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Estimation of capacity and PCU value for heterogeneous traffic stream

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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. Determination of road capacity is a major issue for transport planners. Capacity is defined as the maximum number of vehicles that can be accommodated per unit time under given condition of occurrence. Capacity studies for heterogeneous traffic situations are very complex and only limited studies undertaken. In this paper the required data is collected at five main highways around and in Khandwa City using a digital video recorder. This paper discussed the Capacity estimation of roads and PCU value of a vehicle under heterogeneous traffic condition. In this paper the required data is collected at five main highways around and in Khandwa City using a digital video recorder. Detailed extraction of traffic volume and speed were made for every 5 minute time interval, covering both the peak and non- peak period. Comparison of PCU values has been done and finally Chandra method is observed to give more reliable and realistic results.

Keywords: Heterogeneous traffic, PCU, capacity, space mean speed, urban roads.

Introduction

Due to fast boom in towns of the United States and in search of employment peoples are always move from urban are to rural area, the visitors are improved on the urban roads. As per the United Nations projection, the urban area will be raised from the current urbanization of 32% to 52% in year 2050. The projected urbanization is 75% in 2070. The availability of the space in the urban area is decreasing and vehicular growth increases. The urban roads of India generally carry the heterogeneous traffic. All vehicles are of different speeds, size, load carrying capacities or passenger capacities etc. which affect the performance of the road facility. The rise in the population of urban cities and increasing traffic on transport corridors, it is necessary to improve the existing urban arterial road capacity. Prediction of capacity is fundamental in planning, operation and layout of road network sections. IRC has suggested capacity of various roads of the urban area. The suggested capacity of urban road is not updated considering the latest technological development. Roadway factors that influence capacity of a two-lane road include lane width, gradient, lateral clearance, width and type of shoulder. Lane and shoulder width can have a significant impact on traffic flow[1].

Objective

The aim of present project is to find out traffic condition for considered highway flow and to suggest future development of traffic flow[2]. This project work is explained with the help of following points: i. To collect traffic data on two-way dual carriage way. ii. To analyse the traffic flow data collected on two lane road. iii. To study the effect of influencing parameter, lane width and shoulder width, etc. iv. To compute P.C.U. as various geometric road condition and to study its effect on flow characteristics. v. To estimate the capacity of national highway.

Data Collection

Selection of road: i. Bombay Bazaar road, ii. Ghanta Ghar Road, iii. 3- Puliya Road, iv. Khandwa Indore Road.

Field data and analysis: Field Traffic surveys are conducted to collect the data on selected vehicular volume and vehicular speed on chosen road sections of different roads passes through the Khandwa city. Preliminary surveys are carried to collect the primary information about road condition, no. of lanes, shoulder condition, width of road etc. Field data require for study is obsessed on the study patch of inner city roads, the traffic data for the field study was taken on typical weekdays for this a 30m study patch is elected with consideration of no interaction several entry of intersection. Vehicular traffic volume and speed data are composed for 1 hours for morning peak hour for 9.00 a.m. to 110.00 a.m., evening peak hour for 5.00 p.m. to 6.00 p.m. and night peak hour for 9.00 p.m. to 10.00 p.m. using video filming technique covering varied range of traffic conditions and flow behaviour which intended to require for study intent,

Entire vehicles are categorized in eight class as car, truck, bus, 2 wheeler, 3 wheeler, trailer, light commercial vehicle (LCV) and bicycle. Physical vehicle dimensions of all vehicles on urban highway are specified in Table-1. Speed parameters got from field situation for both the road are specified in Table-2 and Table-3 respectively based on the physical dimensions of all vehicles and speed parameters PCU values determined for both road are specified in below table.

Table-1: Different vehicle and their sizes.

Type of vehicle	Average dimension (m)		Projected rectangular area on ground (m^2)
	Length	Width	
Car	3.72	1.44	5.39
Trailer	7.4	2.2	16.28
Bus	10.1	2.43	24.74
Truck	7.5	2.5	18.75
LCV	6.0	1.9	11.40
Three wheeler	3.2	1.4	4.48
Bike	1.87	0.64	1.2
Bicycle			0.85

Table-2: Carriage way width and Shoulder width on different highways.

Name of site	Carriageway width (m)	Shoulder width (m)	Traffic type
Bombay bazaar road	7.2	1.5	Two-way
Ghantaghar road	7.8	1.6	Two-way
3-puliya road	7.0	1.8	Two-way
Khandwa Indore road	7.5	1.6	Two-way

Table-3: Speed statistics of individual vehicles for Bombay bazaar road.

