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CAPACITY ESTIMATION FOR A TWO LANE UNDIVIDED CARRIAGE WAY – A CASE STUDY FOR NATIONAL HIGHWAY – 63

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ABSTRACT

The majority of National and State Highways of India are two-laneundivided carriage way. These two lane highways reach its maximum capacity very soon and need constant upgradation from two lane to four/six lane, due to the fact that there is a steady increase in the growth of vehicles in India by approximately 7.5% to 8%.To accommodate such growth of vehicular traffic, the existing highways need to be improved and new highways need to be proposed and constructed. Hence traffic forecasts and capacity estimates of a highway is crucial for the development of highways and also in boosting the Indian economy. Roadway capacity estimation involves traffic volume counts and analysis, origin and destination studies,analysis of socio-economic variables, estimation of traffic growth rate, traffic forecasts and finally capacity estimation. In this present paper, thecomplete process of Capacity Estimation for National Highway-63 has beenexpressed through a case study. The results obtained from capacity estimation suggests the year at which the road may reach its maximum capacity. This result of capacity estimation can be used to prioritize the upgradation of the highway under study.

Keywords: Volume, Capacity Estimation, Traffic Forecasting, Traffic Growth Rates Project Influence Area.

I. INTRODUCTION

Road network provides the arterial network to facilitate trade, transport, social integration and economic development. It is used for the smooth conveyance of both people and goods. Transportation by road has the advantage over other means of transport because of its easy accessibility, theflexibility of operations, door-to-door service and reliability. Consequently, passenger and freight movement in India over the years have increasingly shifted towards roads in comparison with other means of transport. The total road length in India increased more than 11 times during the 60 years between 1951 and 2011. From 3.99 lakh kilometer as on 31 March 1951, the road length increased to 46.90 lakh kilometers as on 31 March 2011. Concomitantly, the surfaced road length increased both in absolute and relative terms. The length of surfaced roads which was 1.57 lakh kilometers (39.35 per cent of total road length) as on March 1951 increased to 25.25 lakh kilometers (53.83 per cent of total road length) as on March 2011 [1].

Determination of road capacity is a major issue for transport planners. Capacity is defined as the maximum number of vehicles that can be accommodated per unit time under given condition of occurrence. Capacity

studies for heterogeneous traffic situations are very complex and only limited studies are undertaken [2]. The capacity analysis is fundamental to the planning, design and operation of roads. It is a valuable tool for evaluation of the investment needed for the future improvements. The capacity figures used for determining the desired carriageway width in differing terrain with respect to traffic volume and composition are as per "Manual of Specification & Standards for Four Lanning of Highways" and Asian Development Bank guidelines for Traffic Projections. In this present study capacity analysis is carried out for a section of National Highway-63 connecting Hubli to Hospet cities in Karnataka [3].

II. STUDY AREA CHARACTERISTICS

The Project stretch is a part of NH-63 in the state of Karnataka which runs from east to west connecting Karnataka to Andhra Pradesh. The total length of NH-63 is about 432 km, out of which 370 km runs in Karnataka State and about 55.4 km runs in Andhra Pradesh.

This case study deals with Hubli – Hospet stretch of NH-63. The project stretch starts at km 132+000 of NH-63 at thejunction with NH-4 Hubli-Dharwad bypass and ends at km 268+700 at thejunction of NH-63 and NH-13.

