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Impact of Lane Width of Road on Passenger Car Unit Capacity under Mix Traffic Condition in Cities on Congested Highways

A.R. Khanorkar[1], S.D.Ghodmare[2], Dr.B.V.Khode[3]
[1](M-tech Transportation Engineering,G.H. Raisoni College of Engg, Nagpur, Nagpur-16)
[2] (Assistant Professor, Department of Civil Engineering, G.H. Raisoni College of Engg, Nagpur, INDIA)
[2] (Professor, Department of Civil Engineering, G.H.Raisoni College of Engg, Nagpur, INDIA)

ABSTRACT
Passenger car units are used to represent the effects of varying mixed vehicle types on traffic stream. The traffic volume information about roads which is important for, design and planning analysis for that roadway system. Traffic on congested highways is of the mixed nature to assess the different types of vehicles on highways. This study is concerned with determine the PCU values of vehicles in under mixed nature traffic flow at on congested highways. PCU is the different types of vehicles offer different degree of interference to the other traffic it necessary to bring all types to a common unit. The common unit adopted is expressing the volume as Passenger Car Unit (PCU) per hour. In this paper the required data is collected at five main highways around and in Nagpur City using a digital video recorder. During recent years traffic on road has been grow up at rapid rate which causes congestion on the roads. Speeds of vehicle reduced due to congestion and vehicle operating cost is high on such highways. Accident rate is also usually high. Our aim is to work out the passenger car unit PCU for different types of vehicles under mixed nature traffic conditions. This PCU value is utilized to increase the area of shoulder linearly for free speed of a vehicle with width of carriageway. Data collected and analyzed the traffic characteristic. It has been observed that from the present study of traffic volume and roadway conditions that the PCU value of a vehicle significantly changes with change in traffic volume and width of 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 increases lane width.
Keywords- Data collection, Highway capacity, PCU, Traffic volume,

I. INTRODUCTION

Two-lane highways represent the majority of road networks in the world. Most of the national highway and state highway system present in India is of two lane highway with two-way mixed traffic condition and with very little lane discipline. Different types of vehicles with varying dynamic and static characteristics share the same road space without much segregation and control of speed. Indian traffic streams consist of heterogeneous traffic which also includes non-standard vehicles the behaviour of Indian driving on highways such heterogeneous, that is, the lane discipline and lane change behaviour affects roadway capacity on highways. The different types of vehicle and their size and speed of that vehicle create a number of problems for traffic operations. In this paper, an attempt has been made for the first time to study on the highways around Nagpur cities to identify the impact of lane width on the capacity of two-lane highways under mixed nature traffic conditions. To calculate the passenger car unit PCU of wide verities of vehicles under mixed traffic conditions on two-lane divided highways in plain terrain. The Indian Roads Congress (IRC) code specifies the PCU values for different vehicle types also such as car, truck, trailer tractors, hand carts, motor cycle, rickshaws, bullock carts, etc. However, these PCU values are fixed and only depend on traffic composition on highways. The capacity of two-lane highways includes lane width and type of shoulder influence volume of traffic. Lane and shoulder width can be a great impact on traffic flow on congested highways. This paper is focused on the study of the effect of variation in nature of traffic volume, road width and size of the vehicles, on PCU value of vehicles.

II. OBJECTIVES

The main aim of the study is to examine the credibility of PCU values given in IRC for the present roadway and traffic condition. In view of the main aim of the study, the following objectives are

1) To estimates the value of PCUs for mix traffic condition of moving vehicles in the traffic stream.
2) To develop new PCU values applicable to current highway and traffic conditions.

3) To compare the PCU values obtained by current studies to know whether they are different with IRC.