Type of vehicle	9:00 am to 10:00 am	5:00 pm to 6:00 pm	9:00 pm to 10:00 pm
	Mean speed (Km/h)	Mean speed (Km/h)	Mean speed (Km/h)
Car	53.41	32.56	41.13
Truck	-	-	37.78
Bus	-	-	36.44
2 wheeler	38.71	30.12	32.66
3 wheeler	39.12	36.58	38.24
Trailer	37.58	35.03	35.23
LCV	38.63	38.46	33.47
Bicycle	13.53	12.53	13.32

Table-4: Speed statistics of individual vehicles for Ghanta Ghar road.

Type of vehicle	9:00 am to 10:00 am	5:00 pm to 6:00 pm	9:00 pm to 10:00 pm
	Mean speed (Km/h)	Mean speed (Km/h)	Mean speed (Km/h)
Car	51.41	53.56	48.63
Truck	-	-	39.47
Bus	-	-	35.14
2 wheeler	35.71	39.45	33.45
3 wheeler	38.47	36.48	37.56
Trailer	36.26	37.24	34.12
LCV	37.12	36.87	34.78
Bicycle	12.69	15.16	12.45

Table-5: Speed statistics of individual vehicles for 3 Puliya road.

Type of vehicle	9:00 am to 10:00 am	5:00 pm to 6:00 pm	9:00 pm to 10:00 pm
	Mean speed (Km/h)	Mean speed (Km/h)	Mean speed (Km/h)
Car	42.46	41.32	43.55
Truck	-	-	37.58
Bus	-	-	38.94
2 wheeler	36.01	35.64	35.14
3 wheeler	33.12	32.56	33.56
Trailer	36.78	35.23	32.11
LCV	34.38	33.64	33.47
Bicycle	14.42	13.11	13.23

Table-6: Speed statistics of individual vehicles for Khandwa Indore road.

Type of vehicle	9:00 am to 10:00 am	5:00 pm to 6:00 pm	9:00 pm to 10:00 pm
	Mean speed (Km/h)	Mean speed (Km/h)	Mean speed (Km/h)
Car	40.22	40.22	42.11
Truck	39.62	38.63	38.01
Bus	37.55	37.11	37.69
2 wheeler	36.42	36.45	38.12
3 wheeler	34.11	35.1	35.87
Trailer	33.1	34.67	34.47
LCV	34.78	33.88	35.45
Bicycle	15.23	14.22	15.36

Traffic Volume: Percentage of vehicle in traffic flow is important with regards to the design evaluation of pavement. So, it is essential to identify the traffic composition of various sections[3]. Traffic data are collected for the morning, evening and night peak hours only. Traffic composition is calculated and presented in the form of pie chart in Figure-1-4.

Vehicle class percentages on Bombay bazaar road for morning, evening and night hours are shown in Figure-1. In morning, evening and night hours it's miles determined that; trailer vehicle and car has the very best percent inside the traffic flow.

Vehicle class percentages on Ghanta Ghar road for morning, evening and night hours are shown in Figure-2. In morning, evening and nighthours, traffic flow has car vehicle has the highest proportion.

Vehicle class percentages on 3-Puliya road for morning, evening and night hours are shown in Figure-3. In morning, evening and nighthours, traffic flow has car vehicle has the highest proportion.

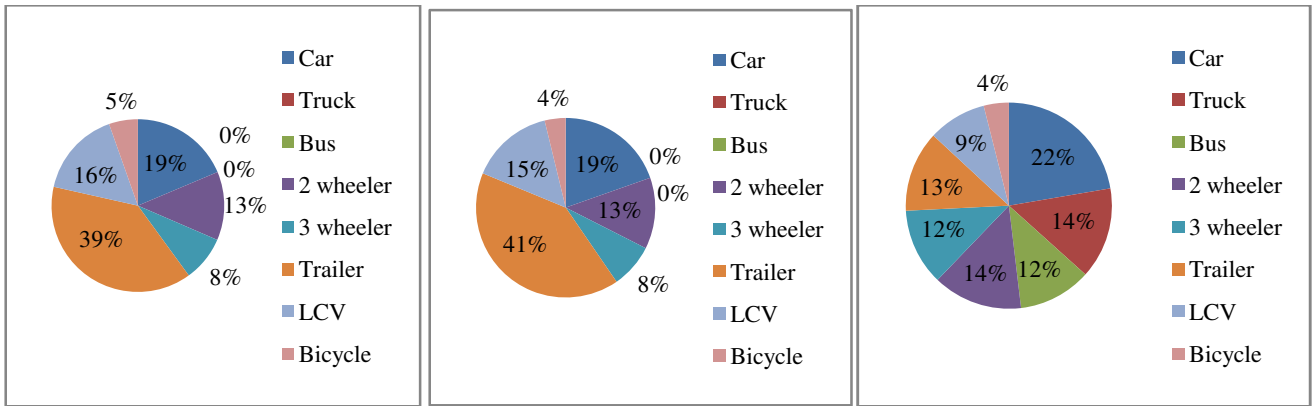

Figure-1: Percentage of individual vehicle for Bombay bazaar road 9:00am to 10:00am, 5:00pm to 6:00pm, 9:00pm to 10:00pm.

