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A Review on Estimation of the Capacity at Urban Arterial

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Abstract - *The scenario of traffic in India is extremely heterogeneous due to several types of vehicles operating with various lane behavior and driver behavior, resulting in highly heterogeneous character due to their static and dynamic characteristics. Currently, traffic on the road is rising exponentially, and the amount of traffic exceeds the acceptable limit. For the planning, design, and management of roadway infrastructure, a deep understanding of several aspects of roadways is important. It is necessary to have a better highway system with more capacity in order to enhance vehicle traffic. In India, highways usually operated in mixed traffic environments, with massive differences in driving behavior from one location to the next. The variety of influencing elements present on a highway significantly affects the traffic flow stream, and therefore capacity becomes unpredictable in mixed traffic. Another aspect that determines the overall operating characteristics and capacity of a multilane roadway is vehicle flexibility. It will be easy to analyze and estimate the diverse traffic behaviors of the region by considering the appropriate traffic flow characteristics like speed, density, and flow in the mixed traffic at urban road networks using simulation software like VISSIM.*

***Key Words*: Traffic volume, Capacity, Traffic Simulation, VISSIM, Urban Roads**

1. INTRODUCTION

In developing nations, the transportation system is crucial because it connects commodities and passengers from one region to another. Road transport does have a greater portion in the transportation system than any other mode of transportation. Road transportation delivers the majority of passengers and freight. In a growing country like India, people use road transportation more than any other means of transportation. With a total length of 6,215,797 kilometers, India has the world's second-largest road network. A better system for delivering products and people across the country is required due to the significant expansion in vehicular traffic growth on roadways. Because of its quick social and economic development, India's traffic volume is likely to expand in the coming years. Recognizing this, the Government of India (GOI) has taken new steps under the National Highway Development Program (NHDP) to provide high-density corridors, such as multilane highways and expressways, to meet the current and future demands for rapid, efficient, safe, and interconnected highway networks. When it comes to traffic flow and capacity, multilane roadways require attention. On such roads, a variety of lane switching and overtaking maneuvers occurs, some of which result in serious accidents. The behavior of traffic flow on multilane highways is a complicated phenomenon that requires a more conceptual and logical approach to data collection, analysis, and interpretation. Various attempts to model and quantify traffic flow behavior by utilizing empirical and analytical approaches, even in mixed traffic, have been effective, but they are confined to field particular roads and traffic circumstances. Practical problems in performing huge field tests under vast fluctuations of traffic flow characteristics, non-availability of essential field conditions, and difficulty in testing with individual components are all factors that contribute to the limits. Computer simulation has shown to be a useful tool in replicating complicated traffic systems and allowing experimenting with the fundamental traffic flow system as a solution to these real difficulties. VISSIM a traffic simulation model built in Germany based on Wiedemann's research work on car following behavior, is one example.

Now India contains the second-largest population in the world and is a developing nation. Therefore, the increased traffic on the roadways is significantly impacted by these higher population numbers. There are now multi-lane metropolitan roadways with four, six, and eight lanes in industrialized nations like the developed countries. However, due to the uneven distribution of traffic on Indian highways, there are few of these kinds of roads here. The traffic on Indian roadways is affected differently by different types of non-motorized vehicles including bicycles, hand carts, animal carts, and so on. These non-motorized vehicles include two-wheelers, three-wheelers, cars, buses, light commercial vehicles and high commercial vehicles. Comparing to other Indian highway systems, the traffic on urban roadways is different. Because of the mixed traffic conditions on urban highways, Vehicle mobility and acceleration are slower than on any other type of highway

infrastructure due to mixed traffic situations. Therefore, it's indeed crucial to properly evaluate and analyze the characteristics of traffic on India's urban roadways. In addition, there are a variety of cars on the urban road, some of which move quickly and others slowly. When urban roads have multilane features the traffic composition, vehicle speeds, and other factors become extremely important because it makes things easier to define the delivering high quality, capacity, and level of service. The design and implementation of the highway system must beginning with all these considerations. Now, in cities heavier vehicles move less slowly and have a greater surface area on the road. The traffic flow on urban roadways is significantly impacted by these kinds of vehicles.

