National Conference on Recent Research in Engineering and Technology (NCRRET-2015)
International Journal of Advance Engineering and Research Development (IJAERD)
e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

"A study of Macroscopic Traffic Stream Parameters for Undivided Collector Streets in India"

*Rinkal T. Patel, **Shree Chetan. R. Patel, ***Dr. G. J. Joshi

*Assistant Professor, CGPIT, Bardoli, rinkal.patel@utu.ac.in,
**Assistant Professor, CED SVNIT Suratcrp@ced.svnit.ac.in ,
***Associate Professor, Transportation Engineering and Planning, SVNIT, Surat, gj@ced.svnit.ac.in

Abstract: **Indian traffic is highly heterogeneous which consist of wide variety of vehicles in terms of static and dynamic characteristics. Due to heterogeneity of traffic, analysis of traffic stream parameter become complex in nature. Collector road is a part of urban street hierarchy whose function is to collect traffic from local streets and distribute the traffic to arterial and sub-arterial streets or vice-versa. Collectors are designed to provide a greater balance between mobility and land access within residential, commercial, and industrial areas. Hence proper planning for collector Street is important for efficiency of network of the urban road system. Hence the traffic characteristics are very important in case of Collector Street. In view of this, attempt has been made to study traffic flow behaviour on macroscopic scale by deriving relationship between speed (V), flow (Q) and density (K) for a selected stretch of collector street. Bhubaneswar the largest city of the Indian state of Orissa is selected for the study. Field traffic surveys were carried out on typical week day and traffic data was extracted. The extracted data are analyzed in terms of vehicle composition, directional split, and space mean speed. Parameters like capacity, optimal density, optimal speed and jam density are derived from the Q-K-V models. Results are compared with the IRC prescribed capacities and also with the traditional Greenshield's model.**

Key Words:-Heterogeneity, Collector Road, Q-K-V models, Greenshield's model

1 INTRODUCTION

As the Indian road traffic is highly heterogeneous, analysis of traffic parameter become complex in nature. Study of the various characteristics of road traffic is enormously useful for planning and design of roadway system and operation of road traffic. The traffic stream parameter provides information regarding the nature of traffic flow, which helps the traffic planner in designing the system for optimal performance in terms of offered mobility and accessibility. The performance of traffic stream parameters can be mainly classified as: measurements of quantity which includes density and flow of traffic and measurement of quality which include speed.
Very little empirical research has been conducted regarding the mix traffic characteristics of urban undivided carriageway. Traffic flow characteristics include speed, flow, density, headway, directional distribution, and variation in traffic flow with respect to time. On undivided two-way carriageway traffic is permitted in both directions without any segregation, therefore traffic stream behaviour becomes complex in nature due to interaction among the vehicles coming from the opposite directions. Also, collector street in cities allow road side activity like parking and direct access onto the carriageway. This adds further complexity in traffic flow estimation procedure.

Present study is concerned with the macroscopic traffic characteristics observed on 2-lane undivided carriageway of Bhubaneswar city in India. Classified traffic volume survey for 16 hour duration on a typical weekday has been carried to identify peak and off peak hours. Traffic survey during identified peak and off peak durations has been carried out by vidiographic technique. Classified volume, density and speed data of each direction for 1-minute interval has been extracted by playing the traffic video films in the laboratory. Data has been processed in MS-Excel to develop relationships between speed (V)-density (K), flow (Q)-density (K) and speed (V) - flow (Q). Important parameters of the models at capacity and at jam conditions are derived. Estimated parameters are compared with the parameters obtained from Greenshield's model. IRC prescribed capacity is also compared with the empirically obtained capacity for the study road stretch.

2 LITERATURE REVIEW

S. Chandra and Upendra Kumar (2003), studied the effect of Lane width on Capacity under Mixed traffic conditions in India. Data collected at ten sections of two-lane roads in different parts of India. It was found that the PCU for a vehicle type increases linearly with the width of carriageway. The capacity of a two-lane road also increases with total width of the carriageway and the relationship between the two follows a second-degree curve. S. Chandra (2004), proposed Capacity estimation procedure for two-lane roads under mixed traffic conditions. The data for this study were collected at more than 40 sections of two-lane roads to determine the effect of gradient, lane width, directional split, shoulder's

condition and pavement roughness on capacity of two lane roads. The effect of influencing parameters like gradient, lane width, shoulder width, traffic composition, directional split, slow moving vehicles and pavement surface conditions, on capacity of two-lane roads under mixed traffic conditions is evaluated and adjustment factors for each of these conditions are proposed. Partha Pritam Dey, S. Chandra et. al. (2008), have studied the mix traffic flow on two lane road. The analysis is carried out using simulation program. It is observed that the capacity of a two-lane road decreases as the proportion of three-wheeler, tractor, or heavy vehicle increases in the traffic stream. But, in the case of two-wheelers the capacity was found to increase with their proportion

3 STUDY AREA

Bhubaneswar is the capital and largest city of the Indian state of Orissa. It has a total area of 124.74 sq km. Geographically Bhubaneswar is situated in the eastern coastal plains of Orissa and south-west of Mahanadi river.