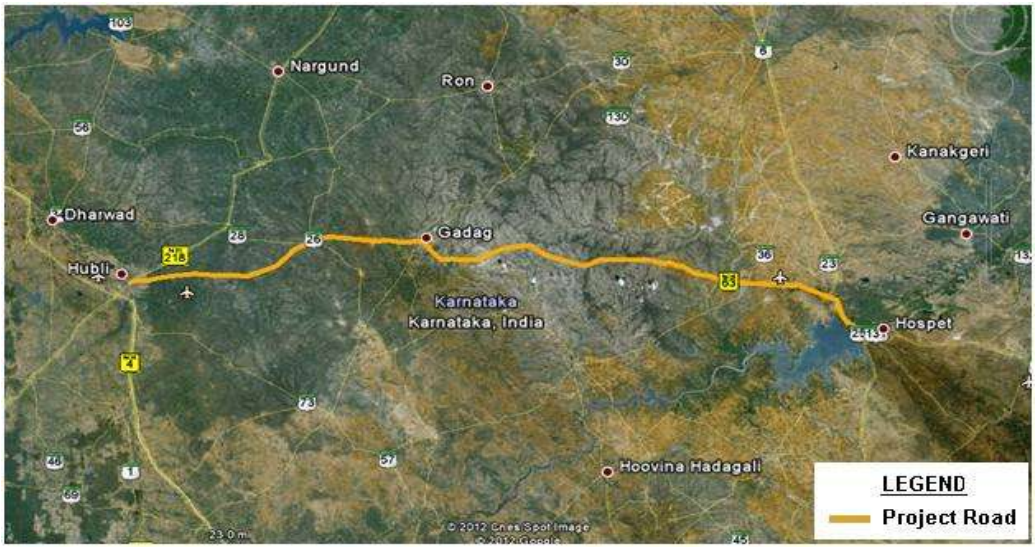

Fig. 1: Project Corridor

III. DATA COLLECTION

For the purpose of capacity estimation, primary data such as 7-day traffic volume counts and 24-hour O-D surveys were carried out. Secondary data such as Fuel Sales along the project stretch, previousyear's vehicle registration data of Karnataka State, Previous year's data such as Per Capita Income (PCI), Net State domestic Product (NSDP), Population data of all the state influencing the project corridor were also collected for analysis.

Arriving at Average Daily Traffic and Annual Average Daily Traffic from Traffic Volume Counts and Seasonal Correction Factors:

Traffic volume count surveys were carried out at Nalvadi, chainage 159.500 and Hallikere, chainage 221.400 of the project stretch. The details of the traffic counts of the two sections are represented as shown in the table below.

Table 1: A

verage Daily Traffic & Percentage Share of Vehicular Traffic on the Project Stretch

Survey Location	Nalavadi -159.500			Hallikeri-221.400		
Vehicle Category	ADT Vehicles	ADT (PCU)	% Share of Traffic	ADT Vehicles	ADT (PCU)	% Share of Traffic
Two Wheeler	898	449	16.6%	329	164.5	10.6%
Auto Rickshaw	40	40	0.7%	36	36	1.2%
Car/Jeep/Van/Taxi	1960	1961	36.2%	1019	1019	32.7%
Mini Bus	24	36	0.4%	18	28.5	0.6%
Buses	658	1974	12.2%	259	780	8.3%
Mini LCV	366	366	6.8%	212	212	6.8%
LCV (4&6 Tire)	282	423	5.2%	212	318	6.8%
Truck (2 and 3 Axle)	887	2661	16.4%	723	2169	23.2%
Multi Axle Trucks	145	652.5	2.7%	204	918	6.6%
HCM / EME	3	13.5	0.1%	5	22.5	0.2%
Tractor	40	60	0.7%	12	18	0.4%
Tractor + Trailer	54	243	1.0%	71	315	2.3%
Cycles	53	27	1.0%	10	5	0.3%
Cycle Rickshaw	1	2	0.0%	1	2	0.0%
Animal Drawn Carts	4	24	0.1%	3	18	0.1%
Total	**5415**	**8932**	**100.0%**	**3114**	**6026**	**100.0%**

Due to seasonal variation in traffic, the fuel sales data were collected for the last five years from the petrol bunks influencing the project corridor. This data was analyzed and seasonal correction factors were arrived. Seasonal Correction Factor (SCF) is obtained by dividing the average daily fuel consumption with the respective month on which the traffic volume count was carried out. The traffic volume count was carried out in the month of February hence seasonal correction factor of 0.88 is applied as shown in the table below:

Table 2: Fuel Sales data and Seasonal Correction Factors

Month	Daily Diesel Consumption (liters)	Daily Petrol Consumption (liters)	Both (liters)	Diesel Consumption	Petrol Consumption	Both
April	4654	396	5051	0.90	1.07	0.91
May	4517	417	4933	0.93	1.01	0.94
June	4289	400	4689	0.98	1.06	0.98
July	3675	392	4067	1.14	1.08	1.14
August	3325	364	3689	1.26	1.16	1.25
September	3532	375	3907	1.19	1.13	1.18

October	3771	437	4208	1.11	0.97	1.10
November	4308	442	4750	0.97	0.96	0.97
December	4474	444	4918	0.94	0.95	0.94
January	4334	448	4782	0.97	0.94	0.97
February	4769	473	5242	0.88	0.89	0.88
March	4681	482	5162	0.90	0.88	0.89
Average	**4194**	**422**	**4616**			

