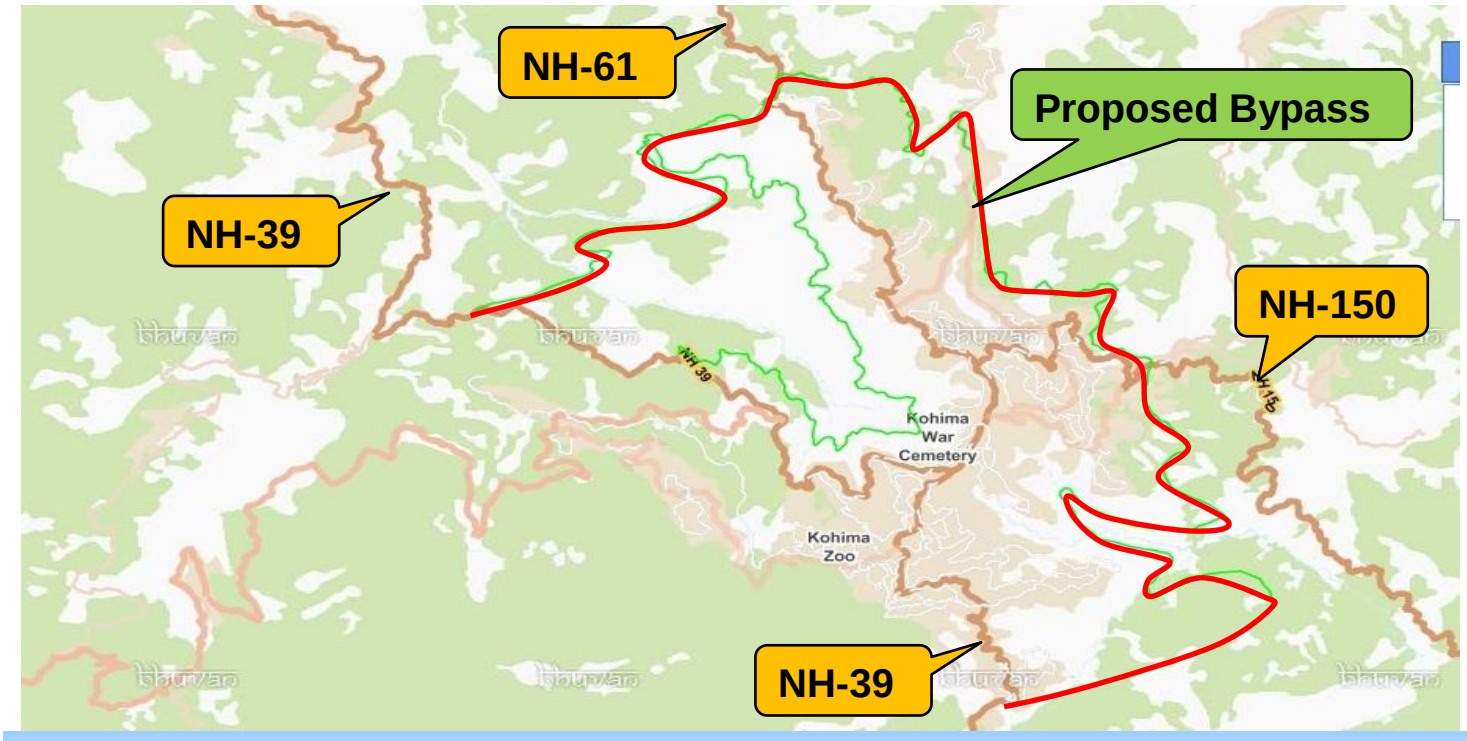
NATIONAL HIGHWAY INFRASTRUCTURE DEVELOPMENT CORPORATION LTD
Government of India
(Ministry of Road Transport and Highways)

Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of **Kohima Bypass** connecting NH-39 (New NH-02),NH-150 (New NH-02), NH-61 (New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland.



FINAL DETAILED PROJECT REPORT

MAIN REPORT (VOLUME-I)

OCT 2018

In Association with

Highway Engineering Consultancy
JM-89/3C, Behind Panchvati Market,
Saket Nagar, Bhopal,
Madhya Pradesh – 462024
Email:hec_bhopal@rediffmail.com

Agnitio Infrastructure Projects Pvt. Ltd.
RN-73, Sector-62, Noida, Gautam Budh Nagar,
U.P-201309
Phone No.- 0120403352, 01202403353
E-mail: aippldpr@gmail.com,
agnitiodelhi@gmail.com

Table of Contents

CHAPTER 0.0EXECUTIVE SUMMARY

0.1 General

The National Highways & Infrastructure Development Corporation Ltd.(NHIDCL) has been entrusted for *Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland* for proper structuring and implementation of projects on EPC mode.

M/s Highway Engineering Consultant (HEC) in Association with Agnitio Infrastructure Projects Pvt. Ltd. (AIPPL) has been instructed to commence the services from 12.12.2016 vide NHIDCL HQ letter no. NHIDCL/ DPR/ Nagaland/ Kohima Bypass/2016/179 dated 11.01.2017.

0.2 Project Description

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavely congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road doesnot have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

0.3 Location

The project road starts from the Km 173.00 of existing NH-39, (which is under widening and improvement for four lane configuration from Dimapur to Kohima), and crosses NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00.

The latitude and longitude of the start location of project road is 25.68 & 94.05 and latitude and longitude of the end location of project road is 25.12& 94.12 respectively.Location Map of the project is presented in **Chapter-1.**

0.4 Socio-Economic Profile of Area

The socio-economic profile of the project area is discussed in detailed in Chapter-2.

0.5 Engineering Surveys, Investigation and analysis

The Consultants carried out various field studies, engineering surveys and investigations to collect the necessary data for use in Feasibility for the project. The investigations were carried out to generate adequate supportive database for preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The various engineering investigations and surveys have been carried out following the relevant MoRT&H/ IRC.

The various investigations and surveys, which have been carried out by the Consultants, are as follows:

a) Inventory and condition survey of Road and Pavement

b) Topographic Survey

c) Pavement Investigations

d) Soil and Material Investigations

The surveys and analysis is discussed in detailed in **Chapter-3**.

0.6 Environmental Screening Report

The current project is a part of NH-02 and does not attract Environmental Clearances as per following notification.

The EIA notification 2006

The notification clearly defines the category of any road for clearance process,

Project Activity	A Category	B Category	General Condition
7f (Highways including Expressway)	i) New National Highways; ii) Expansion of National Highways greater than 30 Km, involving additional right of way greater than 20 m involving land acquisition and passing through more than one state.	i) New State Highways; ii) Expansion of National / State Highways greater than 30 km involving additional ROW greater than 20 m involving land acquisition.	General Condition shall apply
General Condition (GC):- Any project activity specified in Category B will be treated as Category A, if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified			

Project Activity	A Category	B Category	General Condition
under the wildlife (Protection) Act, 1972 (ii) Notified Eco-sensitive areas, (iv) inter-state boundaries and international boundaries.			
The Government of India relaxed the condition for Environmental Clearance for road projects less than 100 Km length with additional ROW less than 40 m on existing alignments and 60 m on re-alignments and bypasses on 22nd August 2013 vide notification no SO 2559(E).			

0.7 Traffic Survey, Analysis & Forecast

As discussed earlier in this chapter, the project is to bypass the Kohima town. The maximum part of the proposed alignment is new alignment, hence, current traffic on the proposed alignment is zero. The traffic of NH-39 from Dimapur to Impal and Jessami, constitutes major part of current traffic. Hence, assessment of current traffic on NH-39 has been checked by conducting traffic volume count for 7 days near Km 174.00 and Km 194.00

The proposed alignment of the bypass crossing two NH's (NH-61 & NH-150) and one road connecting to Kohima town. Turning movement count has been performed at 3 locations

The survey schedule and survey locations are presented in Table 6.1 and shown in Figure-6.1. of Chapter-6.

Average Annual Daily Traffic

The traffic data collected from different actual traffic surveys is summarized in table shown below.

Vehicle Type	Km 174.00	Induced traffic from OD Survey	AADT
Car, Jeep, Vans, three wheelers	233	125	358
Motor cycle & Scooters	501	167	668
LCV	134	67	201
BUS	386	136	522
Two Axle Truck, Multi Axle Truck	1455	413	1868
Agriculture Tractor with Trailer	0	0	0
Cycle/Cycle Rickshaw	0	0	0
Animal Driven Vehicles	0	0	0
Other vehicle (Plz Specify)	0	0	0
Total Motorised Vehicles (Number)	**2709**	**908**	**3617**
Total Motorised Vehicles (PCU)	**6387**	**1990**	**8377**
Total Commercial Vehicle per day	**1975**	**616**	**2591**

Traffic Forecast:

Forecast of analysis traffic data is presented below for 30 years:

Year	Two Wheeler	Car, Jeep, Van	Mini / RTVs	Standard Bus	LCV	2-Axle, 3-Axle	MAV	Total Vehicle	Total PCU	Total Commercial Vehicle	Cumulative MSA
2017	668	358	339	183	201	1380	488	3617	8387	2591	**Year of Construction**
2018	702	376	356	193	212	1449	513	3801	8814	2723	
2019	738	395	374	203	223	1522	539	3994	9260	2861	
2020	775	415	393	214	235	1599	566	4197	9731	3150	
2021	960	514	487	265	291	1980	701	5198	12051	3724	
2022	1008	540	512	279	306	2079	737	5461	12662	3913	**2.16**
2023	1059	567	538	293	322	2183	774	5736	13298	4110	**2.16**
2024	1112	596	565	308	339	2293	813	6026	13970	4318	**4.42**
2025	1168	626	594	324	356	2408	854	6330	14674	4536	**6.80**
2026	1227	658	624	341	374	2529	897	6650	15415	4765	**9.29**
2027	1289	691	656	359	393	2656	942	6986	16193	5006	**11.91**
2028	1354	726	689	377	413	2789	990	7338	17009	5258	**14.66**
2029	1422	763	724	396	434	2929	1040	7708	17866	5523	**17.55**
2030	1494	802	761	416	456	3076	1092	8097	18765	5801	**20.59**
2031	1569	843	800	437	479	3230	1147	8505	19709	6093	**23.77**
2032	1648	886	840	459	503	3392	1205	8933	20700	6399	**27.12**
2033	1731	931	882	482	529	3562	1266	9383	21742	6721	**30.63**
2034	1818	978	927	507	556	3741	1330	9857	22841	7061	**34.31**
2035	1909	1027	974	533	584	3929	1397	10353	23991	7417	**38.19**
2036	2005	1079	1023	560	614	4126	1467	10874	25197	7790	**42.25**
2037	2106	1133	1075	588	645	4333	1541	11421	26464	8182	**46.52**
2038	2212	1190	1129	618	678	4550	1619	11996	27796	8594	**51.00**
2039	2323	1250	1186	649	712	4778	1700	12598	29190	9025	**55.71**
2040	2440	1313	1246	682	748	5017	1785	13231	30654	9478	**60.65**
2041	2562	1379	1309	717	786	5268	1875	13896	32195	9955	**65.84**

Year	Two Wheeler	Car, Jeep, Van	Mini / RTVs	Standard Bus	LCV	2-Axle, 3-Axle	MAV	Total Vehicle	Total PCU	Total Commercial Vehicle	Cumulative MSA
2042	2691	1448	1375	753	826	5532	1969	14594	33811	10455	**71.28**
2043	2826	1521	1444	791	868	5809	2068	15327	35508	10980	**77.00**
2044	2968	1598	1517	831	912	6100	2172	16098	37293	11532	**83.01**
2045	3117	1678	1593	873	958	6405	2281	16905	39162	12110	**89.32**
2046	3273	1762	1673	917	1006	6726	2396	17753	41128	12718	**95.94**
2047	3437	1851	1757	963	1057	7063	2516	18644	43191	13356	**102.89**
2048	3609	1944	1845	1012	1110	7417	2642	19579	45357	14026	**110.19**
2049	3790	2042	1938	1063	1166	7788	2775	20562	47634	14730	**117.85**
2050	3980	2145	2035	1117	1225	8178	2914	21594	50023	15469	**125.90**
2051	4179	2253	2137	1173	1287	8587	3060	22676	52529	16244	**134.35**
2052	4388	2366	2244	1232	1352	9017	3213	23812	55160	17058	**143.23**

Capacity analysis

Analysis of capacity of the proposed bypass has been performed as per the guidelines suggested in IRC SP 73:2015 and IRC SP 84:2014. The capacity of 2 lane and 4 lane road is described in table shown below:

S.No	Terrain	Capacity of Road in PCU (LOS B)	
		2-Lane (IRC 73:2015)	4-Lane (IRC 84:2014)
1	Plane	18000	40000
2	Rolling	13000	
3	Mountainous & Steep	9000	20000

As per the traffic projections presented in table 6.22, the capacity of the proposed bypass will cross the capacity limit for 2 lane in year 2019 and 4 lane in year 2032.

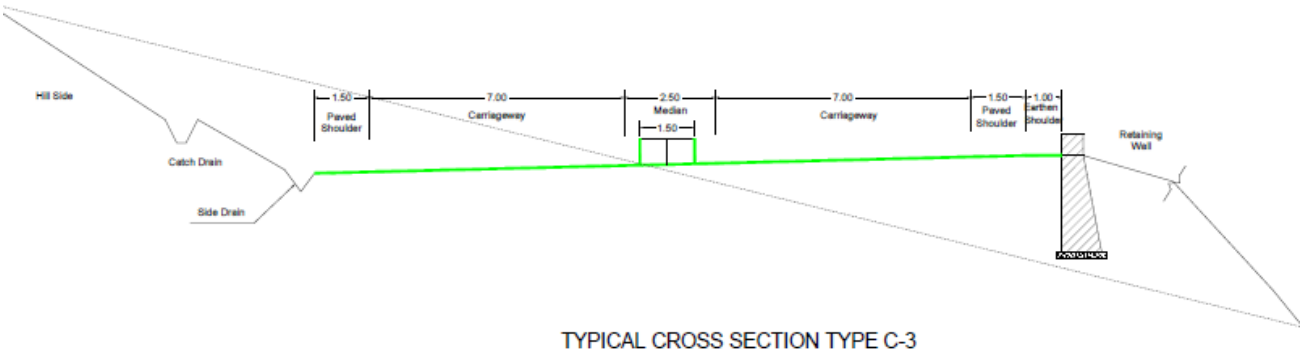
Therefore, it is suggested to start the bypass by or before year 2019 upto 4-lane configuration for smooth movement of traffic in that area.

0.8 Design Standards and Improvement Proposals

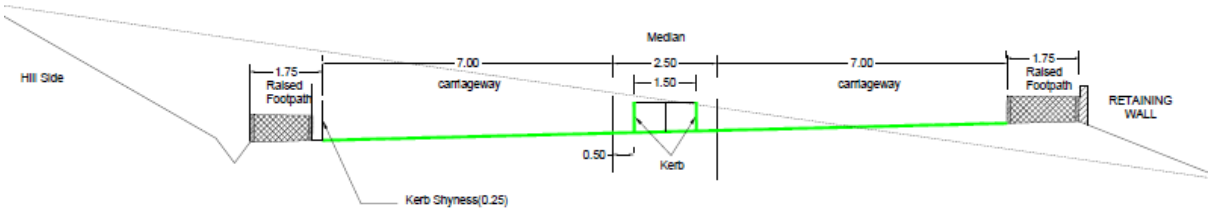
All activities related to field studies, design and documentation shall be based on the latest guidelines / circulars of MoRT&H / NHIDCL and relevant publications of the Indian Roads Congress IRC-SP-84-2014, hill road manual IRC-SP-48-1998 and Bureau of Indian Standards (BIS). For aspects not covered by IRC and BIS, international standard practices, such as, British and American standards may be adopted.

The design standards considered for the current project is discussed in detailed in Chapter-7.

Proposed Typical Cross sections for Roads:

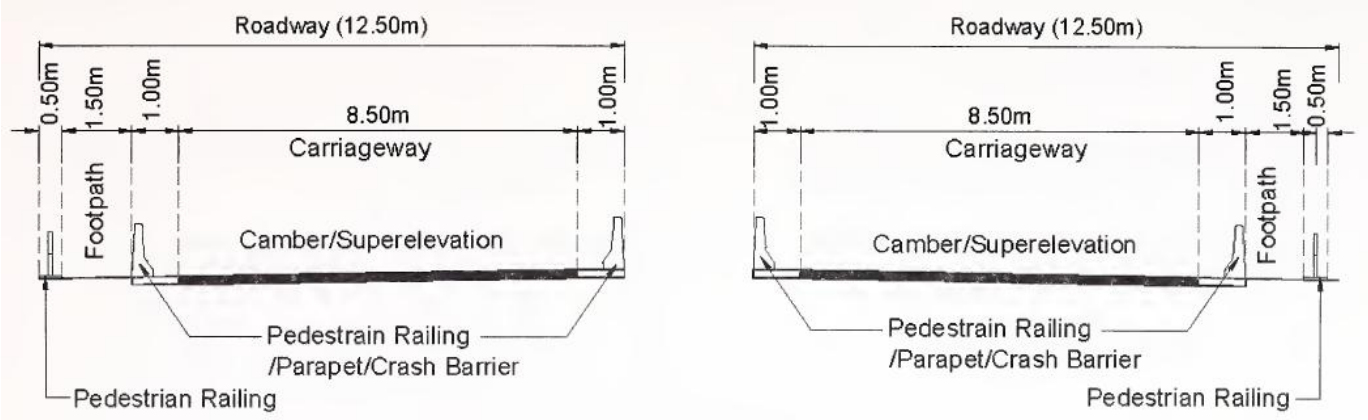


TYPICAL CROSS SECTION TYPE C-3
(Open country- Mountainous Terrain)

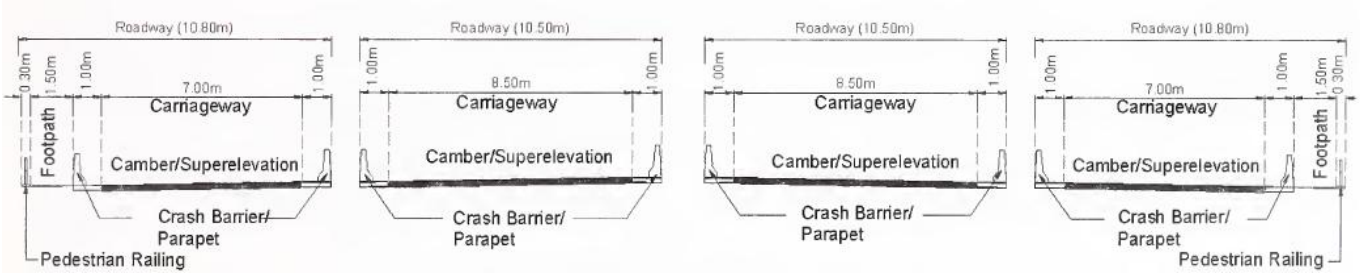


TYPICAL CROSS SECTION TYPE C-4
(Built-up Section-Mountainous Terrain)

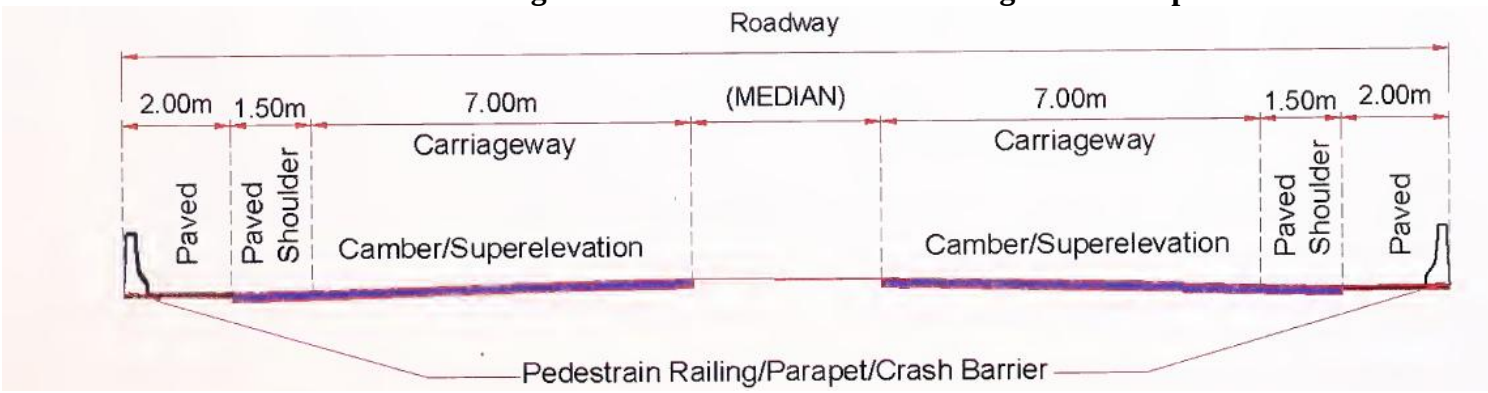
Proposed Typical Cross sections for Bridges and Culverts:



Cross Section of Bridge at Deck Level – with Footpath 4-Lane Divided Highway



Cross Section of Bridge at Deck Level – with Road Bridges and Footpath



Cross Section of Slab/Box Culvert at Road Level 4-Lane Divided Highway

Design Speed

All the curves have been improved to meet design standard requirements for minimum design speed of 60 Kmph.

Design Period

The pavement layers are designed for the time of 15 Years.

Thickness of Flexible pavement (Clause 10.1):

The recommended pavement thickness in accordance with para 10.1 of IRC 37:2012 (Picture of recommended pavement thickness is given in Figure & Table below:

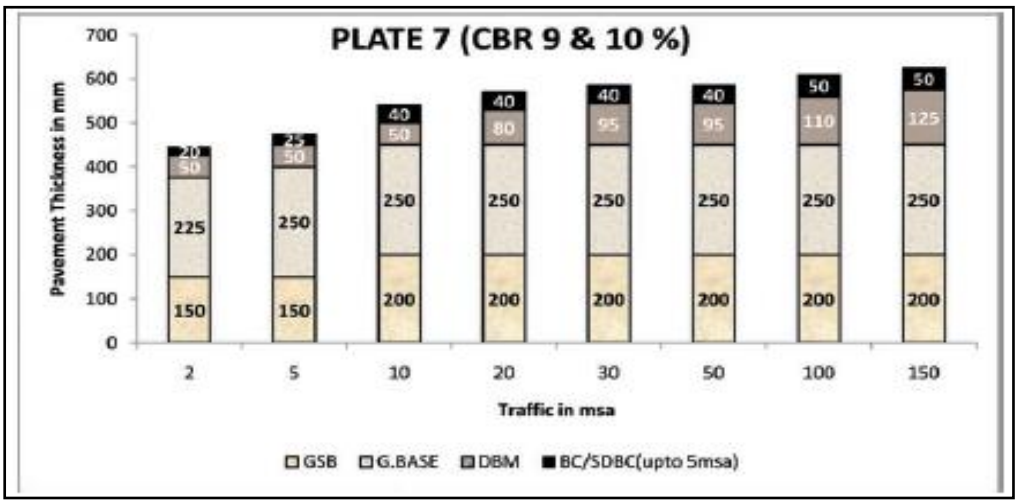


Table 4.6: Recommended Pavement Thickness for New Pavement

Pavement Composition	Pavement Thickness (in mm)
1. Bituminous Concrete - BC	40
2. Dense Bituminous macadam - DBM	95
3. Wet Mix Macadam - WMM	250
4. Granular Sub base - GSB	200
Total thickness of Pavement	**710 mm**
6. Subgrade	500

Slope Stabilization through Retaining / Breast wall/Bio Engineering

The total length of Breast wall, Retaining wall and slope stabilization through Bio engineering for the project is 4500 m, 8700 m, & 5000m respectively

Bridges and Major structures

4 numbers of new bridges, 1 number of tunnel and 1 Fly Over bridge are proposed to be developed on the alignment. The summary of bridge improvement proposal is given below, however, the detailed design is presented in Volume-II(B) of current submission.

The list of proposed bridges is shown below:

S.No.	Chainage (m)	Type	SPAN
1	4+020	Truss	1 x 80m
2	14+850	Truss	1 x 80m

S.No.	Chainage (m)	Type	SPAN
3	23+620	Truss	1 x 80m
4	32+400	PSC	13x30m
5	35+600	RCC Girder	1 x 24m

Culverts

Total 267 numbers of box culverts of size 1x2x2m and 1 culvert of size 1x2x5 is proposed on the alignment. The list of Proposed Culverts is enclosed at the end of Chapter-7 as **Appendix-7.4** and drawing of culvert is presented in drawing volume.

Trucklay byes

Truck laybyes is proposed at design chainage 38+300

Bus Shelters

Busbays/Bus shelters is proposed at 8 locations on the proposed alignment. The list of presented below:

S.No	Chainage	Village	District	Proposed Chainage	
				LHS	RHS
1	0+200	Jotsama	Kohima	0+150	0+250
2	12+200	-		12+150	12+250
3	13+400	Merima		13+350	13+450
4	16+900	Secretariat		16+850	16+950
5	31+950	BSF Camp		31+900	32+000
6	37+150	Kohima		37+100	37+200
7	40+100	Pjuchama		40+050	40+150
8	43+700	Phesama		43+650	43+750

Junctions

Three major junctions have been created on the proposed alignment of Kohima bypass and two junctions at start and end of the project road.

Major Intersections

S.No.	Location of Intersection (Design Chainage)	Junction with	Name of the Location
1	0+000	NH-39	Start of Project road

S.No.	Location of Intersection (Design Chainage)	Junction with	Name of the Location
2	13+400	NH-61	High Court Junction
3	32+150	NH-150	BSF Camp
4	44+519	NH-39	End of the Project road

Minor Junctions

S.No.	Location of Intersection (Design Chainage)	Other Features
1	12+200	Junction with Village road
2	41+540	Junction with Village road

0.9 Cost Estimation & Rate analysis

The preliminary cost estimates have been prepared considering the various items of works associated with identified improvements so as to assess financial and economic costs for evaluating viability of the project.

All broad work items have been identified. Unit rates of different work items have been derived on the basis of current schedule of rates of NH & MoRTH works in Nagaland, Govt. of Nagaland effective from 1st July 2016 with escalation for 2 years upto year 2018.

0.10 Conclusion & recommendation

The project is economically viable but financially not viable. Therefore, it is recommended adopting EPC mode of contract.

Table of Contents

CHAPTER 1.0 INTRODUCTION

1.1 General

The National Highways & Infrastructure Development Corporation Ltd.(NHIDCL) has been entrusted for *Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland* for proper structuring andimplementation of projects on EPC mode .

M/s Highway Engineering Consultant (HEC) in Association with Agnitio Infrastructure Projects Pvt. Ltd. (AIPPL) has been instructed to commence the services from 12.12.2016 vide NHIDCL HQ letter no. NHIDCL/ DPR/ Nagaland/ Kohima Bypass/2016/179 dated 11.01.2017.

1.2 Overview of MORT&H organization, NHDP Programme, Project Financing & Cost Recovery Mechanism

National Highways Development Program (NHDP)

It is an integrated program to develop the national highway system of India through upgradation and strengthening of an arterial network consisting of 70548 kms through various phases. The National Highways Development Project is a project to upgrade, rehabilitate and widen major highways in India to a higher standard. The project was implemented in 1998. "National Highways" account for only about 2% of the total length of roads, but carry about 40% of the total traffic across the length and breadth of the country.

Phases of NHDP

NHDP Phase-I: Government has approved four/six/eight laning of 7,498 km of National Highways at an estimated cost of Rs. 30,300 Crores. It mainly includes four/six/eight laning of Golden Quadrilateral connecting four metropolitan cities i.e. Delhi, Mumbai, Chennai and Kolkata. Implementation of NHDP-I mainly on Item Rate Construction Contract (IRCC). All the contracts awarded and about 94% of NHDP-I project has been completed. Around 12% through PPP route on BOT (Toll) [6.0%] and BOT (Annuity) [6.0%] mode.

NHDP Phase II: Under this Government has approved 6644 km of National Highways to be widened to four/six lane facility at a cost of Rs. 34,339 crore. Under this North South Corridor from Srinagar to Kanyakumari with Cochin Selam Spur and East West Corridor from Silchar to Porbandar are to be developed. Though around 24% through PPP on BOT (Toll) [11%] and BOT (Annuity) [13%]. 87.34% of length

is awarded out of which around 19.51% completed. NHDP-II is scheduled for completion by Dec. 2009.

NHDP Phase-III : Under this, Government has approved upgradation of 12109 km of existing National Highways to two lane with paved shoulders/four/six lane having high traffic density, connecting important tourist locations, economically important areas, State capitals etc on build, operate and transfer (BOT) basis with a maximum viability gap funding (VGF) of 40%. The estimated cost for development of these stretches is Rs. 80,626 Crores. 17.13% of length awarded, out of which 3.39% length completed. NHDP-III is scheduled for completion by Dec. 2013.

NHDP Phase-IV: There is a proposal under consideration for widening of 20,000 km of existing single/intermediate/two lane highways to two lane with paved shoulders at an estimated cost of Rs. 27,800 Crores through PPP route on BOT (Toll)/BOT (Annuity) basis.

NHDP Phase-V: Under this Government has approved six laning of 6500 km of National Highways at a cost of Rs. 41,210 Crores through PPP route on BOT (Toll) mode using Design Build Finance and Operate (DBFO) pattern with a maximum VGF of 10%. In DBFO private parties needs the upfront cost of design, construction and expenditure on annual maintenance and recovers the entire cost along with the interest from toll collection during the concession period. A length of 882 km awarded. NHDP V is scheduled for completion by Dec. 2012.

NHDP Phase-VI: Under this Government has approved construction of 1000 km of expressways at an estimated cost of Rs. 16,680 crore through PPP route on BOT (Toll) mode following a DBFO pattern with a maximum VGF of 40%. Action is being taken for preparation of feasibility report. NHDP-VI is scheduled for completion by Dec. 2015.

NHDP Phase-VII: Under this Government has approved construction of 700 km of standalone ring roads/bypasses as well as grade separators, flyovers, elevated road, tunnels road over bridge, under passes etc at an estimated cost of Rs. 16,680 crore through PPP route on BOT (Toll) mode with a maximum VGF of 40% Action is being taken for preparation of feasibility study. NHDP-VII is scheduled for completion by Dec. 2014.

