JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Effects of Road width estimation of PCU and effect of Carriage way width

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Abstract

One of the most significant aspects of the traffic flow system is traffic volume. It is defined as the number of vehicles that pass through a given site in a certain amount of time, whether actual or expected. Transportation planners and engineers need traffic volume data because it is one of the first things they need to know when designing and developing a route. However, when discussing traffic volume, it is not always sufficient to just say "vehicles," because the sorts of vehicles in traffic can change over time. The Highway Capacity Manual (Highway Research Board) developed the unit of a passenger car equivalent in 1965 as a mechanism to assess traffic volume (PCE). PCE, or passenger car unit (PCU), is defined as "the number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a specific type under specified highway, traffic, and control conditions" (Transportation Research Board 2010). The PCU factors can be used to convert diverse forms of traffic flow into homogeneous counterparts.

Keywords:- PCU,Traffic,Vehicles

INTRODUCTION

As cities become more populous, transportation becomes more complicated. Because more cars are moving into cities, traffic congestion is increasing. Traffic congestion, delays, road safety, pollution, and transportation performance are just a few of the urbanisation's effects that can be seen everywhere. The demand for automobiles of all types, including personal vehicles such as cars and motorcycles, is increasing as the country's population grows. To properly address traffic congestion, far more than simply adding more lanes is required. In addition, the project requires figuring out how to improve the roads that are already in use. It's clear that things are moving

quickly as more and more people travel. When there is too much congestion, a slew of unwelcome consequences arise. The following are the costs to the community and businesses:

- Longer, less expectable travel times.
- Lost productivity and further running costs of vehicles.
- Increased pollution, noise, loss of amenity, driver stress.
- Reduced time, people spend with their families.

FUNDAMENTAL PARAMETERS OF TRAFFIC FLOW

TRAFFIC STREAM PARAMETERS

The actions of both drivers and vehicles contribute to traffic flow. Non-uniform traffic circulation is caused by non-uniform human behaviour or motive force. In addition to human and automobile characteristics, the woman with whom a group of these units interacts has an impact. The flow of traffic over a defined path will change as a function of area and time as a result of these changes in human behaviour.

As a result, a traffic planner must plan and design to keep traffic fluctuations within a certain range. A highway allows you to travel quickly, but it also allows you to travel slowly. For example, a 60 kmph speed limit indicates that all vehicles are travelling at around 40 kmph, rather than 100 or 20 kmph.

As a result, based on a few key parameters, certain characteristics of traffic flow can be predicted. The various parameters are classified using both quantitative and qualitative measurements, such as density and traffic flow. For example, depending on the type of traffic being studied, traffic stream parameters can be classified as macro or microscopic .Flow, density, and rate are examples of macroscopic characteristics that can be broken down into the previously mentioned ways of quantity and magnitude. Separation measures such as headway or separation between motors, which can represent either time or area headway, are also included in microscopic characteristics. The velocity, flow, and density of a stream are the most important characteristics.

PASSENGER CAR UNIT (PCU)

The Passenger Car Unit (PCU) statistic is used in Transportation Engineering to determine the speed of traffic moving along a highway. The effects of a particular mode of transportation on these variables can be measured in terms of a passenger car unit, which compares the effects of a single standard passenger car on these variables. It is also known as a "passenger car." As an example, typical PCU (or PCE) values are:

Table 1: Values of PCU (IRC SP 41-1994)

Car	1.0
Motorcycle	0.5
Bicycle	0.2
LCV	1.5
Bus	3
3- Wheeler	1.0
Truck	4.5

Highway capacity is measured in PCU/hour daily.

NEED FOR PCU VALUES

On the road, there are many different types of vehicles, but only a few are truly exceptional. Unique vehicle drivers have a large selection of vehicles to choose from. As a result, designing roads, intersections, and visitor warnings becomes more difficult. To accurately predict the traffic extent and capacity of roadways under traffic flow, consistent numbers of cars are required. This is more difficult to achieve unless the various vehicle types are described in terms of a commonplace modern automobile unit. As a result, passenger car equivalents (PCEs) and the concept of a "Passenger Car Unit" (PCU) emerged, and the conversion of other vehicle types into PCUs became commonplace. PCU per hour, per lane per hour, or PCU per kilometre are the most common units of measurement.

