International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

IMPACT OF TRAFFIC FLOW CHARACTERISTICS IN MULTI-LANE HIGHWAY ON PAVEMENT DESIGN

Praveen Kumar M. M.[1], Aniket Deshpande[2], Pannaga M. R.[3], J S Vishwas[4]

[1]*U G Student Department of Civil Engineering, PES Institute Of Technology College, (India).*
[2]*U G Student Department of Civil Engineering, PES Institute Of Technology College, (India)*
[3]*U G Student Department of Civil Engineering, PES Institute Of Technology College, (India)*
[4]*Assistant Professor, Department of Civil Engineering, PES University, (India)*

ABSTRACT

Data gathered from traffic flow is an important tool required for planning and operation of road system .Due to mixed flow traffic in India it is important to consider traffic condition while planning and designing of pavement. Inventory survey and traffic survey are conducted at selected stretch of a highway. Data collected from traffic survey is used to calculate future traffic of existing road by simplex method of traffic forecasting. Data collected from the above mentioned survey is used to design of pavement using CBR method. Estimation of PCU value using Satish Chandra method for traffic composition. Determination of capacity and free flow speed to study speed volume relationship.

***Keywords: Capacity, CBR, Free flow speed, Pavement design, PCU, Volume*.**

1. INTRODUCTION

Traffic composition on multilane highways comprise of wide range of vehicles in terms of their type, size, engine, power, etc. which results in broad range of speeds.

The behaviour of traffic flow has to be considered while redesigning the highway stretch.

To understand the real traffic behaviour, it requires some of the basic traffic flow characteristics, such as speed, flow, density and occupancy through which capacity can be derived.

II LITRETURE REVIEW

As per study by A. R. Khanokar, S. D. Ghodmare and Dr. B. V. Khode with title “Impact of Lane Width of Road on Passenger Car Unit Capacity under Mix Traffic Condition in Cities on Congested Highways”. The study is concerned with determining the PCU values of vehicles in under mixed nature traffic flow at on congested

highways. In this paper, the required data is collected at 5 main highways around and in Nagpur city using a digital video recorder.

PCU value of a vehicle significantly changes with change in traffic volume and width of the roadway. The capacity of highways also increases with use of shoulder area and its positive effect on PCU value for type of vehicle increases with increase in lane width.

Keeping some of these journals as reference, we are trying to start our study on Bangalore-Mysore road (NH275, SH17)

HEADINGS

Number	Heading
1.	Introduction
2.	Headings
3.	Methodology
3.1.	Location
3.2.	Inventory Survey
3.3.	Traffic Survey
3.4.	Speed Survey
3.5.	PCU
3.6.	Pavement Design
3.6.1.	CBR method
4.	Indentations and Equations
5.	Results
5.1.	Inventory Survey
5.2.	PCU Results
5.3.	Volume and Speed relationship
5.4.	Capacity and Free flow speed
5.5.	Traffic forecasting
5.6.	Pavement Design
5.6.1	CSA by Traffic Forecasting = 30.760 million standard axles. (Max value) (for present traffic condition)
5.6.2	CSA by Traffic Forecasting = 103.887 million standard axles. (Max value) (After 15 years)
6.	Conclusion
7.	Acknowledgements
8.	References

III METHODOLOGY

3.1. Location

Location selected is done such a way that the stretch should be Straight, clear sight distance and free from intersection.

FIGURE 1: satellite image of selected stretch for traffic survey.

3.2. INVENTORY SURVEY:

Inventory Survey was conducted on a selected stretch of highway using basic surveying instruments.

Purpose of inventory survey is to determine existing condition of the road.

Details:

- Stretch : 1000m
- Interval : 100m

No potholes or cracks were reported throughout the stretch.

3.3. TRAFFIC SURVEY

Two methods which can be used for conducting traffic survey are:

1. Using video recording devices
2. Manual method.

For the purpose of feasibility the method adopted is Manual method in this study. Vehicle count were recorded in the form of tally system using pen and paper.

3.4. SPEED SURVEY:

Speed of vehicle is determined using a relation (1) with basic instruments like measuring tape and stopwatch. Two sections were marked on the road with spacing 50m .Speed of vehicles were calculated by recording the time required by vehicle to cross from one section to another.

3.5. PCU:

- Among various methods Satish Chandra method is adopted to determine the PCU values for various categories of vehicles in this study.
- According to this method PCU value of a vehicle depends on speed and area of vehicle and standard vehicle.

TABLE 1: represents the standard area of various categories of vehicles.