National Highways Development Project at a glance

NHDP Phase	Particulars	Length	Indicative Cost [Indian Rupees (In Crores)]
NHDP-I&II	Balance works GQ and EW-NS corridors	13000	42000
NHDP-III	4-Laning	10000	55000
NHDP-IV	2-Laning	20000	25000
NHDP-V	6-Laning of selected stretches	5000	17500
NHDP-VI	Development of expressways	1000	15000

NHDP Phase	Particulars	Length	Indicative Cost [Indian Rupees (In Crores)]
NHDP-VII	Ring roads, Bypasses, Grade Separators, Service Roads etc	700	15000
	Total	**45000**	**1,69,500 (Revised to 2,20,000)**

NHDP- Project financing and Cost recovery mechanisms

The Sources of Funds for the Projects are

- Cess on Diesel and Petrol.
- Borrowing from Multilateral Financial Institutions.
- Capital Gains Tax Exemption Bonds.
- Toll Collections & Revenue Share.
- Private Sector Investment.

1.3 Project Area

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavely congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road doesnot have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

1.3.1 Location

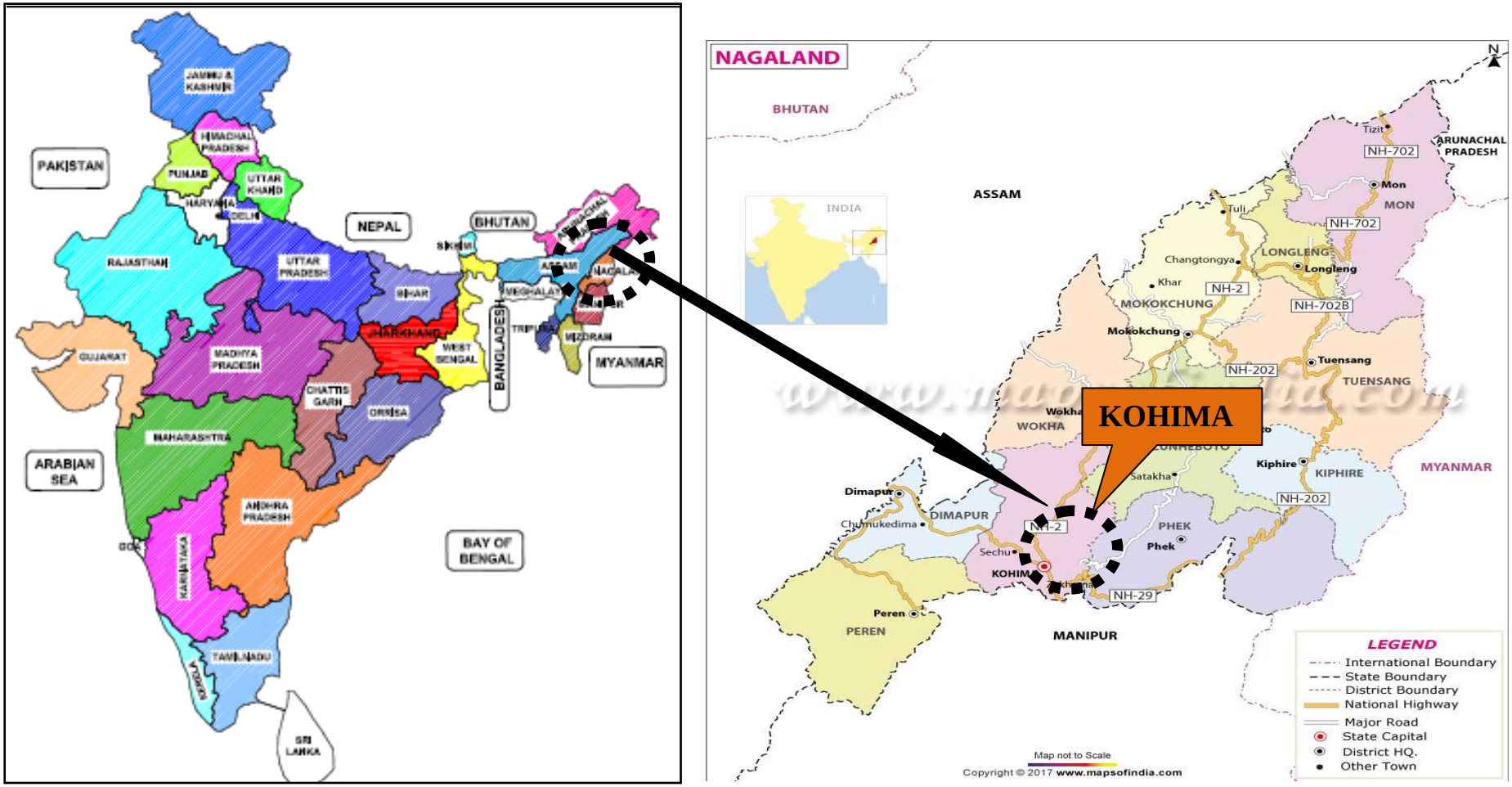
The project road starts from the Km 173.00 of existing NH-39, (which is under widening and improvement for four lane configuration from Dimapur to Kohima), and crosses NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00.

The latitude and longitude of the start location of project road is 25.68 & 94.05 and latitude and longitude of the end location of project road is 25.12& 94.12 respectively.

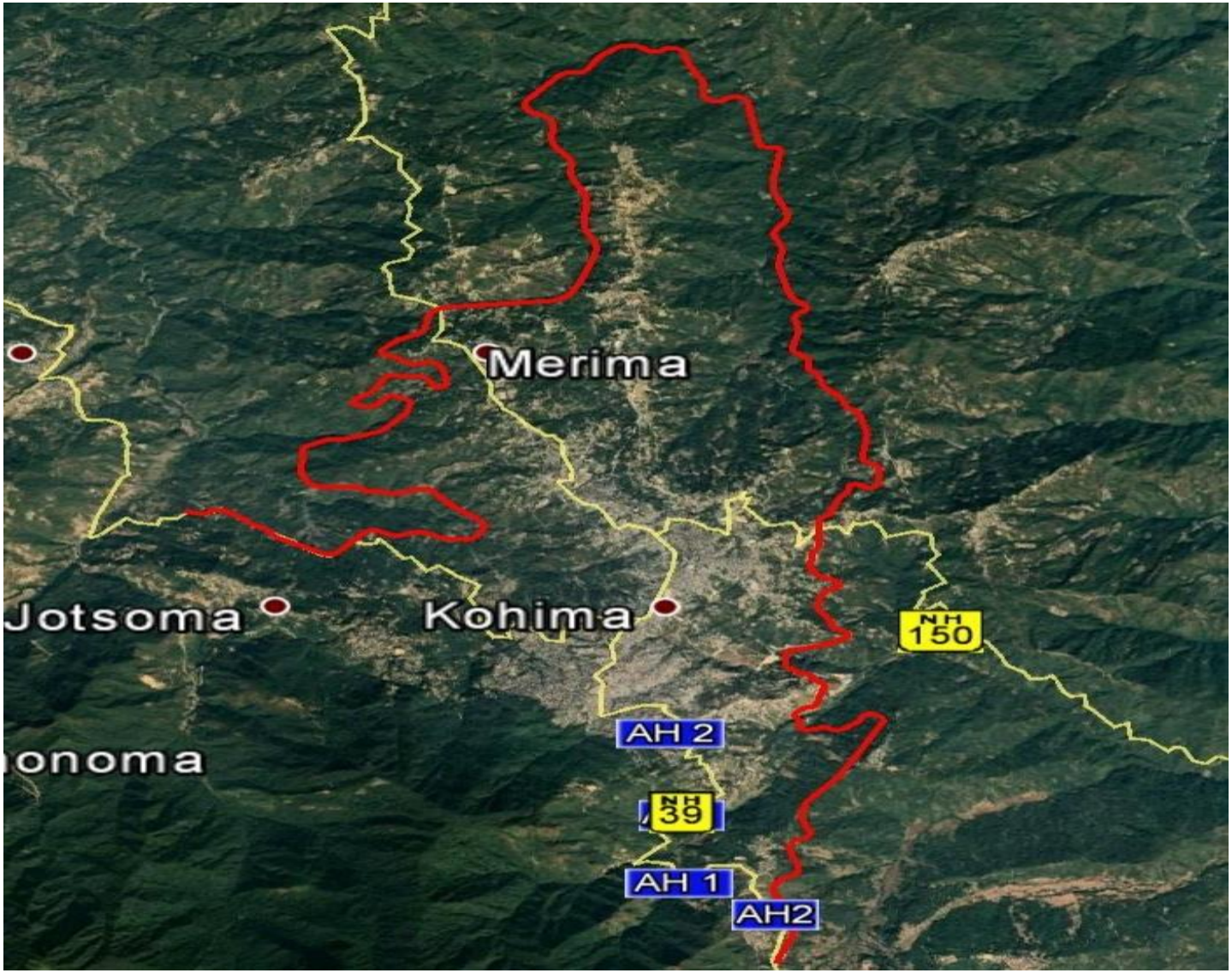
Maximum length of the proposed bypass passes through virgin land. Hence, the details of existing road is not applicable and existing details presented, belongs to part of existing road, where the alignment of proposed and existing road is same.

1.3.2 Location Map

Location of Kohima is as shown in Fig: 1.1



Proposed bypasses alignment is shown in below map Fig 1.2



1.3.3 Terrain

The terrain along the project road has been identified as per method suggested by IRC SP 48:1998 (Hill Road Manual), Fig: 6.2, Page-27.

Terrain Classification	Percentage cross slope of the country
Plain	0 – 10
Rolling	> 10 – 25
Mountainous	> 25 – 60
Steep	> - 60

The project road lies in steep terrain.

1.3.4 Landuse

The Landuse along the existingroad is mainly private forest, the summary of landuse is presented below:

Chainage		Length (m)	Adjacent Landuse Pattern	
From	To		Left	Right
0+000	**0+700**	**700**	Valley	PBU
0+700	**2+400**	**1700**	Valley	Forest
2+400	**2+700**	**300**	Valley	PBU
2+700	**3+500**	**800**	Valley	Forest
3+500	**6+000**	**2500**	PBU	BU
6+000	**6+300**	**300**	Valley	Forest
6+300	**6+900**	**600**	Valley	PBU

Chainage		Length (m)	Adjacent Landuse Pattern	
From	To		Left	Right
6+900	**7+500**	**600**	Valley	Forest
7+500	**7+700**	**200**	Valley	PBU
7+700	**8+000**	**300**	Valley	Forest
8+000	**8+400**	**400**	Valley	PBU
8+400	**9+700**	**1300**	Valley	Forest
9+700	**10+300**	**600**	PBU	BU

**PBU-Partially Builtup areas, BU- Builtup*

1.3.5 Lane configuration

The existing road alignment from High Court Junction to BSF Camp at NH-150 is 2-Lane of carriageway width 7.00 m.

1.3.6 Pavement condition

The pavement condition along the project road is poor. The percentage of pavement condition is presented below:

S.No	Lane	Length (Km)	Percentage
1	Good	0.0	0.0
2	Fair	0.4	3.8
3	Poor	9.9	96.2
4	Washed out section	0.0	0.0
Total		**10.3**	**100**

1.3.7 Existing Culverts

There are 33 culverts along the existing road. It is observed during field studies the number of cross drainage structures is very less in comparison to actual requirement on site. The summary of existing culverts is presented below:

S.No	Type of Culvert	Numbers	S.No	Type of Culvert	Numbers
1.	Arch	0	4.	Slab	7
2.	Box	0	5.	Stone	0
3.	Pipe	25			

1.3.8 Right of way (RoW)

The project is for development of new 4-lane road for bypassing the Kohima town. Land has to be acquired for entire length of project. The proposed ROW is 60 m.

1.3.9 Junctions

The list of junctions is presented below:

SI. No.	Name of Intersection	Type of Intersection
1	High Court	3-Arm
2	NBCC	3-Arm
3	New Secretariat	3-Arm
4	BSF Camp	3-Arm

1.4 Objective

The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project reports for rehabilitation/upgrading/construction of the existing/missing road to 2/4 lane NH configuration. So the selected consultant shall also have to interact with other agencies of State & Central government.

The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

The Detailed Project Report would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international/local competitive bidding.

The consultant should ensure detailed project preparation incorporating aspects of value engineering, quality audit and safety audit requirement in design and implementation.

The consultant should, along with Feasibility Report, clearly bring out through financial analysis the preferred mode of implementation on which the Civil Works for the stretches are to be taken up. The consultant should also give cost estimates and tender documents along with feasibility report/ Detailed Project Report.

1.5 Scope of Services

As per RFP the scope of services has been outlined as below:

As far as possible, the widening/improvement work to 2/4 laning shall be within the existing right of way avoiding land acquisition, except for locations having inadequate width and where provisions of short bypasses, service roads, alignment corrections, improvement of intersections are considered necessary and practicable and cost effective. However bypasses proposals should also be considered, wherever in urban

areas, improvement to 2/4 lane of the existing road is not possible. The Consultant shall furnish land acquisition details as per revenue records/maps for further processing of land acquisition. Consultant shall also submit 3a, 3A and 3D draft notification for acquisition of land.

The Consultant shall study the possible locations and design of toll plaza. Wayside amenities required on tolled highway shall also be planned. The local and slow traffic may need segregation from the main traffic and provision of service roads and fencing may be considered, wherever necessary to improve efficiency and safety.

The Consultant will also make suitable proposals for widening/improvement of the existing road to 2 lane with paved shoulder etc., and strengthening of the carriageways, as required at the appropriate time to maintain the level of service over the design period. The Consultants shall prepare documents for EPC/PPP contracts for each DPR assignment.

All ready to implement 'good for construction' drawings shall be prepared.

Environmental Impact Assessment, Environmental Management Plan and Rehabilitation and Resettlement Studies shall be carried out by the Consultant meeting the requirements of the lending agencies like ADB/ World Bank/JICA, etc.

Wherever required, consultant will liaise with concerned authorities and arrange all clarifications. Approval of all drawings including GAD and detail engineering drawings will be got done by the consultant from the Railways. However, if Railways require proof checking of the drawings prepared by the consultants, the same will be got done by NHIDCL and payment to the proof consultant shall be made by NHIDCL directly. Consultant will also obtain 'NO Objection Certificate' from Ministry of Environment and Forest and also incorporate the estimates for shifting of utilities of all types involved from concerned local authorities in the DPR. Consultant is also required to prepare all Land Acquisition papers (i.e. all necessary schedule and draft 3a, 3A, and 3D, 3G notification as per L.A. act) for acquisition of land either under NH Act or State Act(as applicable).

The DPR consultant may be required to prepare the Bid Documents, based on the feasibility report, due to exigency of the project for execution if desired by NHIDCL.

Consultant shall obtain all types of necessary clearances required for implementation of the project on the ground from the concerned agencies. The client shall provide the necessary supporting letters and any official fees as per the demand note issued by such concerned agencies from whom the clearances are being sought to enable implementation.

The consultant shall prepare separate documents for BoT as well as EPC contracts at Feasibility stage / DPR stage. The studies for financing options like BoT, Annuity, EPC will be undertaken in feasibility study stage.

The Consultant shall be guided in its assignment by the Model Agreement for Engineering, Procurement and Constructions (EPC)/ Model Concession Agreement and the Manual of Specifications and Standards for two lane of highways through Engineering, Procurement and Constructions (EPC) published by IRC (IRC:SP:73) (the "Manual") along with relevant IRC codes for design of long bridges.

The consultant shall prepare the bid documents including required schedules (as mentioned above) as per EPC/ PPP documents. For that it is suggested that consultant should also go through the EPC documents of ministry before bidding the project. The Consultant shall assist the NHIDCL and its Financial Consultant and the Legal Adviser by furnishing clarifications as required for the financial appraisal and legal scrutiny of the Project Highway and Bid Document.

1.6 Stages of Submission

The Project has to be completed in four stages as described herein below:

1. Inception Report
2. Feasibility Report
3. Project Related Clearances
4. Detailed Project Report (DPR)

1.7 Structure of Draft Detailed Project Report

Draft Feasibility Report (DFR) consists of following Volumes as per TOR:-

S.No	Volume No.	Description
1	Volume-I	Main Report
2	Volume-II	Rate analysis and cost estimates
3	Volume-III	Drawing Volume

Volume-I: Main Report will contain following chapters:

S.No	Chapter No.	Description
1	Chapter-0	Executive Summary
2	Chapter-1	Introduction
3	Chapter-2	Socio-economic Profile
4	Chapter-3	Engineering Survey, Investigation and Analysis
5	Chapter-4	Environmental Impact Assessment (EIA) and EMP
6	Chapter-5	Social Impact Assessment studies and Resettlement action plans

S.No	Chapter No.	Description
5	Chapter-6	Traffic Survey, Analysis and Forecast
6	Chapter-7	Engineering Design Standards& Improvement Proposals
7	Chapter-8	Cost Estimation
8	Chapter-9	Financial & Economic Analysis
9	Chapter-10	Conclusions & Recommendations

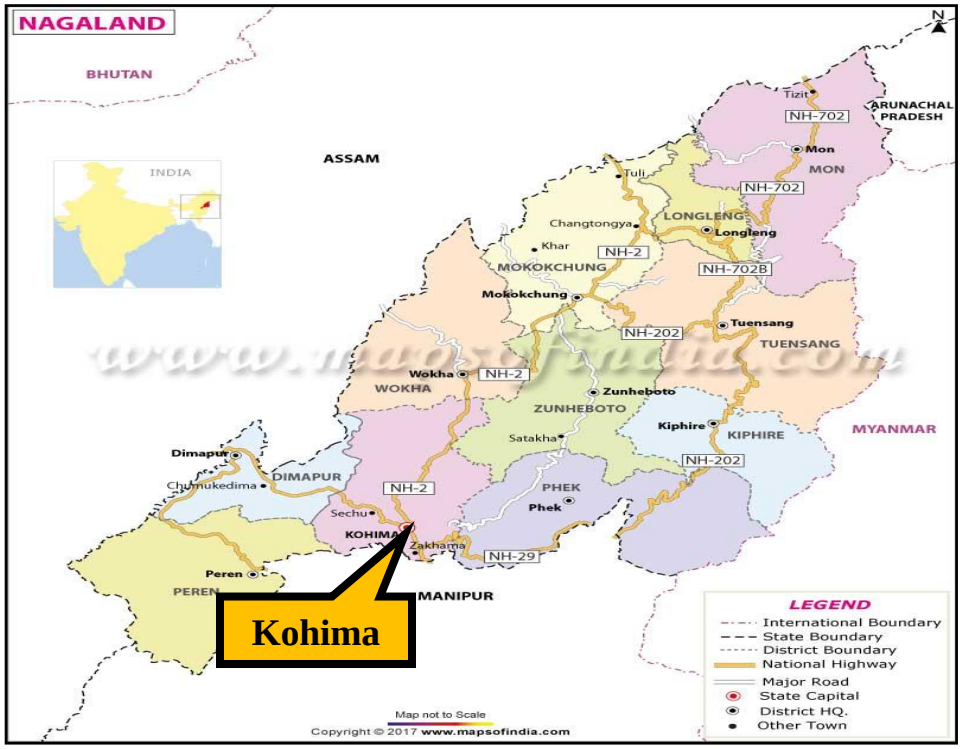
Table of Contents

CHAPTER 2.0 SOCIO-ECONOMIC PROFILE

2.1 State Profile

Nagaland is a state in Northeast India. It borders the state of Assam to the west, Arunachal Pradesh and part of Assam to the north, Burma to the east, and Manipur to the south. The state capital is Kohima, and the largest city is Dimapur. It has an area of 16,579 Square Kilometres (6,401 Sq Mi) with a population of 1,980,602 per the 2011 Census of India, making it one of the smallest states of India.

The state is mostly mountainous except those areas bordering Assam valley. Mount Saramati is the highest peak at 3,840 metres and its range forms a natural barrier between Nagaland and Burma. It lies between the parallels of 98 and 96 degrees east longitude and 26.6 and 27.4 degrees latitude north. The state is home to a rich variety of flora and fauna; it has been suggested as the "falcon capital of the world." Map of Nagaland showing Kohima location in Fig. 3.1.



General Information about Kohima

S.No	Items	Unit	Statistics
(A)	***Geographical Data***		
1.	Latitude	-	25° 40' N
2.	Longitude	-	94° 07' E
3.	Geographical Area	Sq. Km.	16.527
(B)	***Meteorological Data***		
1.	Average Rainfall	mm.	2000
2.	Temperature		
	(i)Minimum (June-Sept.) (Oct-Feb)	° C	16,4
	(ii)Maximum (June-Sept.) (Oct-Feb)	° C	31,24
(C)	***Main Rivers***		Dhansiri, Doyang, Dikhu, Milak, Zungki ,Tizu
(D)	***Highest Peak***	Meters above the sea level	Saramati (3,841)

2.2 Demographic Profile

The Demographic discription of the district presented below:

Table 2.1: Demographic Pattern of Kohima District at a glance

Demographic Data (Kohima)				
1	**Total Population**	**Census 2011**		2,67,988
i.	Male		Lakhs	1,38,966
ii.	Female		Lakhs	1,29,022
iii.	Decimal Growth rate		Lakhs	
2	**Rural Population**			
	Total		Lakhs	1,46,900
i	Male		Thousands	76,369
ii	Female		Thousands	70,531
3	**Urban Population**			
	Total		Lakhs	1,21,088
i	Male		Thousands	62,597
ii	Female		Thousands	58,491
4	Sex Ratio			934
5	Child Sex Ratio			991
6	Density of Population		P.Sq.Km	13399
(B) Schedule Castes				
1	Total Population		Lakhs	0

Demographic Data (Kohima)				
i	Male		Lakhs	0
ii	Female		Lakhs	0
2	Rural Population		Lakhs	0
i	Male		Lakhs	0
ii	Female		Lakhs	0
(C) Schedule Tribes				
1	Total Population		Lakhs	2,24,738
i	Male		Lakhs	1,10,617
ii	Female		Lakhs	1,14,121
2	Rural Population		Lakhs	
i	Male		Lakhs	
ii	Female		Lakhs	
(D) Religion wise Breakup				
1	Hindu		Thousands	25,496
2	Muslims		Thousands	4,384
3	Christians		Lakhs	2,34,955
4	Sikhs		Hundreds	998
5	Buddhist		Thousands	1,519
6	Jains		Tens	80
7	Others & Religions not Stated		Hundreds	556

2.3 Kohima District

Kohima is a hilly district of India's North Eastern State of Nagaland, sharing its borders with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North. One of the oldest among the eleven districts of the state, Kohima is the first seat of modern administration as the Headquarters of Naga Hills District (then under Assam) with the appointment of G.H. Damant as Political Officer in 1879. The name Kohima is so called because the Britishers could not pronounce its original name "KEWHIRA" which is the name of the village where Kohima town is located. Kohima village, also called 'Bara Basti' which is the second largest village in Asia forms the North-Eastern part of Kohima Urban area today. Kohima village is the largest village in Nagaland.

The National Highway 29 passing through the heart of Kohima extending up to the international boundary of Myanmar, i.e, Dimapur-Kohima-Chakhabama. The other National Highways having its connectivity to the capital is the NH 2 which connects Assam-Mokokchung-Wokha-Kohima-Imphal. The boundary of Kohima Southward is as far as Khuzama at Mile Stone (MS) 32 KM, to the North at Kandinu at MS 65 KM

and to the West at Piphema in MS 30 KM. to the East of Kohima lies Chakhabama at MS 27 KM.

2.3.1 History

The British incursions into the Naga territory, beginning in the 1840s, met with stiff resistance from the independence-loving Nagas, who had never been conquered by any empire before. The stiffness of the resistance can be gauged by the fact that it took nearly four decades for the British to conquer a territory that is less than 10,000 square kilometres (the eastern region was left free). Kohima was the first seat of modern administration as the Headquarters of Naga Hills District (then under Assam) with the appointment of G.H. Damant as Political Officer in 1879. When Nagaland became a full-fledged state on 1 December 1963, Kohima was christened as the state capital.

In 1944 during World War II the Battle of Kohima along with the simultaneous Battle of Imphal was the turning point in the Burma Campaign. For the first time in South-East Asia the Japanese lost the initiative to the Allies which they then retained until the end of the war. This hand-to-hand battle and slaughter prevented the Japanese from gaining a high base from which they might next roll across the extensive flatlands of India like a juggernaut.

2.3.2 Geography

Kohima lies north of the Japfu Barail intersection. Due to its elevation, Kohima features a more moderate version of a humid subtropical climate. Kohima has cool winters and hot very rainy summers. The coldest months are from December to February, when frost occurs and in the higher altitudes snowfall occurs occasionally. During the height of summers, from June–August, temperature ranges an average of 80–90 °F (27–32 °C). Heavy rainfall occurs during summer.

As of 2011, Kohima had a population of 2,67,988 of which males and females were 138,966 and 129,022 respectively. Kohima has an average literacy rate of 85.23%, higher than the national average of 74.04%. The city's population is composed of the 16 tribes of Nagaland. The population of the Angamis and Aos are the largest in present-day Kohima urban area.

Greater Kohima which includes Kohima Village, Jakhama and Jotsoma along with Kohima city is the second largest urban area of Nagaland after Dimapur-Chumukedima. It has a population of about 250,000. 'Kohima Village' called 'Bara Basti' or 'large village',which is the second largest village in Asia forms the north eastern part of Kohima urban area today.

The major religion in Kohima is Christianity which is practiced by 80.22% of the population. Other religions includes Hindu (16.09%), Muslim (3.06%) and Buddhist (0.45%).

2.3.3 Transport

The nearest airport is Dimapur Airport at Dimapur about 74 Kilometres (46 miles) away. Kohima is connected by road with National Highways 2 and 29 passing through the city. Kohima is not connected with the rail network. The nearest railway station is at Dimapur. An extension of the railway line from Dimapur to Kohima was proposed and surveyed in 2009.

National Highway 61 (NH 61) is a National Highway of India. It runs from Kohima, the capital of the state of Nagaland and ends at Jhanji in the state of Assam. The highway is 240 Km (150 mi) long, of which 220 Km (140 mi) is in Nagaland and 20 Km (12 mi) is in Assam.

2.4 Roads

The Roads are the major mode of transportation service available in the Kohima. The road network in the state is at developing stage. Several national highways from neighboring state connecting Kohima to other parts of region. The list of National Highways is shown in table below:

National Highway Number	Length of NH in (KM)	States Passing through	Main Cities/Places in National Highway
New NH-02 Old NH-39,150	1214	Assam, Nagaland, Manipur, Mizoram	NH15 near Dibrugarh, Sivasagar, Amguri, Mokokchung, Wokha, Kohima, Imphal, Churachandpur, Seling, Serchhip, Lawngtla, Tuipang
New NH-29 Old NH-61	240	Kohima- Jhanji	Nagaland (220 Km) and Assam (20 Km)

Table of Contents

CHAPTER 3.0 ENGINEERING SURVEYS, INVESTIGATIONS AND ANALYSIS

3.1 General

The Consultants carried out various field studies, engineering surveys and investigations to collect the necessary data for use in Feasibility for the project. The investigations were carried out to generate adequate supportive database for preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The various engineering investigations and surveys have been carried out following the relevant MoRT&H/ IRC.

The various investigations and surveys, which have been carried out by the Consultants, are as follows:

- Inventory and condition survey of Road and Pavement
- Topographic Survey
- Pavement Investigations
- Soil and Material Investigations

3.2 Project Area

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavely congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road does not have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

3.3 Inventory and Condition Survey of Road and Pavement

3.3.1 Road Inventory

The inventory of the project road for assessment of the pavement status has been carried out through measurements and visual inspection. Features like terrain, land use, width of pavement and shoulders, geometric deficiencies, important road junctions, utilities etc. were recorded. The inventory data have been included in Appendix 3.1 at the end of the Chapter.

3.3.2 Pavement Condition Survey

The survey, in general pavement conditions was primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements where necessary. Visual assessment was carried out from a vehicle, with speed not exceeding 20 - 30 km/hr and stopping at various locations at suitable intervals and wherever necessary, by variations in pavement conditions. At the points of stoppage, simple measurements using measuring tape; straight edge was carried out to quantify pavement deficiency on a representative basis. Aspects of pavement conditions assessed include surface defects, rut depth, cracking, potholes, patched areas, shoulder condition etc. An overall assessment of performance – serviceability of the road was also done to qualitatively rate the existing pavement and shoulder condition.

All the distress conditions were estimated by carrying out visual condition survey and taking measurements wherever necessary after dividing each distress mode of the pavement in categories by studying, the pavement condition of the project road.

Results

It is seen from the results of the Appendix-3.2 that the overall Pavement Condition of the project road is in Fair to Poor Condition. The summary of condition survey results is given in Appendix-3.2 at the end of the Chapter.

From the above appendix it can be seen that out of 10.3 Km of total length 9.8 Km of the length is in poor condition, and 4.1 Km of length is in fair condition.

3.4 Topographical Survey

The basic objective of the topographic survey would be to capture the essential ground features along the alignment in order to consider improvements and for working out improvements, rehabilitation and upgrading costs.

Total Station Traverse: The Total Station was run in between two primary control points. The traverse was connected to all secondary points and established traverse point along the edge of the existing road. The closing error of the traverse was found to be within the permissible limits.

Detailed Topographical Survey: Detailed Topographical Survey carried out by running a continuous open traverse along the existing road. It covers the ROW up to 60 m. i.e 30 m on either side of the center line of the exiting road in general. Collection of details for all features such as structure (bridge, cross-drainage works, retaining wall, breast walls, crash barriers etc.) utilities existing roads, electric and telephone installations, (both O/H as well as underground) huts, buildings, fencing ad trees (with girth greater than 0.3 m) oil and gas lines, falling within the extent of survey has been done.

Longitudinal Sections and Cross Sections: Based on the survey data collected Digital Terrain Modeling (DTM) was generated by using appropriate software. The longitudinal sections were prepared by recording reduced levels at 25 m in general and closer interval at curves and summit areas based on contours developed though DTM. The cross-sections have been generated at interval of 50 m in general and closer intervals at curves. The cross – section points have been taken as follows:

- The centre of the existing road,
- Edge of the road,
- Edges of the earthen shoulder,
- At every 3m or closer where it was forced necessary from the edge of earthen shoulder both on hill side and the valley side.
- The cross sections for river and canals have been taken as mentioned in IRC-5

Longitudinal section and cross-section for culvert location: At the culvert locations, the survey has been extended on up and down stream side for different catchment areas relevant to the channel as laid down in IRC Special publication no. 13 and IRC – 5.

