical Maximum Sp. gravity (GMM)
- Air voids

- Compaction
- Extraction and Gradation

Location and Details of the core cutting are given below

	
CEPL-C-1 @ km 231+900 LHS	CEPL-C-2 @ km 238+000 RHS
	
CEPL-C-3 @ km 242+200 LHS	CEPL-C-4 @247+400 RHS
	
CEPL-C-5 @ km 252+200 LHS	CEPL-C-6 @ km 257+500 RHS
	
CEPL-C-7 @ km241+700 LHS	

2.9 AXLE LOAD SURVEYS

Traffic loading has a significant impact on pavement performance and design. This is because the damage that vehicles create to a road depends very strongly on the axle loads of the vehicles. The exact relationship is influenced by the type of road structure and the way the road deteriorates but a "fourth power" damage law gives a good approximation.

Axle load study has been conducted using portable axle load pads. Surveys have been conducted on the Project Road at one location near km 246+960 on 21st to 22nd March 2025. The surveys have been conducted in both the directions. The measurements have been made on random sampling basis. The collected axle load data and analysis is presented in **Appendix 5** of this Report.

The vehicle damage factors have been calculated using the standard axle loadings given in IRC: 37-2018. The standard axle loadings adopted have been presented in the following table

Details of Standard Axles Used

Axle Configuration	Standard Axle load (Tonnes)*	Remarks
Single Wheel, Single Axle	6.60	As per IRC:37-2018
Dual Wheel, Single Axle	8.16	As per IRC:37-2018
Dual Wheel, Tandem Axle group	15.10	As per IRC: 37-2018
Dual Wheel, Tridem Axle group	22.90	As per IRC: 37-2018

Few photographs illustrating the survey locations and axle load measurements are presented below.

At km 246+960

At km 246+960

Direction wise VDF for each mode of commercial traffic has been estimated. Results of axle load surveys have been presented in the following table.

Table 10: VDF Values Estimated at the Survey Location (Near km 246+960)

Mode Type	UP	DOWN
LCV	0.95	0.40
Buses	0.29	0.11
2 Axle Truck	2.40	1.60
3 Axle Truck	**4.25**	**5.06**
MAV (4-6 Axle)	**9.89**	**10.79**

It is observed in LHS direction, the VDF of 3-Axle & MAV were slightly on lower side when compared with the RHS direction.

CHAPTER 3. VALIDATION OF EXECUTED WORKS

3.1 ROAD 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.

Table 11: Scope Comparison of executed works

S. No.	Particulars	Length/ Nos	Total for O&M Estimation	As per Site	As per Sch-A	As per Sch-B	As per Vendor / Data room	Remarks
1	**Start Chainage (Km)**	Kms		230.40	230.40	230.40	230.40	
2	**End Chainage (Km)**	Kms		258.80	258.80	258.80	258.80	
3	Length of the Project Corridor	Kms		28.40	28.40	28.40	28.40	
4	Service Road / Slip Road (Including Taper Length)	Kms		54.61	0.00	54.61	54.61	
5	Urban Length	Kms		28.40	0.00	28.40	0.00	
6	Flyovers	Nos	7.00	7.00	2.00	7.00	7.00	
7	VOP	Nos	2.00	2.00	0.00	2.00	2.00	
8	LVUP's	Nos	6.00	6.00	0.00	4.00	6.00	
9	PUP's/CUP's	Nos	16.00	16.00	16.00	16.00	16.00	
10	FOBs	Nos	3.00	3.00	0.00	1.00	3.00	
11	Subways	Nos	0.00		0.00	0.00	0.00	
12	Major Bridges	Nos	4.00	4.00	4.00	4.00	4.00	
13	Minor Bridges	Nos	1.00	1.00	1.00	1.00	1.00	
14	Culverts (Pipe)	Nos	26.00	26.00	0.00	7.00	26.00	
15	Culvert (Box)	Nos	52.00	52.00	0.00	38.00	51.00	248+830 Extra stream found at LHS Side at site, it was considered as BC
16	Major Junctions	Nos	8.00	8.00	8.00	1.00	0.00	
17	Minor junctions	Nos	28.00	28.00	28.00	26.00	0.00	
18	High Embankments	Kms	7.56	0.88	0.00	0.00	7.56	
19	RCC Wall-Full Height	Kms	29.62	12.42	0.00	0.00	29.62	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
20	RE Panels - Full height	Kms	5.40	4.72	0.00	0.00	5.40	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
21	RE Blocks - Full height	Kms	14.21	11.33	0.00	0.00	14.21	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
23	Toe Wall	Kms	3.50	0.00	0.00	0.00	3.50	Not Visible at site
24	Gabion Wall	Kms	0.20	0.20	0.00	0.00	0.00	
25	Stone Masonry Wall	Kms	0.10	0.10	0.00	0.00	0.00	
26	**Drainage/Utility works**		0.00					
27	RCC Cover Drain	Kms	60.12	45.89	0.00	60.12	60.12	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
28	Toll Plaza	Nos	1.00	1.00	0.00	1.00	1.00	Canopy with Solar Panels

S. No.	Particulars	Length/ Nos	Total for O&M Estimation	As per Site	As per Sch-A	As per Sch-B	As per Vendor / Data room	Remarks
29	No.of Lanes (Both side)	Nos	10.00	10.00	0.00	18.00	10.00	Due to LA issue 10 lanes considered as per Revised Drawing
30	Route Patrolling Vehicle	Nos	2.00	2.00	0.00	2.00	0.00	
31	Ambulance	Nos	2.00	2.00	0.00	2.00	0.00	
32	Cranes	Nos	2.00	2.00	0.00	2.00	0.00	
33	ATMS Length:	kms	28.40		0.00	28.40	28.40	
34	Varying Message Signs(VMS)	Nos	2.00	2.00	0.00	0.00	0.00	
35	Advanced Traffic Management System(ATMS)	Nos	46.00	46.00	0.00	0.00	0.00	
36	High Mast Lights	Nos	26.00	0.00	0.00	0.00	26.00	500W
37	Medium Mast Lights	Nos	16.00		0.00	0.00	16.00	300W
38	Highway Lighting (length only) LHS+RHS	Kms	56.84	46.52	0.00	0.00	56.84	
39	Single Arm Lightings Poles	Nos	275	275	0.00	0.00	95.00	
40	Double Arm Lightings Poles	Nos	1433	1283	0.00	0.00	1433.00	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
41	Lights below underpass/FO	Nos	284	-	0.00	0.00	284	
42	Solar Blinkers	Nos	28	17.00	0.00	28.00	0.00	17 nos are kept at Temporary Div and 28 nos not yet installed
43	Bus Bays	Nos	34	0.00	0.00	34.00	0.00	Not constructed due to LA issue
44	Bus Shelters	Nos	34.00	12.00	0.00	34.00	0.00	
45	Road Markings	Kms	28.40	28.40	0.00	28.40	28.40	
46	Delineators	Nos	0.00	0.00	0.00	0.00	0.00	
47	Kilometer Stones	Nos	46.00	46.00	0.00	46.00	0.00	
48	Hectometer Stones	Nos	230.00	230.00	0.00	230.00	0.00	
49	5th Km Stone	Nos	10.00	10.00	0.00	10.00	0.00	
50	Side Kerb at Separator	Kms	109.22	64.56	0.00	54.61	109.22	PGR proposed on Drain is replaced with side-kerb
51	Studs	Nos	4972.00	4972.00	0.00	0.00	0.00	
52	Road Signs	Nos	1069	184	0.00	0.00	1069	
53	3-Lane Gantry Sign Boards	Nos	18.00	7.00	0.00	18.00	0.00	
54	Cantilever Sign Boards	Nos	2.00	2.00	0.00	0.00	0.00	
55	Rigid Concrete Barriers	Kms	53.77	53.77	0.00	0.00	51.21	Incl Friction-slab crash barrier
56	Concrete Railing	Kms	2.36	2.36	-	-	-	On Ex. Bridges
57	Hand Railing on Crash Barriers	Kms	3.17	3.17	-	-	-	
58	Pedestrian Guard Rails	Kms	3.35	3.35	0.00	0.00	0.00	Existing PGR is 3.35 km: However, PGR proposed on Drain is not constructed at site, instead kerb provided
59	New jersey Barrier	Kms	23.88	23.88	0.00	23.88	0.00	In the median

The carriageway width of 10.5m plus 2.5m wide paved shoulder and a shyness of 0.5m has been provided over the entire length as per TCS schedules except at structure locations.

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 54.612 Km. Location wise details of service roads and slip roads are presented in **Appendix 6.**

Lined Covered drains are provided adjacent to service road locations. Length of lined Covered drain is 45.886 kms (existing)/60.12 kms (vendor list).

Table 12: Summary of Lined Covered Drain

Summary	Units	Length		Total
		LHS	RHS	
Covered Drain as per Site	Kms	22.755	23.131	45.886
Covered Drain as per Vendor	Kms			60.123

Majority length of the project stretch runs in confined areas with approaches of RE Wall/Retaining wall were provided. Detail locations are listed in the **Appendix 6** of this report.

Table 13: Summary of Type of Slope Details

Type of slope Protection		Length as Per Site	Length as Per Vendor	Remarks
High Embankments	Kms	0.880	7.56	
RCC Wall-Full Height	Kms	12.42	29.62	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
RE Panels - Full height	Kms	4.72	5.40	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered
RE Blocks - Full height	Kms	11.33	14.21	Vendors Qty = Completed + Balance Length As per Site: Present completed length considered.
Toe Wall	Kms	0.000	3.500	
Gabion Wall	Kms	0.20	0.000	
Stone Masonry Wall	Kms	0.100	0.000	

Median width of 0.5m was generally observed along the project road placed with New Jersey Barrier.

Safety barriers in the form of concrete barriers are installed along the project road in the median and shoulder side in full length. Details of safety barriers provided along the corridor are as follows

Table 14: Summary of Safety Barriers along Project Road

Safety Barrier	Length (km) as per site	Length (km) as per Vendor
Rigid Concrete Crash Barrier	53.77	51.21
Concrete Railing	2.36	-
Hand Railing on Crash Barriers	3.17	-
Pedestrian Guard Rails	3.35	-
New jersey Barrier	23.88	23.88

8 nos of Major junctions and 28nos of Minor Junctions are developed along the Project corridor summary are presented in the table below and details are provided in **Appendix 6**

Table 15: Summary of Junctions

Junctions	as per site
Major Junctions	8
Minor Junctions	28

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 6**

Table 16: Details of Road Signs along Project Road

Description	LHS	RHS	Junctions	Total
Unit	Nos	Nos	Nos	Nos
Overhead Gantry	4	3	0	7
Cantilever Gantry	1	1	0	2
Toll Boards	0	0	0	0
ADS/RAS	0	0	0	0
Rectangular	2	0	2	4
Triangular	1	3	4	8
Circular	20	41	1	62
Octagonal	0	0	2	2
Flag Type	0	0	0	0
Chevron	24	72	0	96
Hazard	5	4	3	12
Route marker	0	0	0	0
Cluster	0	0	0	0
Total	57	124	12	193

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 6** of this report.