FACTORS AFFECTING PCU VALUES

"On any particular segment of road under current visitors conditions, the addition of one car of the same type per hour will decrease the average vehicle velocity by the same amount as the addition of say, 'X' vehicles of a common size per hour. 'PCU' cost," according to the TRRL. This vehicle has the same PCU as the 'X' PCU. "X" PCU" is equal to the time it takes for one type of vehicle to cross an intersection compared to the time it takes for a median vehicle when the intersection is saturated. If the addition of one automobile of a given type to the traffic flow has the same effect as the addition of one passenger automobile, the addition of one automobile of that type is considered equivalent to the addition of one passenger automobile. Under a specific set of road, visitor, and other conditions, the relative space demand of a vehicle's elegance in comparison to a passenger car can be considered in this cost.

LITERATURE REVIEW

Capacity is a key concept in design, analysis and operation of highway facilities. Estimation of roadway capacity is an important issue for determining the traffic demand for roadways when these facilities are designed. Carriageway width has significant effect on pcu.When estimating capacity, each vehicle type in the traffic stream is considerably different because of occupying different spaces on the roads and moving at variable speeds with different acceleration and deceleration capabilities. This traffic stream is called a heterogeneous traffic and speed differential between different vehicle types is quite substantial. Thus, studying the interaction between moving vehicles under such traffic conditions is complex, and there is a need for a uniform way to measure this traffic composition and thus roadway capacity in terms of a common standard vehicle. For this reason, the concept of passenger car unit (*PCU*) or passenger car equivalent (*PCE*) was developed and is universally adopted to convert different vehicle types into a standard passenger car.As a result, we conducted a thorough review of the relevant literature in order to contextualize and emphasize the importance of our work.

Manjul Sharma et. al. (2021)[1] To account for this, the Passenger Car Unit (PCU) weighs the volume of traffic generated by various types of vehicles. Various vehicle types have long been the subject of PCU estimation research. Various PCU estimation methods have advantages and disadvantages, which are discussed in this paper. Some researchers have proposed a wide range of static PCU values, while others have recognized the PCU's dynamic nature. The traffic patterns and road geometry were also looked into in these studies. Because of their specificity, there is a lot of inconsistency when it comes to PCU recommendations (traffic characteristics and driving culture vary across nations). The PCU's range and the trend of how it changes in relation to other governing factors were found to be incompatible. A number of studies on PCU estimation on urban roads have been conducted, and the results are summarized in this document.

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Ashutosh Pandey et. al. (2021)[3] Interurban and divided urban roads have been the primary focus of PCU estimates. There are significant differences in traffic patterns between urban roads that are not divided and those

divided. An investigation into urban roads without lanes is the focus of this study. To calculate the PCU, each vehicle's speed must be taken into account individually. Thus, a Kriging-based PCU calculation model was developed and implemented. Videography was conducted on urban road segments in several Indian cities in order to gather information on traffic volume and speed. The model was constructed using the information in this file. The proposed model was used to investigate the volume, composition, and width of traffic on a given stretch of road.

Harry Rodin III (2021)[4] When it rains, a multilane highway's skid resistance varies from section to section. If there has been a lot of rain or if the porous surface layer has become clogged, this can happen on porous pavement surfaces. Porous pavement's ability to reduce skid resistance as a function of roadway width is examined in this study using an analytical numerical approach. A module for calculating the thickness of the water film is included, as is a model for simulating skid resistance. It is possible to calculate and compare the skid number for porous asphalt surfaces with different pavement widths in order to determine their skid resistance.

