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Capacity Assessment of S V Road under Heterogeneous Traffic Condition

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Abstract: capacity of a traffic stream plays an important role in the efficient operation of the stream. The capacity depends on many factors and all the factors are more or less interdependent. In present work efforts were made to assess the capacity of Swami Vivekananda Road, this road is located along the western railway and provides connectivity to all western suburbs. The capacity was assesses and modelled for that PCUs were determined under prevailing traffic and geometric condition for four vehicle types whiz are motorised two wheeler, motorised two wheeler, Car and Buses. And finally capacity was assessed for all the selected sections using Greenshields Model.

I. INTRODUCTION

Over the past few years there has been a considerable increase in the population of Mumbai. This increase in the population of the city is mainly because of the overall increase in the population of the entire country over the past few decades (mainly after independence) & also majorly due to the rate of immigration in the city from other cities (especially the northern states) which is mainly because Mumbai is the financial capital of the country and offering more job opportunities available to any other city of India.

However, increased population of Mumbai has created various problems for the citizens like water shortage during summers, increase in the rates of daily used products (like dairy, grocery, etc.), but the main problem created by the rapid population increase is the exponential increase in the traffic congestion in the city due to more number of private vehicles used on the roads which increases the traffic capacity and generates traffic queues. Apart from the increased population, various other factors like shorter lane width (compared to those in cities like Delhi), construction activities which further reduces the lane width of the carriageway, etc. which causes traffic congestion

II. NEED OF STUDY

For our study we have taken the SV Road which is one of the major roads in Mumbai connecting Dahisar to Bandra. It serves as an alternative to the Western Express Highway (which also connects Dahisar to Bandra) and Link Road, but it is a very congested and busy road compared to the western express highway as it has various markets, restaurants, commercial buildings, offices, etc. thus ending any possibility of road widening.

Further it is a two lane divided carriageway and undivided over certain segments. road which has a divided carriageway from Dahisar to Malad & an undivided carriageway further .The lane width of the SV road is also very less compared to that to that of the western express highway. This is the reason why the SV road is usually a congested road having a traffic jam condition not only in the peak hours but also in the off-peak hours.

In present study work efforts were made to analysis the effect of reduced lane with over certain locations under heterogeneous traffic condition. The simple way to analysis the behaviour of different vehicle type is the assessment of their

Passenger Car Unit factor. *PCU is defined as measure of the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single standard passenger car.* The passenger car unit is different for different vehicle type and depends on many factors like geometry of the carriageway, static and dynamic characteristics of vehicle, pavement condition etc.

In present work PCUSs were estimated using Chandra's Methods and for that Motorised Two Wheeler, Car and Motorised Three Wheeler considered for assessment of PCU factors.

III. OBJECTIVE OF THE STUDY

Following are the objectives of our study:

- To determine the PCUs under prevailing traffic flow conditions.
- To model the effect bottle-necks on a given traffic flow.
- To assess the Capacity of the system