Table 17: Summary of High Mast & Lighting along Project Road

Description	Units	High mast	Medium mast	Single Arm	Double Arm
As Per Site	Nos	-	-	275	1284
As Per Vendor	Nos	26	16	95	1433

The Project Road has about 12nos of (34nos as per vendor) Bus shelters. The details of the same are given in **Appendix 6** of this report.

3.2 STRUCTURES

The overall summary of structures present in the project are as listed below:

Table 18: Summary of the Structures

S. No	Type of Str	No. of Structures As per Schedule	As per site					Remarks
			No. of Structures			Total No.of Str's	Total No.of Locations	
			LHS	RHS	BHS			
1	MJB	**4**	8	4	-	12	4	> 4 New Major Bridges on the left side are being executed under a separate EPC agreement.
2	MNB	**1**	3	2	-	5	1	
3	Flyover	**7**	7	7	-	14	7	
4	LVUP	**4**	6	6	-	12	6	
5	PUP	**16**	18	16	-	34	16	
6	VOP	**2**	-	-	2	2	2	
7	FOB	**1**	-	-	3	3	3	> 2 FOBs under COS at 256+860 & 257+380. **Status: Not yet started**
8	BC	**19**	-	-	44	44	44	> 12 No's Box culvert Constructed under COS.
9	PC	**7**	-	-	27	27	27	> 21 No's Pipe culvert Constructed under COS.
10	SC	**3**	-	-	7	7	7	-

Table 19: Age of Structures

S. No	Type of Str	LHS		RHS		BHS		Total (Nos)		Total no. of Str's
		Old	New	Old	New	Old	New	Old	New	
1	MJB	4	4	-	4	-	-	4	8	12
2	MNB	2	1	2	-	-	-	4	1	5
3	Flyover	-	7	2	5	-	-	2	12	14
4	LVUP	1	5	1	5	-	-	2	10	12
5	PUP	8	10	4	12	-	-	12	22	34
6	VOP	-	-	-	-	-	2	-	2	2
7	FOB	-	-	-	-	-	3	-	3	3

Table 20: Summary of Expansion Joints & Bearings

S. No	Type of Str	Expansion joints		Bearings			
				Pot PTFE		Elastomeric	
		Old	New	Old	New	Old	New
1	MJB	34	28	-	300	180	220
2	MNB	2	2	-	-	8	4
3	Flyover	14	77	64	912	-	-
4	VOP	-	6	-	-	-	120
Total		**50**	**113**	**64**	**1212**	**188**	**344**
		163		**1276**		**532**	
				1808			

Table 21: Summary of Superstructures

S. No	Type of Structure	Steel Truss	RCC Girder	RCC Box	PSC Girder	PSC & Steel Girder	PSC U Girder	PSC Box Girder	Total no. of Structures
1	MJB	-	-	-	8	-	4	-	12
2	MNB	-	4	-	1	-	-	-	5
3	Flyover	-	-	-	9	4		1	14
4	LVUP	-	-	12	-	-	-	-	12
5	PUP	-	-	34	-	-	-	-	34
6	VOP	-	2	-	-	-	-	-	2
7	FOB	3	-	-	-	-	-	-	3
Total		**3**	**6**	**46**	**18**	**4**	**4**	**1**	**82**

Table 22: Summary of Substructures

S. No	Type of Str	ABUTMENT				PIER			
		Steel Truss	RCC Wall Type	RCC Box	RCC Rectangular Column type	RCC Circular Type	RCC Box	RCC Wall Type	RCC Rectangular Column type
1	MJB	-	12	-	-	1	-	11	-
2	MNB	-	5	-	-	-	-	-	-
3	Flyover	-	13	-	1	1	-	10	1
4	LVUP	-	-	12	-	-	4	-	-
5	PUP	-	-	34	-	-	-	-	-
6	VOP	-	-	2	-	2	-	-	-
7	FOB	3	-	-	-	-	-	-	-
Total		**3**	**30**	**48**	**1**	**4**	**4**	**21**	**1**
		82				**30**			

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

Table 23: Details of CD & Other Structures along Project Road

S.No.	Site Chainage (Km)	Type of Structure	Side	Str on	Age of Structure	Skew	Span Arrangement (No x Length)	No. of Spans	Span Length (m)	Deck Width (m)	Remarks
1	232+836	MJB	LHS	MCW	New	No	37.087 + 37.104 + 37.138 + 37.156 + 37.084 + 37.138 + 37.156 + 37.063 + 37.179 + 37.134 + 37.084 + 37.105 + 37.139 + 37.139	14	37.12	13.58	-
2	232+836	MJB	LHS	MCW	Old	No	1 x 37.10 + 6 x 37.20 + 1 x 37.00 + 1 x 37.10 + 2 x 37.20 + 1 x 37.10 + 1 x 37.20	13	37.16	9.84	-
3	232+836	MJB	RHS	MCW	New	No	37.087 + 37.104 + 37.138 + 37.156 + 37.084 + 37.138 + 37.156 + 37.063 + 37.179 + 37.134 + 37.084 + 37.105 + 37.139 + 37.139	14	37.12	15.20	-
4	235+389	MJB	LHS	MCW	New	No	37.079 + 37.156 + 37.152 + 37.020 + 37.152	5	37.11	13.58	-
5	235+389	MJB	LHS	MCW	Old	No	1 x 37.00 + 1 x 37.15 + 3 x 37.10	5	37.09	9.84	-
6	235+389	MJB	RHS	MCW	New	No	37.079 + 37.156 + 37.152 + 37.020 + 37.152	5	37.11	15.20	-
7	250+723	MJB	LHS	MCW	New	No	1 x 32.155 + 2 x 32.191 + 1 x 32.205	4	32.18	13.58	-

S.No.	Site Chainage (Km)	Type of Structure	Side	Str on	Age of Structure	Skew	Span Arrangement (No x Length)	No. of Spans	Span Length (m)	Deck Width (m)	Remarks
8	250+723	MJB	LHS	MCW	Old	No	2 x 32.10 + 2 x 32.20	4	32.19	9.84	-
9	250+723	MJB	RHS	MCW	New	No	1 x 32.155 + 2 x 32.191 + 1 x 32.205	4	32.18	15.20	-
10	254+887	MJB	LHS	MCW	New	No	37.151+37.284+36.797+37.615+36.423+37.520+ 36.737+37.044	8	37.07	13.58	-
11	254+887	MJB	LHS	MCW	Old	No	8 x 37.10	8	37.10	9.84	-
12	254+887	MJB	RHS	MCW	New	No	37.151+37.284+36.797+37.615+36.423+37.520+ 36.737+37.044	8	37.07	15.20	Integral Structure .
13	258+603	MNB	LHS	SR	Old	No	1 x 25	1	25.00	7.91	Retained
14	258+603	MNB	LHS	MCW	New	No	1 x 35	1	35.00	3.40	Widening
15	258+603	MNB	LHS	MCW	Old	No	1 x 25	1	25.00	11.95	Retained
16	258+603	MNB	RHS	MCW	Old	No	1 x 25	1	25.00	12.31	Retained
17	258+603	MNB	RHS	SR	Old	No	1 x 25	1	25.00	8.00	Retained
18	231+320	Flyover	LHS	MCW	New	No	10 x 30.00 + 1 x 50.00 + 6 x 30.00	17	31.18	13.73	-
19	231+320	Flyover	RHS	MCW	New	No	10 x 30.00 + 1 x 50.00 + 6 x 30.00	17	31.18	13.73	-
20	236+060	Flyover	LHS	MCW	New	No	18 x 30.00	18	30.00	13.73	-
21	236+060	Flyover	RHS	MCW	New	No	18 x 30.00	18	30.00	13.73	-
22	245+635	Flyover	LHS	MCW	New	No	9 x 24.5 + 1 x 42.75 + 8 x 24.5	18	25.51	13.73	-
23	245+635	Flyover	RHS	MCW	Old	No	9 x 24.5 + 1 x 42.75 + 8 x 24.5	18	25.51	12.00	-
24	248+225	Flyover	LHS	MCW	New	No	23 x 30.0	23	30.00	13.73	-
25	248+225	Flyover	RHS	MCW	New	No	23 x 30.0	23	30.00	13.73	-
26	251+777	Flyover	LHS	MCW	New	No	11 x 30.0	11	30.00	13.73	-
27	251+777	Flyover	RHS	MCW	New	No	11 x 30.0	11	30.00	13.73	-
28	255+548	Flyover	LHS	MCW	New	Yes	1 x 30.0	1	30.00	13.73	-
29	255+548	Flyover	RHS	MCW	New	Yes	1 x 30.0	1	30.00	13.73	-
30	258+306	Flyover	LHS	MCW	New	No	6 x 30 + 2 x 40 + 6 x 30	14	31.43	13.73	-
31	258+306	Flyover	RHS	MCW	Old	No	6 x 30 + 2 x 40 + 6 x 30	14	31.43	12.00	-
32	236+760	LVUP	LHS	MCW	New	Yes	1 x 12	1	12.00	13.75	-

S.No.	Site Chainage (Km)	Type of Structure	Side	Str on	Age of Structure	Skew	Span Arrangement (No x Length)	No. of Spans	Span Length (m)	Deck Width (m)	Remarks
33	236+760	LVUP	RHS	MCW	New	Yes	1 x 12	1	12.00	13.75	-
34	238+300	LVUP	LHS	MCW	New	No	1 x 12	1	12.00	13.75	-
35	238+300	LVUP	RHS	MCW	New	No	1 x 12	1	12.00	13.75	-
36	239+755	LVUP	LHS	MCW	New	Yes	2 x 12	2	12.00	13.75	Under COS
37	239+755	LVUP	RHS	MCW	New	Yes	2 x 12	2	12.00	13.75	Under COS
38	241+603	LVUP	LHS	MCW	Old	Yes	2 x 8.55	2	8.55	13.50	Under COS PUP as per CA
39	241+603	LVUP	RHS	MCW	Old	Yes	2 x 8.55	2	8.55	13.50	Under COS PUP as per CA
40	250+271	LVUP	LHS	MCW	New	No	1 x 12	1	12.00	13.75	-
41	250+271	LVUP	RHS	MCW	New	No	1 x 12	1	12.00	13.75	-
42	253+940	LVUP	LHS	MCW	New	No	1 x 12	1	12.00	13.75	-
43	253+940	LVUP	RHS	MCW	New	No	1 x 12	1	12.00	13.75	-
44	231+485	PUP	LHS	MCW	Old	No	1 x 7.9	1	7.90	9.75	Retained
45	231+485	PUP	RHS	MCW	Old	No	1 x 7.9	1	7.90	9.75	Retained
46	231+611	PUP	LHS	MCW	New	Yes	1 x 8	1	8.00	13.75	-
47	231+611	PUP	RHS	MCW	New	Yes	1 x 8	1	8.00	13.75	-
48	231+889	PUP	LHS	MCW	Old	No	1 x 2.5	1	2.50	13.75	Retained
49	231+889	PUP	RHS	MCW	Old	No	1 x 2.5	1	2.50	13.75	Retained
50	232+316	PUP	LHS	MCW	Old	No	1 x 6	1	6.00	13.80	Retained
51	232+316	PUP	RHS	MCW	New	No	1 x 6	1	6.00	13.80	-
52	233+328	PUP	LHS	MCW	New	No	1 x 4.8	1	4.80	13.50	-
53	233+328	PUP	RHS	MCW	New	No	1 x 4.8	1	4.80	13.50	-
54	233+564	PUP	LHS	MCW	New	No	1 x 9	1	9.00	13.50	-
55	233+564	PUP	RHS	MCW	New	No	1 x 9	1	9.00	13.50	-
56	234+160	PUP	LHS	MCW	New	No	1 x 6	1	6.00	13.50	-
57	234+160	PUP	RHS	MCW	New	No	1 x 6	1	6.00	13.50	-
58	234+726	PUP	LHS	MCW	Old	No	1 x 4	1	4.00	14.05	Retained