3.1 Physical Characteristics

According to 2001 census, municipal area of the city is 135 Sq. Km and development area is 233 sq. km. according to 2011 census, the area of the city is observed 419 Sq. Km. The density observed is 4900 per KM_2.

3.2 Study Stretch details

In Bhubaneswar Ram Mandir Road is selected for the study. The carriageway width is observed 6.5 m and the length of stretch is observed 40 m. On Ram Mandir Road both side 1.5 m unpaved shoulder is observed. Figure 1 shows cross section of Collector Street at Bhubaneswar.

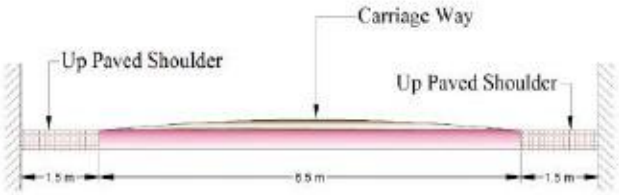


Figure 1: Cross Section of the Collector Road at Bhubaneswar

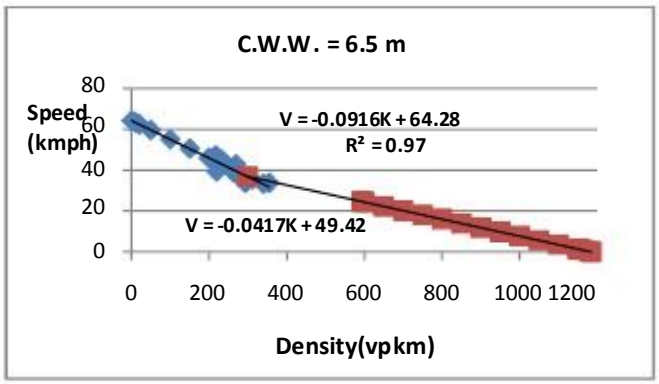
As such there are no obstacles are present on the road. But due to parked vehicle near the local vendors along the road on footpaths, during the peak hour is creating obstacles. Footpaths on both sides are generally occupied by street vendors as well as street hawkers.

4 TRAFFIC CHARACTERISTICS

Classified volume count is carried out for 16 hours (6:00 am to 10:00 pm) by manually, using tally sheets on a working day. Vediographic survey is carried out for the selected Morning Peak Hour (MPH) and Evening peak hours (EPH) from the hourly volume pattern using high resolution camera. On the basis of 16 hour classified volume count, 11:30 hrs to 13:30 hrs is identified as morning peak period with 2834 PCU and 15:20 hrs to17:20 hrs is identified as evening peak period with 2366 PCU. Two wheelers proportion varies from 55-60% of total traffic whereas three wheelers, four wheelers and bicycles constitute about 7%, 20 % and 12% respectively. Directional split is almost even with ratio of 52:48 of traffic in either direction. Average speed of two wheelers is observed as 44 Kmph and three wheelers observed in the range of 35-39 kmph. During all duration the average speed of car varying from 38 to 45 kmph while the average speed of bicycle is 18 kmph.

5 Q-K-V MODELS

Extracted data of speed, flow and density are compiled for each direction and speed – density, speed-flow and flow-density plots are drawn and models are developed by curve fitting technique. In order to fully understand the flow behaviour across the range of volume, it is necessary to generate missing speed – flow – density data. For generating missing data flow-density curve is considered. By differentiating the equation of flow-density curve with respect to density, the capacity and optimum density values are obtained. Figure 2 shows the Density (K) – Speed (V), Flow (Q) – Density (K) and Flow (Q) – Speed (V) models for the selected collector street. The models are found to observed general trend as established by previous research.