Ground Verification: On completion of the topographical detailed survey and development of the base map, the data were verified on ground and updated as necessary.

3.5 Pavement Investigation

3.5.1 General

The project road has been investigated subjectively as well as objectively, where necessary for its functional and structural performance. Pavement condition of the existing road is generally poor. The various surveys for the investigation on the pavement are as follows:

1. Pavement Composition
2. Pavement Condition Survey

3.6 Sub-grade Investigation

3.6.1 Test pit for Sub-grade Investigation

Test pit investigations were carried out at the interface of main carriageway and earthen shoulder at every 5 Km intervals in a staggered manner along the existing road alignment. Following tests were carried out to ascertain the existing physical and strength condition of the sub-grade.

a) In-situ Moisture Content

b) Laboratory soil characterization (Grain size and Atterberg limits)

c) Laboratory moisture-density characteristics (using modified AASHTO compaction)

d) Dry Density (using sand replacement method)

e) CBR tests on 4 days soaked samples

3.6.2 Existing Pavement Composition

Not applicable for this project.

3.6.3 Laboratory Test on Test Samples

The following laboratory tests were conducted on the sub-grade samples collected from test pits :

-	*Grain size analysis*	*As per IS:2720*
-	*Atterberg Limits*	*As per IS:2720*
-	*Maximum Laboratory Dry Density*	*As per IS:2720*
-	*Optimum Moisture Content*	*As per IS:2720*
-	*CBR (4 days soaked) at the specified compaction level of 97% MDD*	*As per IS:2720*

The summary of field and laboratory test results are compiled and provided in the Appendix 3.3 at the end of the Chapter and Material Report (Volume-III) of this submission.

3.7 Sources of materials

The sources of materials are as given below:

1. Moorum (Granular Deposit for construction of Sub-Base) - Joytsma
2. Aggregates (For Base and wearing courses) - Joytsma
3. Sand - Dimapur
4. Water - Local
5. Bitumen - Guwahati
6. Cement - Dimapur
7. Steel - Guwahati

3.8 Inventory and Condition Survey of Bridges and Culverts

3.8.1 Inventory of Bridges

The project is for bypass only, and there is no existing bridge along the proposed alignment.

3.8.2 Inventory of Culvert

The inventory of culverts along the existing road is done for study of existing drainage system of that area. There are 35 culverts along the existing road. The ratio of culverts is 1:1 per Km. It is observed during field studies the number of cross drainage structures is very less in comparison to actual requirement on site. The summary of existing culverts is presented below:

S.No	Type of Culvert	Numbers
1.	Arch	0
2.	Pipe	26
3.	Scooper	0

S.No	Type of Culvert	Numbers
4.	Slab	7
5.	Stone	0
2 culverts are choked		

Detailed Inventory of Culverts is given as Appendix-3.4 at the end of the Chapter.

3.8.3 Inventory of other type of structure

No other type of structure is present on the project road.

3.9 Junctions

There are 3 junctions along the existing road.

1. High court Junction at Km 0.00
2. NBCC Junction at Km 4.100
3. New Secretariat Junction at Km 5.000

   All the above chainages are measured considering High Court Junction as start point.

Table of Contents

CHAPTER 4.0 ENVIRONMENTAL IMPACT ASSESMENT AND ENVIRONMENT MANAGEMENT PLAN

4.1 General

The National Highways and Infrastructure Development Corporation Limited (NHIDCL), Government India has been entrusted with the task of the capacity augmentation of the National Highway-39 for upgrading to 4- lane carriageway configuration.

For the purpose of project preparation, various corridors have been divided into convenient section, selected on the basis of the traffic generation, attraction potential, geographic location and other considerations. This report deals with NH-39 *(which is under widening and improvement for four lane configuration from Dimapur to Kohima)*,NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00. The length of road is approx. 32.300 Kms

4.2 Necessity of EIP

Environmental Impact Assessment is to be carried out during project preparation to ensure environmental compliance. As a first step, **Environmental Screening** has been carried out

- to identify critical environmental issues & impacts,
- to identify environmental considerations to be integrated into the highway design,
- to determine appropriate extent & type of environmental assessment required, and
- to identify the types of statutory clearances to be obtained

4.3 Scope of EIP study

The scope of Consultancy service related to environmental aspects as set out in the TOR covers following major tasks:

- *Environmental screening and preliminary environmental assessment of the project;*
- *Collection and review of all available data, reports and published information relevant to environmental setting of the project road and the project influence area;*
- *Environmental impact assessment including compliance with the requirements of lending agencies, such as related to cultural properties, forestry, natural habitats etc.;*
- *Public consultation, including consultation with Communities located along the road, NGOs working in the area, other stake-holders and relevant Govt. depts. at all the different stages of assignment;*
- *Reconnaissance survey for pedestrian/animal crossings and environmental features;*
- *Field survey for trees (with girth size > 30 cm); and for monuments, burial & cremation grounds, places of worships, stream/river/canal;*
- *Strip plan indicating trees to be felled and planted, and reports, documents and drawings arrangements of estimates for cutting of trees;*
- *Identification of environmental restrictions to borrow areas & quarry sites;*

- *Environmental enhancement measures for highway side cultural properties, water bodies, bus bays/shelters and landscape, and borrow areas on public land;*
- *Preparation of application forms and obtaining NOC and forestry & environmental clearance from the respective authorities like SPCB, MOEF etc. on behalf of NHIDCL;*
- *Preparation of EIA report conforming to the guidelines of Govt. of India, World Bank/ADB as appropriate;*
- *Preparation of EMP report including monitoring plans during construction & operation, environmental mitigation & enhancement measures etc. and complete with plans, designs, drawings, BOQ and technical specifications;*

4.4 Policy, Legal And Administrative Framework

4.4.1 Administrative Framework

The Government through specific legislations regulates the environmental management system in India. The Ministries/Statutory Bodies responsible for ensuring environmental compliance by project promoters include:

- The Ministry of Environment and Forests (MoEF), Government of India
- Central Pollution Control Board (CPCB)
- State Pollution Control Boards
- Ministry/Department of Environment in the States

4.4.2 Legal Framework

Following acts, laws, rules and guidelines are applicable for the study:

1. Environment (Protection) Act, 1986
2. Air (Prevention & Control of Pollution) Act, 1981
3. Water (Prevention & Control of Pollution) Act, 1974
4. Forest (Conservation) Act, 1980 and its amendments
5. Forest (Conservation) Rules, 2003 and its amendments
6. Wildlife (Protection) Act, 1972
7. Wildlife (Protection) Amendment Act, 2002
8. World Bank Guidelines for Environmental Assessment
9. Environmental Guidelines for Rail, Road & Highways Projects, 1989 (MoEF)
10. EIA Manual published by Ministry of Environment & Forests, January 2001
11. IRC: 104:1988, Guidelines for Environmental Impact Assessment of Highways Projects
12. IS Codes & CPCB Guidelines for monitoring & analysis of air, water, soil etc.

The Environment (Protection) Act, 1986, is the most comprehensive law on the subject. The law grants power to the Central Government to take all measures necessary to protect and improve the quality of environment and to prevent pollution of the environment. The

following rules, notifications and standards under the Environment (Protection) Act, 1986 are particularly relevant in this case:

1. Environment (Protection) Rules, 1986 and its amendments
2. Noise Pollution (Regulation & Control) Rules, 2003 and its amendments
3. EIA Notification, 1994 and its amendments
4. Ash Utilisation Notification, 1999 and its amendments
5. National Ambient Air Quality Standards and its amendment

4.4.3 Objective of Screening

The objectives of the screening are:

- To determine the category of the project depending on the type, location, sensitivity, and scale of the project, and the nature and magnitude of its potential environmental impacts.
- To determine the appropriate extent and type of Environmental Assessment (EA) required, i.e. scoping.
- To identify the types of EA instruments suitable for the EA of the project.
- To conduct public consultation shortly after screening and before the Scope of Work for the EA are finalized.

To determine whether the project requires statutory environmental & forest clearance, no objection certificates and consents depending on its scale of investment and type & location of development

4.4.4 Scope of Screening

- The scope of the environmental screening includes:
- Collection & review of available secondary data/information on physical, biological & social environment in the area of influence (study corridor)
- Field study, survey and monitoring in the study corridor for generation of some necessary primary data
- Establishment of baseline environmental status/condition of the study corridor (along the ROW of the road in particular and in a study corridor of 7 km on either side of the road in general)
- Study of the project activities in terms of construction and operation to identify the potential sources/causes of impacts
- Identification & assessment of potential impacts on the environment during construction and operation of the road
- Public consultations shortly after screening and before the Scope of Work for the EA are finalized.
- Recommendation of preventive, mitigatory, compensatory & enhancement measures to eliminate/minimize the adverse impacts

- Categorization of the project depending on the type, location, sensitivity, and scale of the project, and the nature and magnitude of its potential environmental impacts.
- Scoping for finalization of the Scope of Work for the EA, the types of suitable EA instruments to be used and types of statutory clearances required.

4.5 Project Description

4.5.1 The Road Alignment

The project road starts from the Km 173.00 of existing NH-39, (which is under widening and improvement for four lane configuration from Dimapur to Kohima), and crosses NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00.

The entire project road lies in hilly terrain. As per the discussions held with PWD officers, Kohima, in connection with NH-150, ROW of 60 m should be available. Existing roadway width is 7.0 m and adjoining hill side is all private land**.** Some villages are there adjacent to the project road. Some of the important villages are Merima, Taskau, Sunourii, etc.

4.5.2 Existing Features of Project road

The salient features of the road stretch have been summarized in **Table-4.1** below.

Table-4.1 Salient Features of the project road

Terrain	Hilly terrain
Soil Type	Clayey & sandy soil
Wildlife Corridors & Migratory Routes	No movement of wildlife along project road has been reported.
River/Stream crossing	Dhansiri, Dikhu, Doyang, Zungki & Local streams
Existing ROW	NA
Road crossing	None
ROB	None
Bridge & culverts	NA
Archeological, Historical, Cultural & Heritage Sites	No such sites have been reported.
Eco. sensitive areas	There are no reserved forests / national parks/Biosphere reserves in close vicinity of the existing road alignment.

4.6 Baseline Environmental Scenario

In the screening stage, existing environmental set-up of the study corridor (7 km on either side of the project road), in general, and within the Right of Way (ROW), in particular, has been studied and described in subsequent sections.

4.6.1 Physiography of Kohima District

Kohima is the capital city of the north eastern state of Nagaland, India. Kohima is situated in the southern part of the state and at an altitude of 1500 meters above sea level. Kohima is situated around 74 km from Dimapur, a very popular and important town in Nagaland.

4.6.2 Seismicity

Nagaland falls in Zone-V of the Seismic Zonation Map of India with an expected maximum magnitude greater than 8. More than 40 earthquakes of magnitudes greater than 6 on the Richter scale have been recorded in the last century in the NE region. Two earthquakes with magnitudes greater than 8 occurred in 1897 and 1950 in the north-eastern region. The role of seismicity as a triggering mechanism should be studied for historic landslide events (Thigale, 1999). Many large landslides have been triggered by earthquakes (Schuster and Highland, 2001). Repeated earthquakes in the NE region caused by intermittent tectonic stress release indicate that the orogenic movements are still in progress (Verma, 1985). Froehlich et al (1992) maintain that high density of joints in rocks is probably connected with high seismicity of any region. This would also support large scale mass wasting.

4.6.3 Land Use Pattern

Maximum length of the project road is passing through private forest lands.

4.6.4 Soil

Nagaland, being mountainous and prone to heavy rainfall for millennia in the past ages, yet Nagaland has one of the thickest top-soil layers compared to any place in India. In many places in Nagaland even if the ground is cut 100 m into the mountain side, it still does not reach the underlying rock. The reason may be found in the porous nature of soil where every rain drop sinks underground where it falls without surface flow or water current or it may also be due to the tremendous speed with which the plants cover up any bare area of the soil surface. This is due to the excellent plant growth condition of soil, water and temperature prevalent in the area.

The results of subgrade soil investigations along the existing road alignment shows that the soil have gravel (20.76%), sand (31.1%) and silt and clay (48.14%).

4.6.5 Agriculture

Ninety percent of the total population of Kohima lives in rural areas. The rural people are mainly engaged in agriculture which is the major source of the state income. The two forms of cultivation practiced by the people - Terrace and Jhum cultivation.

Terrace cultivation

Under this system, a piece of land, generally in the valley where water can be channeled into it, is made into flat plots depending on the contour and slope of the land. In gentle slope the plots are bigger and in sharp slope plots are smaller. Likewise, the height of the plots depends on the slope of the land. In case of gentle slope the height is less and in case of sharp slop the height is more. The field is prepared in many plots of flat land and the sides of each flat piece of land are raised above the land in order to retain water. Water is brought from nearby rivers, streams or falls. Sometimes water from the roadside is also channelised to the field. As soon as water is available the hard soil is softened and turned into a thick mud. Thus, when the field is ready, paddy are planted in this field. The water is allowed to remain for the whole period of the growing season of the plants but just before harvesting the field is drained and it remains dry up to the time when it is ready for harvesting. In October - November, the field become ready for harvesting. Unlike Jhum, no other crop is grown along with paddy in terrace field. This is called terrace cultivation.

Jhum cultivation

Another form of cultivation in Nagaland is Jhum which mean shifting cultivation. Under this form of cultivation, the field is cultivated for one or even two to three years if it is sufficiently fertile. Then it is kept fallow for a period seven to ten years for regaining of its fertility, and thereafter it is again cultivated. This kind of rotational practice of cultivation is known as Jhum Cultivation. It is the predominant pattern of cultivation practiced in hilly terrains of Nagaland.

Under this traditional agrarian practice, an area selected for cultivation is cleared of all trees, shrubs and under-growths and felled vegetation is left in their respective places for next 2-3 months in order to dry up. This is usually done in the dry winter months on November and December. During the months of February and March, fire is set to these dry vegetative materials and the area is cleared up. Next, the logs obtained by felling of trees are placed in an orderly manner from top to bottom in the field in such a way that the loose earth materials are prevented from being washed away due to monsoon showers. The logs are fixed with pegs to keep them in position. These works are generally completed before the onset of pre-monsoon showers.

The burning of the leaves of the felled trees, shrubs etc. enhance the fertility of the soil because of the presence of lime and phosphate in ashes. The soil is boggy, and loose because its formation has been greatly influenced by decayed leafs, shrubs and undergrowths. Thus, soil is so soft at places that crops can be grown even without tilting the earth. After preparation of the ground, crops are sown, generally in April depending on the pre-monsoonal showers. In Nagaland, paddy is sown in the first year along with the maize and some other vegetables such as taro (a plant of arum family), beans, pumpkin, cucumber and several varieties of gourds. These are grown together, mixed with paddy plants in jhum lly on the outskirts of the field. In the second and third year, Millet, maize etc are grown with some other variety of vegetables.

Food Crops

Rice is the main food for different tribes of Nagaland. Therefore, in most of the places, paddy is the major crop. Paddy can be grown both in terrace and jhum fields. Fertilizer consumption as well as crop yield per hectare of the state is still below the national average.

Other major crops include millet, maize etc. These are taro (a variety of arum), pumpkin, beans, squash, potato, brinjal, chilli, garlic, cucumber, gourd, tomato, cabbage, cauliflower, etc. These vegetables can be well grown both in terrace and jhum and also in private firms and homestead gardens.

The high production cost is one of the major constraints in crop cultivation. The farmers are forced to go for single cropping as they depend purely on monsoon rain for cultivation. The deteriorating condition of natural fertility due to soil erosion and large practice of jhum cultivation is factors for large scale production as soil are found to be highly acidic. The knowledge on water management practices, fertility management and methods of scientific cultivation of crops is lacking among the farmers. Availability of quality seeds and other planting materials in time is also a major constraint. The agricultural produce being organic by default has immense potential of being exported however lack of proper marketing channels to get maximum profit is a limiting factor in this direction. To compete in the national and international market, technology based small scale agro-industries, cold storage; transportation facilities are to be encouraged.

Cash Crops

The important cash crops are orange, pineapple, sugar cane, cotton etc.

4.6.6 River and Drainage

River: Primarily there are four main rivers that flow through Kohima which are Dhansiri, Dikhu, Doyang and Zungki.

Dhansiri: Dhansiri flows through the southwestern part of the state through Rangapahar-Dimapur Plains of Dimapur District. This river receives almost all the western and southern drainages of Nagaland. Its main tributaries are river Dzuza and Diphu. At the extreme southwest of the state, it assumes a northwardly course forming a natural boundary with North Cachar Hills of Assam which finally drains into the Brahmaputra.

Dikhu: River Dikhu, which has a total length of about 160 km, originates from Nuroto Hill area in Zunheboto district. The river traverses towards north along the border of Mokokchung and Tuensang districts. The main tributaries of river Dikhu are Yangyu of Tuensang district and Nanung in the Langpangkong range in Mokokchung district. The river flows further northward and leaves the hill near Naginimora and finally merges with the Brahmaputra River in the plains of Assam.

Doyang: It is the longest river in the state originating from the Japfü Hill near the Southern slope of Mao in Manipur and moves in a south west direction passing through Kohima district and flows northward into Zunheboto and Wokha District. It passes through a great part of Wokha District and flows south westerly into Dhansiri in Sibsagar, District of Assam. The main tributaries of Doyang are Chubi River which flows southward from Mokokchung District and Nzhu River, originating from Nerhema area of Kohima district and flows through Miphong in Tseminyu area and finally pours itself to Doyang.

Zungki: The Zunki River which is the biggest tributary of Tizu, starts from the northeastern part of Changdong forest in the south of Teku and flows in southernly direction towards Noklak, Shamator and Kiphire and finally joins Tizu below Kiphire.

4.6.7 Climate

Kohima features a more moderate version of a ***humid subtropical climate.*** Kohima has a pleasant and moderate climate - not too cold in winters and pleasant summers. December and January are the coldest months when frost occurs and in the higher altitudes, snowfall occurs occasionally. During peak summer months from July-August, temperature ranges an average of 80-90 Fahrenheit. Heavy rainfall occurs during summer.

4.6.8 Flora and Fauna

Flora

The topography and the geography of an area always have a tremendous influence on the vegetation of any area. Nagaland lies in the tropical belt and is mountainous. Nagaland is

botanically one of the richest spots in the world. Nagaland is endowed with rich flora and fauna. Varieties of Bamboo grow throughout Nagaland. Many depend on Bamboo and its product for their livelihood. Bamboo shoot is a favorite dish for Nagas. Furniture, baskets etc. made out of bamboo and harvested a great chunk of income annually. Green grasses and varieties of flowers grow everywhere. Very rare and unique species of flora such as Rhododendron, Magnolia and Juglans are also found in Nagaland. Nagaland is also known for chilly (Capsicum) and rice (Oryza). The number of poisonous plants are also numerous. Some plants are so poisonous that rashes and ruptures appear on the skin of persons who simply happen to walk past the plants.(Rhus species). The stings of others may cause pain continuing for about three months, for which there is no known remedy. A particular variety of plant boiled and served to pigs. There are 22 species of Bamboos available in the state. World tallest Rhododendron tree has been found in Japfu Mountain of Kohima district.

Fauna

Wild elephants are found in the plain sectors of Dimapur areas bordering with Assam. Tiger, Barking deer, Sambar, Bear, Wild Bore, Monkey, Porcupine etc. are found in Nagaland. Partridge, Robin, Quail, Warbler, Hornbill and peasant etc. are some of the important birds found in the state. Nagaland is also popular for Tragopan which is very rare and unique bird.

Domestic Animals

Nagas are very fond of rearing domestic animals. They rear Chicken, Pig, Dog, cat, mithum, Buffaloes, Goats etc. for various purposes. Almost all the Naga families, especially in rural area (i.e. Villages) rear chicken, pig and dog. Chicken and pig are the most common ones. Dog is reared to guard the houses. Mithun is regarded to be the most prestigious among the domestic animals, Buffaloes and goats are reared for milk.

4.6.9 Biodiversity and Forest Types of Nagaland

Nagaland is very rich in bio-diversity, both flora and fauna. Even today some pockets of forests are covered with gigantic trees, where sun- rays cannot penetrate. Due to reckless and uncontrolled cutting of trees for timber, firewood, continued Jhum cultivation and annual fire in vast tracts of land, forests got degraded and barren, which accelerated diminishing of the most of the original characteristics of the forests.

Though Nagaland is a small state but as far as types of forests are concerned it has been endowed with a wide variety of forest types. This is mainly due to the fact that though it is mainly in tropics, Nagaland has land elevation ranging from a few hundred meters up to about four thousand meters.

- ***Northern Tropical Wet Evergreen Forests***

  These forests once covered the Namsa- Tizit area but now only a small vestige is found in the Zankam area. It is found only in Mon District. The dominant species in this type of forest are Hollong*(Dipterocarpusmacrocarpus),*Makai*(Shoreaassamica),* Nahor (*Mesuaferae)* etc

- ***Northern Tropical Semi Evergreen Forests***

  This type of forests are found in the foothills of Assam-Nagaland border in Mokokchung, Wokha and Kohima Districts. The Species that make up these forests are similar to those of the Northern Tropical Wet Evergreen Forests. The only difference is that in the former case the evergreen species dominate though there are deciduous species like *Bhelu, Paroli, Jutuli* etc, whereas in the present case, the number of evergreen species decreases and the deciduous species are dominant.

- ***Northern Sub-tropical Broad Leaved Wet Hill Forests***

  This type of forests are found in the hill areas below 1800m and above 500m in all the districts of Nagaland. The wet evergreen species are conspicuous by their absence and the dominant species are mostly semi-deciduous. Some of the important timber species in this type are - Koroi, Pomas, Sopas, Gamari, Gogra, Khokan, Hollok, Sam, Am, Badam, Betulaetc.

- ***Northern Sub-tropical Pine Forests***

  This types of forests are found in hill elevation of 1000 meters to 1500 meters in parts of Phek and Tuensang Districts of Nagaland. Pine is the dominant species and is found mixed with Quercus, Schima, Prunus, Betulaand Rhododendron.

- ***Northern Montane Wet- temperate Forests***

  This type of forests are found on the higher reaches of the tallest mountains in Nagaland above 2000 meters in - Japfu, Saramati, Satoi, Chentang ranges. The species are typically evergreen with Quercus, Michelia, Magnolia, Prunus, Schima, Alnus and Betula.

- ***Temperate Forests***

  This type of forests are found in peaks of the tallest mountains (above 2500 meters) like Saramati and Dzukou area. The species that dominate are Rhododendron, Patches of Juniperuscoxie and Birch.

Schools, Medical Facilities & Religious Places

There is no sensitive receptors along the project road.

4.7 Requirement of Environmental Clearance

The current project is a part of NH-02 and does not attract Environmental Clearances as per following notification. (Copy of the notification is attached at the end of the chapter as **Appendix-4.1**)

The EIA notification 2006

The notification clearly defines the category of any road for clearance process,

Project Activity	A Category	B Category	General Condition
7f (Highways including Expressway)	i) New National Highways; ii) Expansion of National Highways greater than 30 Km, involving additional right of way greater than 20 m involving land acquisition and passing through more than one state.	i) New State Highways; ii) Expansion of National / State Highways greater than 30 km involving additional ROW greater than 20 m involving land acquisition.	General Condition shall apply
General Condition (GC):- Any project activity specified in Category B will be treated as Category A, if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the wildlife (Protection) Act, 1972 (ii) Notified Eco-sensitive areas, (iv) inter-state boundaries and international boundaries.			
The Government of India relaxed the condition for Environmental Clearance for road projects less than 100 Km length with additional ROW less than 40 m on existing alignments and 60 m on re-alignments and bypasses on 22nd August 2013 vide notification no SO 2559(E).			

Table of Contents

CHAPTER 5.0 INITIAL SOCIAL ASSESSMENT AND PRELIMINARY LAND ACQUISITION/RESETTLEMENT PLAN

5.1 Introduction

The National Highways & Infrastructure Development Corporation Ltd.(NHIDCL) has been entrusted for Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland for proper structuring and implementation of projects on EPC mode .

M/s Highway Engineering Consultant (HEC) in Association with Agnitio Infrastructure Projects Pvt. Ltd. (AIPPL) has been instructed to commence the services from 12.12.2016 vide NHIDCL HQ letter no. NHIDCL/ DPR/ Nagaland/ Kohima Bypass/2016/179 dated 11.01.2017.

5.2 Project Description

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavely congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road do not have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

5.3 Expected Socio-Economic Benefits

The objective of the proposed road is to bypass the heavily congested Kohima town and maintain smooth connectivity between NH-39, NH-61 & NH-150.

The proposed road creates opportunity of development of the area along the alignment near Kohima town without disturbing inside traffic of Kohima town and it will reduce the pollution of Kohima town also, which have positive impact on people’s health and wealth of peoples of Kohima and that region.

Objective of the Study

1. Avoid wherever feasible, or at least minimize involuntary resettlement, by exploring all viable project alternatives

2. Determine the magnitude of adverse social impacts and propose mitigation measures with the agreed policy provisions

3. Outline results of stakeholders' consultation and incorporate the outcome of these consultations in the social management plan

4. Develop institutional mechanism for implementation of the R&R activities and for monitoring and evaluation of the R&R implementation process

5. Address other social issues related to vulnerable groups (including tribals), road safety measures and HIV/AIDS

6. Prepare a plan to address all social issues associated with the project

Methodology

A reconnaissance of the entire stretch was undertaken together with engineering and environmental teams. The purpose of the reconnaissance was to have an overview of the likely extent of impact on people because of the impending development work of the highway.

The survey also brought out issues pertaining to the proposed alignment, which traverses through some settlements. The survey was conducted within the proposed ROW for the Kohima Bypass to understand social impact of the project and the likely impact of the project road widening and a broad overview of the socio-economic profile of the project area.

Simultaneously, a team comprising social and environmental experts, field investigators, surveyors and engineers carried out physical survey of the entire length of the project stretch to measure land and structures to be affected by the widening and strengthening of the project road.

The secondary data/information was collected from various government and non-government agencies so as to verify the ground realities and comprehend the socio-economic characteristics, physical features and cultural set-up of the project area before undertaking detailed field investigations.

A format was used to record the relevant information on squatters and encroachers. The verification included collection of information on the structure, its type and use and portion within ROW. The information collected on field was only used in estimating the PAPs within the Corridor of Impact (COI).

5.4 Project Road Description

The project road starts from the Km 173.00 of existing NH-39, (which is under widening and improvement for four lane configuration from Dimapur to Kohima), and crosses NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00.

The latitude and longitude of the start location of project road is 25.68 & 94.05 and latitude and longitude of the end location of project road is 25.12 & 94.12 respectively.

Table 5.1: Villages along the Project Road

S.No	Chainage		Name of Village
	From	To	
1	0.00	4.00	Jyotsma
2	4.00	9.00	Merima
3	9.00	10.500	Theziama
4	10.500	15.500	Kohima Town
5	15.500	24.500	Kohima Village
6	24.500	27.500	Pfuchama
7	27.500	30.208	Phesama

5.5 Stakeholders Consultation

Introduction

The stakeholders consultation, as an integral part of social assessment process throughout the project preparation stage not only minimizes the risks and unwanted political propaganda against the project but also abridges the gap between the community and the project formulators, which leads to timely completion of the project and making the project people friendly. Public consultation and participation have been viewed as a continuous two way process, involving, promoting of public understanding of the processes and mechanisms through which developmental problems and needs are investigated and solved.

Project Stakeholders Analysis

During the consultation, different government officials, key informants and other Local peoples have been consulted during environmental and social study in the process of information dissemination, collecting relevant information and to acquaint with social requirements of the project. The personalities of the likely affected communities will be consulted about the issues relating to removal of unauthorized encroachments, shifting of religious properties where people's sentiments are involved and also to remove all kind of barriers pertaining to environmental social, political and religious, which may be obstacles in the way of project road.

Stakeholders Analysis Matrix

Table 5.2: Stakeholders Analysis

Stakeholder Category	Relevant Stakeholders	Characteristics (Social, location, size, organizational capacity	Interests in terms of support / opposition	Influence (H-High, M-Medium, L-Low)
Government	Chief Engineer PWD, S.E PWD, E.E. PWD, NHIDCL	NHIDCL	Support	High
Other concerned departments	DFO	Forest Department	Support	Medium
Intended beneficiaries	Local peoples of Project affected villages	Social	Support	Medium
Adversely affected persons	Persons affected by upgradation	Social	Opposition	Medium
Civil society (NGOs, CBOs, religious organizations)	NGOs , Women Groups	Social	Support	Medium
Other external / internal stakeholders	Heads of affected community centers	Social	Support	Medium

Conclusion / Recommendation

People should understand that the construction of the project road will give the boost to the economy of the entire area & improves the quality of riding on the road. Peoples are eager to know compensation matrix, wants the security measures on the road.

It is recommended that

1. Proper compensation should be given to the PAPs.
2. Proper time must be given for resettlement.
3. All possible care should be taken in designing so that minimum land acquisition is to done & that can minimize the adverse effect on environment.
4. Footpath & Railings to be given near community places, if, any.

5.6 Institutional and Legal Framework

Applicable Land Acquisition Act

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013

Institutional Setup

Participation / Consultation Framework

The Participation Framework envisages involvement of all the stakeholders' at each stage of project planning and implementation. The PIU will be responsible for ensuring participation of the community at sub-project level. Involvement of the community is not limited to interactions with the community but also disclosing relevant information pertaining to the project tasks. Community participation shall be undertaken at the following stages:

Pre-Feasibility Stage

Identification of Stakeholders

Identification of important stakeholders for this project was done considering their expected roles in the planning and implementation of the project. Primary stakeholders are ones with whom the project will have direct interactions.

Table 5.3: Identification of Stakeholders

Primary Stakeholders	Potential PAPs
Secondary Stakeholders	Revenue Department (RD) Forest Department (FD) Groups of affected persons; Village representatives like Pradhan and members Health workers, Patwaris Local voluntary organizations like CBOs and NGOs; State AIDS Control Society representatives, Commissioner office of Social Welfare, Tribal Development, Other project stakeholders such as official of line Department

Levels of Consultation

The consultation mechanism had been planned in stages at each level of project preparation. Village and Block level consultations were planned during SA stage which will be continued even during the project implementation. District level consultations, key informant interviews and other focused consultative procedures were organized during the baseline socio-economic/census survey. One of the features of consultation program during SA was to ensure continued involvement of local engineers of NHIDCL & Nagaland PWD in preparing SA framework. Level of consultations carried out during the project preparation and participating stakeholders are presented below.