1.1 Need of Study:

On multilane highways, it is in need of further research on capacity and traffic flow behaviour. Car following and lane switching behaviour modes were established for homogeneous traffic scenarios in industrial nations, but they do not instantly adapt to mixed traffic circumstances. India's population growth and urban area expansion have contributed to a greater expansion of traffic in urban areas. As a consequence, there is a challenge with traffic congestion on urban highways. Urban roadways experience a variety of traffic conditions and each urban region has a different kind of congestion problem. For improved urban road planning, design, and operation, hence it is important to analyse it. Frequent lane changes, vehicle overtaking, and individual vehicle speed always have an impact on a stretch of highway capacity. The speed on urban roads is slower than on rural roads and the traffic density on urban roads is higher than the rural roads. The traffic conditions on urban roadways are influenced by different vehicle categories. Due to their slower on-road movement and higher on-road area occupancy compared to other classes of roads heavy vehicles now have a considerable influence on traffic in urban areas. Heavy vehicle behaviour such as this affects the capacity of the traffic stream and passenger car units of vehicles more. Studying the features of urban road traffic and also how heavy vehicle use affects it is therefore crucial.

1.2 The objective of the Study:

- To analyze the mixed traffic flow characteristics at the urban midblock section under mixed traffic condition.
- To derive the dynamic PCU values for different types of vehicles under the mixed traffic condition.
- To study the effect of mixed traffic on variation of capacity of urban midblock section.
- To calibrate driver behavior model parameters of VISSIM software to replicate mixed traffic condition on urban midblock section.

2. Literature Review

Arpan Mehar, Satish Chandra and Velmurugan, S. (2014). In this study, the VISSIM software is used to determine highway capacity under mixed traffic conditions. The authors of this paper concentrate on the use of VISSIM software to capacity estimation of multilane highways with mixed traffic flow. Data on traffic flow collected from a segment of divided four-lane highway is used to build the speed-flow curve. The simulated speed-flow curve and the field curve are compared by using same set of field data through VISSIM. The speed and capacity of the roadway were found to be overestimated by VISSIM in its original form. The approach was demonstrated to function on a four-lane divided highway with paved shoulders, with simulated capacity of 5329 pcu/hr against 5277 pcu/hr in the field. To determine CCO and CCI for mixed traffic conditions base values of CCO and CCI computed for homogeneous stream are used. This study shows that the weighted average approach for calibrating CCO and CCI for field observed traffic composition is effective in making simulated capacity with a 2 percent error when compared to capacity derived from the field data. [1]

Arpan Mehar and Seelam Mehar. (2017) In this research paper, the traffic flow data is generated using the microscopic traffic simulation flow model to get essential parameters. Inputs to the simulation model VISSIM are analysed using field data obtained at four-lane highway sections. study calibrated and validated the VISSIM model based on the field data Through trial and error and evaluating various influencing simulation factors including RSN (random seed number), limitations of desired speed, output volume, travel time, etc. Traffic volume, speed, and capacity are utilised to calibrate the model up to a certain level of satisfaction and serve as measures of effectiveness. According to the study, the number of lane changes is influenced by both the volume of traffic and the number of lanes available in each direction of travel. On simulated segments of four-lane, six-lane, and eight-lane divided roads, the maximum number of lane changes and lane changes at capacity level of volume are also evaluated. When traffic flow hits its maximum level, it is determined that no further lane changes are seen in any of the simulated segments. The relationship between capacity per lane and the number of lane changes has been established and it reveals that capacity decreases as the number of lanes increases. field data inputs that were as near to the field capacity as possible were used to generate the simulation. It was only 1.25 percent different in capacity. .[2]

S. Velmurugan, Errampalli Madhu, K. Ravinder, K. Sitaramanjaneyulu and S. Gangopadhyay (2010) In this study, based on traditional and microscopic simulation models free speed profiles and speed-flow equations for various vehicle types for various types of multi-lane roads

have been developed and as a consequence roadway capacity has been evaluated. Additionally, several studies have been conducted on the lane change behaviors of various vehicle types and their effects on highways with multiple lanes have been thoroughly assessed and the Design Service Volume for several types of divided carriageways has been developed for India's multi-lane roads, including four-lane, six-lane, and eight-lane lanes, with a reasonable level of accuracy for the current diverse traffic conditions. It was found that for various peak hour ratios of 7 to 10%, the DSV under LOS-B and LOS-C of a four-lane divided carriageway varies from 22296 to 47777 PCUs/day/direction on plain terrain. Similar values are found for six-lane divided carriageways (30932 to 66283 PCUs/day/direction) and for eight-lane divided carriageways (39184 to 83966 PCUs/day/direction) for various peak hour ratios of 7 to 10% on plain terrains. It will often not have been desirable to implement LOS-C on multi-lane highways. In order to upgrade the facility to a six-lane divided carriageway, the DSV values that correlate to LOS - C may be used to determine the holding capacity of four-lane divided carriageways. Similar to this, the DSV values obtained for LOS-C may be used to determine the holding capacity for widening a six-lane divided highway to an eight-lane divided highway.