Vehicle Category	Average Dimensions in (m)		Area on ground (m^2)
	Length	Width	
Car	3.72	1.44	5.39
Bus	10.1	2.43	24.74
Truck	7.5	2.35	17.62
L. C. V.	6.1	2.1	12.81
Trailer	7.4	2.2	16.28
3-wheeler	3.2	1.4	4.48
Motorbike	1.87	0.64	1.2
Bicycles	1.9	0.45	0.85

3.6. PAVEMENT DESIGN:

3.6.1. CBR method:

1. Optimum moisture content of subgrade soil is determined.

2. CBR value of a subgrade is determined by conducting test on subgrade soil for worst moisture condition by soaking the soil specimen for 3 days

3. Using CBR value and CSA (Cumulative Standard Axles) value, thickness of various pavement layers is calculated.

4. INDENTATIONS AND EQUATIONS:

$$\textbf{VELOCITY: } \frac{\text{distance}}{\text{time taken}} \qquad (1)$$

$$\textbf{PCU: } \frac{Av * Vc}{Ac * Vv} \qquad (2)$$

Where,

V_c : Velocity of standard vehicle.

A_v : Area of vehicle.

V_v : Velocity of vehicle.

A_c : Area of standard vehicle

$$\textbf{CSA : } \frac{365 * VDF * LDF * N * ((1+r)^n - 1)}{r} \qquad (3)$$

where,

CSA : Cumulative standard axles.

N : Average daily traffic at the beginning.

LDF : Lane distribution factor =0.6 for 6 lane divided carriageway (As per IRC37-2012).

VDF : Vehicle damage factor = 4.5 for > 1500 commercial vehicles per day initially in a plain or rolling terrain. (As per IRC37-2012).

r : Growth rate = 5% as per IRC37-2012.

n : Design life = 25years (considered in this study).

$$\textbf{CBR : } \frac{Load * 100}{Standard\ load} \qquad (4)$$

where,

CBR : California bearing ratio of soil.

Standard load = 1370kg (for 2.5mm) and 2055kg (for 5.0mm)

5. RESULTS:

5.1 INVENTORY SURVEY:

TABLE 2: represents results of inventory survey

INVENTORY SURVEY (TABULAR COLUMN)									
Chainage (m)	Footpath (m)	Shoulder (m)	Pavement (m)	White to median (m)	Median (m)	Median to White (m)	Pavement (m)	Shoulder (m)	Footpath (m)
0	0.80	1.70	7.20	0.57	1.22	0.57	6.75	3.15	2.75
100	0.80	1.80	7.50	0.61	1.30	0.48	6.92	3.20	2.71
200	1.15	2.60	7.60	0.53	1.34	0.50	7.05	3.24	2.67
300	2.60	4.05	6.90	0.47	1.23	0.57	7.12	3.10	2.70
400	1.65	2.60	6.10	0.62	2.03	0.67	6.65	2.65	0.87
500	3.23	2.52	6.20	0.65	2.10	0.66	6.00	2.70	1.70
600	5.20	2.40	6.40	0.64	1.86	0.47	7.60	1.80	1.30
700	4.80	2.45	6.86	0.60	2.10	0.60	6.50	1.70	1.30
800	3.70	2.78	7.00	0.62	2.30	0.57	6.75	1.80	1.50
900	2.76	2.60	6.50	0.65	2.52	0.61	6.78	2.30	1.80
1000	2.51	2.65	6.75	0.64	2.43	0.60	6.52	2.20	1.75
average	2.65	2.56	6.82	0.60	1.86	0.57	6.79	2.53	1.91

5.2 PCU RESULTS:

TABLE 3: represents PCU values for various categories of vehicles

vehicle type	PCU (Satish Chandra's Method)		PCU (IRC-106:1990)
	Ban-Mys	Mys-Ban	
2-wheeler	0.1550983	0.1468301	0.5
auto rickshaw	0.646734007	0.712270388	1.2
car/jeep/taxi	1	1	1
utility vehicles	0.761315894	0.87982507	NA
mini bus	1.674284446	1.795899387	NA
standard bus	4.071216617	5.295991561	2.2
LCV passenger	1.314147028	1.784080776	1.4
LCV goods	1.364504463	1.573407407	1.4
2-Axle	2.58844482	2.968942189	2.2
3-Axle	2.643993587	3.682303585	2.2
Multi Axle	4.616419919	5.703736523	2.2
Agr. Tractor	3.902161547	3.619917985	4
Tractor-trailer	4.266169154	4.587379362	4
Road roller/JCB/Crane	7.181742044	8.576504553	NA
Hand carts	1.841682185	1.566165026	2

Cycles	0.204081915	0.345215674	0.4

5.3. VOLUME AND SPEED RELATIONSHIP:

Graphs that represent volume of vehicles and speed were plotted and dependency values are determined using excel software.