Consultation during Feasibility Stage

During feasibility stage, consultations were held all over the project road. The focus at this stage was to develop a framework of consultation mechanism; identify needs of the local people in relation to the project and resources assess potential impacts of the proposed improvements; and ascertain options and preferences of people for their R&R including livelihood restoration, relocation sites, alternate alignments etc.

SA at the feasibility stage included consultations at individual PAF level, groups of local people and focused group discussions at strategic locations such as bypasses, locations of likely displacement and other sensitive receptors (such as temples likely to be relocated). The overall objective of the consultations was to ensure that people participate willingly; they are allowed to express their concerns and opinions; and agreements are reached on their suggestion/preferences which are eventually shared with them. For this purpose, the consultation mechanism was initiated with the information dissemination, followed by structured consultation.

Table of Contents

CHAPTER 6.0 TRAFFIC SURVEY ANALYSIS AND FORECAST

6.1 General

Traffic Survey and Analysis is important elements of any Project Report preparation. They have a direct bearing on several aspects. Some of these include lane width requirements and pavement thickness, design features and elements, and wayside facilities. All these signify the importance of base year and design year traffic which determines the type and level of facility to be planned and developed, which in turn forms the base towards determining the up-gradation cost. Given this, decisions on the type of traffic surveys, locations and duration have therefore been taken judiciously to arrive at representative traffic flows on the various sections, traffic desire patterns and characteristics.

The project is to develop bypass of Kohima town. The maximum part of the proposed alignment is new alignment, which starts from Km 173.000 of NH-39 and terminates between Km 192.000 and Km 193.000 of NH-39. This bypass connects NH-39, NH-61 and NH-150. Being an important link in the National Highway network of Nagaland, it probably carries significant border traffic in the area.

In this study, considerable efforts have been made to arrive at realistic traffic picture through an extensive analysis of the database.

6.2 Identification of sections for Traffic Survey

As discussed earlier in this chapter, the project is to bypass the Kohima town. The maximum part of the proposed alignment is new alignment, hence, current traffic on the proposed alignment is zero. The traffic of NH-39 from Dimapur to Impal and Jessami, constitutes major part of current traffic. Hence, assessment of current traffic on NH-39 has been checked by conducting traffic volume count for 7 days near Km 174.00 & Km 194.00

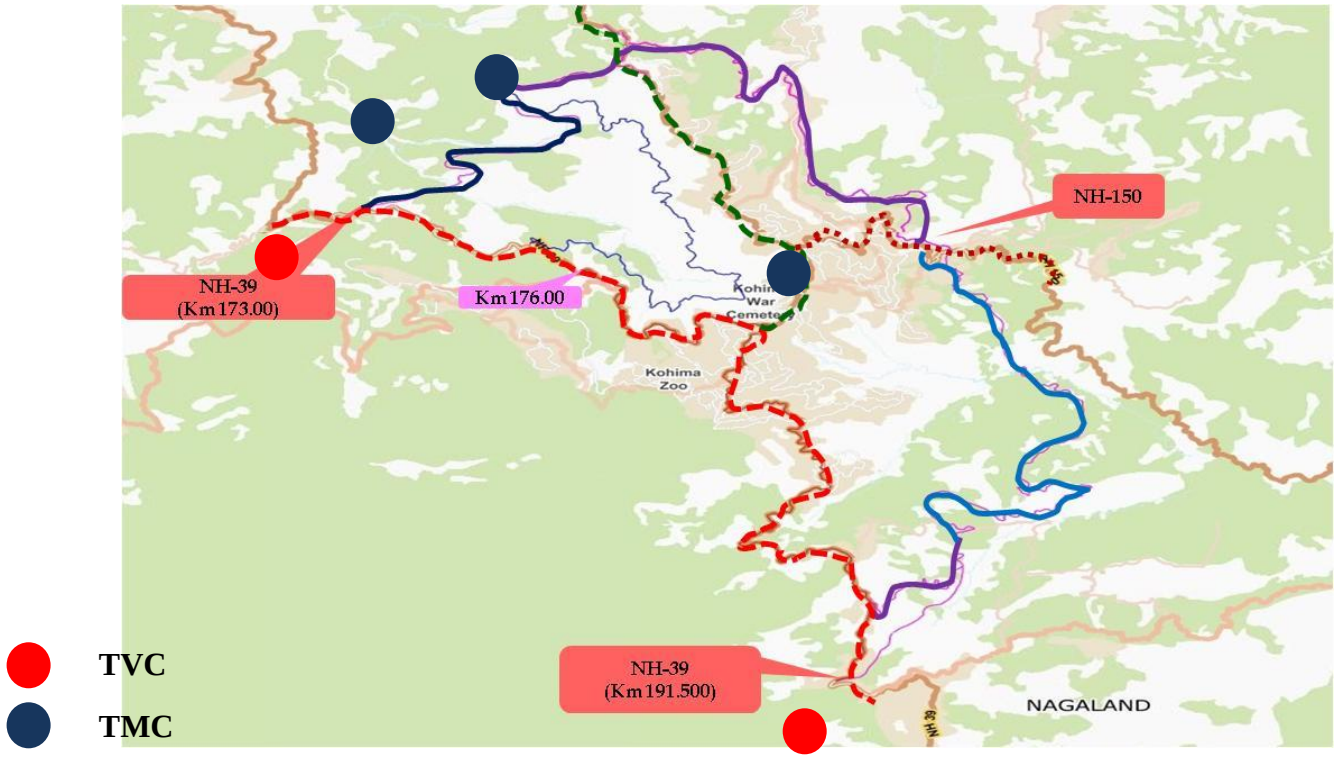
The proposed alignment of the bypass crossing two NH's (NH-61 & NH-150) and one road connecting to Kohima town. Turning movement count has been performed at 3 locations

The survey schedule and survey locations are presented in Table 6.1 and shown in Figure-6.1**.**

Table: 6.1 Type of Traffic Surveys and its locations

Type of Survey	Duration	Location	Chainage (Km)
Classified Traffic Volume Count Survey (TVC)	7 Days	Between Km 172.00 of NH-39 and Kohima Town	Km 174.00
		Km 194.00	Km 194.00
Turning Movement Survey / Intersection Volume Count (TMC)	8 Hours	High Court Junction (Junction with NH-61)	----
		Junction with Road going to Kerain	----
		BSF Camp (Junction with NH-150)	-----
Origin-Destination and Commodity Movement Survey	1 Day	Between Km 172.00 of NH-39 and Kohima Town	Km 174.00
	1 Day	On NH-61	Near High court Junction
	1 Day	On NH-150	Near BSF Camp
Axle load Survey	1 Day	Between Km 172.00 of NH-39 and Kohima Town	Km 174.00

Fig 6.1: Traffic Survey Location Map



6.3 Survey Methodology

6.3.1 Classified Traffic Volume Count

Mid-block volume count surveys were conducted at above shown location along the project road, one in each homogeneous section. The survey was conducted round-the-clock over 7 consecutive days. For recording classified mode-wise information, vehicles were grouped under the categories as given below in Table 6.2.

Table 6.2: Vehicle Classification System adopted

Motorised Traffic		Non-Motorised Traffic
2 wheelers		Bicycle
Auto Rickshaw		Cycle Rickshaw/ Rickshaw Van
Passenger Car : Car, Jeep, Taxi		Animal Drawn/Hand Cart
Van/Tempo		Others
Bus	Mini Bus	
	Standard Bus	
Truck	Light Commercial Vehicle (LCV)	
	2 – Axle Rigid Chassis Truck	
	3 – Axle Rigid Chassis Truck	
	4-6 Axle Trucks	
	> 7 Axle Trucks	
Tractor	Agriculture Tractor	
	Tractor & Trailer	

Enumerators were locally recruited and trained to conduct traffic counts. For the purpose of counting, a day was divided into three shifts of 8 hours each and separate enumerators with a Supervisor were assigned for each shift. The count data were recorded within 15-minute intervals for each vehicle group in each direction.

6.3.2 Origin-Destination (O-D Survey)

The project corridor in its influence area serves as the main spine of traffic movement. Preliminary network analysis in the influence area and travel patterns on the same did not indicate any through traffic movement on the road sections other than the project corridor, and hence no divertible traffic from the surrounding network onto the project corridor has been envisaged in case of further improvement to the project corridor. Further to understand the desire pattern of traffic, the Origin-Destination Survey was conducted at 5 locations on the project corridor for 24 hours continuously, in a manner so as to coincide with the representative volume counts. The road-side direct interview method was adopted to conduct the survey on a pre-designed proforma. The survey sample was captured uniformly following a systematic random approach for all modes, with due care to avoid duplication of samples and undue weightage to any particular mode.

6.3.3 Intersection Turning Movement Survey

Turning Movement Surveys were conducted at major intersections falling on the project corridor for 8 hours (8:00 – 18:00 hrs.) covering all movement combinations. These intersections are three-arm junction type.

6.3.4 Speed and Delay Survey

A Speed and Delay Survey was conducted on the project corridor by the "Moving Car Observer" method, in which a car (Scorpio) was used as the test car. From the homogeneous sections identified for the purpose of traffic appreciation, each section was further divided into a number of sub-sections for a better appreciation of variation in journey speed at a more disaggregated level because of varying physical characteristics of the road sections, despite more or less uniform traffic intensity.

Two round trips were made in the day-time and two more round trips were made during night-time to obtain a better average statistical value and to minimize any temporal effect on the road section.

This survey is not required in this project as the project is only for bypassing the Kohima town.

6.4 Data analysis – Classified Traffic Volume Count

6.4.1 Average Daily Traffic

The traffic data (in vehicles) collected during field surveys have been compiled and converted into equivalent Passenger Car Units (PCU) to determine the Average Daily Traffic (ADT) in vehicles and in PCU. Table 6.3 lists the adopted PCU equivalent for different vehicle type based on IRC 64:1990, and also from previous similar studies (carried out in the state of Nagaland) for the modes not covered in the IRC guideline.

Table 6.3: Adopted PCU Equivalents for Different Vehicle Type

Vehicle Type	PCU Equivalent	Vehicle Type	PCU Equivalent
Two-wheeler	0.5	3-Axle Truck	3.0
Auto Rickshaw	1.0	M-Axle Truck	4.5
Tempo	1.0	LCV/Tempo	1.5
Car/Jeep/Van	1.0	Tractor Without Trailer	1.5
Standard Roadways Bus	3.0	Tractor with Trailer	4.5
Mini Bus	1.5	Cycle	0.5
Private Bus	3.0	Cycle Rickshaw	1.5
2-Axle Truck	3.0	Animal Drawn	6.0

The Table 6.4 presents location wise traffic in Average Daily Traffic (ADT) in vehicles and in PCU. The table also provides the total number of motorized passenger vehicles, motorized goods vehicles and non-motorized vehicles by location on the project corridor.

Table 6.4: Average Daily Traffic (ADT) on Project Corridor by Location

Location	Motorized Passenger Vehicle	Motorised Goods Vehicle	Non-Motorized Vehicle	Total Vehicle	Total PCU
Kohima (Km174)	1130	1579	0	2709	6387
Km 194.00	689	955	0	1644	3880

For TVC near Km 174.000 & Km 194.00 the Vehicle to PCU ratio on the project corridor came out to be 1:2.35 & 1:2.36 (Vehicle: PCU) respectively, signifying a major share of commercial vehicles flow on the same.

6.4.2 Daily Variation of Traffic

The location wise daily variation of traffic for the project corridor is presented in Table -6.5

Table 6.5: Daily Variation of Traffic on Project Corridor by Location

Location (Km 174.00)	Day-1	Day-2	Day-3	Day-4	Day-5	Day-6	Day-7
Motorized Passenger Vehicle	1167	1123	1105	1082	1105	1092	1238
Motorised Goods Vehicle	1538	1549	1473	1550	1622	1631	1688
Non-Motorized Vehicle	0	0	0	0	0	0	0
Total Vehicle	2705	2672	2578	2632	2727	2723	2926
Total PCU	**6298**	**6214**	**6058**	**6254**	**6564**	**6429**	**6895**

Location (Km 194.00)	Day-1	Day-2	Day-3	Day-4	Day-5	Day-6	Day-7
Motorized Passenger Vehicle	702	698	674	661	667	664	760
Motorised Goods Vehicle	920	940	884	943	976	991	1031
Non-Motorized Vehicle	0	0	0	0	0	0	0
Total Vehicle	1622	1638	1558	1604	1643	1655	1791
Total PCU	**3773**	**3809**	**3662**	**3817**	**3972**	**3893**	**4236**

6.4.3 Maximum, Minimum and Average Traffic

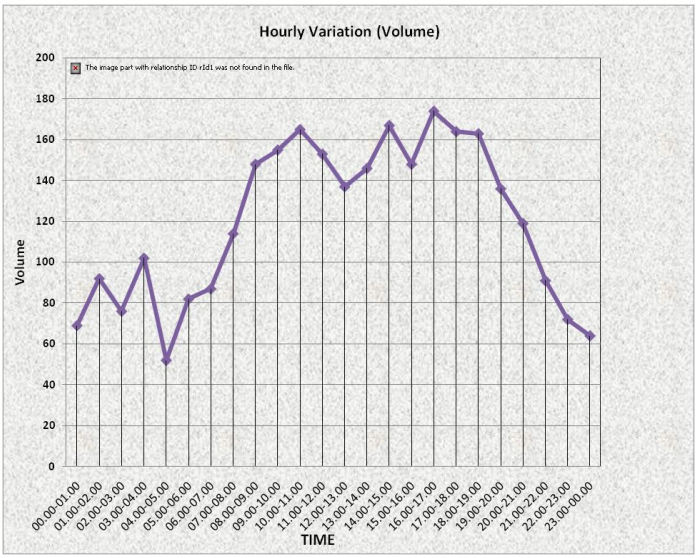
The analysis of traffic volume data indicates maximum traffic volumes on the Project Corridor at Km 174.00 & Km 194.00 is 2926 & 1791 vehicles/day, minimum traffic volume is 2578 & 1604 vehicles/day & the average daily traffic is 2709 & 1644 vehicles/Day respectively.

6.4.4 Percentage variation of Traffic

The percentage variation in daily traffic ranges at Km 174.00 & Km 194.00 is 1% to 8% with respect to ADT.

6.4.5 Hourly Distribution and Directional Distribution of Traffic

Graphical representation of Hourly Variation (Volume and PCU wise) Fig 6.2



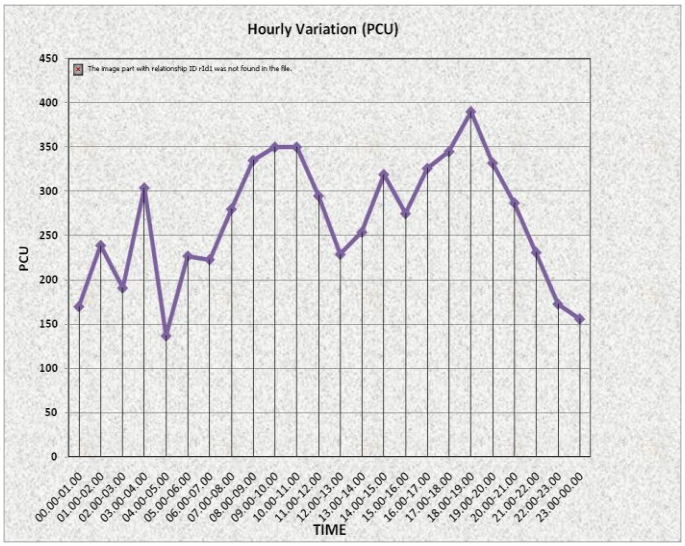
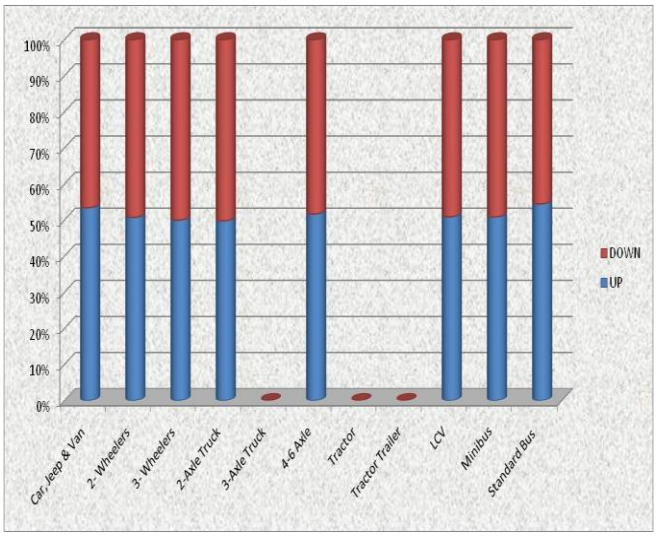


Table 6.6: Tabular representation of Hourly Variation (Volume and PCU wise)

PCU	170	239	191	304	137	227	223	280	335	350	350	295	229	254	319	275	326	345	390	332	287	231	173	156
Volume	69	92	76	102	52	82	87	114	148	155	165	153	137	146	167	148	174	164	163	136	119	91	72	64
Time Period	00.00-01.00	01.00-02.00	02.00-03.00	03.00-04.00	04.00-05.00	05.00-06.00	06.00-07.00	07.00-08.00	08.00-09.00	09.00-10.00	10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	17.00-18.00	18.00-19.00	19.00-20.00	20.00-21.00	21.00-22.00	22.00-23.00	23.00-00.00

Graphical representation of Directional Split of Traffic (Volume and PCU wise) Fig 6.3



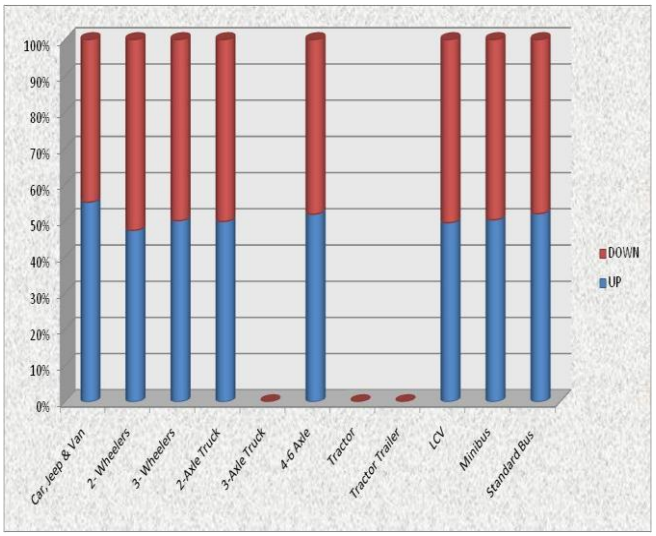


Table 6.7: Tabular representation of volume for directional split of traffic

Volume Data	Car, Jeep & Van	2-Wheelers	3-Wheelers	2-Axle Truck	4-6 Axle	LCV	Minibus	Standard Bus
UP	53	51	50	50	52	51	51	54
DOWN	47	49	50	50	48	49	49	46

Table 6.8: Tabular representation of PCU chart data for directional split of traffic

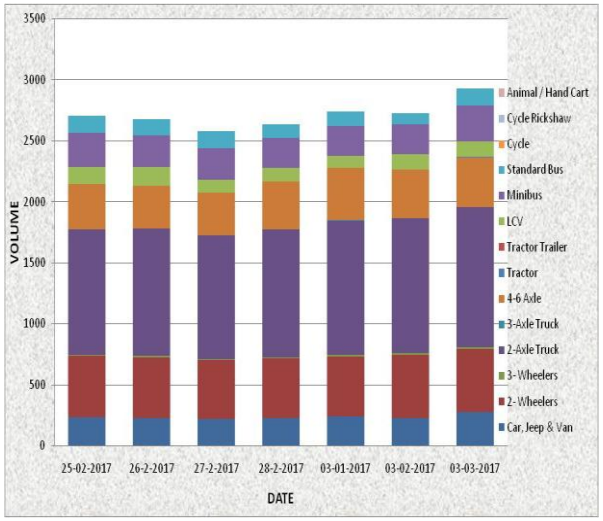
PCU Data	Car, Jeep & Van	2- Wheelers	3-Wheelers	2-Axle Truck	4-6 Axle	LCV	Minibus	Standard Bus
UP	55	44	50	50	52	49	50	52
DOWN	45	49	50	50	48	51	50	48

6.4.6 Traffic Composition

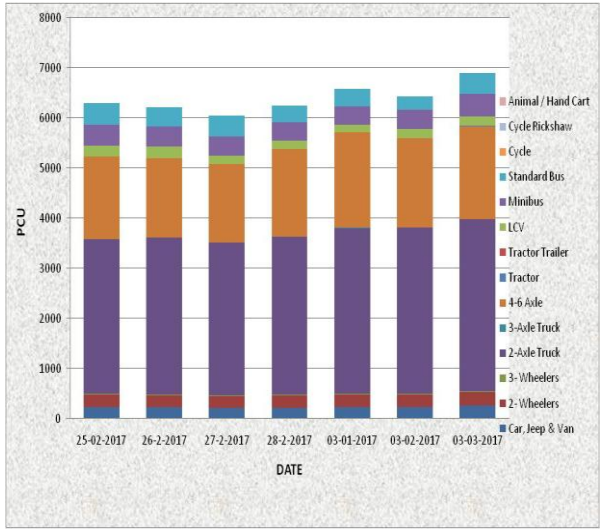
From the analysis of the data it can be seen that Cars/jeep/taxi comprise a significant share, ranging between 40-45 % of the total vehicles, followed by two-wheelers, LCVs and Buses, in the range of 3-20%. The share of commercial traffic (Buses and Trucks) is almost 20% of the total traffic. Non-motorized traffic, are not seen on the project road.

Figure 6.4 below presents overall traffic composition by vehicles along the project corridor.

Graphical & tabular representation of Date wise Traffic Composition at Km 174.00 (Volume and PCU wise) (Table no 6.9&6.10) Fig 6.4

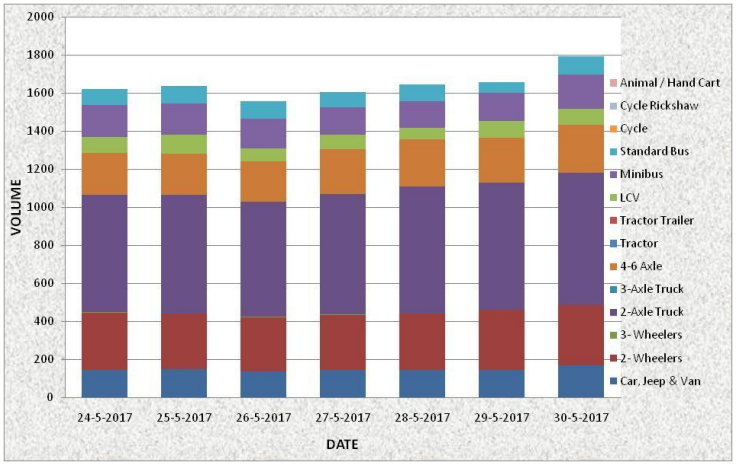


Date	25-02-17	26-2-17	27-2-17	28-2-17	1-3-17	2-3-17	3-3-17
Car, Jeep & Van	230	226	215	223	237	226	275
2- Wheelers	505	496	482	491	494	519	518
3- Wheelers	10	10	10	10	10	10	10
2-Axle Truck	1029	1043	1016	1049	1100	1109	1149
3-Axle Truck	0	0	0	0	0	0	0
4-6 Axle	368	354	350	391	422	395	411
LCV	141	152	107	110	100	127	128
Minibus	277	262	257	247	247	248	295
Standard Bus	145	129	141	111	117	89	140

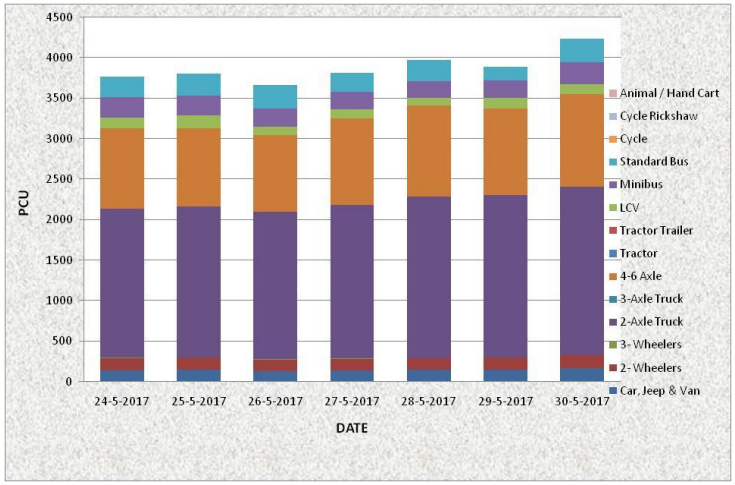


Date	25-02-17	26-2-17	27-2-17	28-2-17	1-3-17	2-3-17	3-3-17
Car, Jeep & Van	230	226	215	223	237	226	275
2- Wheelers	252.5	248	241	245.5	247	259.5	259
3- Wheelers	10	10	10	10	10	10	10
2-Axle Truck	3087	3129	3048	3147	3300	3327	3447
3-Axle Truck	0	0	0	0	0	0	0
4-6 Axle	1656	1593	1575	1759.5	1899	1777.5	1849.5
LCV	211.5	228	160.5	165	150	190.5	192
Minibus	415.5	393	385.5	370.5	370.5	372	442.5
Standard Bus	435	387	423	333	351	267	420

Graphical & tabular representation of Date wise Traffic Composition at Km 194.00 (Volume and PCU wise)

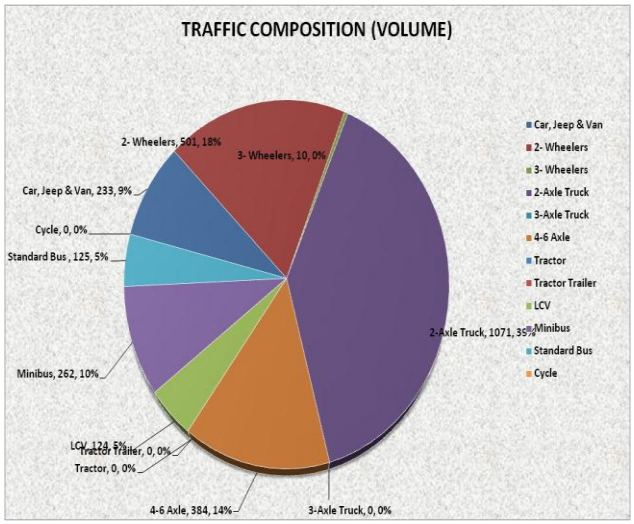


Date	Car, Jeep & Van	2-Wheelers	3-Wheelers	2-Axle Truck	3-Axle Truck	4-6 Axle	Tractor	Tractor Trailer	LCV	Minibus	Standard Bus
24-5-2017	145	300	4	614	0	221	0	0	85	166	87
25-5-2017	150	292	0	622	0	216	0	0	102	164	92
26-5-2017	135	287	2	606	0	210	0	0	68	156	94
27-5-2017	144	292	2	630	0	237	0	0	76	143	80
28-5-2017	146	296	0	665	0	250	0	0	61	139	86
29-5-2017	146	314	0	668	0	237	0	0	86	148	56
30-5-2017	170	314	0	695	0	254	0	0	82	180	96
Average	**148**	**299**	**1**	**643**	**0**	**232**	**0**	**0**	**80**	**157**	**84**



Date	Car, Jeep & Van	2-Wheelers	3-Wheelers	2-Axle Truck	3-Axle Truck	4-6 Axle	Tractor	Tractor Trailer	LCV	Minibus	Standard Bus
24-5-2017	145	150	4	1842	0	994.5	0	0	127.5	249	261
25-5-2017	150	146	0	1866	0	972	0	0	153	246	276
26-5-2017	135	143.5	2	1818	0	945	0	0	102	234	282
27-5-2017	144	146	2	1890	0	1067	0	0	114	214.5	240
28-5-2017	146	148	0	1995	0	1125	0	0	91.5	208.5	258
29-5-2017	146	157	0	2004	0	1067	0	0	129	222	168
30-5-2017	170	157	0	2085	0	1143	0	0	123	270	288
Average	148	150	1	1929	0	1045	0	0	120	235	253

Graphical representation of Traffic Composition at Km 174.00 (Volume and PCU wise) Fig 6.5



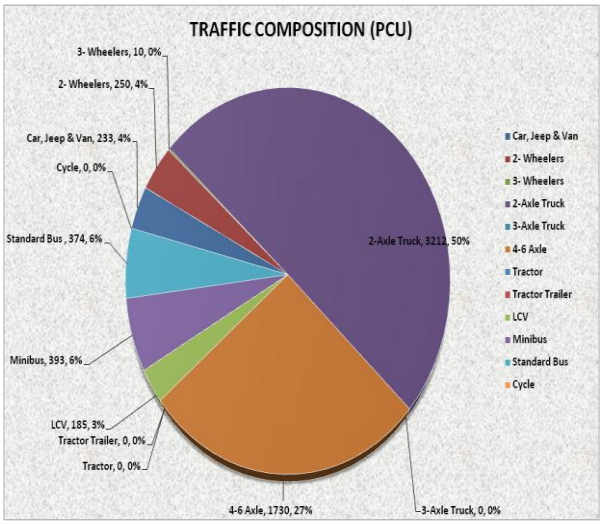
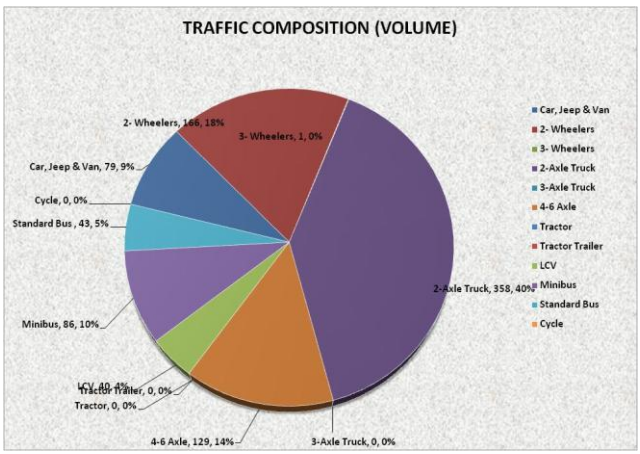


Table 6.11:Tabular representation of traffic composition

Types of Vehicles	Volume	PCU
Car, Jeep & Van	233	233
2- Wheelers	501	250
3- Wheelers	10	10
2-Axle Truck	1070	3212
3-Axle Truck	0	0
4-6 Axle	384	1730
LCV	124	185
Minibus	262	393
Standard Bus	125	374



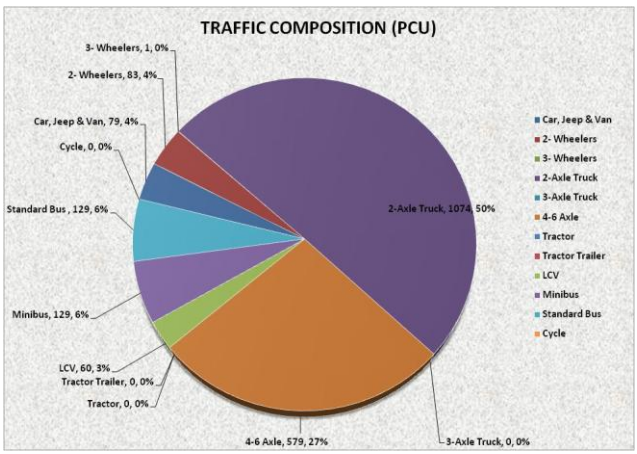


Table 6.12:Tabular representation of traffic composition

Types of Vehicles	Volume	PCU
Car, Jeep & Van	148	148
2- Wheelers	299	150
3- Wheelers	1	1
2-Axle Truck	643	1929
3-Axle Truck	0	0
4-6 Axle	232	1045
LCV	80	120
Minibus	157	235
Standard Bus	84	253

Appendix 6.1 at the end of this chapter presents location wise traffic volume survey analysis summary sheet that comprise averaged (7 day) mode wise hourly traffic (Both Directions), as well as directional traffic flow, in terms of total vehicles and PCU, overall directional split, peak hour traffic, daily variation in traffic intensity, traffic composition, mode wise hourly variation, and other salient features.