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IV.LITERATURE SURVEY

Keller et al. (2005) developed passenger car equivalents through network simulation. Authors developed and tested a macroscopic traffic simulation model to derive passenger car equivalents for large size vehicles by taking vehicle size, traffic volumes and signal timing as important factors. **Elefteriadou et al (2007)** calculated PCU values on two lane highways and arterial roads based on simulation results. Authors developed formulated speed-flow curves with uniform traffic volume and with mix traffic volume. Simulation run performed by selecting subject vehicle type with incremental proportions by
removing some passenger cars in the traffic stream. PCU values have been derived by comparing the points on the curves at same average speed level. **Farouki and Nixon (2007)** studied the effect of the carriageway width on speeds of cars in the special case of free-flow conditions in suburban roads in Belfast. It was found that the mean-free speed of cars in a suburban area increases linearly with the carriageway width over a certain range of width from 5.2 to 11.3 m.**Turner et al (2007)** Found that the conversion of a shoulder to an additional travel lane could be expected to increase the average speed of a two-lane highway by about 5% for volumes exceeding 150 vehicles/h. For an average speed of 80 km/h, this corresponds to an increase of 4 km/h. **Yagar and Aerde (2009)** found that speed changes exponentially with the change in lane width. For a practical range of lane width from 3.3 to 3.8 m, it was found that the operating speed of a given location decreases by approximately 5.7 km/h for each meter reduction in the width. **Zhang et al. (2006)** They used vehicle moving space (VMS) as the measure to derive PCE for vehicles of different categories for Chinese roadway and traffic conditions. They used empirical data and microscopic traffic simulation to develop a set of PCE factors on level terrain and specific upgrades during congestion. **Ramanayya [1999]** opinioned that the standard for capacities followed in western countries cannot be directly applied as PCU of a vehicle type varies with levels-ofservice and traffic composition. The equivalent design vehicle unit for different vehicle types estimated for different vehicle types increases with increase in the percentage of slow moving vehicles at a given level-of-service. **Velmurugan et al (2009)** studied free speed profiles and plotted speed–flow equations for different vehicle types for varying types of multi-lane highways based on traditional and microscopic simulation model VISSIM and subsequently estimated roadway capacity for four-lane, six-lane and eight-lane roads under heterogeneous traffic conditions with reasonable degree of authenticity.**Arasan and Koshy (2009)** developed a heterogeneous-traffic-flow simulation model to study the various characteristics of the traffic flow at micro level under mixed traffic condition on urban roads. The vehicles were represented, with dimensions, as rectangular blocks occupying a specified area of road space. The positions of vehicles are represented using coordinates with reference to an origin. The model was implemented in C++ programming language with modular software design. **Chandra and Kumar (2009)** studied the effect of lane width on PCU values of more than five vehicle types. A new concept called dynamic PCU was used to estimate the PCU factor of all types of vehicles that uses projected area and speed data for finding PCUs. It was found that the PCU of a vehicle type increases linearly with the width of the carriageway. However, the sensitivity was different for different vehicles. Wider roads lead to the greater freedom of movement which results in greater speed differentials between a car and a vehicle type and thus PCU value increases. **Arasan and Arkatkar (2012)** examined the effect of traffic volume and road width on PCU of a vehicle under heterogeneous conditions using simulation model. HETEROSIM was used to study the vehicular interactions at micro-levels and simulated traffic over a wide range volume. **Bains et al. (2012)** simulated Indian Expressway sections for evaluating Passenger Car Unit of different vehicle categories at different volume terrain conditions using micro-simulation model, VISSIM. Authors found that the PCUs decrease with increase in volume to capacity ratio. PCU of a subject vehicle category also decreases when its proportional share increases in the traffic stream. **Mehar et al. (2015)** estimated PCU values of five vehicle types on interurban multi-lane highways. Dynamic PCU method was used to estimate PCUs. PCU values are also estimated at different LOS under varying traffic mix. The traffic simulation model VISSIM used for generating traffic flow after proper calibration. PCU values for different vehicle types were suggested at different LOS on four-lane and six-lane divided highways. **Mehar et al. (2015)** studied the effect of traffic composition on the capacity of multilane highways using micro simulation model VISSIM. VISSIM software was calibrated using speed and flow data and found capacity values for different combinations of the mix in the traffic stream. The study proposed generalised equations to determine the capacity value at given composition. **Khademi et al. (2015)** used MLR, ANN, and ANFIS techniques for determination of the displacement of a concrete reinforced building. Authors found that ANN and ANFIS models show great accuracies in estimating the displacements whereas MLR model did not show acceptable accuracy. **Mashhadban et al. (2015)** used ANN and PSOA are used to generate a polynomial model for predicting self-compacting concrete (SCC) properties. The obtained results showed that PSOA integrated with the ANN is a flexible and accurate method for prediction of mechanical properties of fiber reinforced SCC properties. **Behfarnia and Khademi (2015)** used ANN and ANFIS models for estimation of 28-day compressive strength of concrete for 160 different mix designs. From the results, it is found that ANN model is recognized to be more fitting than ANFIS model in predicting the 28-day compressive strength of concrete. **Biswas et al. (2016)** used ANN to develop a volume-based speed prediction model for individual vehicle category. Results showed a great deal of agreement between the predicted and the observed speeds.

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V. METHODOLOGY USED AND DATA COLLECTED

The proposed methodology for our study involves the following steps:

- Selection of the Study Area
- Selection of Data Collection Points/Sections
- Traffic Survey to be conducted
- Data Collection & Analysis
- Determination of PCU Values

Selection of Study Area and **Data Collection Points**

For our study we have chosen the SV Road as it is a very busy and congested road in the city due to its smaller lane and carriageway width and increased number of road users. Data was collected at various points like Borivali, Kandivali, Jogeshwari and Andheri. There are 3 section are selected for the data collection using video graph. The data is only collected for the morning time. One hour data is collected at the peak time. The video graph is taken such that, that this 30 m section taken for data collection is visible in the video.

Traffic Survey Done for the Study

For this study, the road section of 1 km is selected in which there are 2 intersections are controlled and 2 are uncontrolled. The data is taken for the peak traffic hours because the traffic is maxima at peak hours. So the traffic congestion is maximum at this time. At the selected road section the traffic congestion is very high in whole day,but it is maximum at morning 11:00 am to 12:00 and at evening 6:00pm to 9:00pm.

The collected data were

- Traffic Volume
- Vehicle Speed
- Projected Area of the Vehicle
- Assessment of Capacity

VI. DATA ANALYSIS

After the data is collected, the analysis of the data is under the following heading: -

PCU Calculation: -

The PCU given in the IRC are the general values of that. But the traffic conditions are varying from road to road and city to city. So, new PCUs are calculated for analysis of data's.

The method used for calculating the PCU named CHANDRA's Method. This method uses two factors: namely, velocity of vehicle type and its projected rectangular area to calculate the PCU value.