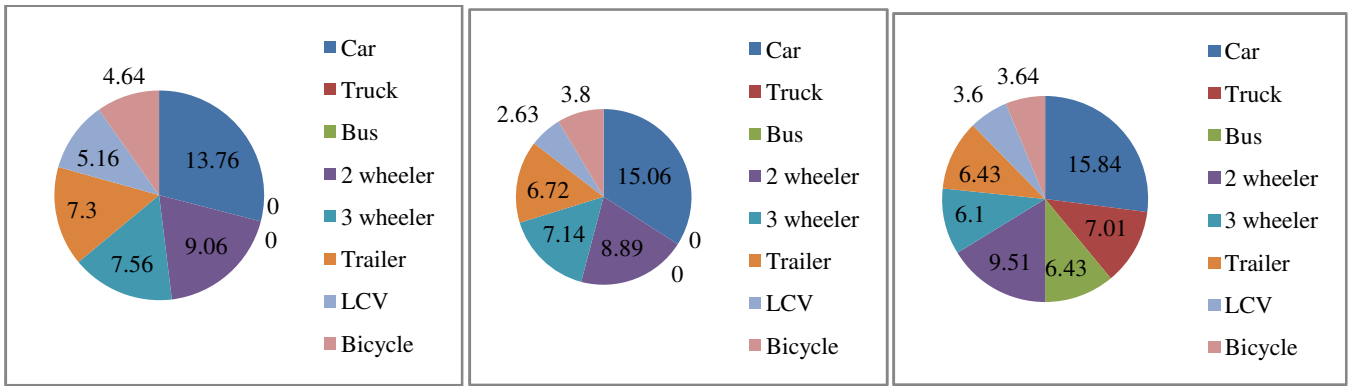

Figure-2: Percentage of individual vehicle for Ghanta Ghar road 9:00am to 10:00am, 5:00pm to 6:00pm, 9:00pm to 10:00pm.

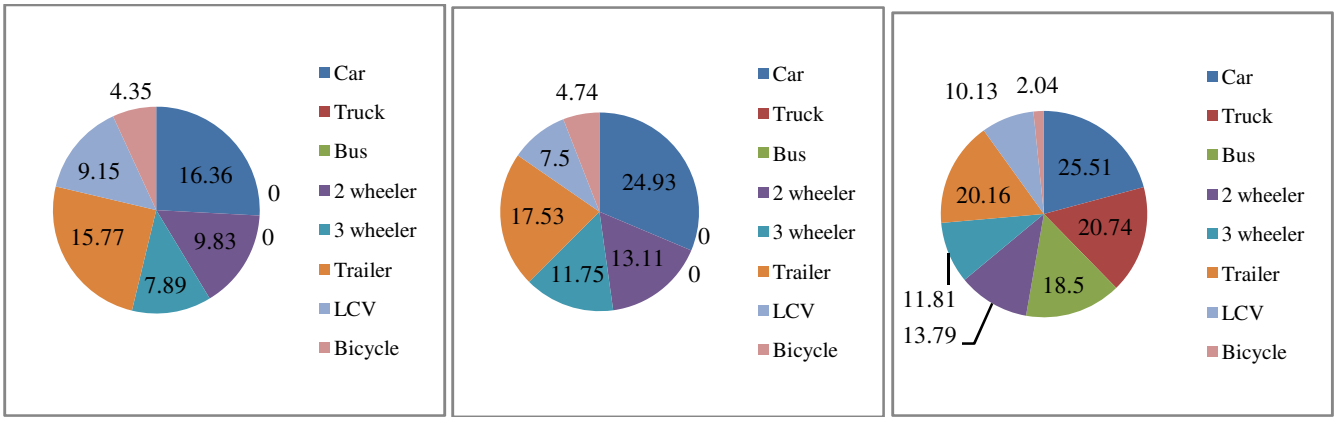

Figure-3: Percentage of individual vehicle for 3- Puliya road 9:00 am to 10:00 am, 5:00 pm to 6:00 pm, 9:00 pm to 10:00 pm.