6.4.7 Origin – Destination Survey

The project road starts from NH-39, and intersects NH-61 at High Court junction and NH-150 near BSF Camp and terminates between Km 192.00 & Km 193.00 of NH-39.

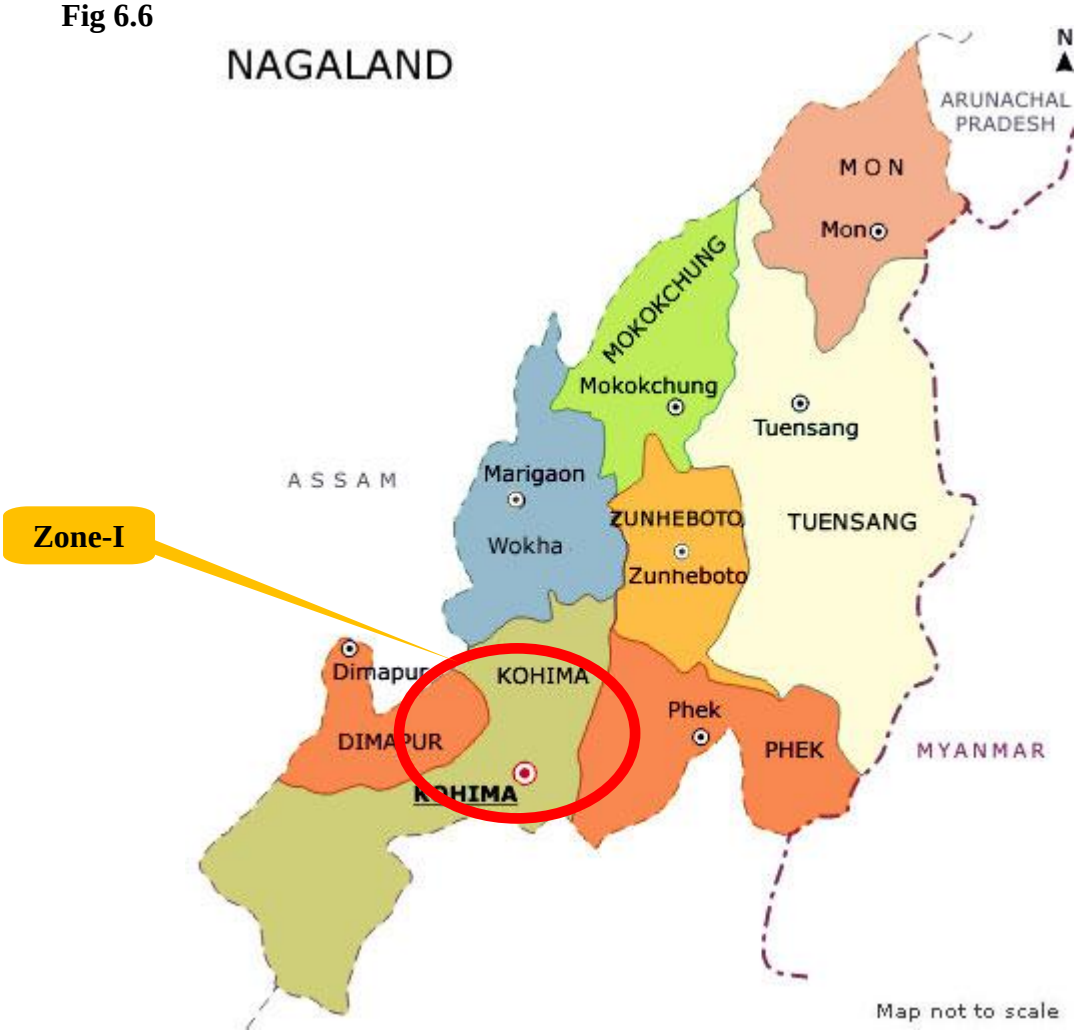
The proposed bypass of the Kohima town is major connecting link between NH-39, NH-61 & NH-150. Therefore the vehicles terminating at Kohima is the only volume which may not use the bypass alignment.

Origin-Destination Surveys were conducted on the project corridor to establish the travel desire pattern. The data collected was analysed to obtain the travel characteristics of the road users of different categories. The desire pattern of the road users have been established on the basis of the O-D survey data and the traffic zones formulated for the same.

6.5.1 Zoning System

A traffic zoning system is essential for the appreciation of the travel pattern, which reflects direct and indirect impacts of the project. Keeping in view the impact of the project corridor, which falls in Kohima district, the study area (India) is divided into a three-stage zoning system. The first stage is at the district level where district(s) or even a portion of the district has been considered as a traffic zone. In the second-stage (i.e. at state level of North-East region) individual or groups of districts form a traffic zone. In the third-stage of the zoning system (i.e. at national level), individual states or group of states form a traffic zone based on their influence on the project corridor.

Fig 6.6


NAGALAND
N
ARUNACHAL PRADESH
MON
Mon
MOKOKCHUNG
Mokokchung
Tuensang
ASSAM
Marigaon
Wokha
ZUNHEBOTO
Zunheboto
TUENSANG
Zone-I
Dimapur
KOHIMA
Phek
DIMAPUR
PHEK
MYANMAR
KOHIMA
Map not to scale

Considering the traffic scenario along the project road zones are divided as the Table 6.12 below.

Table 6.12: List of Traffic Zones

Zone No.	Zone Name	District/ State	Places
1	Kohima	Kohima, Phek, Dimapur	Kohima, Phek, Dimapur
2	Nagaland	Nagaland	Imphal, Golaghat, Guwahati & other major towns of neighbouring states
3	Neighbouring States	India	Assam, Manipur, Arunachal Pradesh,
4	Other States of Nagaland	All other states of North-East	Meghalaya, Mizoram, Tripura
5	India	Other States of India	West Bengal, Bihar, Jharkhand, Orissa

6.5.2 Commodity Analysis

Distribution of trips by vehicle type and commodity carried are described in this section.

Goods Vehicle – Lead and Load Analysis

The proposed corridor, which being part of New National Highway-02 in future, caters to a variety of transported goods. Though being very tough to classify all varieties into categories, effort has been made to group the various types of goods into 7 categories to cover broad cross-section of the various commodities in transit.

Table 6.13: Distribution of Trips (%) by Vehicle Type and Commodities carried

Vehicle Type /Commodity	Food Grains	Textiles Clothing	Petroleum Products	Machine Parts	Fruits Vegetables	Others	Empty
LCV/Tempo	22	18	0	2	35	14	9
2 Axle Truck	15	12	35	20	9	6	3
All Vehicle type	8	0	12	14	7	32	27

From above table, it can be observed that major commodity types carried by goods vehicles are Fruits and Vegetables (35%) & Petroleum products (35%) followed by Food grains (22%). The considerable share of fruits/vegetables, Machine parts and Petroleum products can be attributed by existing agricultural and social development along the project corridor. Significant other commodities include building materials viz. cement, bricks and stone and household goods.

6.5.3 Passenger Vehicles – Head, Occupancy and Trip Purpose

Table 6.14 present the distribution of trips by vehicle type and purpose.

Table 6.14: Distribution of Trips (%) by Vehicle Type and Purpose

Vehicle Type/Purpose	Work	Education	Business	Social	Shopping	Recreation	Health	Others
Car/Jeep	30	10	17	8	6	15	6	8
Two-wheeler	16	8	14	20	20	16	2	4
All Vehicle	30	10	17	8	6	15	6	8

From the table it can be observed that a maximum of trips around 47%, are performed for work and business, followed by social and recreation. For work and business purposes, cars and two-wheelers are the most preferred vehicle type. For other trip purposes, cars are the most preferred one, which indicates the vehicle ownership results in higher trip rates for trips other than work and business.

6.5.4 Development of Origin-Destination Matrices

The location wise O-D matrices have been combined as per the following to obtain a single O-D matrix for the project corridor.

Table 6.15: O-D Matrics for Commercial Vehicles

		Destination				
	Zone	**1**	**2**	**3**	**4**	**5**
Origin	**1**	22	18	9	4	1
	2	23	15	7	0	0
	3	15	2	15	0	0
	4	5	2	1	0	0
	5	7	3	2	0	0

Table 6.16: O-D Matrics for Passenger Vehicles

		Destination				
	Zone	**1**	**2**	**3**	**4**	**5**
Origin	**1**	38	19	5	3	0
	2	15	21	6	2	0
	3	9	18	7	2	0
	4	4	2	1	0	0
	5	1	1	0	0	0

6.5.5 Travel Pattern

From the Origin-Destination matrices generated through the survey, it can be inferred that Zone-1 & 2 attracts a maximum share of traffic movement.

6.5.6 Major Trip generators

From the Origin-Destination matrices generated through the survey, it can be inferred that the Dimapur, Kohima & Phek districts of Nagaland and Imphal in Manipur are the major generators of goods & passengers vehicles followed by neighboring states of Assam, Arunachal Pradesh, Manipur and Tripura.

6.5.7 Outcome of OD survey

One day traffic count survey has been conducted near High court junction & BSF Camp to assess the total volume of traffic coming to Kohima via NH-61 and NH-150.

Summary of one day TVC at above locations is presented as **Appendix-6.2 & 6.3** at the end of this chapter.

Graphical representation of Traffic composition for the above locations is shown below: **Fig 6.7**

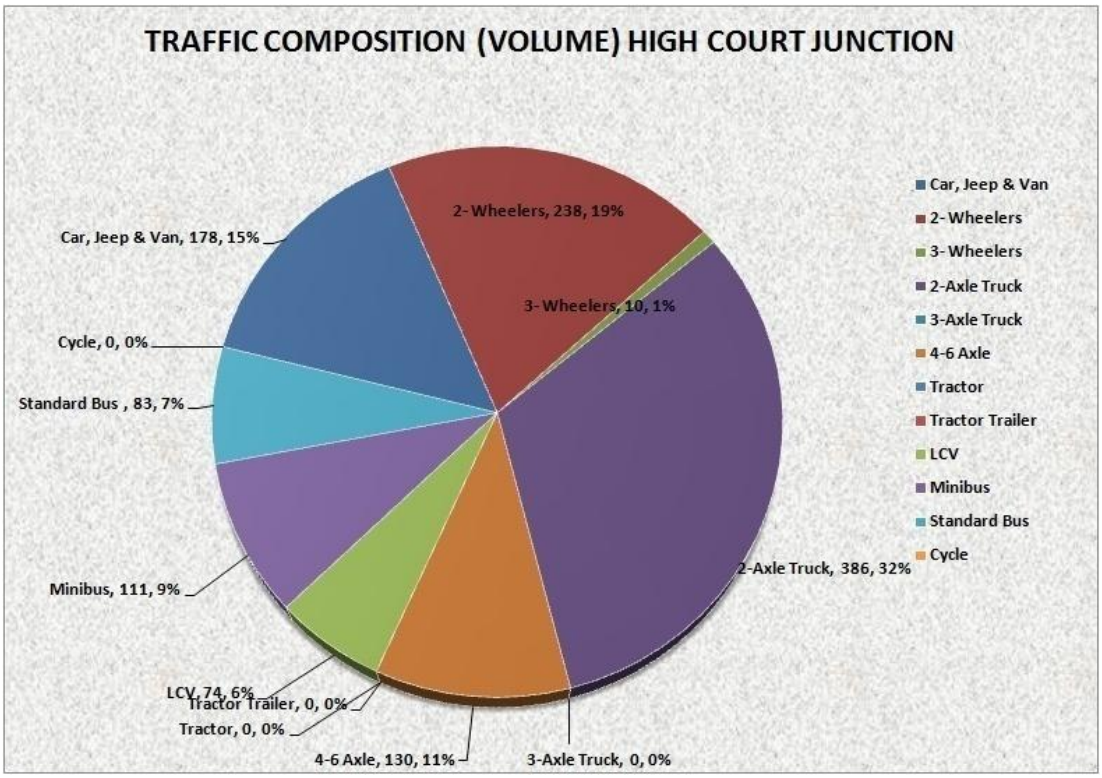
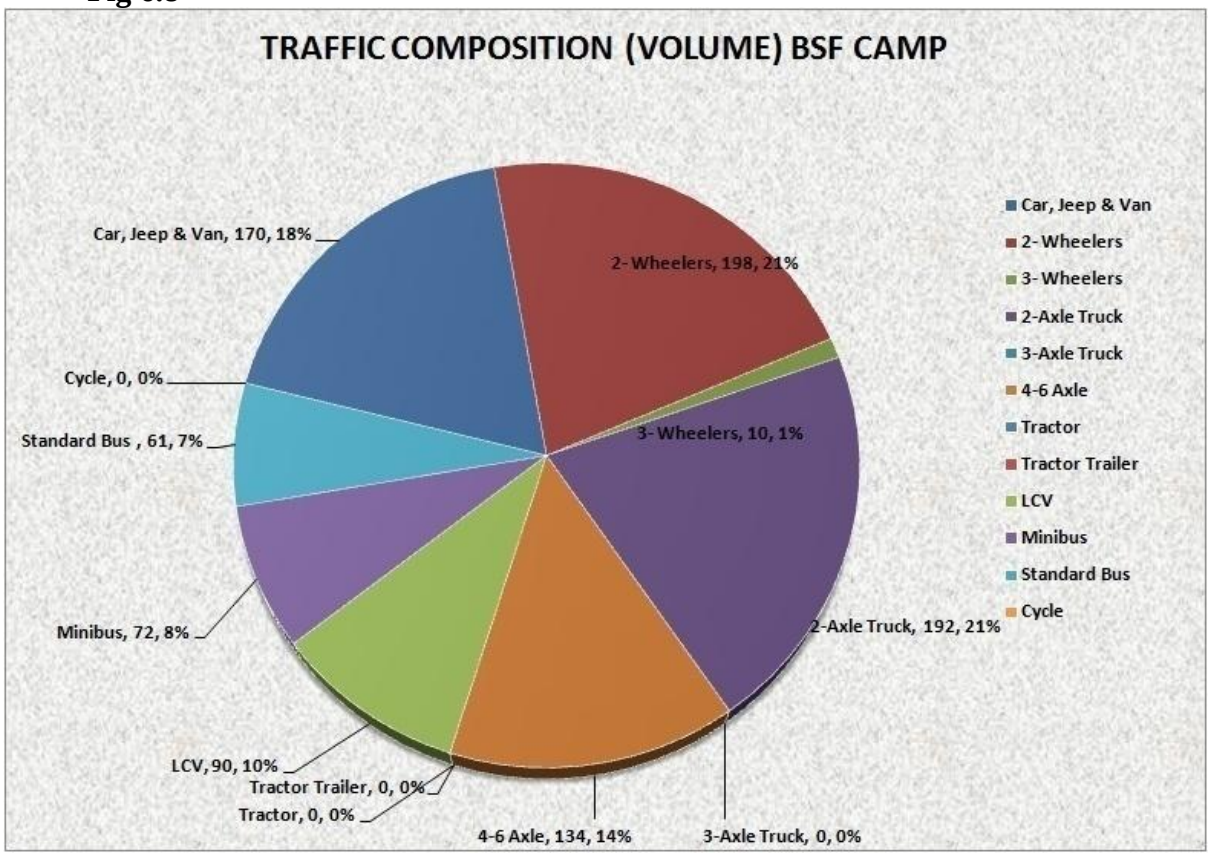


Fig 6.8



It is analysed that the percentage of commercial & passenger traffic, which will utilize the bypass alignment after development is 80% & 70%. The traffic of High Court Junction is considered for future analysis in the higher side.

Traffic count summary of High Court Junction: **Table no 6.17&6.18**

Motorized Passenger Vehicle	**Motorised Goods Vehicle**	**Non-Motorized Vehicle**	**Total Vehicle**	**Total PCU**
620	590	0	1210	2577

Above discussed percentage of commercial and passenger of the traffic volume for High Court Junction is considered as induced traffic for the project for future analysis.

Motorized Passenger Vehicle	**Motorised Goods Vehicle**	**Non-Motorized Vehicle**	**Total Vehicle**	**Total PCU**
348	472	0	820	1990

6.6 Average Annual Daily Traffic

6.6.1 Seasonal Correction

The traffic plying on any road generally varies over different periods of year depending on the cycle of different socio-economic activities in the regions through which it passes. Therefore, in order to have more realistic picture of the traffic on the project road, it is required to assess seasonal variation in traffic to estimate Annual Average Daily Traffic (AADT) and Peak Season ADT. Therefore, the ADT observed during the survey duration is multiplied by a Seasonal Correction Factor (SCF) to derive AADT and Peak season ADT. The seasonal correction factor is generally derived from secondary data sources such as past month-wise traffic data on the project road, sales of fuel at different filling stations along the project highway etc.

In the absence of any other data, either of the project road or in the vicinity, only the monthly figures of fuel sales collected from one petrol pump on the project road is considered in the estimation of seasonal variation and seasonal correction factors.

However, in the current project there is no such special variation of traffic volume is noticed as per the local enquiry. Therefore, the ADT will be considered as AADT with induced traffic analysed from OD survey (Discussed above).

6.6.2 Average Annual Daily Traffic

The average daily traffic for the project corridor is presented in table 6.4 of this chapter and the same is also shown below:

Location	Motorized Passenger Vehicle	Motorised Goods Vehicle	Non-Motorized Vehicle	Total Vehicle	Total PCU
Kohima (Km174)	1130	1579	0	2709	6387
Km 194.00	689	955	0	1644	3880

Average daily traffic for Km 174.00 is considered for Traffic projection and calculation of MSA for project corridor. The average annual traffic comprises with addition of ADT of Km 174.00 and Induced traffic from OD survey, the AADT is summarised in table shown below as **Table 6.19.**

Table 6.19:- Detail of Average Annual Daily Traffic

Vehicle Type	Km 174.00	Induced traffic from OD Survey	AADT
Car, Jeep, Vans, three wheelers	233	125	358
Motor cycle & Scooters	501	167	668
LCV	134	67	201
BUS	386	136	522
Two Axle Truck, Multi Axle Truck	1455	413	1868
Agriculture Tractor with Trailer	0	0	0
Cycle/Cycle Rickshaw	0	0	0
Animal Driven Vehicles	0	0	0
Other vehicle (Plz Specify)	0	0	0
Total Motorised Vehicles (Number)	**2709**	**908**	**3617**
Total Motorised Vehicles (PCU)	**6387**	**1990**	**8377**
Total Commercial Vehicle per day	**1975**	**616**	**2591**

6.7 Intersection Turning Movement Survey

To appreciate the traffic volume characteristics at intersections, turning movement surveys have been conducted at five major intersections. The salient features of volume characteristics are presented in Table 6.20.

Table 6.20: Traffic Volume Characteristics at Intersections

SI. No.	Name of Intersection	Type of Intersection	Survey Duration (hrs)	Total volume (PCU)	Peak Volume (PCU)	Peak hour	% Right Turning Traffic
1	High Court Junction	3-arm	8	2568	395	10.00 – 11.00	29
2	NBCC Junction	3-arm	8	5367	891	11.00 – 12.00	38
3	New Secretariat	3-arm	8	1847	293	13.00 – 14.00	31

The peak hour flow has been observed to be maximum at NBCC Junction (891 PCU). The share or quantity of right turning traffic in peak flow is the index value, which indicates the intensity of vehicle-vehicle conflict at the intersection. The highest share

of right turning traffic has been observed at NBCC Junction, followed by New Secretariat Junction.

The total PCU of all the junctions is less and none of the above junctions comes in the alignment of proposed bypass, hence, it is proposed to develop the above junctions as per guidelines of IRC SP: 41.

Appendix 6.4, 6.5 & 6.6 shows the summary of TMC for above mentioned locations and presented at the end of this chapter**.** Each sheet provides mode wise hourly total intersection traffic volume, direction-wise traffic in terms of total vehicles and PCU, peak hour turning traffic characteristics, traffic composition, hourly variation and a Peak Hour Flow Diagram (PHFD) for one intersection.

6.8 Inventory of Existing Wayside Amenities

The current project is to bypass the Kohima town. There is no existing wayside amenity along the proposed alignment.

6.9 Truck Parking Inventory

To provide an uninterrupted flow of traffic on corridor, it is essential to cater to the road-side parking demand in a systematic manner. Parking studies have been carried out along the project corridor at two pre-identified locations (covering LHS/RHS, or both).

There is no existing truck lay byes near the proposed bypass alignment.

6.10 Traffic Forecast

The traffic forecasting or projections has been done considering the following design data based on **IRC 37:2012**. Calculation sheet of MSA is presented at the end of this chapter

The list of design considerations is presented in table 6.21:

Table 6.21: List of Design Consideration for traffic projections

S.No	Design considerations	Value as per IRC 37:2012
1	Traffic growth rate	5%
2	Design Life	Flexible Pavement 15 Years
3	Vehicle Damage Factor	2.5 for Hilly terrain
4	Lane distribution factor	0.75 for Dual carriageway roads

Table 6.22 shows the Projection of Present Traffic data for project corridor upto 2052 (30 Years).

Table 6.22: Projection of Present Traffic data upto 2047

Year	Two Wheeler	Car, Jeep, Van	Mini / RTVs	Standard Bus	LCV	2-Axle, 3-Axle	MAV	Total Vehicle	Total PCU	Total Commercial Vehicle	Cummulative MSA
2017	668	358	339	183	201	1380	488	3617	8387	2591	**Year of Construction**
2018	702	376	356	193	212	1449	513	3801	8814	2723	
2019	738	395	374	203	223	1522	539	3994	9260	2861	
2020	775	415	393	214	235	1599	566	4197	9731	3150	
2021	960	514	487	265	291	1980	701	5198	12051	3724	
2022	1008	540	512	279	306	2079	737	5461	12662	3913	**2.16**
2023	1059	567	538	293	322	2183	774	5736	13298	4110	**2.16**
2024	1112	596	565	308	339	2293	813	6026	13970	4318	**4.42**
2025	1168	626	594	324	356	2408	854	6330	14674	4536	**6.80**
2026	1227	658	624	341	374	2529	897	6650	15415	4765	**9.29**
2027	1289	691	656	359	393	2656	942	6986	16193	5006	**11.91**
2028	1354	726	689	377	413	2789	990	7338	17009	5258	**14.66**
2029	1422	763	724	396	434	2929	1040	7708	17866	5523	**17.55**
2030	1494	802	761	416	456	3076	1092	8097	18765	5801	**20.59**
2031	1569	843	800	437	479	3230	1147	8505	19709	6093	**23.77**
2032	1648	886	840	459	503	3392	1205	8933	20700	6399	**27.12**
2033	1731	931	882	482	529	3562	1266	9383	21742	6721	**30.63**
2034	1818	978	927	507	556	3741	1330	9857	22841	7061	**34.31**
2035	1909	1027	974	533	584	3929	1397	10353	23991	7417	**38.19**
2036	2005	1079	1023	560	614	4126	1467	10874	25197	7790	**42.25**
2037	2106	1133	1075	588	645	4333	1541	11421	26464	8182	**46.52**
2038	2212	1190	1129	618	678	4550	1619	11996	27796	8594	**51.00**
2039	2323	1250	1186	649	712	4778	1700	12598	29190	9025	**55.71**
2040	2440	1313	1246	682	748	5017	1785	13231	30654	9478	**60.65**
2041	2562	1379	1309	717	786	5268	1875	13896	32195	9955	**65.84**

Year	Two Wheeler	Car, Jeep, Van	Mini / RTVs	Standard Bus	LCV	2-Axle, 3-Axle	MAV	Total Vehicle	Total PCU	Total Commercial Vehicle	Cummulative MSA
2042	2691	1448	1375	753	826	5532	1969	14594	33811	10455	**71.28**
2043	2826	1521	1444	791	868	5809	2068	15327	35508	10980	**77.00**
2044	2968	1598	1517	831	912	6100	2172	16098	37293	11532	**83.01**
2045	3117	1678	1593	873	958	6405	2281	16905	39162	12110	**89.32**
2046	3273	1762	1673	917	1006	6726	2396	17753	41128	12718	**95.94**
2047	3437	1851	1757	963	1057	7063	2516	18644	43191	13356	**102.89**
2048	3609	1944	1845	1012	1110	7417	2642	19579	45357	14026	**110.19**
2049	3790	2042	1938	1063	1166	7788	2775	20562	47634	14730	**117.85**
2050	3980	2145	2035	1117	1225	8178	2914	21594	50023	15469	**125.90**
2051	4179	2253	2137	1173	1287	8587	3060	22676	52529	16244	**134.35**
2052	4388	2366	2244	1232	1352	9017	3213	23812	55160	17058	**143.23**

6.11 Capacity analysis

Analysis of capacity of the proposed bypass has been performed as per the guidelines suggested in IRC 73:2015 and IRC 84:2014. The capacity of 2 lane and 4 lane road is described in table 6.23

Table 6.23: Design service volume of 2 lane & 4 lane

S.No	Terrain	Capacity of Road in PCU (LOS B)	
		2-Lane (IRC 73:2015)	4-Lane (IRC 84:2014)
1	Plane	18000	40000
2	Rolling	13000	
3	Mountainous & Steep	9000	20000

As per the traffic projections presented in table 6.22 for the project corridor, the capacity of the proposed bypass will cross the capacity limit for 2 lane in year 2019 and 4 lane in year 2032.

It is important to be noticed that the traffic projection of traffic data for Km 194.00 (Table 6.23) indicates that in the year 2032, 4-lane is required after the end of project corridor.

Therefore, it is suggested to start the bypass by or before year 2019 upto 4-lane configuration for smooth movement of traffic in that area.

CALCULATION OF MSA

MSA Calculation

$$N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$$

Where,

N= Cumulative number of standard axles to be catered for in the design in terms of msa

A= Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day (CVPD)

$A = P \times (1+r)^x$

Where,

P= Number of commercial vehicles as per last count

x= Number of years between the last count and the year of completion of construction

D= Lane distribution factor

F= Vehicle damage factor

n= Design life in years

r= Annual growth rate of commercial vehicles in decimal

Calculation

1) $A = P \times (1+r)^x$

P= 2591

x= 4

r= 5

$A = P \times (1+r)^x$

$2591 \times (1 + 0.05)^4$

3149.377

3150 Say

2) $N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$ (For year 2022)

A= 3150

r= 5

n= 1

D= 0.75

F= 2.5

$N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$

$\frac{365 \times [(1+0.05)^5 - 1]}{0.05} \times 3150 \times 0.75 \times 2.5$

2155781 Standard Axles

2.16 MSA

3) $N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$ (For year 2027)

A=	3150
r=	5
n=	5
D=	0.75
F=	2.5

$N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$

$\frac{365 \times [(1+0.05)^5 - 1]}{0.05} \times 3150 \times 0.75 \times 2.5$

11912052 Standard Axles

11.91 MSA

4) $N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$ (For year 2032)

A=	3150
r=	5
n=	10
D=	0.75
F=	2.5

$N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$

$\frac{365 \times [(1+0.05)^{10} - 1]}{0.05} \times 3150 \times 0.75 \times 2.5$

27115185 Standard Axles

27.12 MSA

5) $N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$ (For year 2037)

A=	3150
r=	5
n=	15
D=	0.75
F=	2.5

$N = \frac{365 \times [(1 + r)^n - 1)]}{r} \times A \times D \times F$

$\frac{365 \times [(1+0.05)^{15} - 1]}{0.05} \times 3150 \times 0.75 \times 2.5$

46518663 Standard Axles

46.52 MSA

Table of Contents

CHAPTER – 7 DESIGN STANDARDS & IMPROVEMENT PROPOSALS

7.0 DESIGN STANDARDS

7.1 General

Design of the project road is proposed to be done as per guidelines of IRC SP 84: 2014 (Manual of Specifications and Standards for Four Laning of Highways through Public Private Partnership).

7.2 Basis

All activities related to field studies, design and documentation shall be based on the latest guidelines / circulars of MoRT&H / NHIDCL and relevant publications of the Indian Roads Congress IRC-SP-84-2014, hill road manual IRC-SP-48-1998 and Bureau of Indian Standards (BIS). For aspects not covered by IRC and BIS, international standard practices, such as, British and American standards may be adopted.