III. LITERATURE SURVEY

Satish Chandra and Upendra Kumar (2002) Reported data were collected at ten sections of two-lane roads in different parts of India. All vehicles were divided into nine different categories and their PCU's were estimated at each road section. These data were analyzed and adjustment factors for lane width were calculated. V.Thamizh Arasan and Shriniwas S. Arkatkar (2010)reported traffic volume as number of vehicles passing a given section of road or traffic lane per unit time several types of vehicles with widely varying static and dynamic characteristics are comprised in the traffic.. This study is concerned with the estimation of PCU values of vehicles in such traffic conditions, using microscopic simulation. The PCU values obtained for different types of vehicles, , show that the PCU value of vehicle significantly changes with change in traffic volume and width of roadway.Nguyen Y. Cao and Kazushi Sano (2012)Reported the accurate methodology of motorcycle equivalent units (MEUs) in mixed traffic flowThe values ofcapacity, maximum motorcycle flow, critical mean stream speed, and critical density of traffic flow were computed The capacity increse,increases with the number of lanes of urban roads.S.Anand and V.C. Sekhar (1999) reported Passenger Car Unit (PCU) value of each class of vehicle is very important for any mixed traffic flow studies at highways.. the PCU values is used for different classes of vehicles has been proposed for Malaysian roads Parvathy R, Sreelatha T, Reebu Z Koshy (2013) reported determine the PCU values for various types of vehicles, And therefore a comparison of results with PCU factors recommended by IRC code. It is found that the estimated PCU values are different from those being used in India, and they are indirectly related to the length of passenger car. Studies reveal that PCU values have a great impact on signal design, in this study can be used as a guideline in the design and analysis of signalized intersections.

IV. DATA COLLECTION

The data for this study were collected at 6 sections of two-lane highways around Nagpur city to determine the impact of lane width and shoulder's condition on capacity of two lane highways by using a video recording technique during the time of data collection as to cover the total trap length with some margin on either side with stop watch for determine time to cross the trap length. This time was used to calculate the maximum and minimum speed of a vehicle passing through the section. The vehicles were divided into different categories and Average dimensions and projected areas of different type of vehicle category are also given as shown in Table1

V. TRAFFIC VOLUME DATA

The proportion of vehicles in a traffic stream is very important parameter for geometric and structural design of any pavement. Analysis of traffic composition gives the idea of proportion of wide verity of vehicles. So, it is crucial to know the traffic composition of various sections. Vehicle class percentages on N.H-07 are shown in below Fig.1. It is found that; Motor vehicle has the highest percentage in the traffic stream. Vehicle class percentages on S.H-09 are shown in below Fig.2. It is Found that, Truck, trailer, by-cycle, light commercial vehicle has the lowest percentage in the traffic stream and percentage ofcar shows slightly variation in volume of traffic. All these locations are presented through pie charts in Figs. 1 to 2. It is observed from these figures those two wheelers traffic is predominant at all the locations and the percentage shares of vehicles are also given.

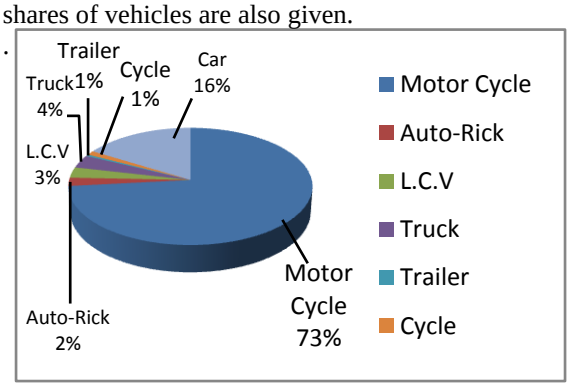

Fig 1. Observed traffic composition on N.H-07 sections

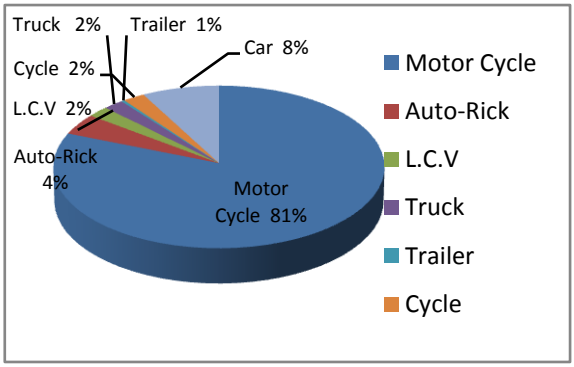

Fig 2.Observed traffic composition on S.H-09 sections

Table1: vehicle categories and their sizes

Category of vehicle	Average Dimension in (**m)**		Projected 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

