

Development of PCU Value of Vehicle under mix Nature Traffic Condition in Cities on Congested Highways

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Abstract: Highways in India are different from other roads of the country. Traffic on Indian roads consists of a mix characteristic type of vehicles. These vehicles in the highway have widely different static and dynamic characteristics. Traffic is essentially consists of bicycles, two-wheelers, three-wheelers, Light commercial vehicle, cars and trucks this work aims to study of traffic flow on Indian highways by evaluating Passenger Car Unit (PCU) of different vehicle categories at different section of highways around Nagpur city. Our aim is to work out the passenger car unit PCU for different types of vehicles under non homogeneous traffic conditions. Field data collection was conducted at four highway links and at outside of urban areas and the different types of vehicles in Non Homogeneous traffic, for a wide range of mix traffic volume and width of highways. This PCU is utilized to increase the area of shoulder linearly for free speed of a vehicle with width. I observed that from the study of traffic volume and roadway conditions that the PCU value of a vehicle significantly changes with change in volume of mix traffic 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 This is resulting due to the high proportion of the road space occupied (high area occupancy) by heavy vehicles even when less number of heavy vehicles are present on the road. Because of this, maximum PCE value for both trailer and truck is increasing at low proportions and remains constant at high proportion. The relationship between the volume and speed at different highway section developed a second-degree curve. This relationship is used to calculate capacity of highways.

Keywords: Traffic Data, Highway capacity, PCU factor, Traffic flow

1. Introduction

The traffic on Indian roads is heterogeneous or mixed in nature and character. Traffic stream comprises of varieties of slow and fast modes. The slow moving category consists of cycles and hand carts. Fast moving traffic is dominated by two wheeled vehicles like scooters, motor cycles, mopeds, and three wheeled auto-rickshaws. In addition to the above, the traffic consists of cars, commercial vehicles including light commercial vehicles, trucks and large city buses. 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 behavior of Indian driving on highways such heterogeneous, that is, the lane discipline and lane change

behavior 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 varieties 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.

2. LITERATURE SURVEY

Satish Chandra and Upendra Kumar (2002) Reported data were collected at ten sections of two-lane roads in different parts of India. The width of carriageway this term is commonly used in India for the total width of the paved surface of a road excluding its shoulders area. 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. 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. These may be concerning with traffic flow parameters, capacity of highways, signal design, parking lots etc. 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 Yahya Sarraj(2012) developed PCU factors for buses and animal-driven carts at signalized intersections in Gaza City. PCU (or passenger-car equivalent unit, PCEU) is a factor used to convert all vehicle types other than passenger car into passenger car calculate PCU values from the headway method used. Geetam Tiwari (2007) presents studies conducted on non-homogeneous traffic The density method used motorized, four-wheeler traffic, i.e., homogeneous traffic, and does not include motorized three-wheelers, motorized two-wheelers, and non-motorized traffic often present on Indian highways. He modify the density method to represent non-homogeneous traffic which Transport professionals can use these PCU values for accurate capacity.

3.Data Collection

The data for this study were collected at five 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 in Table.1 and in Table 2.

Table 1.: Vehicle categories and their sizes

Category of vehicle	Average Dimension in (m)		Projected rectangular area on ground (m ²)
	Length	Width	
Car	3.72	1.44	5.39
Trailer	10.1	2.43	24.74
Truck	7.5	2.5	18.75

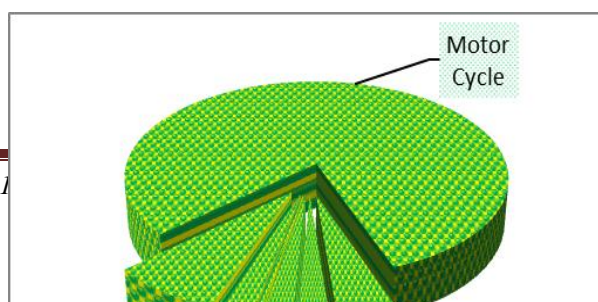
Light Commercial Vehicle	6.0	1.9	11.40
Three wheeler	3.2	1.4	4.48
Scooter, motorbike	1.87	0.64	1.2
Bicycles	1.9	0.45	0.85

Table-2.Shoulder condition on different highways

Name of the Road	Carriageway Width(m)	Shoulder Width (m)
Hingna Road	7.2	1.6
Bhandara Road	7.8	1.8
Umred Road	7.0	1.6
Wardha Road	7.8	1.8

4. 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 variety of vehicles. So, it is crucial to know the traffic composition of various sections. Vehicle class percentages on S.H-09 are shown in below Fig.1. It is found that, Motor vehicle has the highest percentage in the traffic stream. Vehicle class percentages on Bhandara Road 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 of car 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.



determine the speed - flow relationships accordingly in the present study.

Table 3: Passenger Car Unit for different types of vehicles at different highways section

HS	T	T. W	Ca r	L.C. V	T	CY	R
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

H.S=Highway Section, TW=Two Wheeler, TR=Trailer, CY=By-Cycle, L.C.V=light Commercial Vehicle, T = Truck

Fig.No 1. Observed traffic composition on Hingna Road

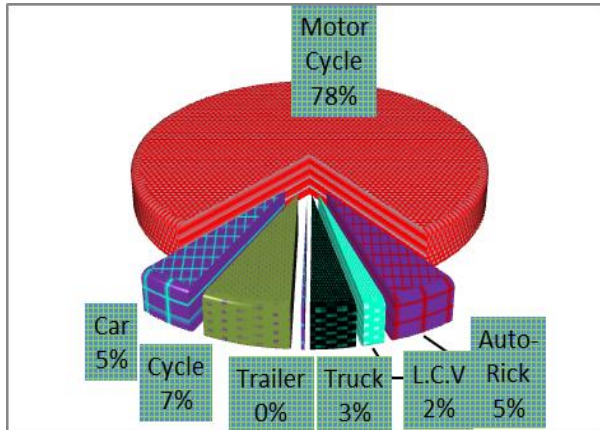


Fig.No 2. Observed traffic composition on Umred Road

5. 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 all types 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. a car,. The PCU of a vehicle type is taken as given by Chandra and Kumar (2003).