S.No.	Site Chainage (Km)	Type of Structure	Side	Str on	Age of Structure	Skew	Span Arrangement (No x Length)	No. of Spans	Span Length (m)	Deck Width (m)	Remarks
59	234+726	PUP	RHS	MCW	Old	No	1 x 4	1	4.00	14.05	Retained
60	234+897	PUP	LHS	MCW	New	No	1 x 9	1	9.00	13.50	-
61	234+897	PUP	RHS	MCW	New	No	1 x 9	1	9.00	13.50	-
62	235+071	PUP	LHS	SR	Old	No	1 x 2.5	1	2.50	7.05	Retained
63	235+071	PUP	LHS	MCW	Old	No	1 x 2.5	1	2.50	13.50	Retained
64	235+071	PUP	RHS	MCW	New	No	1 x 2.5	1	2.50	13.50	-
65	235+165	PUP	LHS	MCW	Old	No	1 x 4.7	1	4.70	14.89	Retained
66	235+165	PUP	RHS	MCW	New	No	1 x 4.7	1	4.70	14.89	-
67	235+895	PUP	LHS	MCW	New	No	1 x 7.9	1	7.90	13.75	-
68	235+895	PUP	RHS	MCW	New	No	1 x 7.9	1	7.90	13.75	-
69	239+898	PUP	LHS	MCW	New	No	1 x 8	1	8.00	13.50	-
70	239+898	PUP	RHS	MCW	New	No	1 x 8	1	8.00	13.50	-
71	239+918	PUP	LHS	MCW	New	No	1 x 4	1	4.00	13.75	-
72	239+918	PUP	RHS	MCW	New	No	1 x 4	1	4.00	13.75	-
73	242+283	PUP	LHS	SR	New	Yes	1 x 10.283	1	10.28	7.25	Under COS
74	242+283	PUP	LHS	MCW	Old	Yes	1 x 10.283	1	10.28	13.50	-
75	242+283	PUP	RHS	MCW	Old	Yes	1 x 10.283	1	10.28	13.50	-
76	247+210	PUP	LHS	MCW	New	No	1 x 7	1	7.00	13.50	Under COS
77	247+210	PUP	RHS	MCW	New	No	1 x 7	1	7.00	13.50	Under COS
78	241+000	VOP	BHS	MCW	New	No	2 x 14.9	2	14.90	45.00	-
79	242+900	VOP	BHS	MCW	New	Yes	2 x 15.455	2	15.46	40.00	-
80	253+460	FOB	BHS	MCW	New	0	1 x 45	1	45.00	3.00	Scope
81	256+860	FOB	BHS	MCW	New	0	1 x 45	1	45.00	3.00	COS
82	257+380	FOB	BHS	MCW	New	0	1 x 45	1	45.00	3.00	COS

4.1 MATERIAL INVESTIGATION INFERENCES

4.1.1 EMBANKMENT, SUBGRADE SAMPLES

The embankment for project road has been constructed with available soils from nearby areas. The soil appears to be silty sand and silts with Coarse Grained in nature and embankment appears to be in good condition over the entire length of project. No major settlements or depressions have been noted even at high embankment locations. There are no marshy/water logging areas along the length of project road.

Borrow area samples collected from 6 locations. Out of 6 samples, 5 sample belongs to SC type of soil, 1 sample belongs to CL type of soil.

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

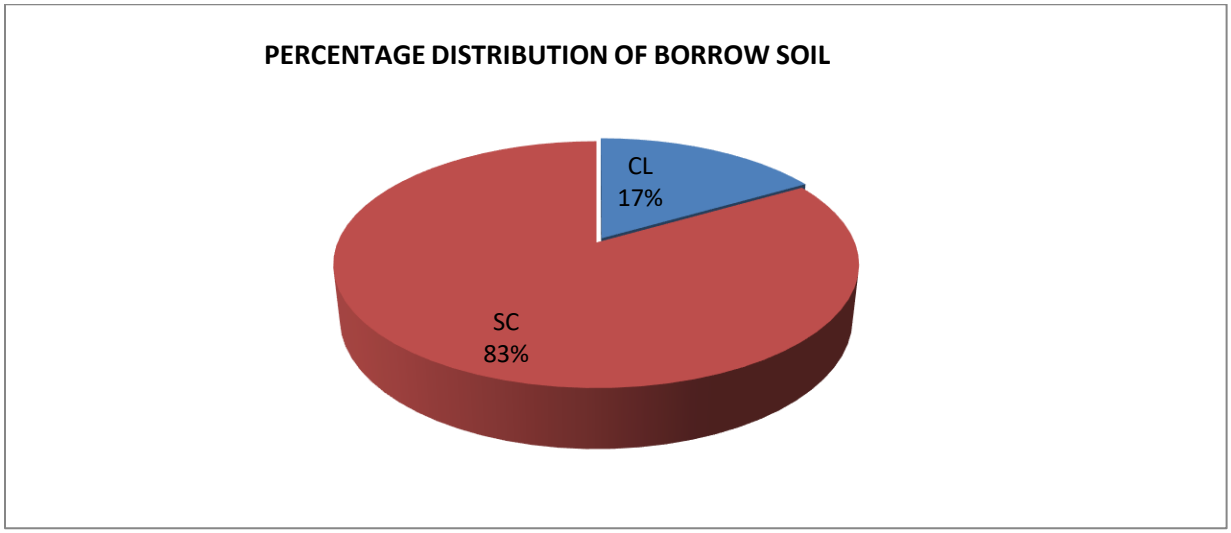


Table 23: Test results of Borrow Soils

Lab Sample No	Site Identification		Grain Size Analysis					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Final Soaked CBR 97% MDD	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 %								
CEPL-BP-1	236+800	LHS	89.38	49.89	44.11	10.62	45.27	40	29	11	SC	1.87	14.00	16.55	30
CEPL-BP-2	241+070	LHS	95.43	62.09	43.31	4.57	52.12	41	25	16	SC	1.87	13.40	14.16	18
CEPL-BP-3	251+780	RHS	81.80	68.56	28.34	18.20	53.46	27	19	8	SC	2.10	12.60	42.82	10
CEPL-BP-4	255+540	LHS	89.56	68.29	55.96	10.44	33.60	44	27	17	CL	1.79	15.20	11.53	15
CEPL-BP-5	258+320	LHS	81.63	51.19	37.25	18.37	44.38	43	30	13	SC	1.85	16.80	16.79	20
CEPL-BP-6	258+320	LHS	83.53	55.24	38.12	16.47	45.41	44	28	16	SC	1.78	15.00	12.65	20

The following observations can be made from the above test results conducted on borrow area samples

- Liquid Limit: All the samples are within the limits (LL< 50%). Ranges 27 % to 44 %.
- Plasticity Index: All samples having PI Values within the limits (PI< 25%); Ranges 8% to 17 %,
- Maximum Dry Density: All samples are having MDD >1.75 gr/cc; Ranges 1.78 gm/cc to 2.10 gm/cc
- California Bearing Ratio Test: CBR value varying with Minimum is 11.53 and Maximum is 42.82 %
- Free Swell Index: FSI value for samples are below limiting value (<50%). Minimum is 10 % and Maximum is 30%.

All the samples collected are meeting specification requirement.

Material related tests reports are provided in **Appendix 7** of this report.

4.1.2 AGGREGATES

Aggregates to be used for sub-base, base, surface courses and concrete works have been collected from the crushers under operation near the existing quarries. The Table below represents the test results of the Aggregate Samples

Table 24: Test Results of Aggregate Samples Details

S. No	Sample	Location (km)	Side	Aggregate Size	A.I.V, %	Water Absorption, %	Specific Gravity	Remark
1	CEPL-AQ-1	258+320	LHS	12 MM	16.0	0.27	2.77	
				20 MM		0.19	2.79	

Note: Aggregates sample is satisfying MoRTH requirements i.e., AIV (max. limit is 24% for Asphalt layer), Water Absorption (max. limit is 2%)

4.1.3 SAND

The test results of the sand samples are as presented below.

Table 25: Test Results of Sand Samples Details

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	Water Absorption %	Specific Gravity
CEPL-M_Sand-1	258+320	LHS	100.00	98.75	81.37	68.55	53.28	30.47	9.89	**2.58**	ZONE-II	1.00	2.72

These sample are suitable for construction works.

4.1.4 CORE SAMPLES

The core samples as extracted at 7 locations were tested in the laboratory to find the engineering properties of BC/DBM materials.

Core reults are provided in **Appendix 7** of this report.

The test results of the pavement cores are as presented below.

Table 26: Test Results of Pavement cores-BC Layers

Sl. No.	Name of Material	Core No.	Chainage	Direction	Carriage way lane	Distance from kerb M	Condition of Road	% of Bitumen Obtained (by extraction of core)		% Agg by Wt.of tatol Mix	Thickness of Specimen mm	DENSITY	Miximum Theoretical Sp.Gr.of Mix (GMM)	% of Air Voids	Filler Asphalt Ratio (%)	% compaction	Gradation as per Morth
								BC	Limits						0.075 mm		
1	BC	CEPL-C-1	231+900	LHS	Outer	10.1	Good	5.22	As per MORTH 4th Revision Table no 500-18, Bitumen Content for BC grading - 1 is 5-6%	94.78	47.11	2.497	2.606	4.183	0.47	96	Grade-I
2	BC	CEPL-C-2	238+000	RHS	Middle	6.6	Good	5.37		94.63	51.75	2.456	2.586	5.027	0.35	95	Grade-I
3	BC	CEPL-C-3	242+200	LHS	Inner	1.7	Good	5.27		94.73	46.96	2.452	2.553	3.956	0.51	96	Grade-I
								5.13		94.87	87.46	2.561	2.714	5.637	0.15	94	Grade no Match
4	BC	CEPL-C-4	247+400	RHS	Outer	8.3	Good	5.18		94.82	44.30	2.434	2.533	3.908	0.51	96	Grade-I
5	BC	CEPL-C-5	252+200	LHS	Middle	6.5	Good	5.33		94.67	53.73	2.468	2.573	4.081	0.20	96	Grade-I
6	BC	CEPL-C-6	257+500	RHS	Inner	3.6	Good	5.21		94.79	50.07	2.385	2.533	5.843	0.56	94	Grade-I
7	BC	CEPL-C-7	241+700	LHS	Outer	10.0	Good	5.18		94.82	43.65	2.323	2.441	4.834	0.56	95	Grade-I

Observations:

- ✓ Binder content for BC: ranging from 5.13% to 5.37%. The MORTH Table 500-17 specifies the Bitumen content range is 5.2 ± 0.3 %. All the sample satisfy for bitumen requirement.
- ✓ BC-Gradation results indicate the mix design: Grade I proportion except one sample.
- ✓ BC-Air Voids: ranging from 3.908% to 5.843% (MORTH Table-11, specifies 3% to 5%)
- ✓ Compaction –More than 94% of Compaction is observed.
- ✓ Filler Asphalt Ratio is considered to be little lower-side as Filler –Asphalt ratio should within the specified limit of 0.6-1.2 (refer MORTH clause 505.3 or as per MS-2 (5.10).