Vehicle class percentages on Khandwa Indore road for morning, evening and night hours are shown in Figure-4. 2 wheeler vehicles have a highest percentage among all vehicles in morning, evening and night hours.

Estimation of PCU: The PCU values for vehicles have been calculated at unique sections of highways. This indicates. It is required to adapt the heterogeneous traffic into homogeneous by using a common unit, which is termed as Passenger Car Unit[5]. Density method and Chandra's model has been used to determine the PCU of different vehicle categories.

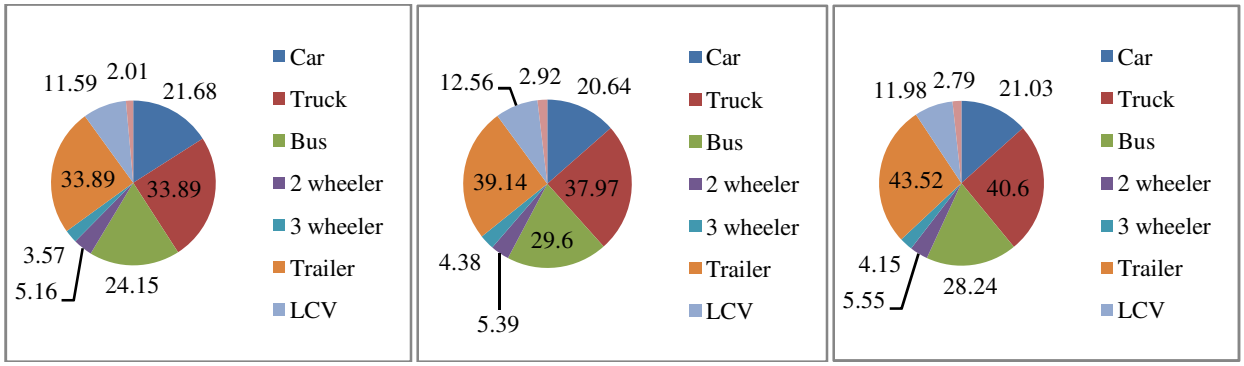

Figure-4: Percentage of individual vehicle for Khandwa Indore road 9:00am to 10:00am, 5:00pm to 6:00pm, 9:00pm to 10:00pm.

Table-7: Comparison of PCU for Bombay bazaar road by density and chandra method**.**

Type of Vehicle	09:00 a.m. - 10:00 a.m.		05:00 p.m. - 6:00 p.m.		09:00 p.m. - 10:00 p.m.	
	Density method	Chandra's method	Density method	Chandra's method	Density method	Chandra's method
Car	1	1	1	1	1.00	1
Truck	-	-	-	-	2.61	3.79
Bus	-	-	-	-	2.10	5.18
2 wheeler	0.49	0.27	0.63	0.24	0.54	0.22
3 wheeler	0.81	1.01	1.25	0.74	1.03	0.71
Trailer	0.53	3.82	0.82	2.81	0.65	2.79
LCV	1.17	2.60	1.93	1.79	1.32	2.06
Bicycle	0.03	0.55	0.04	0.41	0.04	0.39

Table-8: Comparison of PCU for ghantaghar road by density and chandra method**.**

Type of Vehicle	09:00 a.m. - 10:00 a.m.		05:00 p.m. - 6:00 p.m.		09:00 p.m. - 10:00 p.m.	
	Density method	Chandra's method	Density method	Chandra's method	Density method	Chandra's method
Car	1	1	1	1	1	1
Truck	-	-	-	-	2.70	3.62
Bus	-	-	-	-	2.00	5.37
2 wheeler	0.49	0.30	0.49	0.27	0.61	0.22
3 wheeler	0.77	1.03	0.73	1.08	1.01	0.72
Trailer	0.59	3.96	2.60	3.86	3.00	2.88
LCV	1.20	2.71	5.79	2.73	4.59	1.98
Bicycle	0.03	0.59	0.03	0.49	0.05	0.41

Table-9: Comparison of PCU for 3 Puliyaroad by density and chandra method.

Type of Vehicle	09:00 a.m. - 10:00 a.m.		05:00 p.m. - 6:00 p.m.		09:00 p.m. - 10:00 p.m.	
	Density method	Chandra's method	Density method	Chandra's method	Density method	Chandra's method
Car	1	1	1	1	1.00	1
Truck	-	-	-	-	1.66	3.81
Bus	-	-	-	-	1.28	4.85
2 wheeler	0.66	0.29	0.77	0.30	0.70	0.21
3 wheeler	0.81	1.19	0.84	1.21	0.83	0.81
Trailer	1.42	3.91	1.91	4.08	1.47	3.06
LCV	2.02	2.93	3.79	2.99	2.71	2.06
Bicycle	0.04	0.52	0.06	0.57	0.13	0.39

Table-10: Comparison of PCU for Khandwa Indore road by density and chandra method.