Narayana Raju et. al. (2021)[5] How to keep a multi-line subway system moving during rush hour was the subject of this paper. Passengers entering and leaving multiple stations or lines at the same time can be managed through a process known as "multi-station coordinated passenger flow control." It is similar to ramp metering in that it regulates the number of vehicles that can enter a highway segment by entering passengers who do not have to wait in line at designated places. Passenger flow control Logit-based stochastic user equilibrium assignment is a lower-level problem. These issues include the evolution of passengers and dynamic costs, as well as the selection of routes, in a two-tiered approach aimed at maximising system efficiency.

Liang Chen et. al. (2020)[6] Using a bilevel programming model that accounts for the time it takes to walk through variously congested areas, the capacity of subway stations to evacuate people in an emergency is determined. Evacuees can be more efficiently routed to safe areas using lower-level models, while higher-level models maximise the efficiency of evacuation facilities. The model can be solved using a more advanced version of the particle swarm optimization algorithm. As an example of an evacuation simulation, the Beijing Subway's capacity estimation for the Fuxingmen Station is used to determine the best routes and the most accurate capacity estimation for the Fuxingmen Station. Passenger flow per unit time and network crowdedness are used in an emergency to estimate the capacity of a station.

Y. Idel Mahjoub et. al. (2020)[7] In order to plan and run urban rail systems, the number of passengers is critical. Sample sizes are constrained by the high cost of infrared and video-based counting systems. As a result, there are inaccuracies in the total number of passengers carried on various train routes. In both manual and electronic counting systems, the amount of uncertainty increases with the number of items counted, which means that errors are frequently flow-dependent. Modern trains' weighing systems, as this paper shows, can be used to improve brake control. Passenger counting using this method is less expensive and more accurate.

METHODOLGY

CHANDRA'S METHOD:-

This method is Given by Professor Satish Chandra (IIT Roorkee). This methos is based on occupancy time of vehicle while clearing the intersection.

This method uses two factors namely velocity of vehicle, type and its projected Rectangular Area to calculate the PCU value.

$$(PCU)_i = (V_c/V_i)/(A_c/A_i)$$

Where,

PCU = passenger car unit value of ith type vehicle

Speed ratio of the car to the ith vehicle = Vc/Vi

Area 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 (m2)

Ai = static (projected rectangular) area of ith type of vehicle (m2)

Table 2: Table for the Area of Different type of vehicle

Category	Vehicle	Dimension	Projected Area
Car	Car, Jeep, Van	3.72 x 1.44	5.39
Bus	Bus	10.10 x 2.43	24.74
Truck	Truck	7.50 x 2.35	17.62
LCV	Mini bus/trucks	6.10 x 2.10	12.81
M-Truck	Multi-axle truck	2.35 x 12.0	28.60
Bikes	Scooter, Motorbike	1.87 x 0.64	1.20

Cycle	Pedal Cycle	1.90 x 0.45	0.85
Autos	Auto, Tempo	3.20 x 1.40	4.48

DENSITY METHOD

Use this method for calculating PCU values when there are different levels of traffic. PCU estimates for heterogeneous traffic were derived using the density method, which accounted for all of the traffic entities in the traffic. The modified density method yielded the following PCU values for various vehicle classes.

$$PCU = (Kcar/ Wcar) / (Ki/Wxi)$$

Where, Ki = density of a particular vehicle class

Kcar = density of the car

Wcar = width occupied by cars in heterogeneous traffic condition

Wxi = width occupied by corresponding vehicle class in heterogeneous traffic condition.

Methodology

Selection and prioritization of sites has been done step wise as detailed out. The best way to estimate PCU by vehicle and their direction of travel on highway surveys the steps are given as below,

Step I: First we select the site Sanganer Thana to B2bypassTonk road and B2bypassTonk road to Sanganer pulia, Jaipur

Step II: Next we divided selected section into two suitable points of distance 30 m from which reading can be taken.

Step III: Then we count traffic volume and speed of vehicle at 5 min interval with stop watch.

Step IV: After counting no. of different vehicles we will find traffic composition of different road.