Note: From the cores taken, it is noted that there are no serious abnormalities were found.

Table 27: Test Results of Pavement cores-DBM Layers

Sl. No.	Name of Material	Core No.	Chainage	Direction	Carriage way lane	Distance from kerb m	Condition of Road	% of Bitumen Obtained (by extraction of core)		% Agg by Wt.of tatol Mix	Thickness of Specimen mm	DENSITY	Miximum Theoretical Sp.Gr.of Mix (GMM)	% of Air Voids	Filler Asphalt Ratio (%)	% compaction	Gradation as per Morth
								DBM	Limits						0.075 mm		
1	DBM	CEPL-C-1	231+900	LHS	Outer	10.1	Good	4.10	As per MORTH 4th Revision Table no 500-10, Bitumen Content for DBM grading - 1 is 4%	95.90	80.39	2.557	2.635	2.96	0.51	97	Grade-II
2	DBM	CEPL-C-2	238+000	RHS	Middle	6.6	Good	4.36		95.64	88.52	2.532	2.639	4.05	0.98	96	Grade-II
3	DBM	CEPL-C-3	242+200	LHS	Inner	1.7	Good	4.36		95.64	62.27	2.560	2.655	3.58	0.24	96	Grade-II
4	DBM	CEPL-C-4	247+400	RHS	Outer	8.3	Good	4.11		95.89	67.38	2.569	2.682	4.21	0.49	96	Grade-II
5	DBM	CEPL-C-5	252+200	LHS	Middle	6.5	Good	4.31		95.69	82.13	2.531	2.639	4.09	0.51	96	Grade-II
6	DBM	CEPL-C-6	257+500	RHS	Inner	3.6	Good	4.31		95.69	80.95	2.541	2.651	4.15	0.15	96	Grade-II
7	DBM	CEPL-C-7	241+700	LHS	Outer	10.0	Good	4.29		95.71	80.25	2.634	2.752	4.29	0.14	96	Grade-II

Observations:

- ✓ Binder content for DBM: ranging from 4.10% to 4.36%. The MORTH Table 500-10 specifies the Bitumen content range is 4.5 ± 0.3 %..
- ✓ DBM-Gradation results indicate the mix design: Grade II proportion.
- ✓ DBM-Air Voids: ranging from 2.96% to 4.288% (MORTH Table-11, specifies 3% to 5%)
- ✓ Compaction –More than 95% of Compaction is observed.
- ✓ Filler Asphalt Ratio– is considered to be little lower-side as Filler –Asphalt ratio is within the specified limit of 0.6-1.2 (refer MORTH clause 505.3 or as per MS-2 (5.10)).

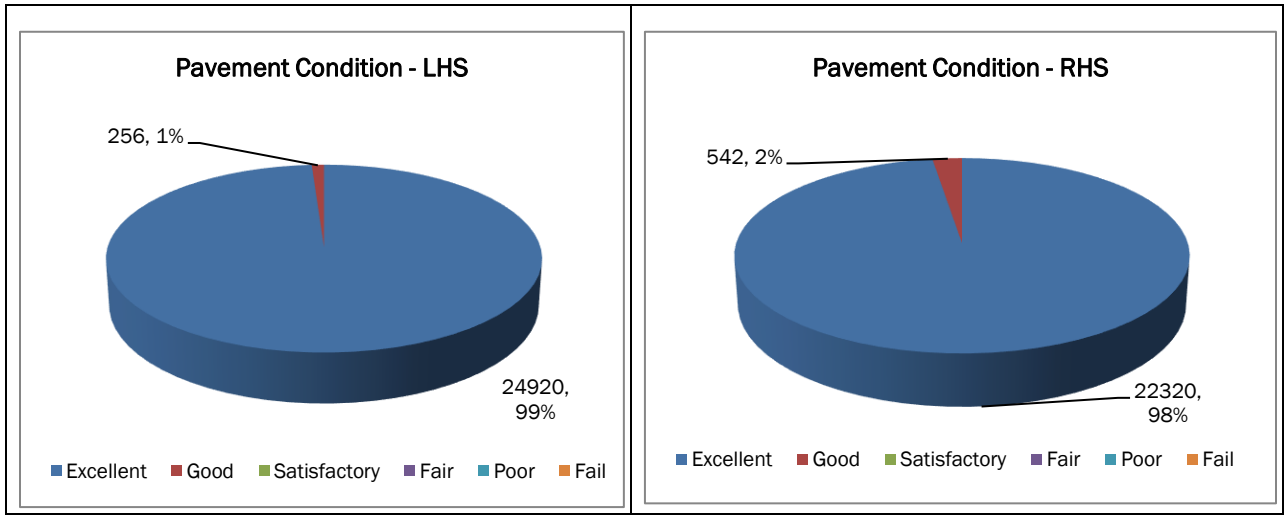
Note: From the cores taken, it is noted that there are no serious abnormalities were found.

4.2 PAVEMENT CONDITION

The distress in bituminous surface have been captured on the project corridor for each lane separately by using Network survey vehicle (NSV). Pavement Condition rating (PCI) as per IRC:82-2023 from the data collected for each km length in each direction has been presented in the **Annexure-2** of this report.

The project corridor has been provided with flexible pavement over entire length and even on service roads also. Rigid pavement is only provided at Toll Plaza including tapering section.

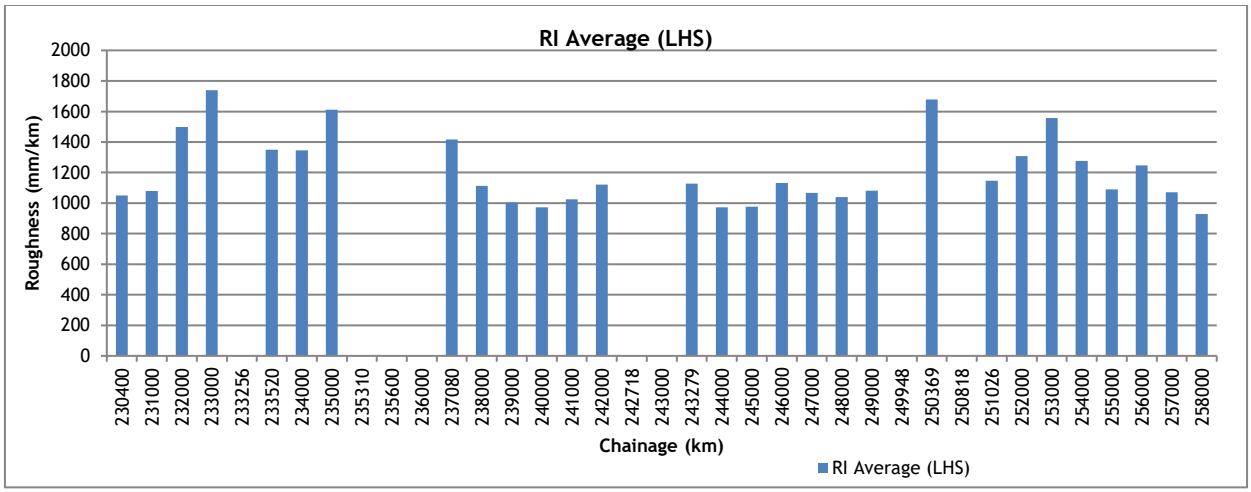
The Pavement condition rating (PCI) is presented in Pie-chart from Excellant to Fail are as below::

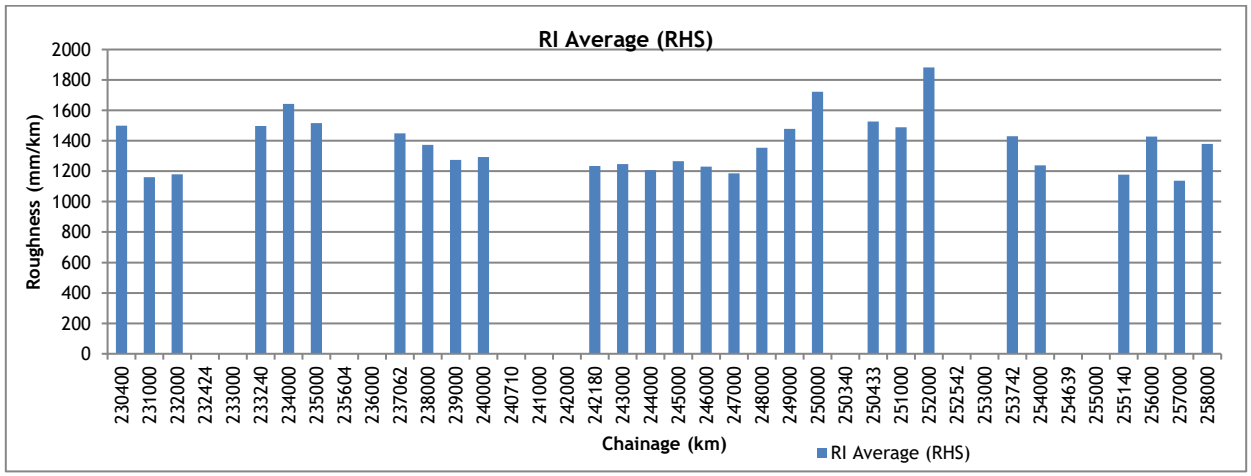


From NSV pavement condition (PCI) analysis, entire length falls under Excellent to Good condition.

4.3 ROUGHNESS

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





Based on the above, considering the Km-stone reference system the summary of direction-wise km lengths having varying roughness values are as presented below:

Roughness Range (mm/km)	Length in Km	
	LHS	RHS
Less than 2000	25176	22862
2000 – 2500	-	-
2500 -2750	-	-
More Than 2750	-	-
Under Construction	3224	5538

It can be noted that for the entire stretch, roughness is less than Schedule-K, specified limit of 2750mm/km and thus no functional overlay is warranted.