7.3 Highway Geometric Design

The design philosophy basically involves providing suitable horizontal alignment, longitudinal profile, cross section layout, safety and access control to cater to the fast and uninterrupted movement of through traffic. The geometric design elements can be broadly grouped under the following:

- *Horizontal Alignment*
- *Vertical Profile*
- *Superelevation*
- *Cross Sectional Elements*
- *Sight Distance*
- *Traffic Composition / Intensity*
- *Pavement Composition*
- *Intersection*
- *Bridges and Structures*
- *Drainage*
- *Land Use*
- *Access Control*
- *Traffic Control and Safety measures*
- *Efficiency and Comfort in Vehicle Operation*
- *Aesthetics*

- *Environmental constraints*

7.4 Proposal of project road

The project road starts from the Km 173.00 of existing NH-39, (which is under widening and improvement for four lane configuration from Dimapur to Kohima), and crosses NH-61, NH-151 and again meets with NH-39 after crossing Kohima town between Km 192.00 & Km 193.00

Hence cross section likely to be developed as per typical cross sections provided in IRC 84:2014 for open country in hilly terrain with improvements to longitudinal profiles

7.5 Horizontal Alignment

General

The horizontal alignment of the proposed road is based on the recommendations of IRC 38:1988 (Guidelines for Design of Horizontal Curves for Highways) & IRC 84:2014 (4-lane Manual).

7.5.1 Terrain Classification

Gradients

The following gradients will be adopted for different types of terrain.

Table 7.4

Terrain	Mountainous	Steep
Ruling gradient	5%	6%
Limiting gradient	6%	7%
Exceptional gradient	7%	8%

The "Limiting Gradient" will be adopted only where the adoption of gentler gradient would result in excessive cost.

Exceptional gradients are meant to be adopted only in very difficult situations and for short lengths not exceeding 100m at a stretch.

During our reconnaissance survey Kohima bypass traverses the hilly and mountainous terrain.

7.5.2 Design Speed

For this subject project the design standards of hilly and mountainous is applicable.

Table 7.1 : Design Speed

Terrain	Design Speed (Km/hr.)	
	Ruling	Minimum
Mountainous and steep	60	40

The ruling design speed will normally be the guiding criterion for correlating the various design features. The minimum design speed will be adopted in sections where the site conditions or economics do not permit a design speed based on the ruling design speed and will be adopted in consultation with the client.

7.5.3 Sight Distance

Safe stopping sight distance will be applicable, both in the vertical and horizontal directions in the geometric design.

7.5.4 Radius of Horizontal Curve

Based on the site conditions, a horizontal curve radius for hilly terrain as per IRC : 48-1988 recommendations with local adjustments for congested sections will be adopted.
The radius of horizontal curves will be calculated from the following formula :

$v^2/gR = e+f$

or

$R = V^2 / 127 (e + f)$

Where,

v= Vehicle speed in metres / Sec.

V = vehicle speed in km / h

g = acceleration due to gravity in metre / Sec ^{2}

e = superelevation in metre per metre

f = coefficient of side friction between vehicle tyre and pavement (taken as 0.15)

R = radius in metres

Based on equation and the maximum permissible value of super elevation for horizontal curves corresponding to ruling and minimum design speeds will be as per Table 5.3 given below :

Table : 7.2

Nature of Terrain	Desirable Radius	
	Desirable Radius Minimum	Desirable Radius Absolute
Mountainous and steep	150	75

7.5.5 Transition Curves

Minimum length of the transition curve to have a smooth entry/maneover will be used. This will be determined from the consideration based on rate of change of centrifugal acceleration and rate of change of super elevation. The larger value is to be adopted for design.

(a) $Ls = 0.0215\ V^3 / CR$

Where

Ls = length of transition in metres

V = speed in km / h

R = radius of circular curve in metres

C = 80 / (75 + V) (subject to a maximum of 0.8 and minimum of 0.5)

(b) The rate of change of super-elevation will not be steeper than 1 in 150 for roads in plain and rolling terrain and 1in 60 in hilly terrain. The formulae for minimum length of transitions on this basis are:

$Ls = 2.7\ V^2 / R$ For Plain and Rollin Terrain

$Ls = 1.0\ V^2 / R$ For hilly Terrain

7.5.6 Widening of carriageway on Curves

At sharp horizontal curves it is necessary to widen the carriageway to provide for safe passage of vehicles.. The extra width of carriageway to be provided at horizontal curves for two lanes road is given in Table 5.6 below.

Table 7.3: Extra Width of Pavement at Horizontal Curves

Radius of curve (m)	Upto20	21 to 40	41-60	61-100	101-300	Above 300
Extra Width (m)						
Two lane	1.5	1.5	1.2	0.9	0.6	Nil

7.5.7 Superelevation

The super elevation, where required, will be provided as per recommendation of IRC 38-1988 :

Formula :

$e = V^2 / 225R$

Where.

e = Superelevation in metre per metre

V = Design speed in km/h and

R = radius of the curve in metres

Superelevation obtained from the above expression will be kept limited to a maximum of 7 percent in snow bound areas and 10 percent in hilly area not bound by snow

The superelevation will proposed to be attained gradually over the full length of the transition curve so that the design super elevation is available at the starting point of the circular curve portion. Incase where transition curve cannot be provided and also in case of circular curves, two-third of the superelevation will be attained on the tangent section and the balance one-third on the circular portion. Each carriageway will be rotated independently about the edge.

7.6 Vertical Alignment

General

The vertical alignment of the proposed highway is based on the recommendations of IRC SP 23 and IRC SP 84:2014.

7.6.1 Vertical Curves

Parabolic vertical curves will be introduced between sections to ensure a smooth transition at change of grades.

Vertical curves will be provided at all grade changes exceeding those indicated in Table 7.5. For satisfactory sight distance the minimum length of vertical curve shall generally be kept as 100 m with absolute minimum length as shown in the table 7.6 below.

Table 7.5 : Minimum length of vertical curves

Design Speed (km / h)	Maximum grade change (percent) not requiring a vertical curve	Minimum length of vertical curve (m)
Upto 35	1.5	15
40	1.2	20
50	1.0	30
65	0.8	40

Summit curves will be designed for safe stopping sight distance. The values of the safe stopping sight distance / head light sight distance are given in Table 5.9

Table 7.6 : Safe Stopping Sight Distance / Head Light Sight Distance (m)

Design Speed (km / h)	Safe stopping sight distance / Head light sight distance (m)
60	80
40	45

7.6.2 Summit Curves

For safe stopping sight distance the length of summit curve will be calculated from the following formulae:

(a) When the length of curve (L) exceeds the required sight distance (S) i.e.
$L > S$
$L = NS^2 / 4.4$

(b) When the length of curve (L) is less than the required sight distance (S) i.e

$L < S$
$L = 2S - 4.4 / N$

Where N = algebraic difference between the grades.

7.6.3 Valley Curves

The length of valley curves will be calculated by the following two criterion:

(a) When length of the curve (L) exceeds the required sight distance (S) i.e.
$L > S$
$L = NS^2 / (1.50 + 0.0355)$

(b) When the length of curve (L) is less than the required sight distance (S) i.e.

$L < S \qquad L = 25 - \frac{1.50 - 0.035S}{N}$

Where
N = deviation angle i.e. the algebraic difference between two grades
L = Length of parabolic vertical curve in meters
S = Stopping sight distance in meters

7.7 Cross-sectional Elements

7.7.1 Lane Width of Carriageway

The standard lane width of the Project Highway shall be 3.5 m.

7.7.2 Median

In open and builtup sections 2.5 m wide raised median shall be provided in hilly and steep terrain without and with footpath respectively.

The median in built up areas shall be paved and railings of steel and suitable antiglare measures such as plastic screens shall be provided at the center of median to reduce headlight glare from opposite traffic. The total height of screen including the height of the barrier shall be 1.5 m and spacing shall be such as to effectively cut the glare.

7.7.3 Shoulders

Width of Shoulders

The shoulder width on both sides of the carriageway shall be as given in **Tables 7.7**

Table 7.7 Width of Shoulders in Mountainous and Steep Terrain (Hilly Area)

Type of Section		Width of Shoulder (m) *		
		Paved	**Earthen**	**Total**
Open country with isolated built up area	Hill Side	1.5 m	-	1.5 m
	Valley Side	1.5 m	1.0 m	2.5 m
Built up area and approaches to grade separated structures/ bridges	Hill Side	0.25 m + 1.5 m (Raised)	-	1.75 m
	Valley side	0.25 m + 1.5 m (Raised)	-	1.75 m

* Exclusive of parapets on valley side and side drains on hill side.

Notes :

i) In case retaining wall with parapet is provided on valley side, the earthen Shoulder may not be provided.

ii) Width of paved shoulders in approaches to grade separated structures as indicated in Table 7.7 and 7.8 above shall extend on either side of the structure in the entire length of retaining/RE wall. The retaining/RE wall on either side shall be abutting the paved shoulders and shall have crash barriers on top.

iii) In built up area where two lane highway is provided and extra right of way is available, the space between the paved shoulder and foot path cum drains on both sides shall be covered with paver block flooring. Similarly in 4-lane sections the space between carriageway and footpath cum drains on both sides shall be covered with paver block flooring,

Where embankment is more than 6 m high, kerb with channel shall be provided at the end of paved shoulder to channelize the drainage as an erosion control device in accordance with Section 6 of this Manual and earthen shoulder shall be raised upto the level of kerb.

7.7.4 Roadway Width

The width of roadway shall depend upon the width of carriageway, shoulders and the median.

On horizontal curves with radius upto 300 m, width of pavement and roadway shall be increased as per Table 7.9

Table 7.9 Extra Width of Pavement and Roadway

Radius of Curve	Extra Width
75-100 m	0.9 m
101-300 m	0.6 m

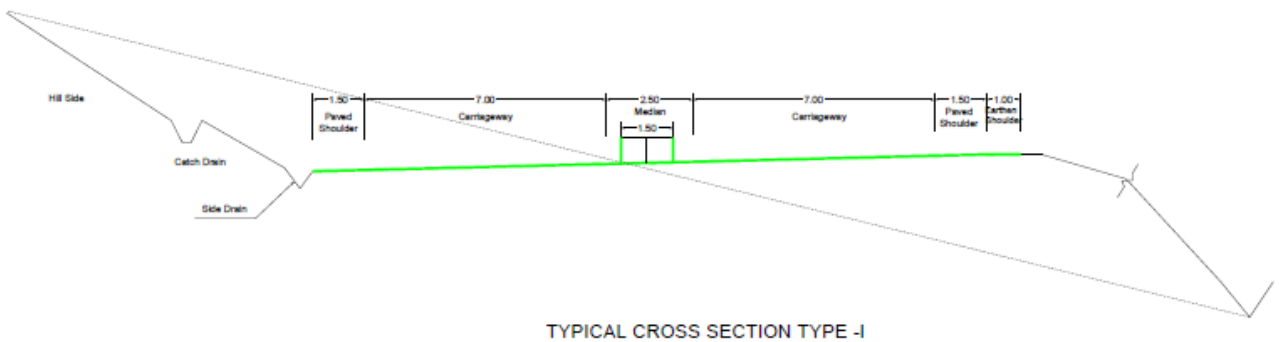
7.7.5 Camber or Cross Fall

The cross fall on straight sections of road carriageway, paved shoulders and paved portion of median shall be 2.5 percent for bituminous surface and 2.0 percent for cement concrete surface.

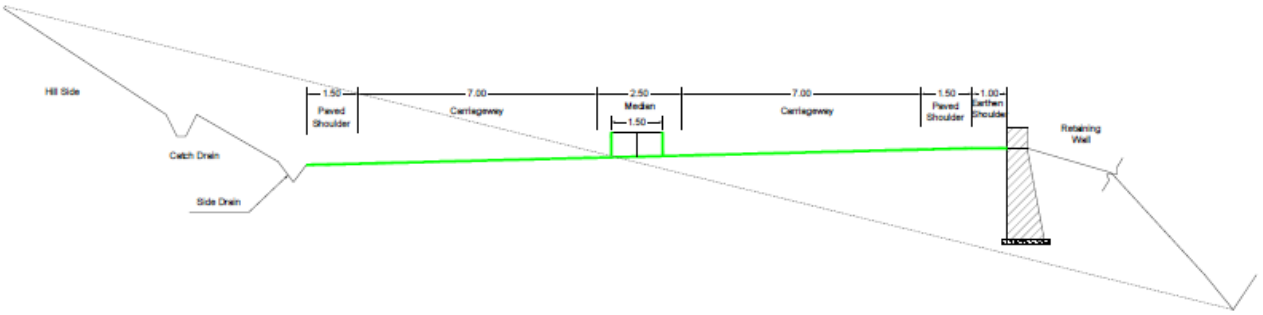
The cross falls for earthen shoulders on straight portions shall be at least 0.5 percent steeper than the slope of the pavement and paved shoulder subject to a minimum of 3.0 percent. On super elevated sections, the earthen portion of the shoulder on the outer side of the curve shall be provided with reverse cross fall of 0.5 percent so that the earth does not drain on the carriageway and the storm water drains out with minimum travel path.

7.7.6 Typical cross sections of road are shown below:

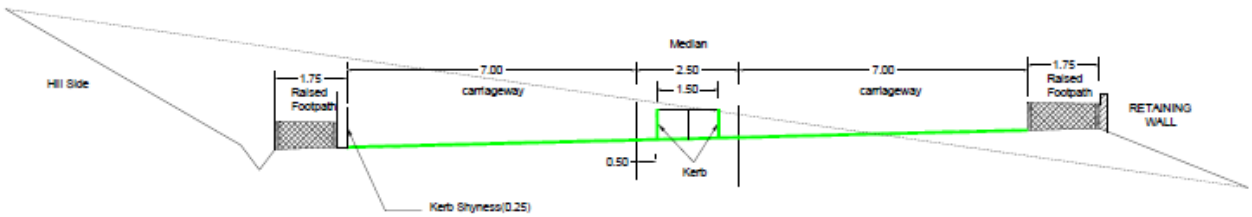
Type of TCS	Description
TCS -I	Open country- Mountainous Terrain without Retaining wall on New alignment
TCS-II	Open country- Mountainous Terrain with Retaining wall on New alignment
TCS-III	Built up section-Mountainous Terrain
TCS-IV	Open country- Mountainous Terrain without Retaining wall on Existing Road
TCS-V	Open country- Mountainous Terrain with Retaining wall on Existing Road



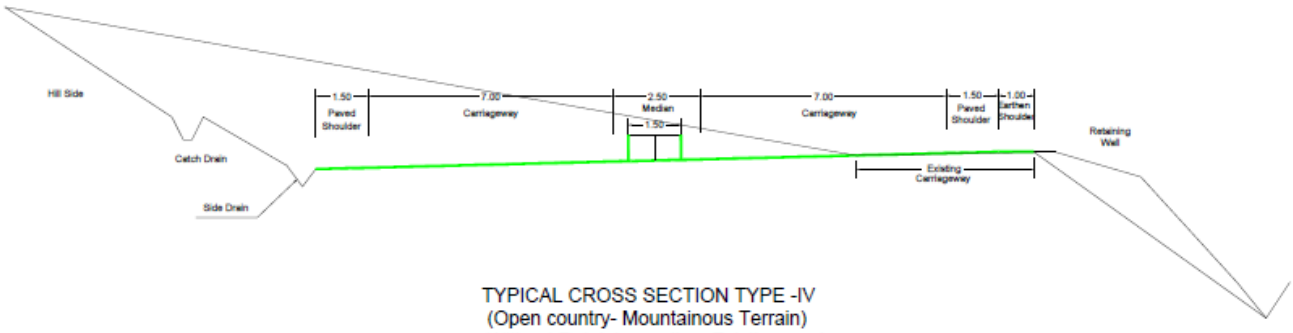
TYPICAL CROSS SECTION TYPE -I
(Open country- Mountainous Terrain)
Without Retaining wall on New Alignment



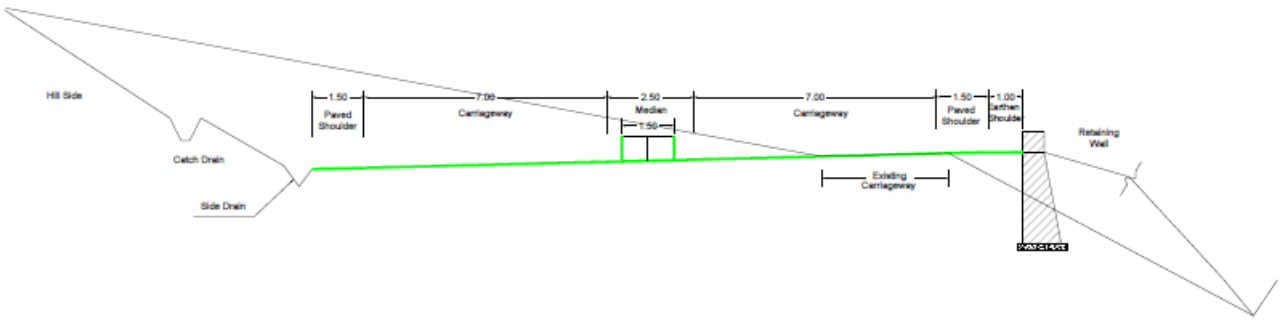
TYPICAL CROSS SECTION TYPE -II
(Open country- Mountainous Terrain)
With Retaining wall on New Alignment



TYPICAL CROSS SECTION TYPE-III
(Built-up Section-Mountainous Terrain)



TYPICAL CROSS SECTION TYPE -IV
(Open country- Mountainous Terrain)
Without Retaining wall on Existing road



TYPICAL CROSS SECTION TYPE -V
(Open country- Mountainous Terrain)
With Retaining wall on Existing road

7.9 Pavement Design

Pavement would be designed as per IRC 37-2012 for flexible pavement and IRC 58:2015 for rigid pavement.

7.10 Standards for Interchange and at-grade Intersections

Where requirement of providing interchanges arises, the standards developed from AASHTO/IRC standards will be proposed for approval of NHIDCL.

The standards proposed in IRC: SP: 41 "Guidelines for the Design of At-Grade Intersection in Rural and Urban Areas" will be applied.

7.11 Bridges

The design of various components of bridges / structures viz. Superstructure, substructure, foundations, protection works and preparation of repair and rehabilitation plans for existing bridges / structures will be carried out based on relevant IRC codes of practice (prescribed for design, execution, maintenance and safety during construction and service), MoRT&H specifications, latest guidelines and circulars as well as relevant Bureau of Indian Standards (BIS). For aspects not covered by IRC and BIS Standards, relevant recommendations of the International Standards or Sound Engineering Practice will be followed. The structures for new bridges will be aesthetically pleasing and the form selected will be most innovative and cost effective and suitable for construction by locally available technology. Various designs will be prepared as per the following detailed methodology given in the following standards :

7.11.1 Standards and Codes of Practice

Various Codes of Practices referred are as under

- IRC:5-1998
- IRC:6-2014
- IRC: 112-2011
- IRC:22-1986 (latest revision)
- IRC:24-1967
- IRC:45-1972 (reprint 1996)
- IRC:78-2000
- IRC:83-1982 (Part II)
- IRC:83-2000 (Part III)
- IRC:86 1987 (Part II)
- IRC:86-1983
- IRC: 87
- IRC: 89
- IRC: SP 13-2004
- IRC:SP-33-1989 (Provisions wherever applicable)
- IRC: SP 40
- IRC: SP 64
- IRC: SP 66
- IRC: SP 69
- IRC: SP 70
- IS:456-2000
- IS:2502-1963
- IS: 2911 (latest)

a) Protection Works

- IRC:89-1997

b) Repair / Rehabilitation Proposals of Bridges

- IRC:SP-37 Guidelines for Evaluation of Load Carrying Capacity of Bridges.
- IRC:SP:40 Guidelines on Techniques for Strengthening and Rehabilitation of Bridges.

7.11.2 Typical Cross Sections for Structures

The typical cross-sections for structures are presented below as Fig no._____

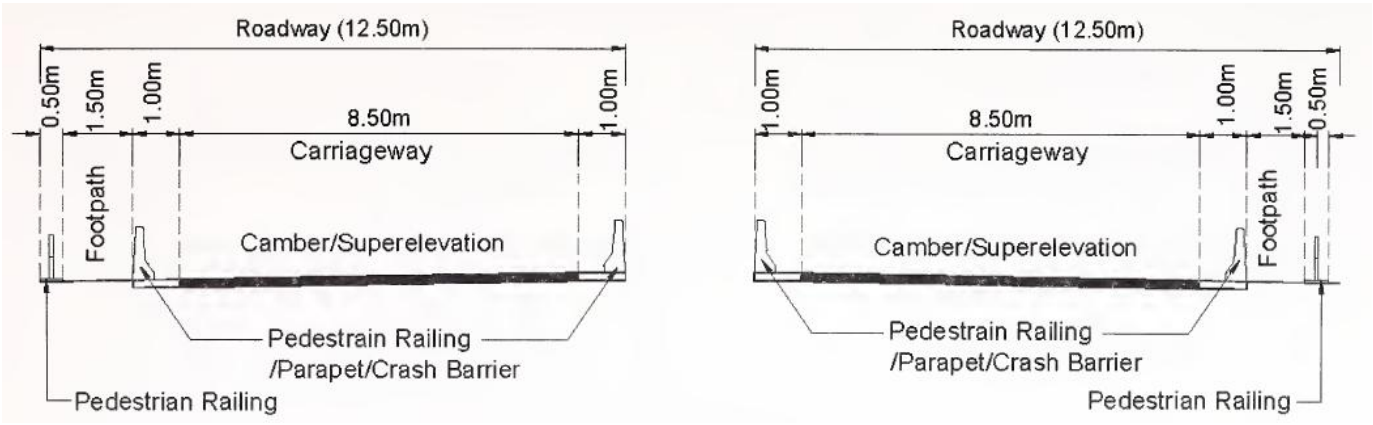


Fig. 7.3.3: Cross Section of Bridge at Deck Level – with Footpath 4-Lane Divided Highway

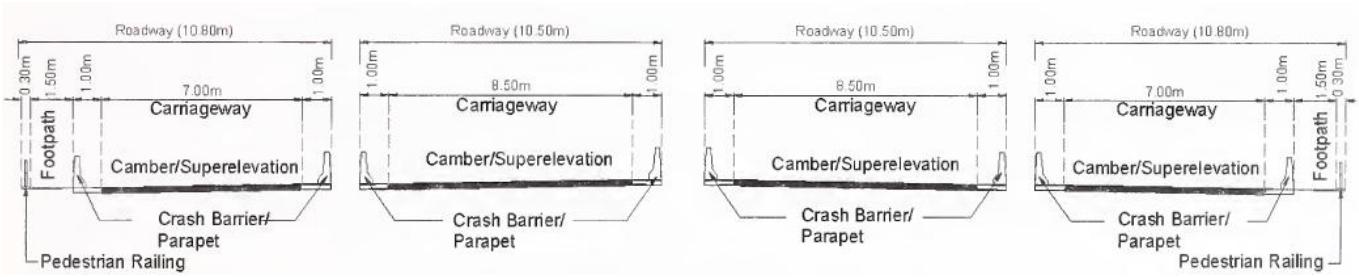


Fig. 7.3.4: Cross Section of Bridge at Deck Level – with Road Bridges and Footpath

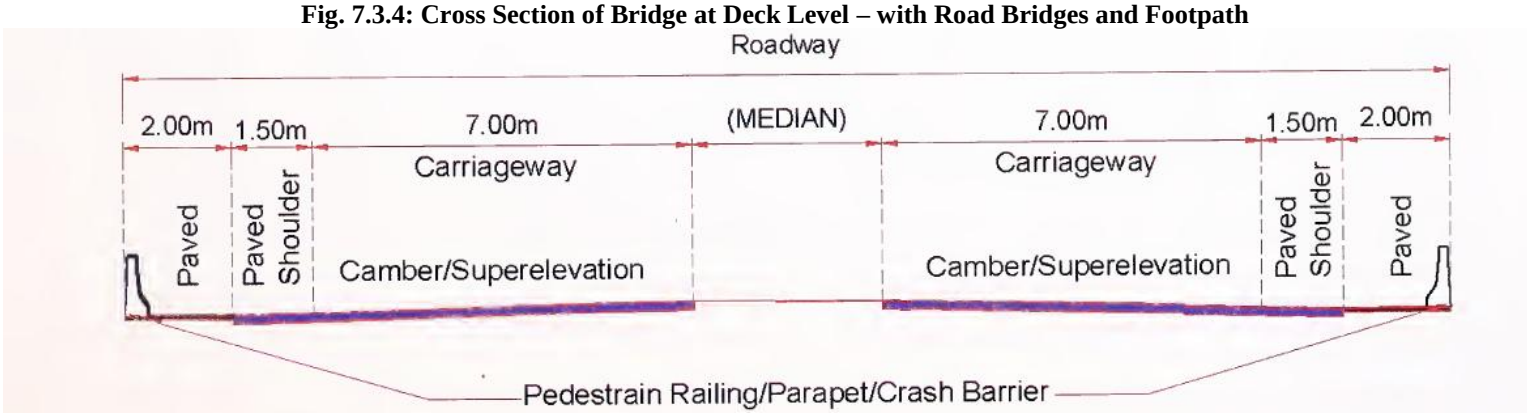


Fig. 7.3.2: Cross Section of Slab/Box Culvert at Road Level 4-Lane Divided Highway

Materials

Concrete Grade

Grade of concrete in various elements has been given as under :

- PSC box - M45/M50
- RCC pedestal below bearing - M40
- RCC Arch bridge & foundation - M35/M40
- RCC Pile & Pile cap - M35/M40
- RCC T girder superstructure - M35
- RCC Substructure - M35/M40
- RCC open foundation - M35
- Crash barrier - M40
- Railing - M30
- All PCC structural member - M25
- All PCC non structural members - M15

Reinforcement Steel

- High yield strength deformed bar of grade Fe500D conforming to IS:1786/ /TMT bar of the same grade may be used

- Mild steel bars shall be of grade Fe240

Prestressing System

a)	System	:	19T13 multipull strand system of "Freyssinet" or "ISMALCCL" or equivalent
b)	Cables	:	19T13/12T13 cables with strands of 12.7mm nominal dia
c)	High Tensile Steel	:	
	- Strands	:	Nominal 12.7mm dia 7 ply low relaxation strands conforming to class 2 of IS:14268
	- Area	:	98.7 sq.mm per strand (nominal cross sectional area)
	- Ultimate load	:	183.71 KN per strand
	- Modulus of Elasticity	:	1.95x105MPa
d)	Sheathing	:	90mm OD Bright metal corrugated flexible sheathing for 19T13 cables respectively.

e)	Friction Coefficient	:	0.20/radian
f)	Wobble Coefficient	:	0.0030/m
g)	Anchorage Slip	:	6mm average
h)	Loss of force due to relaxation after 1000 hrs.:		3.8% at 0.765 UTS has been assumed in design.

Structural steel

- Structural steel tubes shall conform to IS:1161
- Grade of structural steel rolled section Fe: 410WA

7.11.3 Bearings

POT – PTFE Bearings

For small span elastomeric bearing may be proposed. Elastomeric bearings shall be designed as per IRC:83 (Part II) and shall conform to Cl. 2005 of MoRTH's Specifications for Road & Bridge Works.

POT-PTFE bearing have been proposed for long span. The loads and forces coming on the bearings shall be provided to enable the manufacturer to design these bearings and these shall conform to Cl. 2006 of MORT&H's Specifications for Road & Bridge Works (4th Revision). To calculate load on bearing Latest IRC slandered to be followed with appropriate Seismic response reduction factor in seismic case.

7.11.4 Expansion Joints

Elastomeric Single Strip Seal Expansion Joints shall be proposed for superstructure having more movement. For small span filler type expansion joint may be proposed.

Strip seal type expansion joints shall conform to and be installed as per the requirements of MORT&H's Specifications issued vide letter no. RW/NH-34059/1/96-S&R dated 30.11.2002, subsequent amendments no. RW/NH-34059/1/96-S&R dated 25.01.2001 duly supplemented by manufactures specifications.

The expansion joint assembly shall follow the profile of the crash barrier and the footway kerbs for the full height.

7.11.5 Loads and Load Combinations

a) Dead Loads

Following unit weights shall be assumed in the design as per IRC Codes.

-	Presstressed Concrete	:	2.5 t/m3
-	Reinforced Concrete	:	2.5 t/m3
-	Plain Cement Concrete	:	2.4 t/m3
-	Structural Steel	:	7.85 t/m3
-	Dry Density of Soil	:	2.0 t/m3
-	Saturated Density of Soil	:	2.07 t/m3

b) Superimposed Dead Loads

- Wearing Coat : 40mm thick asphaltic concrete & 25mm thick mastic asphalt with total of 2.2 t/m3

- Crash barrier : From design (i.e. 1.0 t/m per side)

c) Live Loads

- Road Live Loads :
  - One/Two/Three lanes of IRC Class A.
  - One lane of IRC Class 70R (wheeled/ tracked)
  - One lane of IRC Class 70R (wheeled) with one lane of IRC Class A

  Whichever produces worst effects

- Minimum clear distance between 70R vehicle and Class A vehicle, when placed side by side in combination, shall be as per latest IRC:6:2014 for design.

- Resultant live load stresses shall be reduced by 10% in case all the three lanes are loaded i.e. in case of three lanes of IRC Class A or one lane of IRC Class 70R with one lane of IRC Class A.

- Impact factor shall be as per Cl. 211 of IRC:6 for the relevant load combinations. For simplicity in design, Impact factor for continuous structures shall be calculated for the smallest span of each module and used for all the spans of that module.

d) Longitudinal Forces

Following effects shall be considered in the design.

- Braking forces as per the provision of Cl. 211 of IRC:6-2014
- Longitudinal forces as per the provision of Cl. 211 of IRC:6-2014.

e) Horizontal Forces due to Water Currents

Substructure of road bridges which is in the water shall be designed to sustain safely the horizontal pressure due to force of current as per the stipulations of Cl. 210 of IRC:6-2014.

f) Earth Pressure Forces

Earth pressure forces shall be calculated as per the provision of Cl. 214 of IRC:6-2014 assuming the following soil properties :

-	Type of soil assumed for backfilling	:	As per Appendix 6 of IRC:78 with dry density of 2.07 /cu.m and submerged density of 1.2 t/cu.m.
-	Angle of Internal Friction	:	$\phi = 30°$
-	Angle of Wall Friction	:	$\delta = 20°$
-	Coefficient of Friction `μ' at base	:	tan (2/3 ϕ), where ϕ is the angle of internal friction of substrata immediately under the foundations.

Live load surcharge shall be considered as per the provisions of Cl. 714.4 & Cl. 715.15 of IRC:78 i.e. equivalent of 1.2m height of fill in case of abutments, return/wing walls.

g) Centrifugal Forces

Centrifugal forces shall be calculated as per the provisions of Cl. 212 of IRC:6-2014.

h) Wind Effect

Structures shall be designed for wind effects as stipulated as Cl. 209 of the IRC:6-2014.