Type of Vehicle	09:00 a.m. - 10:00 a.m.		05:00 p.m. - 6:00 p.m.		09:00 p.m. - 10:00 p.m.	
	Density method	Chandra's method	Density method	Chandra's method	Density method	Chandra's method
Car	1.00	1	1.00	1	1.00	1.0
Truck	0.98	3.53	0.81	3.62	1.73	3.68
Bus	0.87	4.92	0.67	4.97	1.28	4.90
2 wheeler	1.78	0.25	1.62	0.25	0.78	0.23
3 wheeler	2.58	0.98	2.06	0.95	0.92	0.93
Trailer	0.83	3.67	0.72	3.50	1.63	3.52
LCV	2.27	2.45	1.94	2.51	2.97	2.40
Bicycle	0.14	0.42	0.08	0.45	0.15	0.41

From above tables it is observed that the PCU value of Bus/Truck obtained by Chandra's method is slightly higher than that of IRC value whereas the value obtained by density method is nearer to IRC value. The PCU values of other vehicles (3- W, LCV and 2-W) obtained by Chandra's method are very nearer to that of IRC values whereas those values obtained by density method differ slightly. Results obtained from Chandra's method indicate that the method is far more reliable than other methods. Thus Chandra's method can be adopted for estimation of Passenger Car Units.

Flow fluctuation: Flow rate was calculated and plotted for different roads. It shows that flow rate is higher at 3-puliya road.

Capacity estimation: The capacity of road is determined by imperial method, depending by traffic volume and traffic attribute. Traffic data is extracted to obtain 5-5 minute speed data and flow data for each vehicles category, speed data for the vehicles obtained for 5-5 minute count interval are converted to average speed for each vehicles in traffic stream to obtain avg.spot speed for each vehicle category. In order to develop speed-volume relationship and to estimate roadway capacity the observed traffic volume is altered in an identical numeral of vehicles by use of passenger car unit[6].

Traffic on the road has been increasing with a growth of vehicle. The knowledge of traffic flow is beneficial of a traffic flow for estimating the capacity of a road. The common movement imply pace calculated at highway section changed into plotted in opposition to the traffic volume[7].

Effect of carriageway width on capacity in peak hours

From given speed volume correlation obtained from field data it was suggested that the width of road Increases capacity of road also increases and it is more noticeable in heterogeneous flow situation where motor vehicles don't postdate lane discipline.

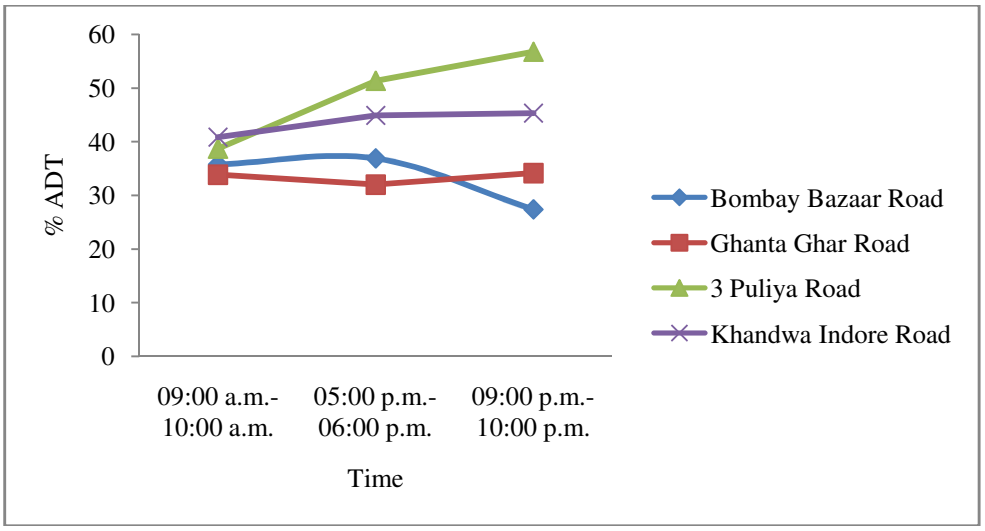

Figure-5: Flow fluctuation curve for different roads.