Step V: Then we will calculate PCU value by density and Chandra method and compare them with IRC values.

Step VI: Then we measure the lane width, shoulder width by inch tape to evaluate the capacity of road.

SITE SELECTION

Four major traffic sites were identified for carrying out the study which is as follows:-

Name of location: “Sanganer Thana to B2bypass tonk road” and “B2bypassTonk road to Sanganer Thana”, Jaipur.

Date: Data for spot speed and volume study was collected.

Time: Time of data collection for spot speed and volume study was different for three groups is 9:00 am to 10:00 am, 5:00 pm to 6:00 pm and 8:00 pm to 9:00 pm.

Observation: Spot speed and classified vehicle counts.

Method: Direct manual method.

Duration: 5 minutes (short count)

Equipment: Stop watch, Tally sheet, Clip board, video camera etc.

No. of Lanes: 4

Methodology of Reconnaissance Survey

Each of the tests requires a minimum of three people to be carried out. We measured a 30-meter stretch of road with a measuring tape. At the start of the stretch, observers with stop watches and data sheets keep an eye on things. A third observer stood at the start of the stretch and counted the number of vehicles.

When the vehicle passes through the segment, the observer starts the stopwatch as soon as he or she is assigned a role. Vehicle crossing times should be recorded, and a third observer should count the number of vehicles passing through.

Fig. 1 Traffic Count on Tonk road, Jaipur

DATA COLLECTION AND ANALYSIS

DATA COLLECTION

- In order to measure how long it took to cross the trap's length, a stopwatch was used with a margin of error on both sides.

- The area being observed serves as a data source. Along the corridor, traffic data is collected. It takes one hour of traffic surveys every morning, evening, and night to complete.

- Various vehicle categories' average dimensions and projected regions can be found in Tables 3 and 4. Similar divisions have been made among the vehicles.

Table 3 Vehicle categories and their sizes

S. No.	Category of vehicle	Average dimension (m)		Projected rectangular area on ground (m^2)
		Length	Width	
1	Car	3.72	1.44	5.39
2	Trailer	7.4	2.2	16.28
3	Bus	10.1	2.43	24.74
4	Truck	7.5	2.5	18.75
5	LCV	6.0	1.9	11.40
6	Three wheeler	3.2	1.4	4.48
7	Bike	1.87	0.64	1.2
8	Bicycle	1.9	0.45	0.85

Table 4 Carriage way width and Shoulder condition on different highways

S.No.	Name of site	Carriage way width (m)	Shoulder width (m)	Traffic type
1	Sanganer Thana to B2bypass tonk road	7.2	1.5	One-way
2	B2bypassTonk road to Sanganer Thana	7.2	1.5	One-way

Fig. 2 Traffic Count on Tonk Road Jaipur

LOCATION: 1.Sanganer Thana to B2Bypass Tonk Road, Jaipur

2. B2 Bypass Road To Sanganer Thana, Jaipur

Date: 12&13 Oct. 2021, Time: 9:00 am to 10:00 am

Date: 12&13 Oct. 2021, Time: 5:00 pm to 6:00 pm

Date: 12&13 Oct. 2021, Time: 8:00 pm to 9:00 pm

Light commercial vehicles (LCVs) and bicycles are among the various types of vehicles that can be found on the road.

Table 5 Observed capacity in evening hours

S. no	Location	Carriageway width (m)	Observed Capacity(PCU/hr)
1	Airport road Taron ki khoot	11.00	1574.5
2	Airport road Taron ki khoot	10.2	1346.5

You can calculate how much room there is in the traffic flow for different roads using the data above. As evidenced by an increase in the equations, cars in a wider traffic stream have more room to move. These findings demonstrate the importance of widening highways in congested areas. Because the lanes are so narrow, individual vehicles' speeds are reduced as a result of the lack of space.