Seismic Effect

The road stretch falls in seismic Zone V as per IRC:6. The seismic forces have been calculated as per seismic coefficient method outlined in Cl. 219 of IRC:6-2014. Horizontal seismic coefficient calculated separately for various components of bridge with different seismic reduction factors as stipulated in details in IRC: 6-2014. Importance factor is considered 1.20 as per IRC:6-2014. The vertical seismic forces has been considered as two third of horizontal seismic force as per IRC:6-2014.

j) Temperature Range

i) The bridge structure/components i.e. bearings and expansion joints, are designed for a temperature variation of $\pm$ 35°C considering extreme climate.

ii) The superstructures is also designed for effects of distribution of temperature across the deck depth as applicable.

- Appropriate factors of temperature taken as per load combination.

k) Differential Shrinkage Effects

A minimum reinforcement of 0.2% of cross sectional area in the longitudinal direction of the cast-in-situ slab has been provided to cater to differential shrinkage stresses in superstructures with in-situ slab over precast girders as per Cl. 605.2 of IRC:22-1986 in case this type of superstructure is used.

l) Construction Stage Loadings

A uniformly distributed load of 3.6 KN/m2 of the form area has been considered to account of construction stage loadings in the design of superstructure elements, wherever applicable, as per Cl. 4.2.2.2.2 of IRC:87-1984.

m) Buoyancy

100% buoyancy has been considered while checking stability of foundations irrespective of their resting on soil/weathered rock/or hard rock. However, the maximum base pressures checked under an additional condition with 50% buoyancy in cases where foundation are embedded into hard rock. Pore pressure uplift limited to 15% has been considered while checking stresses of the substructure elements.

n) Load Combination

All members has been designed for limit statw load condition as per IRC:6-2014. Partial safety factor for verification of equilibrium load combination Table 3.1, for structural strength load combination Table 3.2, for serviceability limit state (for checking of stress and crack width) load combination Table 3.3 and foundation design load combination Table 3.4 used. Seismic cases considered for all the above combination as stipulated in IRC:6.

In addition, the stability of bridge resting on neoprene/POT/POT cum PTFE bearings has been checked for one span dislodged condition. The load case has been checked with seismic/wind load combinations.

0) Exposure Condition

Moderate exposure conditions has been considered while designing various components of the bridge.

a) Units : Metric units shall be followed.

b) Concrete clear cover

- For all reinforcement - As per IRC:112
- For prestress cable duct to outer most fibre of girder - As per IRC:112
- For other covers and interduct spacings. - As per IRC:112

c) Crack width

Crack width considered as per Table 12.1 of IRC:112-2011

d) Type of Superstructure

RCC Solid Slabs, RCC T-beam, PSC T beam, steel composite girder or steel truss have been provided based on the span lengths. The following criteria, in general, have been followed while deciding type of superstructure for various bridges (this is a broad guideline only):

	Type of Superstructure	**Span Length**
i)	RCC solid slab / RCC box	upto10m
ii)	RCC T-beam & slab	10m < span length <= 24m
iii)	PSC T beam	25m < span length <= 40m
iv)	Steel composite girder	35m < span length <= 50m
v)	Structural steel truss & RCC deck	span length > 50m

The depth of superstructures has been decided based on structural considerations and also keeping in view the minimum vertical clearance requirements and the road formation levels.

- The depth of superstructures shall be decided based on structural considerations and also keeping in view the minimum vertical clearances above HFL and the road formation levels.

Wearing Coat

65 mm thick wearing course comprising of under layer of 40 mm thick asphaltic concrete overlaid with 25 mm thick mastic asphalt shall be provided as per section 500 of MoRT&H specification.

- Approach Slab

Reinforced concrete approach slabs, 3.5 m long and 300 m thick in M30 grade concrete at either end of the bridge, will be proposed with one end supported on the reinforced concrete bracket projecting out from the dirt wall and the other end resting over the soil, in accordance with the guidelines issued by MoRT&H. A levelling course, 10 cm thick in M 10 grade concrete, will be provided under the approach slab.

- Drainage Spouts

Drainage spouts will be proposed in accordance with MoRT&H standard plans.

- Protection Works

Details of protection works provided for the existing bridges will be studied and new proposals framed,if needed, taking into account the behavior of the existing protection works.

Design Methodology

- **Truss**

bending moments, shear forces, axial load and other design forces have been worked out by grillage method using STAAD Pro. All load combination and live load placement done in STADD. Critical forces for are extracted from STADD analysis and design done after word.

- **Deck slab**

Transverse analysis of deck slab done separately and designed separately by using grillage method using STAAD Pro. bending moments, shear forces and other design forces have been worked out. Design done in limit state as pert IRC: 112-2011.

- ***Design of Bearings***

The loads transferred from the superstructure to the bearings shall be taken from the earlier analysis of superstructure. Short and long term deformations are computed for the temperature, shrinkage and creep of concrete.

Pot/ Pot-cum-PTFE bearings shall be designed and supplied by the manufacturer. However, design loads and movements shall be computed and supplied to the manufacturer to enable him manufacture these bearings. The manufacturer's details & design shall be got checked to ensure compliance with the design requirements.

Substructure and Foundation

Abutment

Abutments shall be wall type. These shall be designed resting on open foundations and have cantilever returns at top. In case the cantilever returns become too long. RCC retaining walls shall be provided. In this project RCC cantilever abutment resting on pile foundation and RCC counterfort abutment resting on open foundation are adopted.

Open foundation for piers and abutments are designed in limit state method with load combination as per IRC guidelines. The stability checks are carried out as per relevant IRC Codes.

7.11.6 Design Calculation and Detailed Drawings

Design calculation is prepared as per the design consideration discussed in the foregoing article. These are also based on the general arrangement drawings for the bridges developed based on the inventory of the existing adjacent bridges. The results of geotechnical investigations and hydrological investigation of the bridge sites form the basic input for the design.

7.11.7 Construction Methodology

- ***Foundations***

Open foundations for piers and abutments are proposed to be constructed wherever the footings will rest on rock. For foundation in soil, open foundation is preferred due to simplicity of construction and accordingly adopted based on subsoil investigation.

A slope of 1.5 (horizontal) : 1 (vertical) approximately may be required in the overburden zone for stability of sides. Soft/hard rock which is likely to be encountered below overburden in many cases shall be excavated by rock breaker. The loose muck shall be removed by crane. Excavation for footings confined to shallow depth in dry zone and/or in approaches does not pose any dewatering problem. Wherever required, hydraulic pumps shall be installed during construction for continuous pumping to tackle the problem of dewatering either during excavation or during laying of the foundation concrete. All attempts shall be made to keep the foundation pit dry during concreting of the footing and the substructure below water level.

Backfilling of foundation trench shall be done by means of dosers/manually and compacting it properly. In case of excavation in rock, the space around the footing shall be filled back with plain cement concrete of grade M15.

- ***Substructure***

The pier and abutment substructures are proposed to be cast adopting conventional method of construction.

- ***Superstructure***

Truss

This can be constructed by staging or cantilever method or any other method suggested by the contractor. Method of construction should be approved from competent authority before commencement of construction activity. First truss to be constructed and after that deck slab may be constructed supported on truss members.

Miscellaneous Item of Works

Crash barriers are proposed to be cast after completion of superstructure i.e. after release of staging from below and after completion of entire prestressing operations. The wearing coat shall be laid in one operation (layer by layer) as per specifications in between the crash barriers for the full length of the bridge.

7.11.8 Brief Maintenance Aspects

1) It is proposed for maintenance of bridge time to time. for inspection, an independent arrangement is require to be made to reach the pier/abutment caps from the bed level. Access at truss can be made with any suitable arrangement.

2) Provision is kept in the designs to facilitate replacement of bearings in future. Superstructure elements will be designed to cater for this condition i.e. under jacked up condition. Necessary markings both on substructure and superstructure will be itched/engraved to show these jack-up locations.

3) Deck drainage - Designed super-elevation are provided in the deck which will facilitate water to flow towards the lower edge of the deck where 100φ drainage spouts, provided at regular intervals, would collect the surface water and drain off.

7.12 Improvement Proposals

7.12.1 Geometric Design

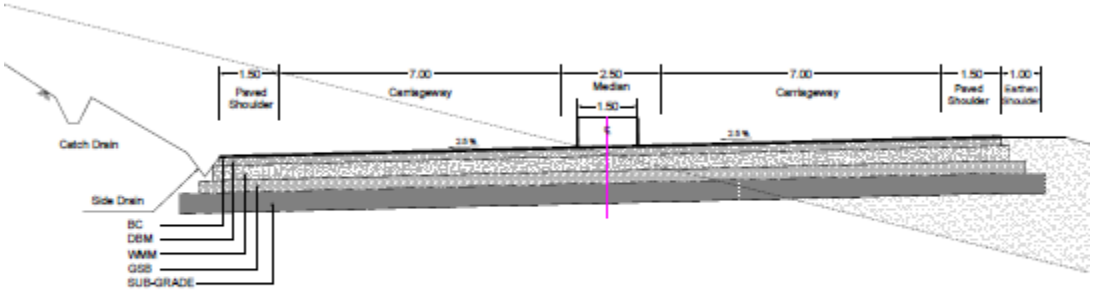
Horizontal Alignment Design

The development of the project corridor involves construction of new 4 - lane configuration road as per IRC SP 84:2014. The following table shows the important items of proposed road.

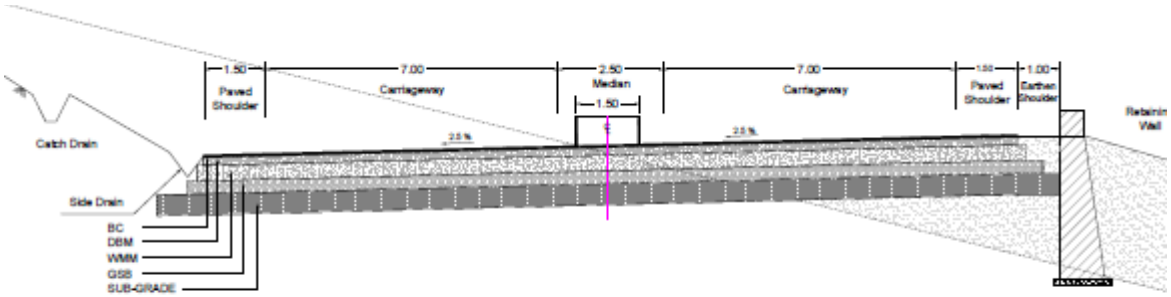
S.No	Feature of road	Width in M	
		Open Area	Built-up area
1	Median	2.5	2.5
2	Main Carriageway	7.0 x 2	7.0 x 2
3	Paved Shoulder	1.5 x 2	-
4	Earthern Shoulder	1.0 in valley side	-
5	Drain in Hill side	1.5	1.0
6	Footpath	-	1.75 x 2

Table & Figure shown below describes the proposed typical cross section of road:

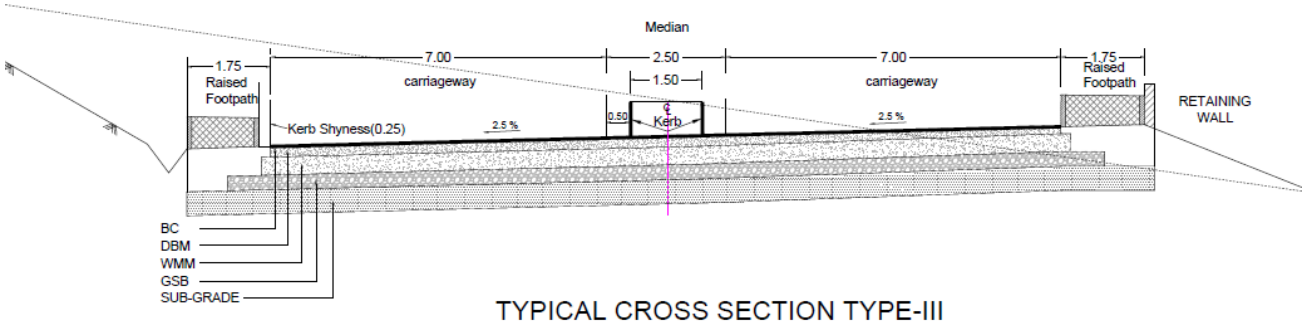
Type of TCS	Description
TCS -I	Open country- Mountainous Terrain without Retaining wall on New alignment
TCS-II	Open country- Mountainous Terrain with Retaining wall on New alignment
TCS-III	Built up section-Mountainous Terrain
TCS-IV	Open country- Mountainous Terrain without Retaining wall on Existing Road
TCS-V	Open country- Mountainous Terrain with Retaining wall on Existing Road



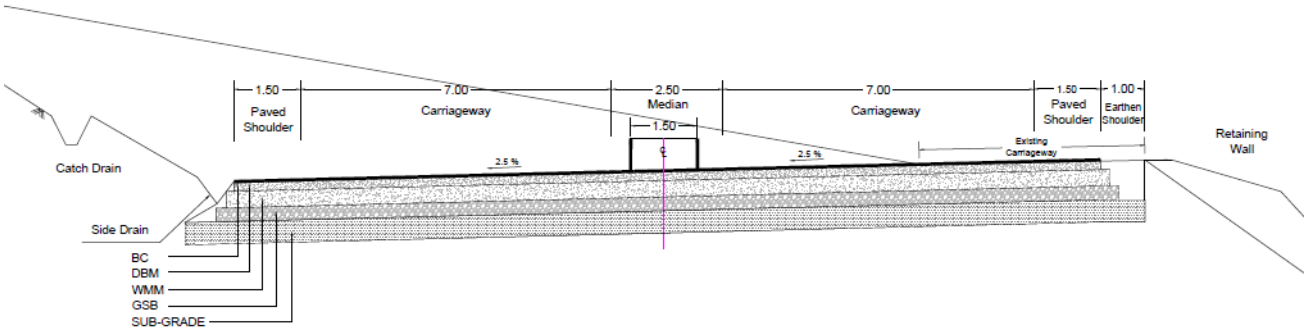
TYPICAL CROSS SECTION TYPE -I
(Open country- Mountainous Terrain)
Without Retaining wall on New Alignment



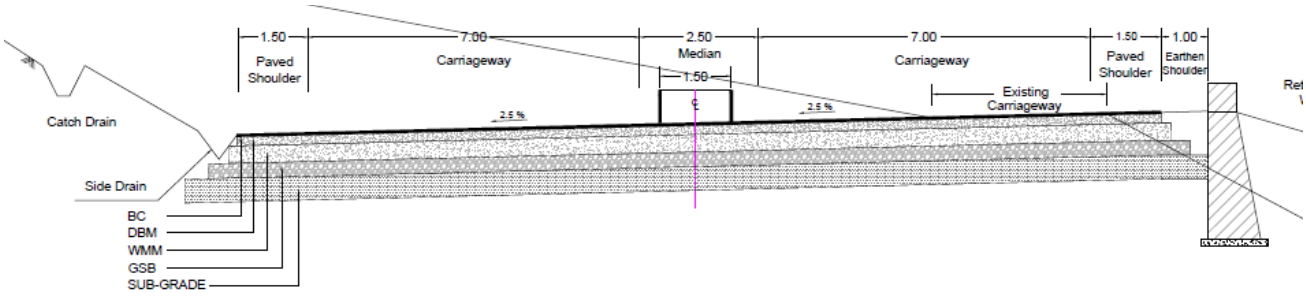
TYPICAL CROSS SECTION TYPE -II
(Open country- Mountainous Terrain)
With Retaining wall on New Alignment



TYPICAL CROSS SECTION TYPE-III
(Built-up Section-Mountainous Terrain)



TYPICAL CROSS SECTION TYPE -IV
(Open country- Mountainous Terrain)
Without Retaining wall on Existing road



TYPICAL CROSS SECTION TYPE -V
(Open country- Mountainous Terrain)
With Retaining wall on Existing road

All the curves have been improved to meet design standard requirements for minimum design speed of 60 Kmph.

The detailed horizontal alignment report is enclosed with drawing volume of this report.

Vertical Alignment Design

The project road is predominantly on steep terrain. Vertical profile has been designed in accordance with the guidelines and geometric standards of IRC SP 84:2015 and IRC SP 48 (Hill road manual). The gradient for the entire road is not more than 7% at any place.

The vertical alignment report is enclosed with drawing volume of this report.

Scheme for implementation of TCS / Widening scheme / Widening schedule

The construction of proposed road includes implementation of five typical cross-sections shown above in para 7.12.2 (Horizontal alignment). The summary of implementation schedule is presented below:

S. NO.	Chainage		Length (m)	TCS Type
	From	To		
1	0+000	2+400	2+400	TCS-4
2	2+400	5+400	3+000	TCS-1
3	5+400	6+700	1+300	TCS-2
4	6+700	7+300	0+600	TCS-1
5	7+300	8+400	1+100	TCS-2
6	8+400	11+700	3+300	TCS-1
7	11+700	12+100	0+400	TCS-2
8	12+100	12+500	0+400	TCS-1
9	12+500	13+100	0+600	TCS-2
10	13+100	13+700	0+600	Tunnel
11	13+700	15+100	1+400	TCS-1
12	15+100	15+600	0+500	TCS-2
13	15+600	17+400	1+800	TCS-1
14	17+400	17+800	0+400	TCS-2
15	17+800	21+100	3+300	TCS-1
16	21+100	21+900	0+800	TCS-2
17	21+900	27+400	5+500	TCS-1
18	27+400	27+900	0+500	TCS-2
19	27+900	28+800	0+900	TCS-1
20	28+800	29+100	0+300	TCS-2

S. NO.	Chainage		Length (m)	TCS Type
	From	To		
21	29+100	31+700	2+600	TCS-1
22	31+700	32+100	0+400	TCS-3
23	32+100	32+500	0+400	Flyover
24	32+500	35+000	2+500	TCS-5
25	35+000	36+800	1+800	TCS-2
26	36+800	37+500	0+700	TCS-5
27	37+500	38+100	0+600	TCS-4
28	38+100	39+000	0+900	TCS-2
29	39+000	39+900	0+900	TCS-4
30	39+900	40+400	0+500	TCS-2
31	40+400	41+400	1+000	TCS-1
32	41+400	44+519	3+119	TCS-2

7.13 Pavement Design

7.13.1 Methodology of Design

The pavement has been designed using the Indian Road Congress "IRC 37:2012 "GUIDELINES FOR THE DESIGN OF FLEXIBLE PAVEMENTS" for flexible pavements. As this method has been developed in India to suit local conditions and the traffic composition, it is considered to be the most appropriate.

7.13.2 Construction and Maintenance Standards

The pavements will be constructed using the latest revision of the Ministry of Road Transport & Highways (MORTH) Specifications for Road and Bridge Works where appropriate.

7.14 Design Traffic

In accordance with IRC:37-2012, the design traffic loadings have been calculated in the terms of cumulative number of standard axles using the following formulae:

$$N = \frac{365 \times [(1 + r)^n - 1]}{r} \times A \times D \times F$$

where:

N_s Is the cumulative number of standard axles to be catered for in the design in terms of ESA.

A Is Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day (CVPD)

r Is the growth rate for the vehicle category
n Is the Design Life in years
D Is the Lane Distribution Factor
F Is the Vehicle Damage Factor

7.14.1 Average Annual Daily Traffic

The average annual daily traffic based on the traffic volume counts of the classified traffic volume are shown in Table below

Average Annual Daily Traffic (AADT)

Commercial Vehicle Category	AADT
Bus	522
Light Commercial Vehicle (LCV)	201
Two , Three Axle Truck (2AT) & MAV	1868
Total Commercial Vehicle	**2591**

7.14.2 Growth Rates for Traffic

Traffic growth rate is considered as 5% for Fast moving vehicles as per IRC 37:2012

7.14.3 Lane Distribution and Directional Distribution Factor

The values adopted for these factors are those that are suggested by IRC: 37-2012. The values used are given below:

- A directional distribution factor of 0.75 has been adopted.

7.14.4 Vehicle Damage Factor

Value for Vehicle damage factor (VDF) for design requirement is considered is 2.5 as per IRC 37:2012

7.14.5 Calculation of Design Traffic Loadings

The above formula and assumptions were used to calculate the design traffic loadings for the following sections of the project corridor where the traffic loadings are uniform. The construction period of 2 financial years (2017-2018 & 2018-2019) is considered for design purpose.

Design Traffic Loadings

Year	Design Million Standard Axles (MSA)
2022	2.16
2027	11.91

Year	Design Million Standard Axles (MSA)
2032	27.12
2037	46.52

7.14.6 Design life of flexible pavement

Flexible pavement has been designed for the design period of 15 years.

7.14.7 Detailed Design of Flexible pavement

The flexible pavement has been designed as per para 9.2 of IRC 37:2012 (USING DESIGN CATALOGUES).

7.14.8 Recommended Pavement Thicknesses for Flexible pavement

The recommended pavement thickness in accordance with para 10.1 of IRC 37:2012 (Picture of recommended pavement thickness is given in Figure & Table below:

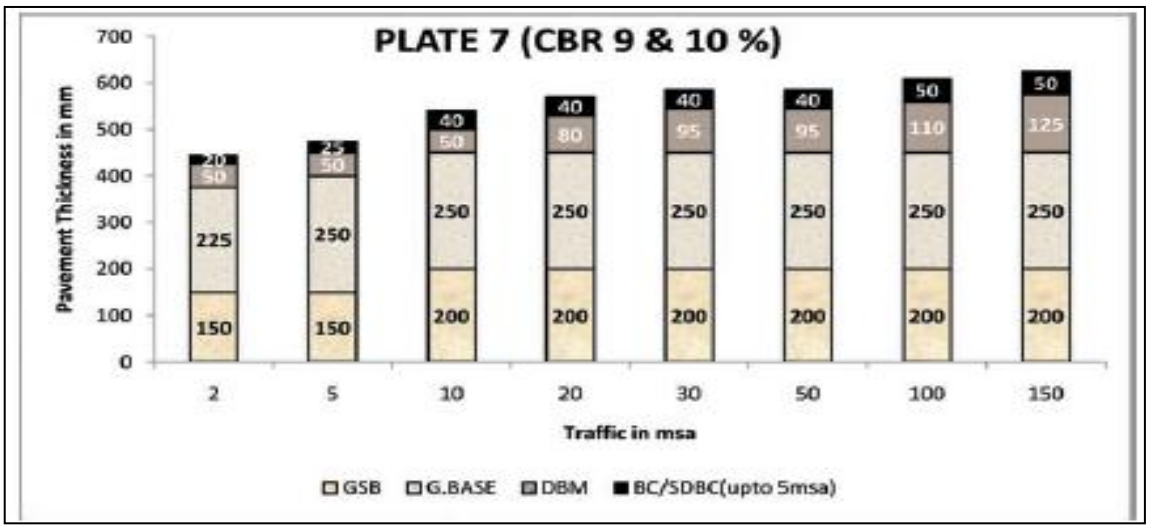


Table 4.6: Recommended Pavement Thickness for New Pavement

Pavement Composition	Pavement Thickness (in mm)
1. Bituminous Concrete - BC	40
2. Dense Bituminous macadam - DBM	95
3. Wet Mix Macadam - WMM	250
4. Granular Sub base - GSB	200
Total thickness of Pavement	**710 mm**
6. Subgrade	500

7.14.9 Slope Stabilisation through Breast wall/Retaining wall/Bio Engineering

Along the project road some locations are identified for slope protection. For stability of slopes, retaining wall / breast walls are proposed. The list of those locations is presented below:

Proposed location for Breast walls:

Sr. No.	From	To	Side	Length (m)
1	3+300	3+600	RHS	300
2	3+350	3+550	LHS	200
3	3+750	3+850	RHS	100
4	4+400	4+650	RHS	250
5	5+450	5+550	LHS	100
6	6+100	6+150	LHS	50
7	6+750	6+800	LHS	50
8	8+050	8+150	LHS	100
9	11+100	11+400	B/S	300
10	11+750	11+850	RHS	100
11	14+550	14+600	RHS	50
12	15+650	15+700	RHS	50
13	15+900	16+050	RHS	150
15	15+900	16+000	LHS	100
16	16+500	16+600	RHS	100
17	16+850	17+000	LHS	150
18	16+850	17+000	RHS	150
19	17+450	17+650	LHS	200
20	21+850	22+000	LHS	150
21	22+550	22+650	RHS	100
22	22+600	22+700	LHS	100
23	23+200	23+350	LHS	150
24	27+150	27+250	LHS	100
25	27+850	27+950	LHS	100
26	28+150	28+200	RHS	50
27	28+600	28+700	LHS	100
28	29+000	29+050	RHS	50
29	30+850	30+950	LHS	100
30	32+950	33+050	B/S	100
31	33+100	33+150	RHS	50
32	33+950	34+050	B/S	100
33	34+550	34+650	LHS	100
34	36+500	36+550	LHS	50

Sr. No.	From	To	Side	Length (m)
35	37+300	37+400	RHS	100
36	40+300	40+350	RHS	50
37	40+950	41+000	LHS	50
38	41+550	41+650	RHS	100
39	41+800	42+100	RHS	300
			Total	**4500**

Proposed location for Retaining walls (5m Height):

Sr. No.	From	To	Side	Length (m)
1	5+350	5+450	LHS	100
2	5+850	5+925	LHS	75
3	6+200	6+400	LHS	200
4	7+775	7+900	LHS	125
5	8+050	8+100	LHS	50
6	8+600	8+700	RHS	100
7	17+450	17+700	RHS	250
8	18+350	18+500	LHS	150
9	19+550	19+600	RHS	50
10	21+050	21+200	LHS	150
11	22+900	23+200	LHS	300
12	28+100	28+250	LHS	150
13	28+950	29+100	LHS	150
14	29+300	29+550	LHS	250
15	34+550	34+800	RHS	250
16	35+700	35+950	RHS	250
17	36+100	36+150	RHS	50
18	36+100	36+150	LHS	50
19	36+950	37+300	RHS	350
20	37+650	37+700	RHS	50
21	40+900	41+150	RHS	250
22	42+300	42+550	LHS	250
			Total	**3600**

Proposed location for Retaining walls (8m Height):

Sr. No.	From	To	Side	Length (m)
1	5+350	5+450	RHS	100
2	6+000	6+450	RHS	450
3	6+700	6+800	RHS	100
4	7+150	7+250	LHS	100
5	7+150	7+250	RHS	100
6	7+850	7+900	LHS	50
7	8+050	8+100	RHS	50
8	9+700	9+850	LHS	150
9	9+750	9+900	RHS	150
10	10+350	10+400	LHS	50
11	10+800	10+900	RHS	100
12	12+000	12+300	RHS	300
13	12+050	12+300	LHS	250
14	18+300	18+550	RHS	250
15	20+500	20+650	RHS	150
16	20+600	20+650	LHS	50
17	21+050	21+250	RHS	200
18	21+800	22+000	RHS	200
19	22+900	23+350	RHS	450
20	30+000	30+150	LHS	150
21	30+050	30+150	RHS	100
22	35+700	35+800	LHS	100
23	36+200	36+300	RHS	100
24	36+950	37+300	LHS	350
25	39+050	39+300	LHS	250
26	39+050	39+300	RHS	250
27	42+250	42+800	RHS	550
			Total	**5100**

Proposed location for Bio Engineering as per IRC: SP: 56 2011:

Sr. No.	From	To	Side	Length (m)
1	5+350	5+450	RHS	100
2	6+000	6+450	RHS	450
3	6+700	6+800	RHS	100
4	7+150	7+250	LHS	100

Sr. No.	From	To	Side	Length (m)
5	7+150	7+250	RHS	100
6	7+850	7+900	LHS	50
7	8+050	8+100	RHS	50
8	9+700	9+850	LHS	150
9	9+750	9+900	RHS	150
10	10+350	10+400	LHS	50
11	10+800	10+900	RHS	100
12	12+000	12+300	RHS	300
13	12+050	12+300	LHS	250
15	18+300	18+550	RHS	250
16	20+500	20+650	RHS	150
17	20+600	20+650	LHS	50
18	21+050	21+250	RHS	200
19	21+800	22+000	RHS	200
20	22+900	23+350	RHS	450
21	30+000	30+150	LHS	150
22	30+050	30+150	RHS	100
23	35+700	35+800	LHS	100
24	36+950	37+300	LHS	350
25	39+050	39+300	LHS	250
26	39+050	39+300	RHS	250
27	42+250	42+800	RHS	550
			Total	**5000**

7.15 Bridges and Major structures

4 numbers of new bridges, 1 number of tunnel and 1 Fly Over bridge are proposed to be developed on the alignment. The summary of bridge improvement proposal is given below, however, the detailed design is presented in Volume-II(B) of current submission.

The list of proposed bridges is shown below:

S.No.	Chainage (m)	Type	SPAN
1	4+020	Truss	1 x 80m
2	14+850	Truss	1 x 80m
3	23+620	Truss	1 x 80m
4	32+400	PSC	13x30m
5	35+600	RCC Girder	1 x 24m

7.16 Culverts

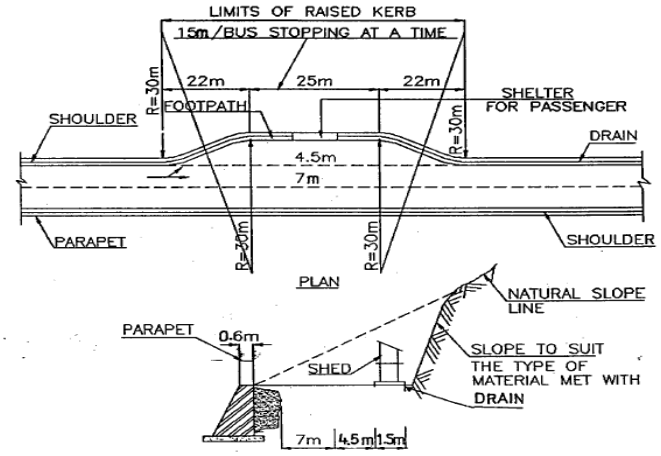
Total 267 numbers of box culverts of size 1x2x2m and 1 culvert of size 1x2x5 is proposed on the alignment. The list of Proposed Culverts is enclosed at the end of Chapter-7 as **Appendix-7.4** and drawing of culvert is presented in drawing volume.

7.17 Trucklay byes

Truck lay bye is proposed at design chainage 33+800.