Ravikiran Puvvala, Balaji Ponnu and Shriniwas S Arkatkar (2013) In this research paper the highway capacity is estimated using the micro-simulation model, VISSIM for Indian Expressways. In this study to estimate the capacity for eight lane urban expressway, Delhi–Gurgaon expressway was selected. The purpose of this research is to use the VISSIM micro-simulation model to model traffic flow on Indian urban expressways with a focus on the Delhi-Gurgaon expressway. The micro simulation model VISSIM has been found to be suitable for simulating and hence analyzing heterogeneous traffic flow in expressways with statistical relevance, according to this study. When input flow is provided every 15 minutes and output is collected every 30 minutes, the simulated flow and speed from the calibrated model meet the observed data the closest, however the capacity value predicted from the model is closer to the observed value when the output is taken every minute. This makes sense because when the level of period aggregation is reduced, lower speeds and lower flows would be detected at more frequencies. Therefore, a more fully-developed flow-speed curve results when the interval for consideration is small, lower and higher mean speeds as well as lower and higher flow levels are recorded. Based on the observed vehicle class mix during the research period, the capacity calculated from this study is 10560 vehicles per hour in one direction of travel for the Delhi-Gurgaon Expressway. [4].

Pratik U. Mankar and Dr. B.V.Khode (2016) In this study the highway capacity of urban roads is estimated by the green shield model and results are compared with the Microscopic simulation model. The intension of this research is to analyze the capacity for urban roads in mixed traffic condition. It has been found from this study is the sudden increase in width of lane on the road the PCU values and traffic composition are also increases as well as the highway capacity of the road increase. The observed field capacity and simulated capacity found to be 5 %. [5].

Partha Pratim Dey, Satish Chandra; and S. Gangopadhyay (2008) In this study, the simulation program is developed to simulate the traffic flow on a two-lane road. A two-lane road's capacity in an all-cars scenario is calculated as 2,860 PCU/h. When there are just two-wheelers, the speed rises to 5,600 vph, and when there are only tractors, it falls to 580 vph. Additionally, the capacity decreases linearly when the directional split deviates from a split of 50/50. Furthermore, it has been found that a two-lane road's capacity reduces when the proportion of heavy vehicles , tractor or three-wheeler vehicles grows in the stream of traffic. However, it was discovered that the capacity of two-wheelers increased in accordance with their own proportion. This is attributed to two – wheelers because of the small size and their maneuverability. Similar to this, PCU for a particular vehicle type falls as its proportion of the traffic stream and volume-to-capacity ratio increase. For two-wheelers, three-wheelers, and tractors, the high PCU value is shown at extremely low volume to capacity ratios and proportions of these vehicles in the traffic stream. However, this tendency is not seen for heavy vehicles, where PCU increases with its own proportion in the traffic stream rather than decreasing with volume-capacity ratio. It might be attributable to these vehicles' large size and poor operating effectiveness. [6].

Puvvala, R., Ponnu, B., Arkatkar, S., & Velmurugan, S. (2013). In this research paper the highway capacity is estimated for eight lane divided urban expressway under the mixed traffic condition. In this study to estimate the capacity for eight lane urban expressway, Delhi–Gurgaon expressway was selected. The purpose of this research is to use the VISSIM micro-simulation model to model traffic flow on Indian urban expressways with a focus on the Delhi-Gurgaon expressway. The simulation model is calibrated and validated using field data obtained on expressway traffic flow parameters. The verified simulation model is then used to calculate Passenger Car Unit (PCU) values and capacity values for various vehicle types. Under an uncongested environment, the PCU value for each of the vehicle types falls as vehicular traffic increases. It was also discovered that in crowded conditions, the PCU value for heavy and bigger vehicle classes is greater than their respective PCU values near capacity. According to the speed-volume curve created using the simulation model, the capacity of an eight-lane divided urban expressway in flat terrain with a road space of 14.0 m wide is approximately 9700 PCU/h for one direction of traffic flow. The calculated PCU values of the various

vehicle types are determined to be accurate at a 5% level of significance. [7].