4.4 FWD ANALYSIS AND ASSESSMENT OF OVERLAY REQUIREMENT

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)	750-3000	350-600	50-100

Bituminous layer Moduli obtained from back calculations shall be corrected for a standard pavement temperature of 35ºC using given equations. Whereas, for back calculated moduli values obtained for granular and subgrade layer shall be corrected for seasonal variations (using winter and summer equations). Accordingly, seasonal correction factor 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.

Table 28: Summary of Design Moduli of different layers – LHS

S. No	Side	From	To	Length (Km)	15th Percentile MR values		
					MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)
1	LHS	230.40	231.80	1.40	U/C & Diversion		
2	LHS	231.80	232.40	0.60	2442	430	77
3	LHS	232.40	233.53	1.13			
4	LHS	233.53	235.22	1.69			
5	LHS	235.22	236.60	1.38	U/C & Diversion		
6	LHS	236.60	238.45	1.85	2399	426	77
7	LHS	238.45	240.16	1.71	2441	430	77
8	LHS	240.16	242.70	2.54	2449	427	77
9	LHS	242.70	243.20	0.50	U/C & Diversion		
10	LHS	243.20	245.30	2.10	2477	429	77
11	LHS	245.30	245.80	0.50	2469	430	77
12	LHS	245.80	248.00	2.20			
13	LHS	248.00	248.95	0.95			
14	LHS	248.95	249.75	0.80	2426	430	77
15	LHS	249.75	251.05	1.30			
16	LHS	251.05	251.60	0.55			
17	LHS	251.60	252.00	0.40			
18	LHS	252.00	252.30	0.30			
19	LHS	252.30	253.80	1.50	U/C & Diversion		
20	LHS	253.80	254.66	0.86	2419	429	77
21	LHS	254.66	255.14	0.48			
22	LHS	255.14	256.00	0.86			
23	LHS	256.00	258.10	2.10	2398	430	77
24	LHS	258.10	258.75	0.65			
25	LHS	258.75	258.80	0.05			
Total length (kms)				28.400			

Table 29: Summary of Design Moduli of different layers - RHS

S. No	Side	From	To	Length (Km)	15th Percentile MR values		
					MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)
1	RHS	230.40	231.80	1.40	U/C & Diversion		
2	RHS	231.80	232.40	0.60	2520	430	77
3	RHS	232.40	233.53	1.13			
4	RHS	233.53	235.20	1.67			
5	RHS	235.20	237.14	1.94	U/C & Diversion		
6	RHS	237.14	238.75	1.61	2525	427	77
7	RHS	238.75	239.55	0.80	2527	427	77
8	RHS	239.55	239.90	0.35			
9	RHS	239.90	240.70	0.80			
10	RHS	240.70	242.23	1.53	U/C & Diversion		
11	RHS	242.23	242.70	0.47	2531	429	77
12	RHS	242.70	243.20	0.50			
13	RHS	243.20	245.45	2.25			
14	RHS	245.45	245.80	0.35	U/C & Diversion		
15	RHS	245.80	248.10	2.30	2668	430	77
16	RHS	248.10	248.90	0.80	U/C & Diversion		
17	RHS	248.90	249.80	0.90	2689	427	77
18	RHS	249.80	251.30	1.50			
19	RHS	251.30	251.60	0.30			
20	RHS	251.60	252.00	0.40			
21	RHS	252.00	252.58	0.58			
22	RHS	252.58	253.80	1.22			
23	RHS	253.80	254.14	0.34			
24	RHS	254.14	254.60	0.46	2647	431	77
25	RHS	254.60	255.14	0.54			
26	RHS	255.14	256.61	1.47			
27	RHS	256.61	258.10	1.49	2662	429	77
28	RHS	258.10	258.75	0.65			
29	RHS	258.75	258.80	0.05			
Total length				**28.400**			

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 2398Mpa to 2477Mpa in LHS & 2520Mpa to 2689Mpa in RHS Carriageway. The MR value for Granular Layers is 426Mpa to 430Mpa in LHS & 427Mpa to 431Mpa in RHS Carriageway. Similarly, the MR value for Subgrade Layer is 77Mpa to BHS Carriageway.

4.5 STRUCTURES

Inventory and asset condition 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

Each and every structure has been verified at site and detailed inventory and condition survey is presented in **Appendix-8** of this report.

Overall condition of few of the major structures are presented on sample basis as below. However, each and every structure detail are presented in **Appendix-8** of this report.

Chainage: 232+836
General Description
LHS MCW (New)

- Type of Structure : MJB
- Span Arrangement : 37.087 + 37.104 + 37.138 + 37.156 + 37.084 + 37.138 + 37.156 + 37.063 + 37.179 + 37.134 + 37.084 + 37.105 + 37.139 + 37.139 m
- Total length of Structure : 519.706 m
- Total deck width of Structure : 13.58 m
- Type of Foundation : Pile
- Type of Substructure (Abutment & Pier) : RCC Wall type
- Type of Superstructure : PSC U Girder
- Type of Bearing : Pot PTFE
- Type of Railing / Crash Barrier : Crash Barrier
- Method of Inspection : Visual

Observations

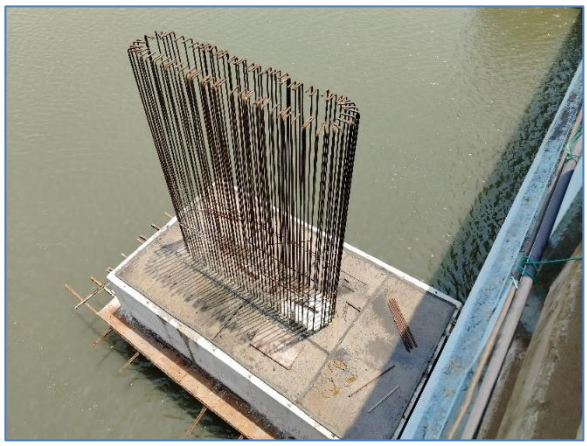
Visual Observations on condition of the structure are as below:

- ✓ New Bridge is under construction
- ✓ Foundation works under progress. (Piling & Pile caps)
- ✓ At present this structure is not in CEPL scope and it is executing under separate EPC Agreement.

Balance Works

- ✓ From Substructure to Wearing course.






Chainage: 232+836
General Description
LHS MCW (Old)

- Type of Structure : MJB
- Span Arrangement : 1 x 37.10 + 6 x 37.20 + 1 x 37.00 + 1 x 37.10 + 2 x 37.20 + 1 x 37.10 + 1 x 37.20 m
- Total length of Structure : 483.1 m
- Total deck width of Structure : 11.85 m
- Type of Foundation : Pile
- Type of Substructure (Abutment & Pier) : RCC Wall type & RCC Circular
- 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:

- ✓ Approach slab damaged at A2 side.
- ✓ Hand railing partially damaged at shoulder side in Span-14.
- ✓ Rubber sealant damaged in Expansion joint No- 4,7,8,9,10,13&14.
- ✓ At present this bridge is not under CEPL Scope.




General Observations: -

- The Project stretch have 39 numbers of major structures, in that 3 FOB's, 2 VOP's, 16 PUP's, 6 LVUP's, 7 Flyover's, 1 MNB's & 4 MJB's.
- The Project Road has varieties of super structure types for various structures such as Steel Truss, RCC Girder, RCC Box, PSC Girder, Steel Girder & PSC Box Girder.
- Within this project stretch, Elastomeric bearings (188 old and 344 New) and Pot-PTFE bearings (64 Old and 1,212 New) have been identified in girder-type structures.
- A total of 163 expansion joints have been provided in the structures, comprising 50 on existing structures and 113 on newly constructed ones.
- Four new major bridges on the left side are currently under construction. These structures are not within CEPL's scope and are being executed under a separate EPC agreement.
- Two additional FOBs have been proposed under COS at chainages 256+860 and 257+380. Construction has not yet commenced

Photos depicting the existing culverts are presented below

Box Culvert @ 231+989

Box Culvert @ 233+903

Box Culvert @ 236+504

Box Culvert @ 237+420

Box Culvert @ 239+370

Box Culvert @ 242+381

4.6 DRAINAGE AND SLOPE PROTECTION

Lined Covered drains observed on Edge of Service Roads along the corridor. These are found to be in fair condition.

Slope protection in the form of RCC Walls, RE blocks Etc… has been provided along the corridor. These are found to be in fair condition.

4.7 TRAFFIC SAFETY AND ROAD FURNITURE

The earlier constructed Service Road is provided with PGR on outer-side and this appeared to be in fair condition and requires the painting. Presently, kerb is being constructed adjacent to the newly constructed service road with Drain. Further, Concrete Barriers that are provided in the median and shoulder side are intact.

Street lighting in the form of Double/ Single Arm lights are observed along project corridor and high mast/medium mast lighting are yet to be placed near Toll Plaza.

4.8 ROAD USER FACILITIES

There are 12 nos of bus shelters completed (remaining locations needs to be constructed). The overall condition is considered to be good.

CHAPTER 5. REHABILITATION PLANS AND DESIGNS

5.1 DESIGN TRAFFIC LOADING

Design Traffic loading has been estimated by considering the traffic (as per PDR YR2018 and projected to YR2025) and VDFs as estimated from the latest axle load survey data and with growth Rates as mentioned in pavement design for 10 years, 15 years and 20 years design period as below:

Table 30: AADT for YR-2025

Vehicle/Mode	LHS	RHS
Car	14738	14873
LCV	2137	1996
2A truck	706	577
Buses	491	459
3A truck	515	493
MAV truck	505	579

Table 31: Estimated Design traffic loading from YR2025

Years	Design Traffic (MSA)	
	UP	DN
10 Years	33	31
15 Years	56	53
20 years	87	82

The computation of traffic loadings is presented in **Appendix 9** of this Report. As per the Manual, projected 10-year traffic loading must be considered for the design of Overlay i.e., 33MSA/31MSA. However, since the project road is a newly constructed pavement and has not yet been opened to the traffic, it has been verified for 70MSA for full deign life, in accordance with MSA specified in Schedule-B.