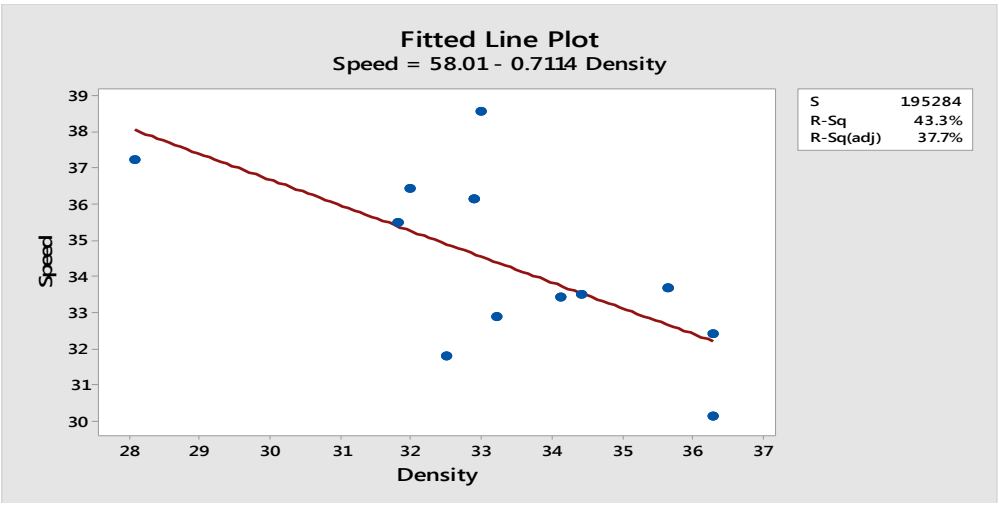

Figure-6: Speed density relationship for Khandwa Indore road at 09:00 a.m. - 10:00 a.m.

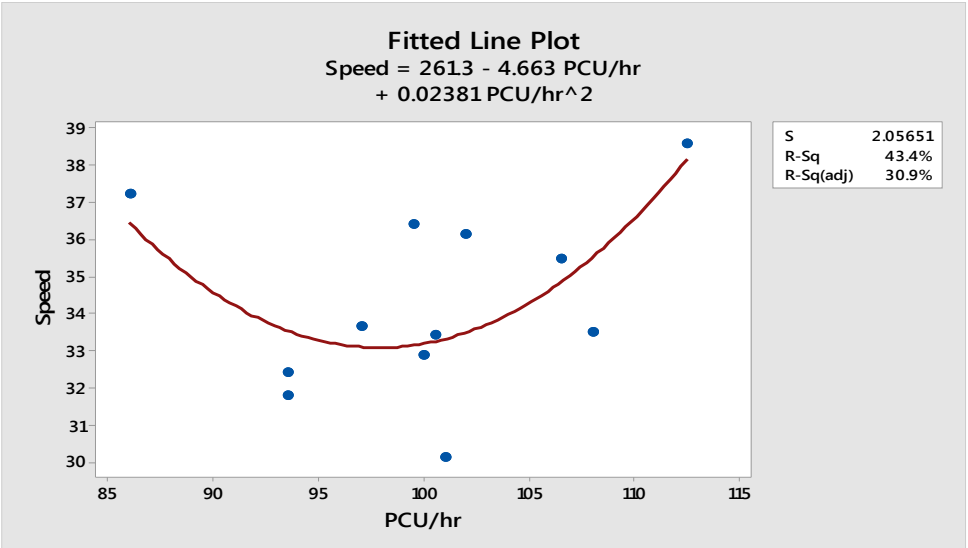

Figure-7: Speed volume relationship for Khandwa Indore road at 09:00 a.m. - 10:00 a.m.