Raju, N., Chepuri, A., Arkatkar, S., & Joshi, G. (2020). This research paper about the simulation study for improving the traffic flow efficiency of an intersection coupled with BRT. In this paper the author focuses on increasing the traffic flow efficiency of the Bhathena crossroads in Surat, which is connected to the BRT system. The study intersection is modelled in microscopic simulation software VISSIM 8.0 using field data. Based on this, a simulation model is calibrated and validated by comparing the probe vehicle's travel time with recorded queue lengths, as well as other observable data and simulation results, in such a way that the absolute percentage error is restricted to 15%. Traffic signal design is carried out utilising Webster's technique of signal design in order to enhance traffic flow behaviour at the intersection in terms of minimising travel time. The design of 2-phase, 3-phase, and 4-phase signal systems is one of the eventualities. The signal design is carried out using the Webster approach in each scenario and the same traffic signal system is simulated using the VISSIM model with the travel time results across the arms compared to the base case. The 3-phase system was found to be adequate for the junction when considering BRTS operation. [8].

Arkatkar, S., Velmurugan, S., Puvvala, R., Ponnu, B., & Narula, S. (2016). In this research paper author gives the methodology for simulating heterogeneous traffic on expressways in developing countries. For simulating heterogeneous traffic on expressways the Delhi–Gurgaon expressway is selected. In this research authors intends to study traffic flow on Indian urban expressways with a focus on the Delhi–Gurgaon expressway and estimate capacity using a VISSIM software micro-simulation model. Field data on traffic-flow characteristics on expressways was utilized in the calibration and validation of the simulation model for this purpose. The verified simulation model was then used to generate essential traffic–flow relationships, such as speed–flow, speed–area occupancy, and flow–area occupancy for all traffic-flow levels from near-zero to the facility's capacity. The capacity of an eight-lane divided urban expressway on flat terrain with a 14-meter wide road area (one direction of traffic flow) was determined to be between 9700 vehicles per hour. [9].

Chepuri, A., Raju, N., Bains, M. S., Arkatkar, S., & Joshi, G. (2018). This paper reviews the literature on the performance of an urban corridor using microscopic traffic simulation model under mixed traffic environment in India. The purpose of this research is to assess traffic flow characteristics on a busy road segment of an urban arterial corridor with BRT system in Surat, which covers five crossings. Using the microscopic simulation model VISSIM the paper attempts to examine the delays caused to both BRT buses and motorised vehicle traffic at crossings. The purpose of this study is to use simulation as a tool for enhancing the performance of an urban arterial corridor. The effort focuses on the construction of the study stretch's microscopic simulation model, as well as model calibration and validation. As a consequence, the built simulation model was used to assess the feasibility of different traffic management methods that might reduce delay and travel time for both BRT buses and private vehicles in motorised lanes, potentially lowering emissions. Furthermore, it is emphasised that the overall performance of the urban corridor's transportation system may be enhanced by applying well-tested traffic management solutions that are pre-simulated. [10].

Satish Chandra and Upendra Kumar (2003) This study has demonstrated how lane width affects the PCU for various vehicle classifications and consequently the capacity of a two-lane road. Data were collected at ten sections of two-lane roads in different parts of India. It has been discovered that as lane width increases with the increases PCU for a particular vehicle type. The carriageway's width varied from 5.5 to 8.8 metres. At each road stretch, the PCUs of all the vehicles were estimated which were classified into nine separate categories. This is explained by the fact that wider roads allow for more mobility and as a result have higher speed differences between cars and other types of vehicles. With increased carriageway width, a two-lane road's capacity also increases. It appears that lane width has a linear impact on PCU. However, the slope of the linearity varies depending on the kind of vehicle. 2818 PCU/h is the calculated capacity of a 7.2 m wide road. [11].

Menneni, S., Sun, C., & Vortisch, P. (2008). This paper reviews the Microsimulation calibration using speed-flow relationships. In this paper the authors discussed about how to make microsimulation model using the speed flow relationship graphs from field data. A microsimulation calibration process based on field and simulation speed-flow graphs is described. Pattern recognition algorithms are used to evaluate and execute matching speed-flow graphs. An Evolutionary Algorithm was used to apply the concept to the US101 highway network in San Francisco, California. When compared to existing capacity-based calibration approaches, the methodology improves them. A small-scale test network simulation model was also created to help with the deployment of this technique for massive simulation models. The test network simulation model performs similarly to the US101 simulation model. [12].