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 (equation 16 & 17 given in the IRC: 115) 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 32: Remaining life of the existing pavement on Both Carriageways

Remaining Life as per IRC -115 Equations for 90% Reliability with Va, Vbe:

S. No	From	To	Length (Km)	15th Percentile MR values			Average Existing Crust		Total Crust (mm)	Adopted MR for BT (Mpa)	Strains From IITPAVE		Remaining Life as per IRC -115 Equations for 90% Reliability						
				MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)	BT (mm)	Granular (mm)			Vertical strain at bottom, epZ	Tensile strain at top, epT	Va	Vbe	C	Nf-Fatigue life, mSA	Rutting life,mSA	Target MSA	Remarks
LHS																			
1	230.40	231.80	1.40																U/C & Diversion
2	231.80	232.40	0.60								0.0003332	0.00015610	3.5	10.5	2.0	**83**	**82**	70	No Overlay
3	232.40	233.53	1.13	2442	430	77	130	350	480	2442			3.5	10.5	2.0				U/C & Diversion
4	233.53	235.22	1.69										3.5	10.5	2.0				No Overlay
5	235.22	236.60	1.38										3.5	10.5	2.0				U/C & Diversion
6	236.60	238.45	1.85	2399	426	77	130	350	480	2399	0.0003353	0.00015800	3.5	10.5	2.0	**80**	**80**	70	No Overlay
7	238.45	240.16	1.71	2441	430	77	130	350	480	2441	0.0003332	0.00015610	3.5	10.5	2.0	**83**	**82**	70	No Overlay
8	240.16	242.70	2.54	2449	427	77	130	350	480	2449	0.0003339	0.00015670	3.5	10.5	2.0	**81**	**81**	70	No Overlay
9	242.70	243.20	0.50										3.5	10.5	2.0				U/C & Diversion
10	243.20	245.30	2.10	2477	429	77	130	350	480	2477	0.0003326	0.00015560	3.5	10.5	2.0	**83**	**83**	70	No Overlay
11	245.30	245.80	0.50								0.0003325	0.00015560	3.5	10.5	2.0	**83**	**83**	70	Flyover
12	245.80	248.00	2.20	2469	430	77	130	350	480	2469			3.5	10.5	2.0				No Overlay
13	248.00	248.95	0.95										3.5	10.5	2.0				Flyover
14	248.95	249.75	0.80								0.0003335	0.00015650	3.5	10.5	2.0	**82**	**82**	70	No Overlay
15	249.75	251.05	1.30										3.5	10.5	2.0				U/C & Diversion
16	251.05	251.60	0.55	2426	430	77	130	350	480	2426			3.5	10.5	2.0				No Overlay
17	251.60	252.00	0.40										3.5	10.5	2.0				Flyover
18	252.00	252.30	0.30										3.5	10.5	2.0				No Overlay
19	252.30	253.80	1.50										3.5	10.5	2.0				U/C & Diversion
20	253.80	254.66	0.86								0.0003340	0.00015680	3.5	10.5	2.0	**82**	**81**	70	No Overlay
21	254.66	255.14	0.48	2419	429	77	130	350	480	2419			3.5	10.5	2.0				U/C & Diversion
22	255.14	256.00	0.86										3.5	10.5	2.0				No Overlay
23	256.00	258.10	2.10								0.0003342	0.00015710	3.5	10.5	2.0	**82**	**81**	70	No Overlay
24	258.10	258.75	0.65	2398	430	77	130	350	480	2398									Flyover
25	258.75	258.80	0.05										3.5	10.5	2.0				No Overlay

From	To	Length (Km)	15th Percentile MR values			Average Existing Crust		Total Crust (mm)	Adopted MR for BT (Mpa)	Strains From IITPAVE		Remaining Life as per IRC -115 Equations for 90% Reliability with Va & Vbe						
			MR for BT (Mpa)	MR for Granular (Mpa)	MR for Subgrade (Mpa)	BT (mm)	Granular (mm)			Vertical strain at bottom, epZ	Tensile strain at top, epT	Va	Vbe	C	Nf- Fatigue life, mSA	Rutting life,mSA	Target MSA	Remarks
RHS																		
230.40	231.80	1.40										3.5	10.5	2.0				U/C & Diversion
231.80	232.40	0.60								0.0003314	0.00015450	3.5	10.5	2.0	84	84	70	No Overlay
232.40	233.53	1.13	2520	430	77	130	350	480	2520			3.5	10.5	2.0				U/C & Diversion
233.53	235.20	1.67										3.5	10.5	2.0				No Overlay
235.20	237.14	1.94										3.5	10.5	2.0				U/C & Diversion
237.14	238.75	1.61	2525	427	77	130	350	480	2525	0.0003321	0.00015510	3.5	10.5	2.0	82	83	70	No Overlay
238.75	239.55	0.80								0.0003321	0.00015500	3.5	10.5	2.0	83	83	70	No Overlay
239.55	239.90	0.35	2527	427	77	130	350	480	2527			3.5	10.5	2.0				Diversion (VOP U/C
239.90	240.70	0.80										3.5	10.5	2.0				No Overlay
240.70	242.23	1.53										3.5	10.5	2.0				U/C & Diversion
242.23	242.70	0.47								0.0003314	0.00015450	3.5	10.5	2.0	84	84	70	No Overlay
242.70	243.20	0.50	2531	429	77	130	350	480	2531			3.5	10.5	2.0				U/C & Diversion
243.20	245.45	2.25										3.5	10.5	2.0				No Overlay
245.45	245.80	0.35										3.5	10.5	2.0				Flyover
245.80	248.10	2.30	2668	430	77	130	350	480	2668	0.0003281	0.00015150	3.5	10.5	2.0	86	88	70	No Overlay
248.10	248.90	0.80										3.5	10.5	2.0				Flyover
248.90	249.80	0.90								0.0003285	0.00015180	3.5	10.5	2.0	85	88	70	No Overlay
249.80	251.30	1.50										3.5	10.5	2.0				Diversion (VUP U/C)
251.30	251.60	0.30										3.5	10.5	2.0				No Overlay
251.60	252.00	0.40	2689	427	77	130	350	480	2689			3.5	10.5	2.0				Flyover
252.00	252.58	0.58										3.5	10.5	2.0				No Overlay
252.58	253.80	1.22										3.5	10.5	2.0				U/C & Diversion
253.80	254.14	0.34										3.5	10.5	2.0				No Overlay
254.14	254.60	0.46								0.0003283	0.00015160	3.5	10.5	2.0	87	88	70	No Overlay
254.60	255.14	0.54	2647	431	77	130	350	480	2647			3.5	10.5	2.0				U/C & Diversion
255.14	256.61	1.47										3.5	10.5	2.0				No Overlay
256.61	258.10	1.49								0.0003285	0.00015180	3.5	10.5	2.0	86	88	70	No Overlay
258.10	258.75	0.65	2662	429	77	130	350	480	2662			3.5	10.5	2.0				Flyover
258.75	258.80	0.05										3.5	10.5	2.0				No Overlay

From the above, **no overlay** is warranted as remaining life is more than Target Traffic (10-year design MSA). In both LHS and RHS side considering Va-3.5 & Vbe-10.5 with 90% Reliability.

Input data used and the output from the IIT Pave software has been presented as screen shots for ready reference in **Appendix 10** of this Report.

5.3 STRUCTURAL REHABILITATION

All the structure found to be in good condition except little minor treatment like repair of stone pitching, cleaning of drainage spouts, cleaning of vegetation etc. may be required. In general, for rehabilitation work of the Existing Bridges includes the following.

- 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 2750mm/km as per Schedule K.

6.2 CA SPECIFICATIONS FOR MAJOR MAINTENANCE

- Appliable Manual: Six lane manual IRC SP 87-2013 published by IRC
- Applicable Schedule for O&M: Schedule-K and Manual
- Maximum Roughness Allowed: 2750mm/km
- Frequency of Roughness Test: 2 times per year
- Frequency of Deflection Test (Manual Clause 5.8): once in a 5-years
- Allowed Characteristic deflection (as per Manual): Not Mentioned
- As per Manual, Cl. 5.9.6: Strengthening overlay thickness, shall not be less than 50mm BC

6.3 INPUTS FOR M&M SCHEDULE

6.3.1 Project Sections

The entire project road is considered as only “single section” based on traffic characteristics.

As there is no overlay requirement from FWD perspective, by considering the Roughness as a key criterion for major maintenance, sub-sections are categorized in to four cases below:

- Case 1: Roughness value <2000 mm/Km
- Case 2: Roughness values >2000<2500 mm/Km

- Case 3: Roughness >2500<2750 mm/Km
- Case 4: Roughness >2750 mm/Km

Direction wise analysis has been done separately for LHS (UP)/RHS (DN) along the project.

6.3.2 Traffic (AADT)

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

Vehicle/Mode	LHS	RHS
Car	14738	14873
LCV	2137	1996
2A truck	706	577
Buses	491	459
3A truck	515	493
MAV truck	505	579

6.3.3 Vehicle Damage Factor (VDF)

Mode Type	UP	DOWN
LCV	0.95	0.40
Buses	0.29	0.11
2 Axle Truck	2.40	1.60
3 Axle Truck	**4.25**	**5.06**
MAV (4-6 Axle)	**9.89**	**10.79**

6.3.4 HDM Inputs

FWD, Roughness, Pavement condition values are used as obtained from surveys and investigations for various sections and different cases as below:

LHS& RHS: No Overlay

No OL	LHS					RHS			
	<2000	>=2000 and <2500	>=2500 and <2750	>= 2750		<2000	>=2000 and <2500	>=2500 and <2750	>= 2750
Length, kms	28.400	-	-	-		28.400	-	-	-
Roughness, mm/km	1261	-	-	-		1460	-	-	-
IRI. m/km	1.85	-	-	-		2.11	-	-	-
Deflection, mm	0.26	-	-	-		0.27	-	-	-
Cracking %	0.01	-	-	-		0.11	-	-	-
Raveling %	0.01	-	-	-		0.03	-	-	-
Rut Depth, mm	2.20	-	-	-		2.26	-	-	-
Patching, %	0.02	-	-	-		0.03	-	-	-
Potholes, %	0.00	-	-	-		0.00	-	-	-
BT Crust, mm	130	-	-	-		130	-	-	-
Granular Crust, mm	350	-	-	-		350	-	-	-

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 2750mm/km. Micro surfacing has also been considered to examine its feasibility for major maintenance.