Table 1: - PCUs for different Vehicle Type Across Various Locations

Vehicle	Location I	Location II	Location III	IRC 106:1996
M2W	0.256	0.263	0.233	0.5
Pass. Car	1.02	1.01	1.01	1.00
M 3W	0.6711	0.599	0.579	0.75
Bus/Truck	2.39	2.99	2.56	3.7

Capacity Calculation: -

According to IRC the Capacity of the roads are given for the particular width of road. But the capacity varies with the varying site condition.

Volume is calculated with new PCUs and density is calculated by using the relation given below:

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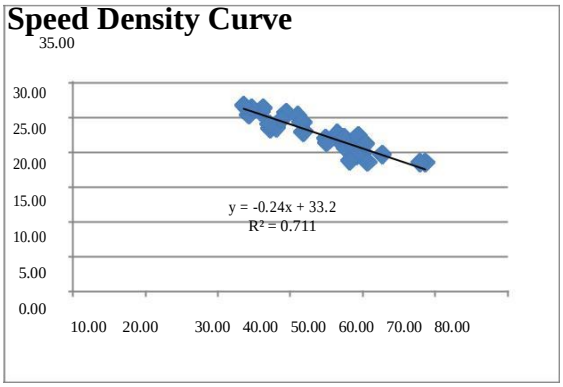

Figure: 1 Speed Density Curve for Location I

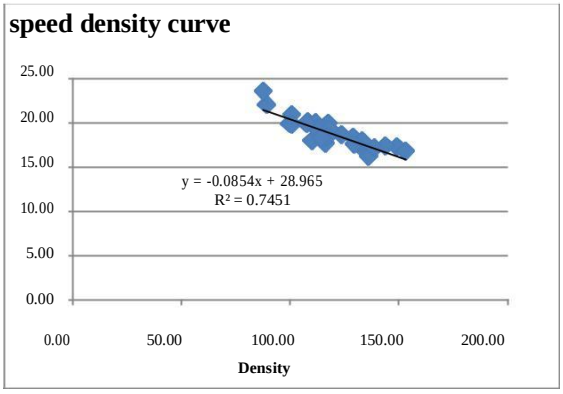

Figure: 2 Speed Density Curve for Location II

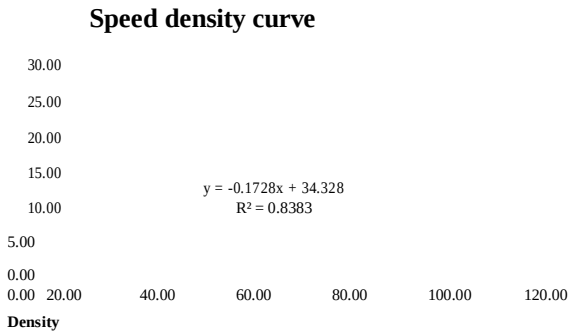

Figure: 3 Speed Density Curve for Location III

Table 2: - R square test of the speed density curve

Location	R^2 test	Equation
Location-I	0.711	y = = -0.24x + 33.2
Location-II	0.745	y = -0.085x + 28.96
Location-III	0.838	y = -0.172x + 34.32

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Now, the above equation is compared with Greenshield Model equation and finds the value of free flow Speed (Vsf) and Jamming Density (Kj). By Greenshield Model, find the Maximum Flow (Qmax) of the section. This is shown in table 3

Table: 3 Free Flow Speed, Jam Density and Capacity

Location	Speed (Km/Hr)	Density (Vh/Km)	Flow/Capacity (Vh/Hr/Lane)
Location I	39.17	137.92	**1351**
Location II	28.96	340.7	**2467**
Location III	34.32	200	**1712**

From the table: 3 it is observed that the Capacity of the section is different for different section, depend of the site condition. But according to IRC the capacity of the road is fixed. The capacity of road is changed because of the change in the free flow speed and jamming density. When it is compared with the capacity given in IRC it is already on the jamming condition. But in the actual condition the traffic is flow but with slow speed. This show that the capacity of the road is increases by decreasing the free flow speed used for the analysis of the capacity.

Thus, from the Greenshield model we obtain the values of Kj, Qmax, Vsf via a linear relationship between 'Speed' and 'Density'.

VII. RESULT AND CONCLUSIONS

1. Following are the obtained PCU Values for the conducted study at the selected three locations 1,2,3 for the following vehicles:2W- 0.256(1), 0.263(2), 0.233(3) Passenger Car- 1.02(1), 1.01(2), 1.01(3)3W- 0.6711(1),0.599(2),0.579(3) Bus- 2.39(1),2.99(2), 2.56(3)
2. The average values of PCU's for the different types of vehicles are Two Wheeler : 0.253-Wheeler : 0.616 Passenger Car : 1.013 Bus/Truck : 2.646 However according to IRC following should be values of PCU: 2-Wheeler : 0.5 3-Wheeler: 0.8 Passenger Car: 1 Bus/Truck: 3.7
3. Since the R^2 Values for all the vehicles at all locations are above 0.5, the data collected and analyzed in correct.
4. Following are the capacity values for all the three locations : Location 1- 1351 vh/km/lane Location 2-2647 vh/km/lane, Location 3- 1712 vh/km/lane

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