Table-2.shoulder condition on different highways

Name of the Road	C W	Shoulder		Physical condition Of shoulder
		Type	Width (m)	
S.H-255 (Hingna Road)	7.2	Earthen	1.2	Drop at pavement edge was 8.0 cm.
N.H-06 (Bhandara Road)	7.8	Earthen	1.6	Drop at pavement edge was 12.0 cm.
S.H-09 (Umred Road)	7.0	Soil and gravel mix	1.2	Drop at pavement edge was 10.0 cm.
N.H-06 (Amravati Road)	7.8	Earthen	1.8	Drop at pavement edge was 10.0 cm.
N.H-07 (Wardha Road)	7.8	Earthen	1.8	Drop at pavement edge was 12.0 cm.

CW=Carriageway width

VI. SPEED DISTRIBUTIONS

The PCU factor is based on the mean speed values of different vehicle classes. This is calculated by dividing the mean speed value of passenger cars by the mean speed value of any vehicle class. The distance between entry and exit points kept according to the site conditions. Synchronised stop watches were used to record the timings of all vehicles passing through the traveling the section. To analyses these parts and determine the speed - flow relationships accordingly in the present study. Table no.3 shows the average speed of vehicle at different section of highways.

Table 3.Speed Statistics of Individual Vehicles

Type of vehicle	Mean Speed (Km/h)
Car	54.40
Truck/bus	41.00
Two-wheeler	39.54
Light Commercial Vehicle	39.69
Rickshaw	39.18
cycle	11.32
Trailer	38.53

VII. DETERMINATION OF PCU VALUES

In British practice it is usual to express capacity in The different types of vehicle offer different degree of interference to other traffic and it is necessary to bring alltypes to a common unit adopted is the passenger Car Unit (PCU).In the present study on the highways to determine PCUs values are follows. To estimate the PCU values is that it is directly proportional to the ratio of clearing speed of vehicle, and inversely proportional to the space occupancy ratio of vehicle with respect to the standard Area of vehicle,i.e. acar,. The PCU of a vehicle type is taken as given by Chandra and Kumar (2003).

$$PCU = \frac{Vc/Vi}{Ac/Ai}$$

Where,
PCU_1 = passenger car unit value of ith type vehicle
Speed ratio of the car to the ith vehicle = Vc/Vi
Space ratio of the car to the ith vehicle = Ac/Ai
Vc = speed of car (km/h)
Vi = speed of i^{th} type vehicle (km/h)
Ac = static(projected rectangular) area of a car (m^2)
Ai = static (projected rectangular) area of i^{th} type of vehicle (m2)

The PCU values for different categories of vehicles were calculated at different sections of highways. This shows the variation in PCU for different types of vehicles with lane width at different section. The PCU factor is based on the mean speed values of different vehicle classes. This is calculated by dividing the mean speed value of passenger cars by the mean speed value of any vehicle class. To analyses these parts and determine the speed - flow relationships accordingly in the present study.

Table 4: Passenger Car Unit for different types of vehicles at different highways section.

Highway Section	Truck	Two Wheeler	Car	Light Commercial Vehicle	Trailer	Cycle	Rrickshaw
S.H-255	5.51	0.35	1.0	3.1	6.29	0.42	1.14
N.H-06	6.19	0.31	1.0	3.65	7.31	0.83	1.32
S.H-09	4.31	0.27	1.0	3.38	6.84	1.02	1.18
N.H-07	5.04	0.26	1.0	3.21	6.49	0.62	1.04
N.H-06	5.26	0.28	1.0	3.17	6.51	0.75	1.13

L.C.V=light Commercial Vehicle

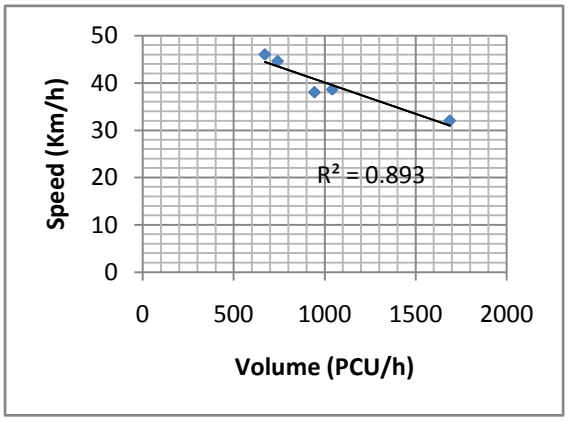

Fig 3.Speed - Volume relationships for Two Wheeler Truck.