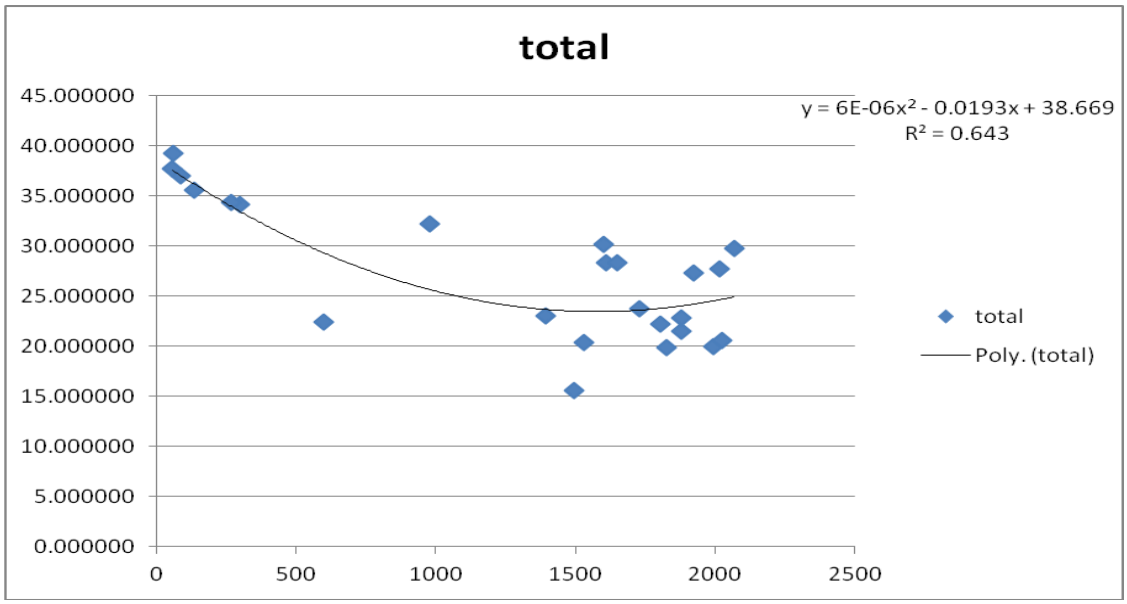

FIGURE 2: represents speed volume relationship for total number of vehicles with dependency value.

TABLE 4: represents dependency values between speed and volume for various category of vehicles.

Vehicle Category	Dependency (R^2)	Vehicle Category	Dependency (R^2)
2-wheeler	0.8637	2-axle	0.6693
Auto Rickshaw	0.8792	3-axle	0.3784
Car/ Jeep/ Taxi	0.8142	Multi axle	0.3441
Utility Vehicles	0.4624	Tractor-trailer	0.7649
Mini Bus	0.8325	Road roller/ JCB/ Crane	0.9478
Standard Bus	0.8572	Handcarts	NA
LCV Passenger	0.3089	Cycles	0.1289
LCV Goods	0.4353	Total	0.643

5.4. CAPACITY AND FREE FLOW SPEED:

TABLE 5: represents average free flow speed for various categories of vehicles

VEHICLE TYPE	FREE FLOW SPEED	VEHICLE TYPE	FREE FLOW SPEED
2-wheeler	39.98798	2-Axle	29.1179024
auto rickshaw	29.43951	3-Axle	23.5177311
car/jeep/taxi	44.3455364	Multi Axle	24.88130
utility vehicles	23.2683826	Agr. Tractor	Nil
mini bus	32.9248862	Tractor-trailer	28.07707
standard bus	28.5590621	Road roller/JCB/Crane	18.98583
LCV passenger	30.0910969	Hand carts	11.98851
LCV goods	29.067295	Cycles	14.10363

MAXIMUM CAPACITY = **2181 PCUs /hr**
AVERAGE FREE FLOW SPEED = **27.24467 km/hr**

5.5 TRAFFIC FORECASTING:

TABLE 6: represents traffic in million standard axles for every 5 years of interval.

YEARS	BANGALORE TO MYSORE CSA (in msa)	MYSORE TO BANGALORE CSA (in msa)
0 (Present traffic)	30.362	30.760
5	38.739	39.229
10	49.430	50.036
15	63.076	63.827
20	80.492	81.427
25	102.721	103.887

5.6. PAVEMENT DESIGN:

For the pavement design the laboratory tests that were conducted and their results are as follows:

- **OMC = 14.81%**
- **CBR = 7.3576%**

5.6.1. CSA by Traffic Forecasting = 30.760 million standard axles. (Max value) (for present traffic condition)

TABLE 7: represents results of pavement design for present traffic condition.