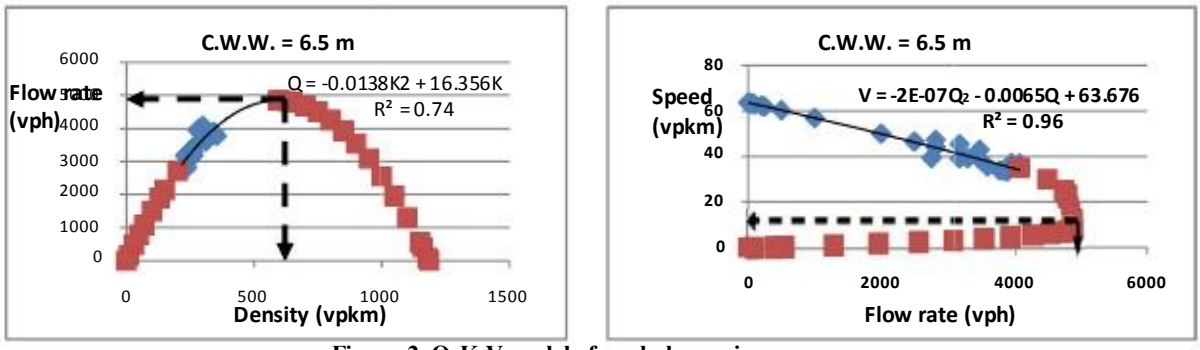


Figure 2: Q-K-V models for whole carriageway

By differentiating equations relating V-Q and Q-K with respect to Q and K respectively, optimum density, jam density and maximum flow rate (Q_{max}) i.e. capacity are calculated. The maximum flow rate (Q_{max}) obtained for the carriageway is 4846 vph, optimum density (K_{opt}) is 593 vpkm and jam density (K_{jam}) is 1185 vpkm. The speed at capacity (V_{opt}) is 8.18 kmph.

6 STREAM FLOW PARAMETERS

Table 1 shows the summary of parameters of Q-K-V models estimated for individual direction, combined direction and that obtained by application of classical Greenshield's model.

IRC:106:1990 specifies design service volume of 900 PCU per hour for level of service C for 2 lane two way collector street resulting into capacity of 1286 PCU per hour.

Table 1: Summary of Q-K-V Model parameters

Bhubaneswar (Effective Width = 6.5 m)				
	Q_{max} (vph)	K_{opt} (vpkm)	K_{jam} (vpkm)	V_{opt} (kmph)
Towards Ram Mandir Road	2753	360	721	8.16
Away from Ram Mandir Road	2424	323	656	7.96
Combined of both directions	4846	593	1185	8.18
Greenshield	11277	351	702	32.14

7 CONCLUSIONS

For efficient design of traffic facility understanding of traffic flow characteristics and their inter-relationship is necessary. In the present study, macroscopic traffic flow characteristics has been adopted for developing speed-flow-density equations for selected undivided two way collector street of Bhubaneswar in India. From the study it is observed that 2w is dominating with highest share of 60% while car and bicycle share is observed as 18% and 12% respectively. In Bhubaneswar, the stream speed varies from 18 kmph to 50 kmph. Flow-density-speed models are developed in the study are able to explain the behaviour of traffic stream precisely with a significant coefficient of determination R^2 under heterogeneous traffic environment. For the developed Q-K-V model the capacity of selected undivided street is observed 4846 vph. Difference in parameters based on Greenshield model and the derived in the present study reflect the effect of heterogeneity of traffic as well road side friction.

REFERENCES

1. Highway Capacity Manual (HCM). Transportation Research Board, National Research Council, Washington, D.C Special Rep. No. 209, 4th Ed, (2000).
2. IRC: 106-1990, *Guidelines for Capacity of Urban Roads in Plain Areas,* Indian Code of Practice, Indian Road Congress, New Delhi.
3. Kadiyali L. R, *Traffic Engineering and Transport Planning,* Khanna Publishers, New Delhi, 7th Edition (2008).
4. Partha Pratim Dey, S. Chandra,. *Simulation of Mixed Traffic Flow on Two-Lane Roads,* ASCE, Journal of Transportation Engineering, Vol.134, No.9, pp. 361-369, (2008).
5. Rinkal T. Patel " A Study on mixed traffic Speed-Flow-Density relationship under varying roadway and traffic conditionfor undivided collector street" Unpublished M Tech Thesis, SVNIT, Surat (2012)
6. S. Chandra, *Capacity Estimation Procedure for Two-Lane Road Under Mixed Traffic Condition,* IRC, New Delhi, pp. 139-170, (2004).
7. S. Chandra and Upendra Kumar, *Effect of Lane Width on Capacity under Mixed Traffic Conditions in India,* Journal of Transportation Engineering, vol. 129, No.2, ASCE, 155-160, (2003).
8. S. Chandra, *Effect of Road Roughness on Capacity of Two-Lane Roads,* Journal of transportation engineering, vol.130, ASCE, No.3, pp. 360-364, (2004).
   V. Thamizh Arasan and G. Dhivya, *Measuring Heterogeneous Traffic Density,* World Academy of Science, Engineering and Technology 46, (2008)