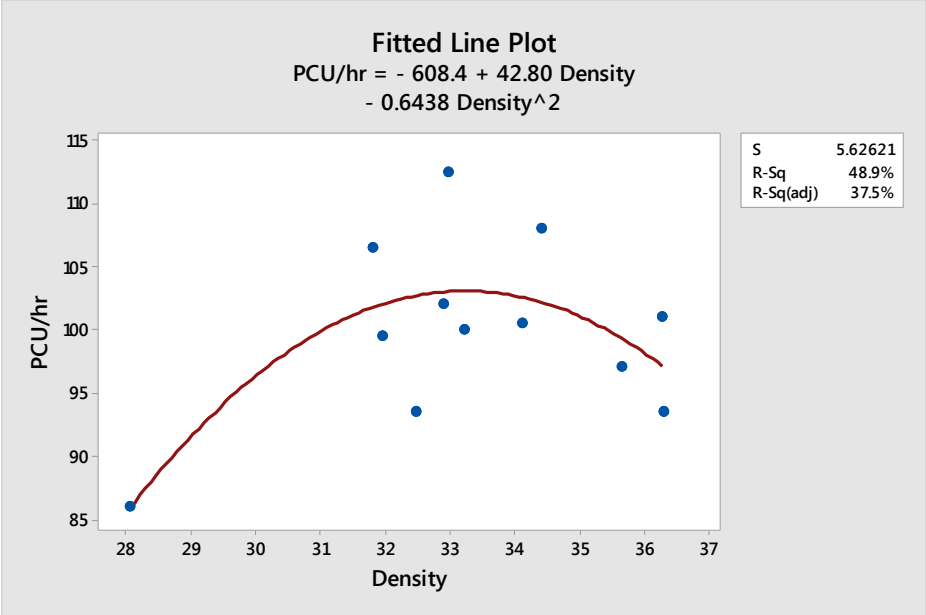

Figure-8: Volume- density relationship for Khandwa Indore road at 09:00 a.m. - 10:00 a.m.

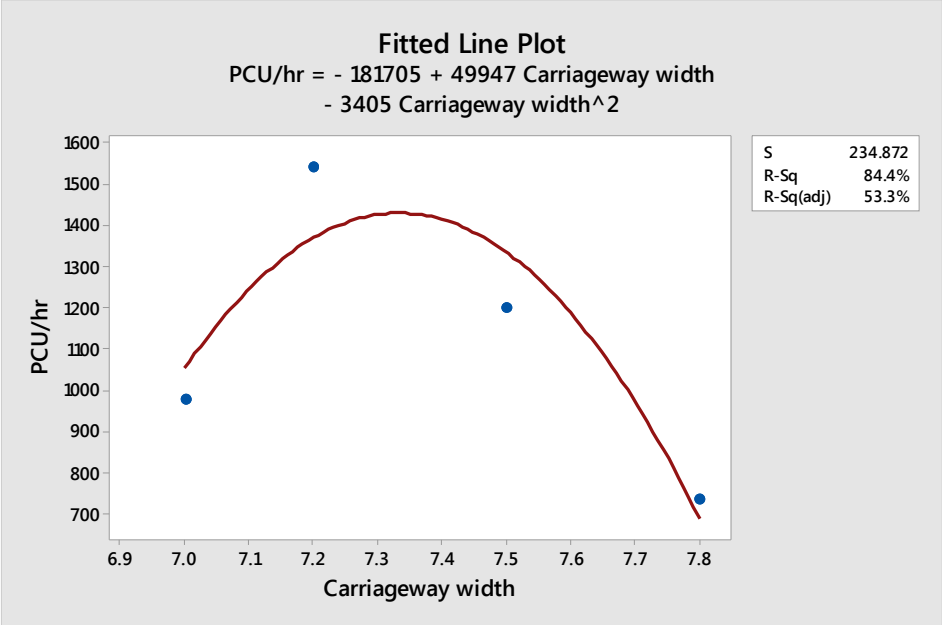

Figure-9: Capacity as related to carriageway width in morning hours.

Table-11: Theoretical and Observed capacity in morning hours.

Location	Carriageway width (m)	Theoretical Capacity (PCU/hr)	Observed Capacity (PCU/hr)
Bombay Bazaar road	7.2	1540.5	1398.2
Ghantaghar road	7.8	731.5	721.4
3 Puliya road	7	976	1079
Khandwa Indore road	7.5	1200	1366.25

Table-12: Theoretical and Observed capacity in evening hours.

Location	Carriageway width (m)	Theoretical Capacity (PCU/hr)	Observed Capacity (PCU/hr)
Bombay Bazaar road	7.2	1653.5	1497.92
Ghantaghar road	7.8	681.5	629.12
3 Puliya road	7	1226	1276
Khandwa Indore road	7.5	1254	1351.25

Table-13: Theoretical and Observed capacity in night hours.

Location	Carriageway width (m)	Theoretical Capacity (PCU/hr)	Observed Capacity (PCU/hr)
Bombay Bazaar road	7.2	814.5	1144.72
Ghantaghar road	7.8	695	790.12
3 Puliya road	7	1286	1157
Khandwa Indore road	7.5	1265	1027