PAVMENT LAYERS THICKNESS (**AS PER IRC 37:2012**)	
TOTAL PAVEMENT THICKNESS (mm)	611
BITUMINOUS CONCRETE (mm)	40
DENSE BITUMINOUS MECADAM (mm)	101
GRANULAR BASE COURSE (mm)	250
GRANULAR SUB BASE COURSE (mm)	220

5.6.2. CSA by Traffic Forecasting = 103.887 million standard axles. (Max value) (After 15 years)

TABLE 8: represents results of pavement design for traffic condition after 15 years.

PAVMENT LAYERS THICKNESS (**AS PER IRC 37:2012**)	
TOTAL PAVEMENT THICKNESS (mm)	623
BITUMINOUS CONCRETE (mm)	43
DENSE BITUMINOUS MECADAM (mm)	110
GRANULAR BASE COURSE (mm)	250
GRANULAR SUB BASE COURSE (mm)	220

6. CONCLUSION:

- PCU Values obtained by Satish Chandra method, were found to be less compared to IRC values, for major portion of vehicles.

- Because of mixed Indian Traffic Conditions the dependency between volume and speed were found to be varying for different categories of vehicles.

- For a CBR Value of 7.3576% and CSA Value of 63.827 msa (for 15th year), total thickness of pavement was found to be 623mm. For a CBR Value of 7.3576% and a CSA value of 30.76 msa (for present year), total thickness of pavement was found to be 611mm.

- Finally we can conclude that, difference between pavement thickness for present year and 15th year is around 12mm (which is less compared to total thickness of the pavement), so it is advisable to design for the 15th year instead of designing for present year traffic. By doing so, the lifespan of the pavement can be doubled. The only constraint for the above case is requirement of proper maintenance of the pavement.

7. ACKNOWLEDGEMENTS:

We were very glad to acknowledge Registrar and Chairperson of Civil Department **Dr V Krishnamurthy**, PES University for helping us to publish this article and PES Institute Of Technology for supporting us for the project. We would also like to thank PES University for providing us the laboratory instruments.

8. REFERENCES:

JOURNAL PAPERS:

1) S. Chandra, *"Highway Capacity Research on Inter-urban Highways in India" DOI 10.1007/s40890-015-0003-4 (Springer International Publishing AG 2015)*
2) P. M. Shah and N. Gupta, *"Study of Traffic Flow Characteristics on National Highway (NH1) connecting Jalandhar-Phagwara". (IJLTET) Vol. 6 Issue 4 March 2016.*
3) E. Madhu and S. Velmurugan, *"Estimation of Roadway Capacity of Eight-lane Divided Urban Expressways under Heterogeneous Traffic through Microscopic Simulation Models". (IJSTE). Research Vol. 1(6), November 2011.*
4) H. Faheem and I. H. Hashim, *"Analysis of Traffic Characteristics at Multi-lane Divided Highways, Case Study from Cairo-Aswan Agriculture Highway". (IRJES). Volume 3, Issue 1 (January 2014).*
5) A. R. Khanokar, S. D. Ghodmare and Dr. B. V. Khode, *"Impact of Lane Width of Road on Passenger Car Unit Capacity under Mix Traffic Condition in Cities on Congested Highways". (IJERA). Vol. 4, Issue 5 (Version 2), May 2014.*
6) H. C. Chin and A. D. May, *"Examination of the speed – Flow Relationship at the Caldecott Tunnel". (Transportation Research Record 1320).*
7) *"Design of flexible pavement by CBR method". (IJCEM). Vol. 3, Issue 2, May 2016.*

CASE STUDY:

"Traffic Growth rate estimation using transport demand elasticity method: A case study for National Highway-63" –IJRET

CENSUS REPORT:

"Government of Karnataka Public Works, Ports & Inland Water Transport Department 210 Road traffic Census Report"

BOOKS:

S. K. Khanna, C. E. G. Justo and A. Veeraragavan ***"****highway engineering 10th edition"* ISBN 978-81-85240- 80-0

IRC CODES:

1.) IRC-106:1990: *Guidelines for capacity of urban roads in plain areas*.

2.) IRC – 37:2012: *Guidelines for the design of flexible pavement*.

AUTHOR BIOGRAPHY

	**Praveen Kumar M. M. is a Final Year undergraduate student at PESIT, Bangalore.**
	**Aniket Deshpande is a Final Year undergraduate student at PESIT, Bangalore.**
	**Pannaga M. R. is a Final Year undergraduate student at PESIT, Bangalore.**

J S Vishwas is a Assistant Professor in the Department of Civil Engineering PES University Bangalore. He is currently a board of member for International Journal of Emerging Trends in Technology. He is a Life Time Member for International Society of Research Development and Institution of Highway Engineers.