$$PCU = \frac{V_c/V_i}{A_c/A_i}$$

Where,

PCU = passenger car unit value of ith type vehicle

Speed ratio of the car to the ith vehicle = V_c/V_i

Space ratio of the car to the ith vehicle = A_c/A_i

V_c = speed of car (km/h)

V_i = speed of Ith type vehicle (km/h)

A_c = static (projected rectangular) area of a car (m²)

A_i = static (projected rectangular) area of ith 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 analyze these parts and

6. 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 speeds measured of at all the locations of highways. The test section was marked by chalk pieces or lime powder at the entry and exit points and observers are stations at entrance and exit of test section in both directions. 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. Table no.4 shows the average speed of vehicle at different section of highways.

Table 4.Average Speed Statistics of Individual Vehicles,

Type of vehicle	Mean Speed (Km/h)
Car	54.40
Truck/bus	41.00
Two-wheeler	39.84
L.C.V	39.69
Rickshaw	39.18
cycle	11.32
Trailer	38.53

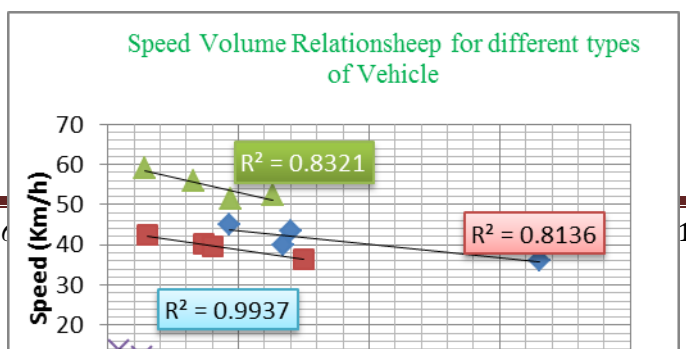


Fig No 3.Speed - Volume relationships for Different types of vehicle

Sr. No	Highway Section	Carriageway Width (m)	Theoretical Capacity (PCU/h)	Observed Capacity (PCU/h)
1	S.H-09	7.0	1826	1897.30
2	N.H-07	7.8	4105.68	2675
3	N.H-06	7.8	4105.68	4652.84
4	S.H-255	7.2	3662.28	3738.4

7. 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. It can be observed that the restriction of a speed to road user to travel through heavy vehicle in highways. The PCU values for different types of vehicles as calculated at different sections are given in Table 3. Figs.3 show the variation in PCU for different types of vehicles with lane width at different sections. The fig. indicates that PCU for a vehicle type increases linearly with the carriageway width. Vehicles move with more freedom on wider roads but the increase in speed is not uniform for all types of vehicles due to a change in their size and acceleration capability. Therefore, the speed differential between a car and another type of vehicle increases as does the PCU

Fig.4 shows a plot between capacity and the carriageway width. It follows a second degree curve relationship of the form given as

$$C = -10553 \cdot X^2 + 159034 \cdot X - 594315$$

Where,

C = Capacity of the road (pcu/hr)

X = Total width of the carriageway (m)

Using above Equations the theoretical capacity at different highway section in the traffic stream for Nagpur. It can be seen from the equations that the capacity increases with the increase carriageway width in the traffic stream

Table.No.5. Capacity of Two-Lane Roads with Different Carriageway Width

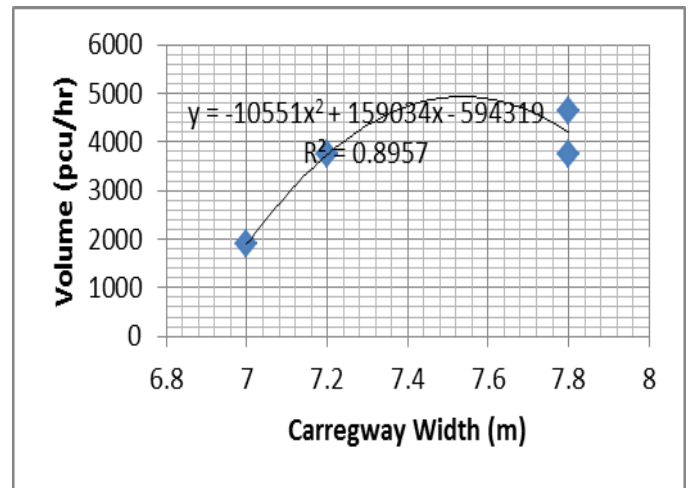


Fig.No 4. Capacity as related to carriageway width

8. 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 64-1990 code. It is found that PCU values obtained for motor cycle and auto rickshaw from all sections are smaller than the values given in IRC 64-1990. PCU values obtained for trailer, L.C.V and truck from all section of highways are higher than the value given in IRC 64-1990. This study has shown the impact of lane width on the PCU for different categories of vehicles and on the capacity of 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 3738.40 PCU/h which is larger than the value of 3,200 PCU/h suggested in HCM 2000. The first 1.0 m of lane widening lanes from 7.2 to 8.2 m, to an increase in capacity of about 13.88% while 1.0 m of lane widening from 7.8 to 8.4 m Results in a 12% increase in capacity. It has been observed that from the 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. These results is shows the

importance of increase the a lane width in congested areas. The narrow width of lanes does not provide an adequate margin for vehicles movement so therefore, speeds of individual vehicles drop.

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Author Profile



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