Table 3: ADT and AADT details of the project corridor after applying SCF

Survey Location	**Nalavadi -159.500**		**Hallikeri-221.400**	
Vehicle Category	**ADT (PCU)**	**AADT**	**ADT (PCU)**	**AADT**
Two Wheeler	449	395	164.5	147
Auto Rickshaw	40	36	36	32
Car/Jeep/Van/Taxi	1961	1727	1019	897
Mini Bus	36	32	28.5	25
Buses	1974	1739	780	686
Mini LCV	366	322	212	186
LCV (4&6 Tire)	423	372	318	279
Truck (2-axle and 3-Axle)	2661	2341	2169	1908
Multi Axle Trucks (4 axles & more)	652.5	574	918	807
HCM / EME	13.5	12	22.5	20
Tractor	60	54	18	16
Tractor + Trailer	243	214	315	277
Cycles	27	27	5	4
Cycle Rickshaw	2	2	2	2
Animal Drawn Carts	24	24	18	18
Total	**8932**	**7869**	**6026**	**5305**

IV. PROJECT INFLUENCE AREA

From the analysis of O-D surveys, the project influence areas were identified. The influence areas were developed from the O-D matrices and influence of each state is given in the table below:

Table 4: Project Influence Areas

States	**Cars**	**Buses**	**Truck**	**Average**
Karnataka	97.0%	93.9%	86.4%	92.4%

Goa	1.3%	0.5%	3.7%	1.8%
Andhra Pradesh	1.1%	3.7%	6.6%	3.8%
Maharashtra	0.6%	1.9%	2.7%	1.7%
Rest of India	0.0%	0.0%	0.7%	0.2%
Total	100.0%	100.0%	100.0%	100.0%

V. TRAFFIC GROWTH RATES

5.1. Growth estimates from Vehicle Registration Data

From the vehicle registration data for Karnataka state the following growth rate is observed for each class of vehicles:

Table 5: Summary of Cumulative Average Annual Growth Rate of Vehicles (%) in Karnataka State

Year	Goods Vehicles	Buses	Car/Jeep/Taxi	Two Wheelers	Three Wheelers
2006-2007	221913	89294	841846	3957762	284078
2007-2008	276013	95627	958300	4512910	307862
2008-2009	312272	99202	1030629	3755719	359920
2009-2010	344764	110558	1209431	4230864	403910
2010-2011	366597	115016	1326395	4796587	364781
2011-2012	377495	159377	1398221	6404905	349729
2012-2013	415491	167087	1561131	7033045	440368
CAAGR in %	**11.22%**	**11.62%**	**10.91%**	**11.10%**	**8.27%**

Source: Ministry of Road Transport & Highways Government of India (MoRT&H)

5.2. Growth Estimate by Transport Demand Elasticity method

According to IRC-108-1996, elasticity based econometric model for highway projects could be derived in the following form:

$$\log_e(P) = A0 + A1 \log_e(EI)$$

Where:

P = Traffic volume (of any vehicle type)

EI = Economic Indicator (GDP/NSDP/Population/PCI)

A0 = Regression constant;

A1 = Regression coefficient (Elasticity Index)

Elasticity Values:

Considering the Project Influence Area (PIA) and economic indicators of the influencing states, the projected elasticity values for various vehicle types are presented in the table below:

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Table 6: Elasticity values (Estimated and Recommended)

Mode	Estimated Elasticity(2006-2013)	Recommended Elasticity	2013-2018	2018-2023	2023 and Beyond
Goods	1.20	1.20	1.08	0.97	0.87
Buses	1.45	1.20	1.08	0.97	0.87
Passenger Cars	1.50	1.5	1.43	1.28	1.15
Two Wheelers	2.86	1.6	1.52	1.37	1.23
Three Wheelers	0.84	0.84	0.80	0.72	0.65

Growth Rate Projection:

From the socio-economic analysis and elasticity values obtained the growth rates for each class of vehicles are estimated as shown in the table:

Table 7: Projected Traffic Growth Rates from 2013 to 2023

Projected Traffic Growth Rates		Pessimistic Approach			Normal Approach			Optimistic Approach		
Sl. No	Vehicle Type	Projected Traffic Growth Rate (%)			Projected Traffic Growth Rate (%)			Projected Traffic Growth Rate (%)		
		2013-2018	2018-2023	2023-2033	2013-2018	2018-2023	2023-2033	2013-2018	2018-2023	2023-2033
1	**LCV**	8.0%	7.6%	6.5%	9.2%	8.7%	7.5%	10.5%	9.8%	8.5%
2	**2-Axle Truck**	4.9%	4.6%	3.9%	5.6%	5.3%	4.5%	6.4%	6.0%	5.2%
3	**3-Axle Truck**	8.0%	7.6%	6.5%	9.2%	8.7%	7.5%	10.5%	9.8%	8.5%
4	**Multi-Axle Truck**	7.0%	6.6%	5.6%	8.0%	7.6%	6.5%	9.1%	8.6%	7.4%
5	**Bus**	6.8%	6.6%	5.7%	7.9%	7.6%	6.6%	9.0%	8.5%	7.4%
6	**Car**	8.5%	8.3%	7.1%	10.0%	9.6%	8.3%	11.4%	10.9%	9.4%
7	**Two Wheeler**	8.9%	8.7%	7.5%	10.5%	10.1%	8.7%	12.1%	11.5%	10.0%
8	**Auto Rickshaw**	5.2%	5.1%	4.4%	6.0%	5.8%	5.0%	6.8%	6.5%	5.6%

Traffic projections and Impact of Mining Activities

The project stretch falls in the mining region. The mining in this region was banned at the time of volume counts, but the mining will resume very soon as the ban has been lifted and this will add 3000 mining trucks plying in this region. Hence, the mining trucks are also incorporated in the process of traffic forecasting and capacity analysis.

Table 8: Projected Traffic Growth Rates from 2013 to 2023

Traffic projections for different sections				
Year	Nalavadi		Hallikeri	
	Vehicles	PCU's	Vehicles	PCU's
2013	8415	16868	6112	14299
2014	9033	17789	6487	14964
2015	9712	18788	6894	15681
2016	10788	20292	7523	16753
2017	11643	21511	8029	17616
2018	12586	22837	8582	18549
2019	13575	24216	9162	19516
2020	14659	25710	9792	20558
2021	15849	27331	10481	21682
2022	17156	29092	11234	22897
2023	18591	31006	12058	24211
2024	19977	32848	12853	25477
2025	21473	34821	13707	26827
2026	23098	36944	14632	28273
2027	24864	39231	15633	29825
2028	26784	41694	16718	31489
2029	28871	44350	17892	33277
2030	31141	47215	19165	35196
2031	33609	50305	20545	37260
2032	36295	53641	22041	39478
2033	39218	57242	23665	41865

VI. CAPACITY ANALYSIS

Recommended Design Service Volume for Two Lane Highway in PCU's per day as recommended by IRC: SP 73:2007:

Table 9: IRC Recommendation for Design Service Volume for Two Lane Highway

Nature of Terrain	Design Service Volume in PCU's per day	
	Without paved shoulder	With minimum 1.5 m paved shoulder
Plain	15,000	18,000
Rolling	11,000	13,000
Mountainous and Steep	7,000	9,000

Results of Capacity Analysis:

Table 9: Details of the capacity analysis

Project facility	Level of Service	Design Service Volume (PCU/day)	Traffic Homogenous Sections	
			Nalavadi - (Year)	Hallikeri - (Year)
2-Lane with1.5m Earthen Shoulder	LOS B	15000	Maximum Capacity Reached	Maximum Capacity Reached
	LOS C	21000	2016	2020
2-Lane with1.5m Paved Shoulder	LOS B	18000	Maximum Capacity Reached	2017
	LOS C	24000	2018	2022
4-Lane with 1.5m Earthen Shoulder	LOS B	35000	2025	2029
	LOS C	49000	2030	-
4-Lane with 1.5m Paved Shoulder	LOS B	40000	2027	2032
	LOS C	60000	-	-

VII. DISCUSSION AND CONCLUSION

- In the area of influence of the project road, there is no good network of National Highways. The development of the project corridor will further boost the economy of the area and is considered to be the most desirable feature for the social and economic prosperity for the people of the area.
- The traffic projections for the years up to 2033 have been worked out using the Econometric method under three scenarios. The overall traffic levels under the likely and pessimistic scenario are around 15% to 25% lower compared to the optimistic scenario in the horizon year.
- 4-laning of this National highway is necessary as the maximum capacity has already been reached at both the sections where the survey was conducted.

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