7.18 Bus Shelters

In hilly areas, there are several locations, where buses make short stops-overs for alighting / getting down passengers. These locations are provided with a suitable shed for waiting passengers. The bus stop/shelter is normally located, where the road is straight on both sides, the gradient is level or as flat as possible and the visibility is reasonable (not less than 50 m). Suitable signs are provided at and in advance of such locations. The typical drawing of truck lay bye suggested in IRC SP:48 (Hill road manual) is presented below:



Bus Shelters

Busbays/Bus shelters is proposed at 8 locations on the proposed alignment. The list of presented below:

S.No	Chainage	Village	District	Proposed Chainage	
				LHS	RHS
1	0+200	Jotsama	Kohima	0+150	0+250
2	12+200	-		12+150	12+250
3	13+400	Merima		13+350	13+450
4	16+900	Secretariat		16+850	16+950

S.No	Chainage	Village	District	Proposed Chainage	
				LHS	RHS
5	31+950	BSF Camp		31+900	32+000
6	37+150	Kohima		37+100	37+200
7	40+100	Pjuchama		40+050	40+150
8	43+700	Phesama		43+650	43+750

7.19 Junctions

Two major junctions have been created on the proposed alignment of Kohima bypass and two junctions at start and end of the project road.

Major Intersections

S.No.	Location of Intersection (Design Chainage)	Junction with	Name of the Location	Proposal
1	0+000	NH-39	Start of Project road	At Grade
2	13+400	NH-61	High Court Junction	Tunnel
3	32+150	NH-150	BSF Camp	Flyover
4	44+519	NH-39	End of the Project road	At Grade

Minor Junctions

S.No.	Location of Intersection (Design Chainage)	Other Features
1	12+200	Junction with Village road
2	41+540	Junction with Village road

7.20 Toll Plaza

The toll plaza is proposed at Km 14+200 of design chainage.

7.21 Traffic Signs

Road Signages

The functions of traffic signs are timely warning of hazardous situations when they are not self-evident. Regulation of traffic imparting messages to drivers about the need to stop, give way and limit their speed and also inform them about the directions & points of intersections.

According to Motor Vehicles Act of India 1988 the state governments are required to erect traffic signs, which have been prescribed in the act. IRC standards have been evolved keeping in consideration the above act. General principles of traffic signing in brief are:

a. Excessive signs should not be resorted to and unofficial signs should not be permitted. The signs should be legible to those using that and should be understood in time to have a proper response and it should be designed for the foreseeable traffic conditions and speeds on the highways

b. Besides this it should have high visibility both during day and at night. The letter or the symbol should be of adequate size for being read from far away by a speeding driver.

c. It should be simple and uniform in design, position and application.

d. It should have two sizes for each type of sign. A standard size for main highway and a reduced size for less important roads.

Traffic signs are of the following type

a) Dangerous signs also known as warning or cautionary signs.

b) Signs having definite instructions also known as Regulatory signs as per Motor Vehicles Act of India 1988. It is further divided into 2 types

i) Prohibitory signs

ii) Mandatory signs

c) Information signs, further subdivided into

i) Indication signs

ii) Advanced Direction and Direction signs

iii) Place & Route identification signs

The IRC standards confirms to the above classifications.

Dangerous Signs (Warning or Cautionary signs)

They are used when it is necessary to warn the traffic of hazardous conditions on or adjacent to the highway. The UN protocol as well as IRC recommends the equilateral triangle side with one point upwards. The standard is 900 mm & reduced size is 600 mm. The signs have a red border and symbols indicated therein are black colour against a white pattern. The warning signs as per IRC are illustrated. These may be kindly be referred to in drawing vol.

Regulatory signs

These signs are a part of regulatory signs, which are intended to inform the traffic users of traffic laws and regulations. These are about 35 in number.

Prohibitory signs

These give definite negative instructions prohibiting the motorist from making particular maneuvers and they may be

i) movement restrictions

ii) waiting restrictions

iii) restrictions on dimensions

According to IRC standards, these are of a standard size of 600 mm and 400mm for reduced size. The signs have a red border, the colour of the background is white for speed control. Blue for waiting and parking restrictions and direction controls. The signs are illustrated drawing volume.

Mandatory Signs

These are a part of regulatory signs and are intended to convey definite positive instructions when it is desired o take positive actions. The two important Mandatory signs are STOP signs and GIVEWAY or YIELD

1) STOP signs:

The stops signs require all the vehicles to come to a stop before the stop line. The general principles of use of stop signs are the following

i) Intersection of less important roads with main highway where the application of normal right of way is unduly hazardous. A stretch intending a through highway unsignalised intersection in signalized area.

ii) Other intersections where a combination of high-speed restrictions, severe accident record need a control by stop sign.

The stop signs should not be used on through highway for a speed control at signalised intersections. There are different practices such as American, English & IRC for the safe and size of stop signs. IRC standards have been used in this highway as per octagon with white border and red back background, with the side of the octagon 900 mm, 600mm for a smaller size has been used. It shall be used in combination with a definition plate carrying a message ‘stop’.

2) YIELD or GIVEWAY Sign :

The yield or giveway sign is used to assign right of way on traffic at approaches to intersections. Vehicles controlled by yield sign need a stop when necessary only to avoid infiltration i.e., give right of way. It controls the traffic at major intersections.

At places where stop sign is on the thorough highway, the yield sign has an equilateral triangle with one point downwards having a red border & white background of 900 mm size and 600mm for a smaller size. It shall be used in combination with a plate-carrying message Giveway.

Informatory signs

These are intended to guide the motorist along highway. Information of intersections, routes to direct him to the cities, towns, villages and other important destinations and to identify nearby rivers and streams, parks, forests and historical sites giving general information which will help him along the carriageway in most simple and direct manner as far as possible. Informatory signs do not lose their effectiveness and it is desirable to erect them as frequently as is necessary and in any case at locations where motorists is in doubt.

In Indian practice only the upper case letters are used. Informatory signs generally used in Indian state highways are enclosed in drawing volume.

Indication signs

Indication signs are a subclass of informatory signs. They generally provide the information of facilities such as filling station, telephone, eating home, first aid course etc. IRC standards provide a size of 600mmx450mm with a black symbol against a white rectangle and blue background. The indication signs is a part of information sign which are 15 in number.

Direction signs, advanced destination signs and place identification signs

Direction signs, advanced directions signs and place identification signs indicate the name of place and are rectangular in shape terminating in the form of a arrow. Advanced destination signs are necessary at the intersection of roads. They are also rectangular in shape. Advanced destination signs indicate the name of the place and the distance. A place destination sign is rectangular in shape with name of place written in specified size of letter. A destination signs reassures the traveler about the places ahead and the distances. All the above signs shall be of IRC standards.

Over head signs

These are provided at locations such as where the traffic volume at or near the capacity, complex interchanges, closely spaced interchanges where multiple lane roads exist in sufficient space for the round mounted signs. These are also located at Toll plaza and junctions of an interstate road with another freeway.

Route marker signs

It is standardized by IRC:2-1968. It consists of a shield painted on a rectangular plate 400mm x 600mm. The sign has a yellow background and lettering & bordering are black.
All the signs of different category shall be placed at suitable location and height as per requirement.

Location and hight

As per IRC standards the signs should be erected not less than 60cm away from the edge of the kerb, in case of road and at a distance of 2-3m from the carriageway edge in case of unkerbed roads.

The mounting height shall be atleast 1.5m (measured from the bottom to the pavement). In business and commercial areas where parking and pedestrian movement is to occur the height is atleast 2.1m. The IRC standards prescribe a height of 1.5m for unkerbed and 2m for the kerbed roads. IRC standards have been followed. A stop sign is to be located at the point where the vehicle is to stop or as near as possible say 1.5m where there is pedestrian crossing. The stop sign shall be erected in 1.2m in advance before the stop line.Warning sign for a National Highway shall be located at definite intervals wherever necessary of the hazard warned against.

Road markings

Road markings are basically of 2 types carriage marking and object marking. As the name implies the former type of markings are those that are applied to the road itself, the latter type covers marking on the objects such as abutments, piers, kerbs, traffic islands, culvert head walls etc.

The carriageway marking are of following category

1) Centre line

2) Traffic lane lines

3) No overtaking zone markings

4) Pavement edge lines

5) Carriageway width reduction transition marking

6) Obstruction approach marking

7) Pedestrian marking

8) Stop lines

9) Cyclist crossings

10) Route direction arrows etc.

11) Markings at approaches to intersections

12) Word messages

13) Parking space limits

14) Bus stops

Object markings are of the following categories

1) Objects within the carriageway

2) Kerb marking for parking restrictions

3) Objects adjacent to carriageway

General principles of longitudinal pavement

Solid lines are restrictive in nature and it is a offence to cross the line, broken lines are also restrictive in nature but vehicles can cross these lines provided safety measures are taken. Double lines indicate maximum restriction.

Material & Colour

Material

Thermoplastic paints applied hot shall be used as per MOST specifications. Improved night visibility shall be obtained by the use of minute glass pieces incorporated in the markings to the produce a retro reflective surface.

Color

The commonly used color for road markings is white and yellow. As per Indian practice the color of road marking is as below.

Color	Uses
White	All Carriageway marking except those intended for parking restrictions
Yellow	i) Marking intended for parking restrictions ii)Continuous centre and barrier line markings

The different markings such as centre line, traffic lane lines, no overtaking zone marking, pavement edge lines carriageway reduction transition marking, Obstruction approach marking Pedestrian marking, stop lines, route direction arrows, markings at approaches to intersections, parking space limits etc. shall be as per IRC:35-1970 revised, specifications for road marking for paints shall be as per IS-164-1981 revised, BIS-1986. A specification for Road and Bridge works published by IRC revised upto date shall be followed.

Roadway delineators

These are intended to provide visual aide connecting the roadway alignment at night times. They are effective in locations where the horizontal and vertical geometric changes and in severe weather conditions. Generally delineators are reflectorised for better illumination. Road delineators are generally in the form of guide post of metal concrete. These shall be provided as per IRC-1981. The side facing the traffic should have dimension not less than 80-100cm in length. The use of road delineators in rural highway section under the following situations

Curve sections

In the horizontal curve section having radius 1000m or less, and vertical curves with adequate visibility.

Straight sections

In the section of roadway where there are heavy rainfall, mist, fog etc., at the side of temporary road diversion height exceeding 3m approaching to intersections.

Spacing

The spacing shall be 50cm in straight sections on either side of carriageway. In curves the spacing may be reduced to 50m for a curve of 1000m radius and for a radius of 300-400m it should be 30m.

Road appurtenances

Road Appurtenances have been proposed on the project comprising of :

(i) Hectometer stone

(ii) Kilometer Stone

(iii) 5th Kilometer Stone

(iv) Boundary pillars

Although a very few of the above appurtenances still exist along the road, but many are missing. The existing ones are old, broken, and not of the standard size and shape. It is proposed to fix new hectometer, kilometer and 5th Kilometer stones along both sides of the carriageway. New boundary pillars are proposed to delineate the right-of-way.200 meter stones shall be installed between kilometer stones for ease of maintenance planning.

Kilometer stones and 200 meter stones shall be in accordance with type, size and design as per IRC-8 and IRC-26. Boundary pillars shall be as per design and specifications given in IRC-25.

Table of Contents

CHAPTER -9 FINANCIAL & ECONOMIC ANALYSIS

9.1 BACKGROUND

The main objective of financial analysis is to assess the likely returns to the investors under realistic conditions. In the present studies the financial viability of the project is assessed on the basis of project's financial internal rate of return on investments and Rate of Return on Equity, which is estimated on the basis of cash flow analysis.

9.2 APPROACH TO FINANCIAL EVALUATION

The main objective of financial analysis is to examine the viability of implementing the project on a BOT and if it is not possible on BOT than on any other way of financing the project, in this case the other alternative we are considering is on ANNUTY basis. The analysis attempts to ascertain the extent to which the investment can be recovered through toll revenue and if any gap remains that can be funded through funding from NHAI in the form of Grant. This covers aspects like financing through debt and equity, loan repayment, debt servicing, taxation, depreciation, etc. The viability of the project is evaluated on the basis of Project FIRR (Financial Internal Rate of Return (FIRR) on total investment). The FIRR is estimated on the basis of cash flow analysis, where both costs and revenue have been indexed to take account of inflation. Financial analysis has been carried out with debt equity ratio of 70:30.

Table 1: Details of the Length of the various Roads

Sl. No.	Description	Length (Km)
1	Kohima By Pass	44.519

9.3 COST OF THE PROJECT

The total cost of the project includes cost of civil works involved in the widening of the roads, Flyover. The estimated project cost is considered excluding shifting of utilities, land acquisition, acquisition of structures, rehabilitation and resettlement and environmental mitigation measures. The total cost of the Project has been computed based on the 2017 prices. The annual phasing of capital cost is made as per the work schedule. Construction cost is phased over a 3 years period from 2019 to 2022 as 30% in first year, 30% in second year and 40% in third year.

Table 2: Cost of Civil Works in 2017

Option	Description	Cost of Civil Works Rs millions/-
1	Project cost (For 44.519 Km.)	**13715.90**

9.4 COST ESCALATION and TOTAL PROJECT COST

The base costs have been escalated at a rate of 5% per annum to obtain the actual costs in the year of expenditure. This is in line with long-term inflation rates of major materials utilized for construction. Total Project Cost has been calculated by adding contingencies, Escalation in prices, financing cost, interest during construction and IC and pre-operative cost into the civil cost.

		Cost (Rs. in Million.)
1	**Total Civil Construction cost for 44.519 KM**	13715.90
2	**Contingencies @ 1 %**	137.16
	Total EPC Cost	13853.06
3	**IC & Pre-operative expenses @ 2% of EPC**	277.06
4	**Financing Cost @ 2% of EPC**	277.06
5	**Esclation @ 5% Per Annum**	-4907.30
6	**Total Project Cost before IDC**	9499.88
7	**Interest during Construction @ 11.75 %**	281.29
	TOTAL PROJECT COST *	9781.17
		say 9781
	TOTAL PROJECT COST Rs (million) / Km. *	219.71

Table 9.3 Project Cost Summary of NHIDCL Cost

Sr.No.	Cost	Cost Rs. millions/-
1	Land acquisition including Stamp Duty	0.00
2.	Acquisition of structures and resettlement	0.00
3.	Shifting of utilities	0.00
4	Environmental mitigation measures	0.00
	Total	**0.00**

9.5 TOLL RATES

Tolls can be set either to maximize revenue or maximize the utilization of the project without causing congestion. However, in no case, tolls are set at a level higher than the perceived benefits of using the facility. Toll rates are calculated based on MoSRT&H notification dated5th December 2008/ and amended in December 2010.This is shown in the Table 7.4 below.

Table 4: Toll rates are estimated based on the MoRT&H guidelines.

Sl.No	Description	Toll Rates per vehicle / per Km. 2007- 08 For 4 Lane	Toll Rates per vehicle for 32.263Km. 2020-21 By Pass
1.	Car, Jeep, Van Light Moter Vehicle	0.65	40
2	LCV Lightr Goods Vehicle or Mini Bus	1.05	60
3	Bus or Truck up to 2 Axle	2.20	130
4	Truck 3 Axle	2.40	140
5	Truck 4 to 6 Axle	3.45	170

9.6 TRAFFIC

Traffic surveys is conducted at Km 174.00 of NH-39 For the BOT analysis tollable traffic counts (AADT) of Km 174.00 has been taken for projected revenue.

Table 5: AADT (Vehicles) at Various Locations (Base Year 2017)

Sr. No.	Description	Car/Jeep	Mini Bus	Bus	LCV(Passenger + 4 wl Goods)	Truck-2 Axle	Truck-3	Truck 4 to 6 Axle
1	Km. 174.000 on NH 39	358	339	183	201	1380	0	488

9.7 TOLL REVENUE

The toll revenue is the product of the forecast traffic expected to use the road and the toll fee for the vehicle category.. Toll revenues have been calculated by taking least of the traffic of the seven locations which is indicative traffic for the project road length. While considering the traffic for the purpose of revenue it is assumed to take the through traffic only.The computed toll revenues for various years are given below in Table 6

Table 6 Toll Revenues for the various years

Sr no.	Year	Toll revenue (Rs. Millions)
1	2020	127.29
2	2030	348.42
3	2040	965.85
4	2047	993.79

9.8 TAX CALCULATION MODULE

The tax rate adopted for this study is 33.66% (30% tax + 10% surcharge + 3% education tax) following the deduction of depreciation and amortization. Even the Minimum Alternate Tax (MAT) of 20.96% (18.5% tax + 10% surcharge + 3% education tax) has been taken into account for the total concession period.

9.9 PROPOSED SOURCES OF FINANCE

In general, the developer shall crystallize the sources of finance by optimizing his equity returns keeping in view the project cash flows, terms, and conditions of various financing

options available. Further the market standing and financial strength of the Developer would largely determine the terms and conditions of finance offered to the Developer by various lending agencies. For the purpose of the study, following sources of finance have been taken:

- Equity: To be provided by the Developer
- Subsidy / Grant for viability of funding, to be provided by the NHIDCL.
- Debt: To be arranged by the Developer / Concessionaire

9.10 METHODOLOGY

The procedure and steps undertaken to assess the financial feasibility of the captioned Project are outlined in this section. The first stage in evaluation of the financial feasibility is the identification of revenue and expenditure streams. The revenue for the captioned Project will be generated primarily from Lease Rental from Shops and Revenue from Advertisements. Financial viability has been worked out for the Project under report.

9.11 EXPENSES

Expenses can broadly be classified based on the phases in which these are incurred, viz. construction period expenses and operation & maintenance period expenses, construction period expenses are includes Interest during Construction, contingencies, Escalation etc.

Operation and Maintenance Period Expenses

- Administrative expenses for day-to-day operation.
- Maintenance expenses, which include routine and periodic maintenance.
- Interest expenses incurred for servicing term loans.
- Lighting expenses.
- Patrolling Expenses.
- Insurance

9.12 OPERATION AND MAINTENANCE COST

Routine maintenance costs comprise of maintenance of the pavement, collection of litter, lighting, traffic management (policing), accident repairs and all ancillary works including beautification.

The periodic maintenance costs include cost of overlay, repair/renovation of road furniture, drains, buildings etc. The periodic maintenance includes periodic renewals at every 5th years.

Routine maintenance/ Periodic maintenance costs have been considered as per the MORT&H guidelines 1997 prices. The details of the maintenance costs and administration charges are given below in Table 4

Table *7* Routine & Periodic Maintenance (2010 prices)

Sl.No	Description	Amount (Lakhs/km)
1	Routine maintenance in every year cost per km for the Four lanes with paved shoulder of Rigid Pavement.	4.00
3	Periodic maintenance in every 5^{th} year cost per km for the Four lanes with paved shoulder of Rigid Pavement.	Nil

9.13 RESOURCES MOBILIZATION

In the present study, the project is envisaged to be funded through equity and debt components. Since the Project revenues are not able to sustain the capital structure, option such as capital grant / subsidy utilization of the developmental charges and ANNUTY method of financing shall be explored.

9.14 RESOURCE MOBILIZATION SCHEDULE

In general, the duration of construction for similar size road projects ranges between 24-30 months. Since the proposed Project is to be implemented on a BOT format, the developer has an incentive in early completion of the project in order to expedite toll collection. Hence, the Project implementation period has been taken as 24 months. Based on the implementation period, the project cost has been phased as under.

Table 8: Project Cost Phasing

Description	1^{st} year	2^{nd} year	3^{rd} year
Percentage of total cost incurred	30%	30%	40%

9.15 MINIMUM RETURN CRITERIA

The minimum return criteria for the B.O.T project is considered as follows: -

The return on project investment (Post Tax FIRR) should be between 14% to 16% while the return on equity (Post Tax Equity IRR) ranges from 14% - 16%. The minimum average DSCR is taken as 1.25 and the pay pack period shall be 10 - 12 years.

9.16 FINANCIAL VIABILITY

The main objective of undertaking this study is to assess whether the project is financially viable or not. It is important to note that the proposal should be an attractive proposition for private sector participation under Build, Operate and Transfer (BOT) system. The basic methodology followed for estimating the financial viability of the project is to calculate the FIRR (Financial Internal Rate of Return) on the investment for the project.

The following assumptions are taken into consideration for the financial analysis: -

- Debt – Equity ratio :- 70:30
- Concession period (Including 24 months construction period) – 30
- Escalation – 5%
- Interest on Debt – 11.75%
- Project Phasing: First year – 40%, Second year – 60%..
- Loan Repayment period – 12 years
- Moratorium – 1 year
- Depreciation by Straight line method - 100%
- Depreciation by Written down value method – 10%

9.17 RESULTS AND ANALYSIS

Based on the project structure, study of all possible sources of revenue, financial feasibility analysis has been carried out as per the methodology outlined in earlier sections. The objective of the financial analysis is to ascertain the existence of sustainable project returns, which shall successfully meet the expectations of its financial investors. The analysis reveals various FIRR values corresponding to each year of operation. FIRR for the Returns on Investment and Returns on Equity for the years from 2020 and 2047(concession period 30

years including 2 years construction period) for the following alternatives with varying subsidy options are: -

Alternative I : With Nil Grant.
Alternative I ; With 40%. Grant

With the above mention options financial analysis has been carried out for 30 years concession period when grant is 40% of the Capital Cost. . The results are given below in Table 9 for concession period 30 years are as under.

Table 9 Results at various alternatives (30 years concession period)

Scenario	Pre tax FIRR %	Returns on Equity%	Post tax FIRR%
Alternative- I	0.82%	NA	-0.47%
Alternative- II	3.76%	NA	2.26%

9.18 CONCLUSION

As it is clear from the results of the both the alternatives that the project is financially not viable even with 40% Grant. This is because of high cost of Construction and very low toll able traffic.

Therefore it is strongly recommended to construct the road on EPC basis and not on BOT basis.

9.18 ECONOMIC ANALYSIS

9.18.1 Investment Appraisal

Two alternatives have been considered for the economic analysis. The first is "without Project" (do minimum) where the Project Road, is considered without improvement proposals. In this case, the future traffic volume will continue to follow the existing 2Lane road. In the HDM model analysis, this 'Do Minimum' alternative will form the base strategy against which all other strategies will be compared. The second is 'With Project' alternative. This corresponds to the formation of rehabilitation of existing 2Lane road and new green field road of Kohima Bypass 4L Lanes with earthen shoulder and paved shoulder on both sides. In order to arrive at the net benefits associated with the second strategy, it is compared to the 'Do Minimum Alternative'. By comparing the above alternatives, the net agency costs and net user costs and finally net project benefits, associated with the project during its analysis period of 30 years, are calculated, for the improvement option in order to arrive at the Economic Internal Rate of Return (EIRR) and Economic Net Present Value (ENPV).

In brief, the following two Strategies have been considered and evaluated in this study:

"Without Project" alternative

Strategy 1: This is the "Do Minimum Scenario", in this scenario; the agency performs routine maintenance and pothole patching every year from the starting year. It will receive functional overlay of 30mm BC at 5 year interval.

This strategy has been termed "Do Minimum Scenario" where the existing Project road is maintained at current levels and no improvements are envisaged. In this situation, the projected future traffic is assumed to use the existing road in a congested traffic flow condition.

Agency costs (maintenance cost), distance and time related vehicle operation costs together with travel time costs and accident costs pertaining to this alternative will form the base on which net project cost and benefit streams during the analysis period are calculated for each 'without project' alternative.

"With Project" alternative

Strategy 2: This is the scenario with the upgrading of the existing two lane road, new green field road of Kohima bypass, to 4LPS. Once the construction is complete, the agency will perform routine maintenance every year. This strategy forms a 'With Project' alternative and is compared to 'Without Project' alternative.

Transport Costs

The total transport costs comprise of two basic components, viz. road supplier costs and road user costs. These are depicted in Table Error*! No text of specified style in document.-1*

Table Error! No text of specified style in document.**-1: Total Transport Costs**

Road Supplier Costs	**Road User Costs**
Construction Costs	Vehicle Operating Costs (VOC)
Maintenance Costs	Other User Costs i.e. Travel Time Costs
Replacement Costs Costs of Environmental Impact Mitigation Measures Costs of Rehabilitation and Resettlement (R&R) measures	Accident Costs

The above classification of transport costs is used to estimate the cash flow streams of VOC, value of time and accident cost savings for carrying out the economic analysis by using the DCF techniques.

All costs and benefits considered in the analysis are valued in money terms at the market prices. For economic analysis, these are expressed as economic costs for avoiding distortions in the prices of inputs such as labour, materials, equipment, machinery and foreign exchange arising due to market imperfections.

The economic appraisal has been carried out by using the HDM-IV. The model is used to generate cash flow streams of VOC and value of time to compute the net economic benefits, as inputs for the estimation of the EIRRs and NPVs for Project evaluation.

Basic Data Inputs for HDM Model

The following values have been considered while preparing the input data for the application of HDM Model.

Analysis Period (Years)	: 30 Years including construction period
Pavement Alternatives	: Rigid
Maintenance Costs	: Normal (Routine) Costs, Periodic Costs
Construction Period (Years)	: 36 months
Investment Schedule	: 1st Year 40%, 2nd year 30%, 3rd Year 30%
Salvage Value (%)	: 25%
Discount rate	: 12%

Economic Costs

Standard Conversion factor of 0.90 as per the World Bank guidelines is used for converting market prices of road construction and maintenance inputs into economic costs. For other inputs, like the fuel, vehicles, vehicle components, economic costs have been estimated net of transfer payment e.g. taxes, fees, charges, subsidies etc.

Financial and Economic Cost of the project

The capital costs (financial) of the project road have been converted into economic cost by using a standard conversion factor (SCF) of 0.9, as suggested by the World Bank for highway projects in India. The financial and economic costs are presented in Table Error*! No text of specified style in document.-**2***.

Table Error! No text of specified style in document.**-2: Capital Cost for Economic Analysis (in Rs. Million)**

Project Road	Improvement	Financial Cost	Economic Cost
Kohima Bypass	Existing two lane road and New Green field to 4LPS	13715.90	12805.4

The capital cost has been phased over 36 months from 2019 to 2022.

The salvage value of 25% of capital cost at the end of the analysis period has been considered.

Vehicle Composition, Characteristics and Unit Costs

Vehicle composition for analytical purposes is grouped into eight categories, namely:

Motorised Transport	
Cars	Cars and Jeeps
Mini Bus	Mini Bus
Bus:	Standard Bus
LCV	Light commercial vehicles / Tractors
Medium Trucks	2 axle Rigid Truck
Heavy Trucks	3 axle Rigid Truck
MAV	Multi axle Articulated and Semi Articulated Truck
Motor Cycles	2 Wheelers
Utilities	3 Wheelers
NMT	
Bicycles	Cycle
Rickshaw	Cycle Rickshaw
Animal Cart	Animal Drawn Vehicles

Economic Unit Costs of vehicles and other related components are given in Table Error*! No text of specified style in document.-**3***. These are based on the market survey and the information on applicable tax rates etc. from the annual budgets of Central and State Governments.

Table Error! No text of specified style in document.**-3: Vehicle Characteristics, Utilization Data and Economic Unit Costs**

Item	Car	Two Wheel	Bus	2-Axle Truck	3-Axle Truck	Multi Axle Truck	LCV	Mini Bus
Vehicle Price Rs.	529,824	41,708	1,275,960	1,241,028	1,658,671	1,991,882	1,114,858	1,389,617
No. of Wheels	4	2	6	6	10	12	4	4

Item	Car	Two Wheel	Bus	2-Axle Truck	3-Axle Truck	Multi Axle Truck	LCV	Mini Bus
No. of Axles	2	2	2	2	3	4	2	2
Passengers	3.9	1.0	29					20
Tyre Price Rs.	1,387	1,219	26,100	26,100	23,619	23,619	5,115	5,115
Fuel Per/Lt. Rs.	27.95	27.95	28.45	28.45	28.45	28.45	28.45	28.45
Lubricating Oil (Rs)	78	78	78	78	78	78	78	78
Maint. Labor (per hr.) Rs.	59	26	121	132	129	129	110	121
Crew Wages (Rs.per hr)	30	-	83	132	132	132	34	83
Annual Overhead (Rs.)	22,088	1,165	148,756	31,063	57,688	57,688	12,656	148,756
Interest Rate (%)	12	12	12	12	12	12	12	12
Passanger Work Time Value (Rs. per/hr.)	91	47	58	-	-	-	-	58
Non work Time Value (Rs. per hr)	27	14	17	-	-	-	-	17
Cargo Time Value (Rs. per/hr.)	-	-	-	33	33	61	10	-
Working Hours	1,950	1,300	2,200	2,100	2,100	2,100	1,500	2,200
Annual km	32,000	16,000	1,00,000	75,000	75,000	75,000	60,000	1,00,000
Avg. life (Years)	10	10	8	8	8	8	8	8

Road Characteristics

Values of road characteristics based on the field surveys for running the HDM model are used. The inputs considered in the model have been tabulated in Table Error*! No text of specified style in document.-**4*** and Table Error*! No text of specified style in document.-**5***

Table Error! No text of specified style in document.**-4: HDM Input - Road Sections – Basic data**

Project Road	Length (Km)	Existing Carriageway(m)	AADT 2017
Kohima Bypass	44.519	7	3617

Table Error! No text of specified style in document.**-5: HDM Input - Road Sections – Condition of the Project Road**

Project Road	Condition Year	Roughness (m/km)	Total Cracking Area (%)	Ravelled Area (%)	Potholes (no./km)	Edge Break(m^2/km)	Rut Depth (mm)
Kohima Bypass	2017	8	23	20	9.75	12	8

TRAFFIC VOLUME AND COMPOSITION

Base Year Traffic

The base year traffic estimate for the project road by composition are the basic input for the HDM Model application. The Traffic data presented in the Traffic Study Chapter are considered in the analysis. Future traffic growth has been taken as 10% considering the future generated and induced traffic on the new Kohima Bypass.

ECONOMIC ANALYSIS - RESULTS

Economic analysis results forthe project road are given in Table Error*! No text of specified style in document.-**6***. The Cash flow statement is given in Appendix 1

Table Error! No text of specified style in document.**-6: Economic Analysis Results (Rs. millions)**

Project Road	EIRR (%)	NPV@12% (discounted)
Kohima Bypass	12.1%	298.27

CONCLUSION

The above analysis reveals EIRR of the project road is above the target (EIRR) 12 %, hence the project road can be considered economically viable and recommended for implementation.

CHAPTER -10.00 CONCLUSION & RECOMMENDATIONS

Alignment

Three different options have been studied for the bypass of Kohima town. Alternate-1 of length 44+525 Km has been agreed by NHIDCL, HQ.

Mode of Contract

The project is economically viable but financially not viable. Therefore, it is recommend to go for EPC mode of contract.