Following options were considered in the analysis:

- ✓ Base Case: Micro Surfacing at Roughness of 2750mm/km with regular maintenance It is pertinent to note that Base alternative is included as “Do nothing Scenario” for the purpose of analysis in model. It is not be reckoned with.
- ✓ Opt-1: Responsive Mill & Overlay of 40mm BC whenever roughness is >2750mm/km with regular maintenance

6.3.6 ROUGHNESS PROGRESSION

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

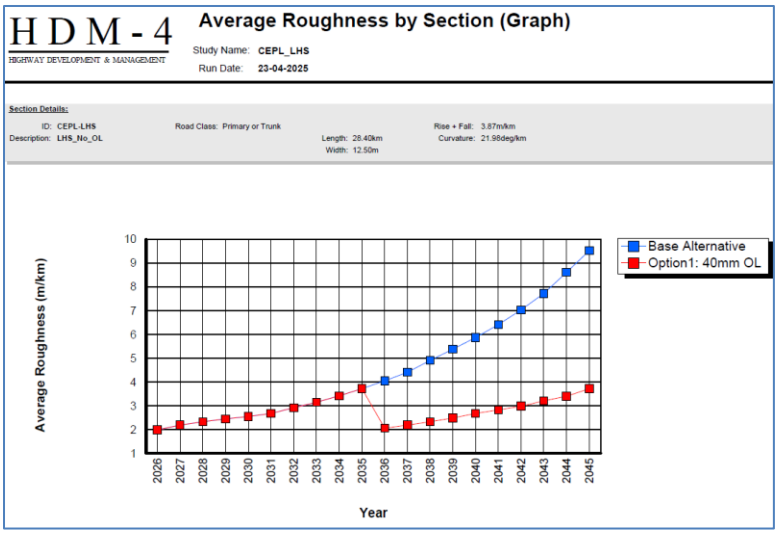


Figure 1: Average Roughness in LHS (UP) Carriageway (No OL<2000mm/km)

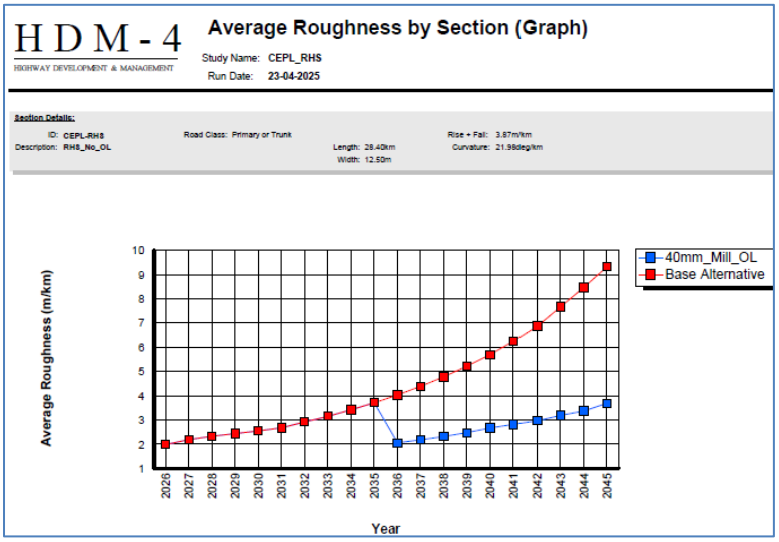


Figure 2: Average Roughness in RHS (DN) Carriageway (No OL <2000mm/km)

6.4 M&M SCHEDULE

Looking at the present condition, progression of traffic with actual traffic growth rates, it is felt prudent to consider 40mm OL as the preferred option, with certain percentage of additional DBM in subsequent cycles. Adopted MM schedule for the project is as below

Table 33: Adopted MM schedule for the project for LHS & RHS

LHS Carriageway (Obtained Vs Adjusted)

Obtained					Adjusted				
LHS	<2000	>=2000 and <2500	>=2500 and <2750mm	>=2750	<2000	>=2000 and <2500	>=2500 and <2750mm	>=2750	Remarks
Criteria:	No Overlay				No Overlay				
Length:	28.400				28.400				
Year									
2026									
2027									
2028									
2029									
2030									
2031									
2032									
2033					40mm				10% DBM
2034									
2035	1								
2036									
2037									
2038									
2039									
2040					40mm				
2041									

RHS Carriageway (Obtained Vs Adjusted)

Obtained					Adjusted				
RHS	<2000	>=2000 and <2500	>=2500 and <2750mm	>=2750	<2000	>=2000 and <2500	>=2500 and <2750mm	>=2750	Remarks
Criteria:	No Overlay				No Overlay				
Length:	28.400				28.400			-	
Year									
2026									
2027									
2028									
2029									
2030									
2031									
2032									
2033					40mm				10% DBM
2034									
2035	1								
2036									
2037									
2038									
2039									
2040					40mm				
2041									

In a nutshell, final recommendations are as summarized below.

Side:	Cycle-1: FY 2033	Cycle-2: FY2040
LHS	40mm BC+ 50mm DBM in 10% length	40mm BC
RHS	40mm BC+ 50mm DBM in 10% length	40mm BC

6.5 STRUTURAL PERIODIC MAINTENACE

Expansion joints:

- Visual inspection is shall be carried out to check for seal breakages, Armor angle, Weld failures, cracks between deck & Expansion joints concrete and Joints filled with debris.
- 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. However, periodic maintenance is considered.

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 strategy for Replacement of Bearings & Expansion joint:

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

S.No	Description	
1	Old structure	Retained at the time of 6 laning
2	New Structure	Constructed during the 6 laning

Age	Description	Item	structures-Assumption-MMR	
			% of Replacement of Major components	
			2033	2040
New	Super structure lifting with Pot bearings	Pot	10%	40%
New	Super structure lifting with Elastomeric bearings	Ela	10%	40%
New	Super structure lifting with Rocker bearings	Rocker	0%	0%
Old	Super structure lifting with Pot bearings	Pot	30%	40%
Old	Super structure lifting with Elastomeric bearings	Ela	30%	40%
Old	Super structure lifting with Rocker bearings	Rocker	30%	40%
New	Pot bearing cost	Pot	10%	40%
New	Elastomeric bearing cost	Ela	10%	40%
New	Rocker bearing cost	0	0%	0%
Old	Pot bearing cost	Pot	30%	40%
Old	Elastomeric bearing cost	Ela	30%	40%
Old	Rocker bearing cost	0	30%	40%
New	Expansion joint Replacement	0	13%	50%
Old	Expansion joint Replacement	0	38%	50%
New	Others	0	13%	50%
Old	Others	0	38%	50%

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 34: Major Material cost

Sl.no	Description	Units	Source	Basic rate excluding Transportation & GST	Lead in Kms
1	VG-40 (CAPEX)	MT	Kochi	52610	214
2	VG-30 (MMR)-SR	MT	Kochi	44966	214
3	PMB - CAPEX	MT	Kochi	59466	214
4	PMB-MMR	MT	Kochi	53520	214
5	Good earth	Cu.m	BA	39	8
6	40 mm	Cu.m	Crusher	1066	41
7	20 mm	Cu.m	Crusher	1244	41
8	12 mm	Cu.m	Crusher	1244	41
9	6 mm	Cu.m	Crusher	1244	41
10	Dust	Cu.m	Crusher	960	41
11	M sand	Cu.m	Crusher	1599	41
12	Bitumen 60/70	MT	Kochi	49830	214
13	Bitumen 80/100	MT	Kochi	48210	214
14	CRMB-55	MT	Kochi	50830	214
15	CRMB-55-MMR	MT	Kochi	53520	214
16	SS1	MT	Kochi	48000	214
17	Steel	MT	CALICUT	87000	8
18	HTS Strands	MT	CALICUT	80000	8
19	Cement	MT	CALICUT	6900	8
	VG-40 (MMR)*	MT	Kochi	47466	214

Note: * For future asphalt pavement rehabilitation works, a normative standardized cost for Bitumen (VG-40) has been determined based on historical bitumen rates from August 2020 to April 2025. But, Presently Bitumen Capex cost is considered for MMR also.

S no	Item	Unit	Rate (INR) Excluding GST
1	BC - G1-VG-40-CAPEX	Cum	12,465
2	BC - G1-VG-40-MMR	Cu.m	11,746
3	PMB-CAPEX	Cu.m	13,502
4	PMB-MMR-Gr1	Cu.m	12,603
5	Tack coat on bituminous surface	Sqm	15
6	DBM G-1-VG-40	Cum	10,260
7	Tack coat on granular	Sqm	16
8	Prime Coat	Sqm	47
9	WMM	Cum	3,000
10	GSB G-2	Cum	2,934
11	CTSB	Cu.m	3,576
12	CTB	Cu.m	3,865
13	PQC	Cu.m	8,531
14	DLC	Cu.m	4,883
15	SG	Cum	525
16	Road Marking	Sqm	585
17	Embankment - borrow	Cum	506
18	Embankment - Excavation	Cum	87
19	Select Fill	Cum	577
20	RE wall	Sqm	4,065
21	Filter Media	Cum	1,622
22	M15	Cum	6,942
23	M20	Cum	7,763
24	M25	Cum	8,363
25	M30	Cum	8,228
26	M35	Cum	8,573
27	M40	Cum	8,709
28	PSC M45	Cum	10,451
29	PSC M50	Cum	12,808
30	PSC M55	Cum	12,964
31	HYSD	MT	1,24,422
32	HT strand	MT	1,60,660

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

There are certain lengths as said in Chapter-1 for Main carriageway and Service Road works are yet to be completed along with ancillary works related to Structures and Toll Plaza. These balance works are quantified as on 31.03.2025 are presented as below.

Table 35: Summary of balance work cost

S.No	Item	Unit	Total Qty	Rate in Rs	Amount in Rs
2	Embankment Cut	Cu.m	54,987	92	50,47,846
3	Embankment Fill	Cu.m	24,924	71	17,64,615
4	Sub Grade (SG)	Cu.m	25,256	378	95,56,790
5	Granular Sub Base (GSB)	Cu.m	1,826	2,561	46,75,148

S.No	Item	Unit	Total Qty	Rate in Rs	Amount in Rs
6	Cement Treated Sub Base (CTSB)	Cu.m	9,924	3,199	3,17,48,822
7	Wet Mix Macadam (WMM)	Cu.m	7,111	2,646	1,88,15,997
9	Prime Coat	Sqm	47,405	45	21,19,015
10	Tack Coat on Granular Surface	Sqm	47,405	15	7,22,456
11	Dense Bituminous Macadam (DBM)	Cu.m	4,802	9,342	4,48,56,247
12	Tack Coat on Bituminous Surface	Sqm	77,123	14	10,78,176
13	Bituminous Concrete	Cu.m	8,739	12,746	11,13,78,190
14	Dry lean concrete (DLC)	Cu.m	1,673	4,514	75,53,460
15	Pavement Quality Concrete (PQC)	Cu.m	3,137	8,109	2,54,34,677
19	RE wall	Sqm	1,349	3,252	43,86,672
20	Excavation	Cu.m	830	127	1,05,511
21	PCC M15	Cu.m	55	6,849	3,75,983
22	Friction Slab with Crash Barrier	Rmt	550	25,506	1,40,28,561
23	Selected Fill	Cu.m	1,985	454	9,01,341
24	Filter media	Cu.m	323	1,622	5,24,319
25	Geotextile	Sqm	1,349	263	3,54,765
30	Covered drain	Rmt	8,109	13,637	11,05,83,532
31	Drain @ Toll Plaza	Rmt	1,326	13,637	1,80,88,297
39	Road Marking	Sqm	9,992	565	56,45,552
41	Road Studs	No.s	29,686	254	75,40,188
42	Delineators	No.s	569	685	3,89,765
43	Solar Blinkers	No.s	81	35,000	28,35,000
46	Kerb	Rmt	21,550	265	57,10,708
47	Kerb Painting	Sqm	113	124	14,052
52	New jersey Barrier	Rmt	124	6,508	8,06,942
54	Pedestrian Guard Rail (PGR)/Ms HR	Rmt	51,322	3,878	19,90,26,716
62	Chequered tiles	Sqm	149	800	1,19,424
69	Double Arm Lighting	No.s	149	63,721	94,94,429
70	High mast Lighting	No.s	4	12,00,000	48,00,000
71	Lighting @ underpass Locations	No.s	510	800	4,08,000
73	Bus Shelters	No.s	22	1,50,000	33,00,000
75	Boundary Fencing	Rmt	620	2,183	13,53,460
77	5th km	No.s	10	6,739	67,390
78	Km Stones	No.s	46	3,847	1,76,962
79	Hm Stones	No.s	230	1,141	2,62,430
82	Sign Boards	No.s	1,210	9,283	1,12,32,430
88	Overhead Gantry boards	No.s	13	18,00,000	2,34,00,000
89	Rainwater Harvesting	No.s	12	2,00,000	24,00,000
90	Patrolling Vehicles	No.s	2	15,00,000	30,00,000
91	Ambulances	No.s	2	40,00,000	80,00,000
92	Crane 20Tonne	No.s	2	35,00,000	70,00,000
93	Admin Building Area	Sqm	119	17,500	20,87,358
94	Traffic Aid Post (TAP)	Sqm	115	12,000	13,74,840