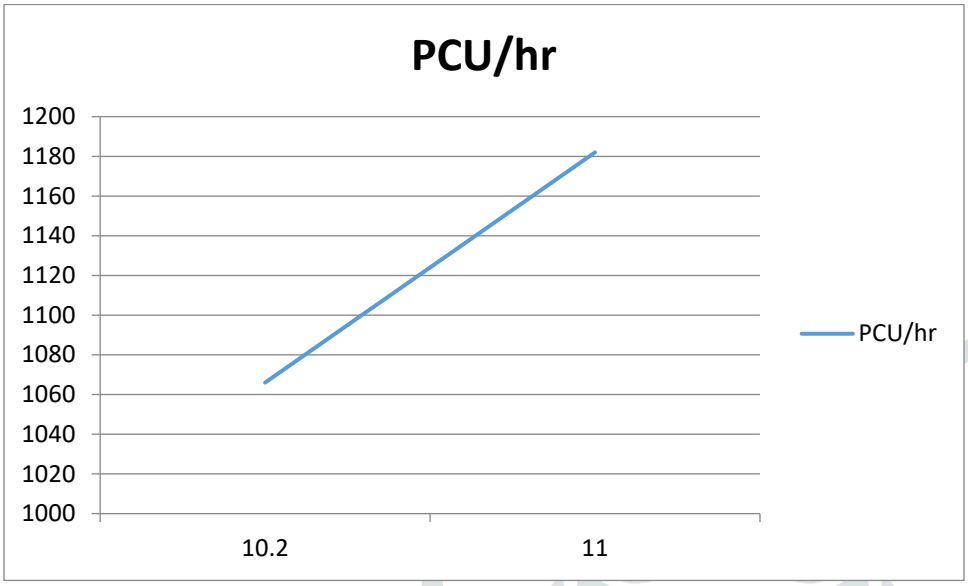

Table 6 Observed capacity in night hours

S. no	Location	Carriageway width (m)	Observed Capacity(PCU/hr)
1	Airport road Taron ki khoot	11.00	1182.9
2	Airport road Taron ki khoot	10.2	1066.5

CONCLUSION

Field studies were conducted on highways in the Jaipur area that included almost all types of vehicles found in India. On five different roads, traffic, road conditions, and PCU values for various types of vehicles are determined.

- Bus account for 24.82% of all vehicle traffic in the study area, according to the data. Automobiles account for a 13.57 % of all traffic. Three-wheelers account for 16.92% of total traffic in the study area during peak and non-peak hours.

- For LCV and trucks, Chandra's method yields PCU values of and 2.27 &5.34, whereas the IRC method yields PCU values of 1.5 and 4.5.
- Other vehicles (3-W, LCV, and 2-W) have PCU values of 0.86, 2.27, and 0.22, respectively, according to Chandra, whereas the density method yields different results.
- The capacity of the road is estimated to be 1462.4 PCU/h using 3 PCU values, which is higher than the values of 1182.9 and 1066.5 PCU/h for a 11 m wide road. Based on these findings, increasing lane widths in congested areas is a good idea.
- Vehicle speed has a significant impact on roadway capacity even at low traffic densities.
- As the width of the road increases, the PCU of a specific vehicle rises. Because of the additional wiggle room provided by a wider roadway, it is more convenient to drive on. However, the speed at which they accelerate is determined by the vehicle's size and acceleration rate. If a car is significantly faster than any other vehicle, the PCU will be higher.
- The equations show that as the width of the road increases, so does its capacity for traffic. Congested areas benefit from highway widening, as evidenced by these findings. Individual vehicle speeds are reduced as a result of reduced space in the narrow lanes.
- PCU/h is the maximum number of vehicles per hour that a road wider than 10.2 metres can handle. After widening the lane by 11.00 metres, capacity increases by 13.88 percent. The capacity increases by 12 percent with an additional 1.0 metre.
- It has been found that changes in traffic volume and roadway width can have a significant impact on a vehicle's PCU value when it comes to traffic conditions. These findings support the need to widen lanes in congested areas. Vehicles have a more difficult time moving through the lanes due to their narrow width, resulting in slower speeds for each vehicle.

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