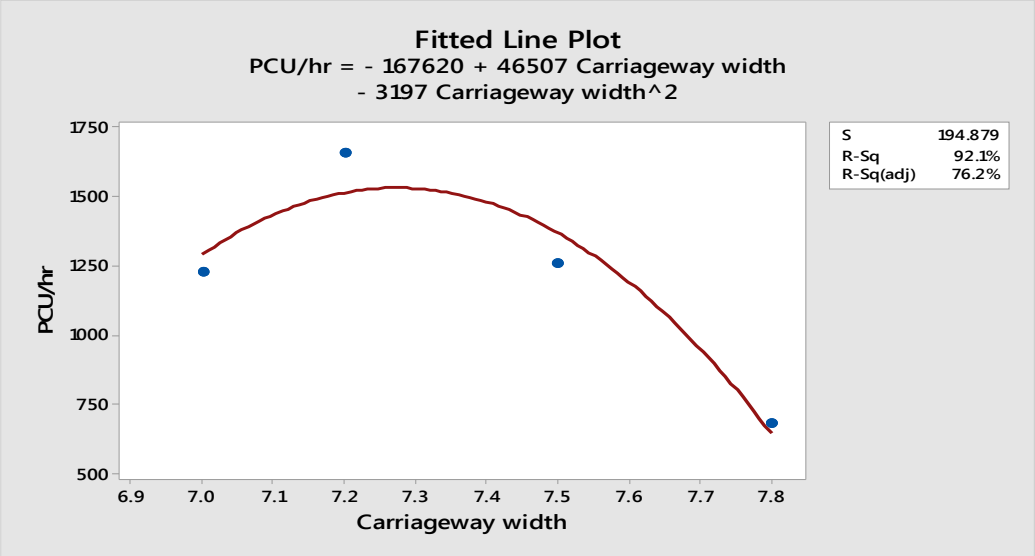

Figure-10: Capacity as related to carriageway width in evening hours.

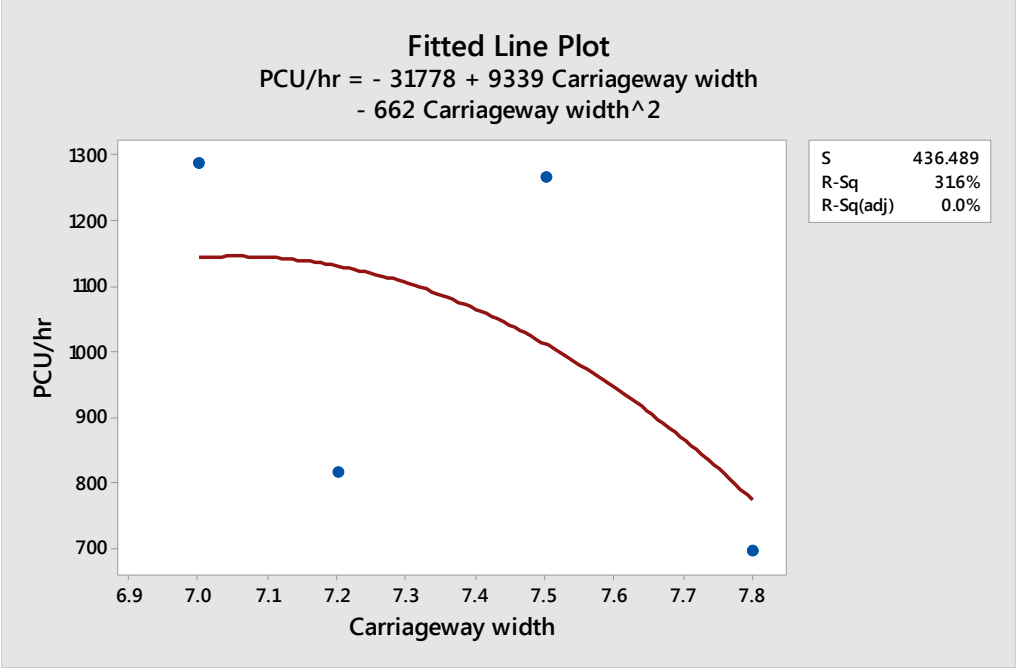

Figure-11: Capacity as related to carriageway width in night hours.

Conclusion

The analysis is based on the research performed on regular highways around Khandwa city. New PCU values received from web page are quite unique from the values given in IRC code. It is observed that PCU values acquired for motor cycle, vehicle rickshaw, from all sections are smaller than the values given in IRC and for Truck, Trailer and L.C.V found better than the fee given in IRC 64-1990 Code. This observes has proven the impact of lane width at the PCU for different categories of vehicles and at the ability of two-lane Highways. It's miles found that the PCU for a vehicle type increases with growing lane width[8].

These outcomes is indicates the importance of growth the lane width in congested areas. it's far determined that PCUs of different categories of automobile are inversely associated with length of passenger automobile PCU values relevant to modern-day conditions need to be developed instead of depending at the vintage PCU values given in code.

The R square value indicates the good relationship between observed speed and density. The developed model can be used for the traffic condition similar to Khandwa city.

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