S.No	Item	Unit	Total Qty	Rate in Rs	Amount in Rs
97	Toll Booth Cabin Area	Sqm	2	75,000	1,50,000
98	Canopy Area/Roofing	Sqm	1,016	1,050	10,66,800
101	Generator Rooms	Sqm	45	7,500	3,34,500
113	Toilet Blocks	Sqm	157	15,000	23,48,340
136	Excavation	Cu.m	1,434	127	1,82,370
138	PCC-M15	Cu.m	992	6,849	67,92,015
141	RCC-M30	Cu.m	686	8,317	57,06,108
142	RCC-M35	Cu.m	172	8,479	14,58,857
157	Reinforcement steel	MT	17	1,24,171	21,27,787
165	RCC-25	Cu.m	2	8,746	18,104
166	RCC-30	Cu.m	364	8,797	32,06,267
167	RCC-35	Cu.m	232	8,968	20,80,074
170	Reinforcement steel	MT	96	1,24,481	1,19,15,296
176	RCC-40	Cu.m	1,738	10,056	1,74,76,291
183	Reinforcement steel	MT	301	1,24,791	3,75,09,174
184	Structural Steel	MT	275	1,24,088	3,41,84,432
187	Approach Slab-P-M-15	Cu.m	41	6,849	2,81,754
188	Approach Slab-P-M-30	Cu.m	122	10,157	12,34,990
193	Gap slab-M-40	Cu.m	227	10,056	22,77,706
195	Tar paper	Sqm	70	200	13,970
202	Filler type	Rmt	55	62	3,410
203	Strip seal	Rmt	196	11,208	21,94,526
205	Modular Strip seal	Rmt	46	21,514	9,81,038
206	Rubber Sealant	Rmt	384	200	76,888
207	Crash Barrier-M40	Rmt	4,713	5,916	2,78,79,872
208	RCC Hand rail	Rmt	1,167	3,878	45,25,153
211	Footpath	Sqm	3,277	777	25,46,989
213	WC(mastic) 25mm	Sqm	10,526	1,838	1,93,42,088
215	WC(BC)	Cum	526	11,746	61,81,929
217	Drainage spouts	No.s	178	3,997	7,11,466
218	PVC pipe down take/for cables	Rmt	442	300	1,32,660
219	Weep Holes	No.s	2,716	350	9,50,737
220	Back filling	Cu.m	95	150	14,269
221	Filter Media	Cu.m	268	1,359	3,64,647
231	Pipe Laying NP4 1200mm Dia	Rmt	19	12,151	2,31,477
235	Steel Handrailing in FOB	Kg	17,977	500	89,88,519
237	Acrylic Elastomeric Coating for Exposed Concrete	Sqm	1,45,227	300	4,35,67,975
238	Poly Carbonate Sheet on FOB	Sqm	1,893	550	10,41,381
Sub-Total Cost					96,46,45,921
Contingencies @ 3%					2,89,39,378
Balance Works Completion Cost (excluding GST 18%) in Rs					99,35,85,299
Balance Works Completion Cost (excluding GST 18%) in Rs Cr					99.4

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 36: Summary of Initial Capex Cost

S.no	Description	Unit	Amount (Rs.)	Remarks
1	Immediate Repair's (Highway)	LS	-	
2	Immediate Repair's - Structures	LS	-	
3	TMS	LS	2,73,50,496	Cost towards reduced lanes
4	ATMS	LS	5,04,94,850	Total ATMS work is still in progress
5	Cost of balance works	LS	99,35,85,299	-
Sub-Total			1,07,14,30,645	
Total cost including 18% GST			1,26,42,88,161	
Total Capex cost in Crs			126.43	

The cost for TMS works is as follows:

S No.	Activity	Cost of equipment (Excluding Tax)
1	TMS works of Toll Plaza	2,73,50,496

Note: Initial capital cost of TMS equipment considered for 18 lanes.

The cost for ATMS works is as follows:

S No.	Activity	Capital cost of complete works (Excluding Tax)
1	ATMS Capital Cost for Complete works	5,04,94,850

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:

- ✓ ATMS control room operations,
- ✓ 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
- ✓ Cost of Periodic replacement of ATMS Equipment's & Software

During discussions with the Concessionaire, it was highlighted that the following four major bridges have been descoped and handed over by the Authority to another Agency, with a 10-year Defect Liability Period (DLP). Accordingly, these locations have not been included in the structural MMR cost.

S. No	Location	Remarks
1	MJB @ 232+836	LHS Old-Existing bridge & LHS: New-Proposed bridge
2	MJB @ 235+389	LHS Old-Existing bridge & LHS: New-Proposed bridge
3	MJB @ 250+723	LHS Old-Existing bridge & LHS: New-Proposed bridge
4	MJB @ 254+887	LHS Old-Existing bridge & LHS: New-Proposed bridge

Table 37: Major Maintenance Cost

Year	Periodic Maintenance				
	Functional +Structural overlay MCW+ S/R	Major Maintenance of Rigid Pavement	Replacement of **ATMS**	Replacement of **TMS @**	Structure specified repairs
2026	-	-			-
2027	-	-			-
2028	1.05	-			-
2029	-	-			-
2030	-	-			-
2031	1.05	-			-
2032	-	-			-
2033	64.77	0.14	3.58	1.94	2.39
2034	-	-			-
2035	-	-			-
2036	1.05	-			-
2037	-	-			-
2038	-	-			-
2039	-	-			-
2040	60.36	0.14	4.17	2.26	5.40
2041	-	-			-
Total:	**128.29**	**0.28**	**7.75**	**4.20**	**7.78**

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

7.6 OPERATIONS COSTS

Cost towards Operations include the following:

- Electricity Bill of lighting
- Toll Plaza Operation cost (Not Applicable, as it is a HAM Project)
- ATMS AMC/ Spare Parts Cost
- SPV Costs
- Survey Costs
- Insurance Charges
- Audit Charges
- IE Fee
- Administrative Cost etc

Following table depicts the cost of operations for the project:

Table 38: Summary of 1st Year O&M Cost

S No	Description	Amount in Crs.	Remarks
	SPV - Expenditure		
1	SPV staff	1.01	
2	Highway lighting	2.14	
3	Tolling and ATMS AMC/ Spare Parts	0.31	
4	Surveys & Investigations (BBD, Roughness)	0.11	
5	IE fees	0.98	
6	Insurance Charges	2.05	
7	Audit Charges	0.50	
8	Admin cost - Board Meeting Expenses, valuation etc.	0.34	
	Agency - Expenditure		
9	Toll Operation - Agency	-	
10	Route patrolling	2.88	
11	TAP & MAP	-	
12	Routine maintenance	2.33	
13	Repair of Road - BoQ Items	1.73	
14	Repair of Structures	0.29	
	Total Amount in CRs	**14.66**	

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

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 39: Cost Abstract

Project Years	Calendar Year	SUMMARY OF VARIOUS EXPENSES in Rs. Crs				
		Immediate Repair's Cost	Toll Collection Expenses and Patrolling expenses	Routine Maintenance Expenses	Periodic Maintenance (Functional +Struc Overlay+ Toll collection system)	Total Cost (Rs. Cr.)
1	2025-2026	126.43	-	14.70	-	141.13
2	2026-2027	-	-	14.66	-	14.66
3	2027-2028	-	-	14.66	1.05	15.71
4	2028-2029	-	-	14.66	-	14.66
5	2029-2030	-	-	14.70	-	14.70
6	2030-2031	-	-	14.66	1.05	15.71
7	2031-2032	-	-	14.66	-	14.66
8	2032-2033	-	-	14.66	72.81	87.47
9	2033-2034	-	-	14.71	-	14.71
10	2034-2035	-	-	14.66	-	14.66
11	2035-2036	-	-	14.66	1.05	15.71
12	2036-2037	-	-	14.66	-	14.66
13	2037-2038	-	-	14.70	-	14.70
14	2038-2039	-	-	14.66	-	14.66
15	2039-2040	-	-	14.66	72.33	86.99
16	2040-2041	-	-	6.86	-	6.86
	Total Cost:	**126.43**	**-**	**226.91**	**148.30**	**501.63**

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

Table 40: Cost Summary

S. No	Year	EPC & Immediate Repair's Cost	Routine Maintenance					Periodic Maintenance					Electricity bill of lighting	SPV Cost	Survey Costs	Insurance charges	Audit charges	IE Fee	Administrative Cost	Total Recurring cost
			Routine Maintenance	R&R of Road items	Toll and HTMS AMC cost	Incident management	R&R of Structures	Functional +Structural overlay MCW+ S/R	Major Maintenance of Rigid Pavement	Replacement of **ATMS**	Replacement of **TMS @**	Structure specified repairs								
1	2026	126.43	2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.15	2.05	0.50	0.98	0.34	141.13
2	2027		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
3	2028		2.33	1.73	0.31	2.88	0.29	1.05	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	15.71
4	2029		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
5	2030		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.15	2.05	0.50	0.98	0.34	14.70
6	2031		2.33	1.73	0.31	2.88	0.29	1.05	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	15.71
7	2032		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
8	2033		2.33	1.73	0.31	2.88	0.29	64.77	0.14	3.58	1.94	2.39	2.14	1.01	0.11	2.05	0.50	0.98	0.34	87.47
9	2034		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.17	2.05	0.50	0.98	0.34	14.71
10	2035		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
11	2036		2.33	1.73	0.31	2.88	0.29	1.05	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	15.71
12	2037		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
13	2038		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.15	2.05	0.50	0.98	0.34	14.70
14	2039		2.33	1.73	0.31	2.88	0.29	0.00	-			-	2.14	1.01	0.11	2.05	0.50	0.98	0.34	14.66
15	2040		2.33	1.73	0.31	2.88	0.29	60.36	0.14	4.17	2.26	5.40	2.14	1.01	0.11	2.05	0.50	0.98	0.34	86.99
16	2041		0.77	0.57	0.10	0.95	0.10	0.00	-			-	0.71	0.33	0.11	2.05	0.50	0.32	0.34	6.86
	Total:	**126.43**	**35.65**	**26.46**	**4.76**	**44.10**	**4.48**	**128.29**	**0.28**	**7.75**	**4.20**	**7.78**	**32.88**	**15.45**	**1.91**	**32.83**	**8.00**	**15.01**	**5.38**	**501.63**

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