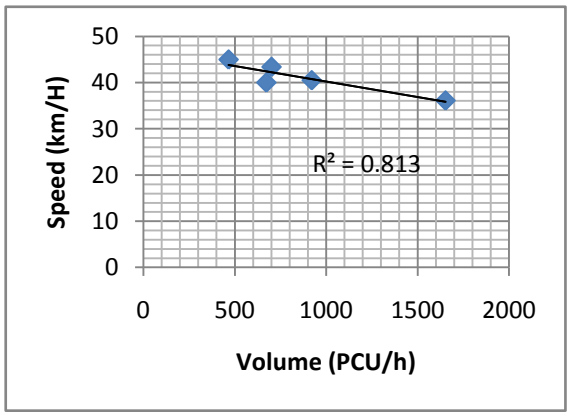

Fig 4.Speed - Volume relationships for Truck

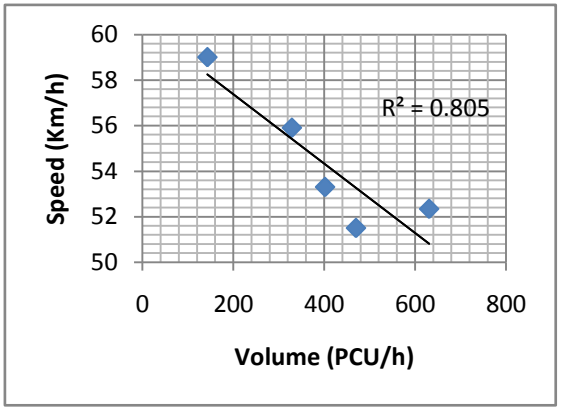

Fig 5. Speed - Volume relationships for Car

VIII. SPEED–VOLUME RELATIONSHIP

A growth of motor vehicle population, the traffic on the road has been increasing, both in terms of volume and intensity Speed, density, and volume are the most important components The knowledge of traffic characteristics is useful of a traffic stream for estimating the traffic carrying capacity of a road. The relationships help the traffic engineer in planning, designing and the effective of implementation to traffic-engineering measures on a road or highway system. The performance Of roadway networks depends on capacity and volume of traffic in the network. The average stream mean speed calculated at highway section was plotted against the traffic volume. Typical curves showing speed–volume relationships are given in Fig 3, Fig. 4 and Fig 5.

Table.5Capacity of Two-Lane Roads With Different Carriageway Width

Highway section	carriageway width(m)	Total Capacity (pcu/h)
S.H-09	7.0	1897.3
N.H-06	7.8	2675
S.H-255	7.2	3738.4
N.H-06	7.8	4652
N.H-07	7.8	3139.74

IX. RESULTS & CONCLUSIONS

The analysis is based on the field studies conducted on typical highways around Nagpur city considering almost all classes of vehicles commonly found in India The present type of traffic and Highway condition PCU values for different categories of vehicle are determined for five sections of Highway separately. New PCU values obtained from site are quite different from the values given in IRC code. It is found that PCU values obtained for motor cycle, auto rickshaw, from all sections are smaller than the values given in IRC and for Truck, Trailer and L.C.V found higher than the value given in IRC 64-1990 Code .This study has shown the impact of lane width on the PCU for different categories of vehicles and on the capacity of a two-lane Highways. It is found that the PCU for a vehicle type increases with increasing lane width. The main aim of this study is to assess the credibility of PCU given in IRC for the present type traffic and Highway way condition. Impact of highway lane width on the PCU is apparently linear. The capacity of a 7.2 m wide road is PCU values is estimate 3348.48 PCU/h which is larger than the value of 3,200 PCU/h suggested in HCM 2000 These results is shows the importance of increase the a lane width in congested areas.. It is found that PCUs of different categories of vehicle are inversely related to length of passenger car PCU values applicable to current conditions need to be developed instead ofdepending on the old PCU values given in code. The narrow width of lanes does not provide an adequate margin o for vehicles movement so therefore, speeds of individual vehicles drop.

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