Chepuri, A., Kulakarni, R., Singh Bains, M., Arkatkar, S., & Joshi E, G. (2015). This paper reviews the Evaluation of BRTS Corridor in India Using Microscopic Simulation. In this paper the authors talks discuss about the evaluation of traffic flow of BRTS corridor in Surat city. The purpose of this research is to assess traffic flow characteristics along a 1.8-kilometer BRTS path in Surat. which comprises four

junctions. There is a limited literature on the evaluation of hybrid BRTS in Indian traffic. Using the microscopic simulation software VISSIM, the effort intends to assess the traffic delays generated at these crossings. The project also involves a BRTS system performance study, which includes an inquiry into the reasons of delays and their overall impact on the BRTS. The research is being carried out in order to recommend realistic traffic management techniques that might reduce delays and travel times for both BRTS buses and private traffic, resulting in a decrease in emissions. [13].

Raj G., G., Sekhar, C. R., & Velmurugan, S. (2013). This paper reviews the literature on the Microsimulation based Performance Evaluation of Delhi Bus Rapid Transit Corridor. In this paper the authors discussed about Bus Rapid Transit System (BRTS) is the most popular form of rapid public transit system. In this study, a quantitative performance strategy based on micro-simulation was developed with the objective of analysing the open system BRT corridor's performance in Delhi. The Ambedkar Nagar to Moolchand BRT section in Delhi is now operational for 5.8 kilometres. Ambedkar Nagar, Sheikh Sarai, Press Enclave, Chirag Delhi, Siri Fort, and G K-I Intersection were among the six main intersections where 16-hour Classified Traffic Volume data was obtained. For bus and vehicle modes, GPS-based Velocity-Box (V-Box) apparatus was used to gather speed and delay data. To replicate real traffic activity on the research corridor, data on signal timing and signal phasing was collected at the junctions described above. The Mixed Vehicle (MV) lane of the Delhi BRT corridor has a capacity of 3607 PCU/hr, while the Bus lane has a capacity of 1701 PCU/hr. For both approaches, micro simulation-based traffic flow models were built with the goal of achieving a wider variety of speed-flow relationships. The models that were created were calibrated and verified. The Golden Section approach is used to optimise the link performance functions designed for the Mixed Vehicle (MV) lane and Bus lane of the Delhi BRT line. The ideal point, V-C for the MV Lane and 0.640 for the Bus Lane of the Delhi BRT path, was found to be 0.677, with the associated traffic volumes of 2438 PCU/Hr and 1120 PCU/Hr on the corresponding MV and BRT lanes, respectively. The created model's GEH statistic is 4.13, which is less than 5, and the percentage error in capacity estimation is 3.49 percent. Both of these findings show that micro simulation is an effective way for testing the BRTS. More calibration criteria need to be researched to improve the accuracy of the micro simulation models for Indian BRT networks. [14].

Mohammad Mardani Nokandeh1, Indrajit Ghosh and Satish Chandra (2016) In this research paper the highway capacity is estimated for two lane inter inter urban road.The purpose of this research is to propose a model which provides a quick estimation of capacity by removing theComplexities. The benefit of the proposed model is that it provides a rapid and accurate prediction of the two-lane interurban road capacity rather than requiring a time-consuming data extraction and analysis process. Using this approach, it would be reasonable to evaluate the suitability of any two-lane facility and determine whether it needed to be improved. The model used in this study is designed for basic 7.0 m-wide two-lane roadways with earthen shoulders on both sides of the road. It was discovered that capacity increases as operating speed increases.The minimum capacity increase was discovered to be 75 PCU/hr for every 2 km/hr increase in operating speed. [15].

3. CONCLUSIONS

All of these studies show the significance of capacity for the traffic studies and the microscopic traffic simulation model VISSIM. The capacity major concept for the traffic study is to understand the traffic characteristics. On the urban roads, the Capacity is affected by factors like, Lane width and Width of shoulder, Lateral clearance, Commercial vehicles, Road alignment and geometry (curves, Super elevation etc), Existence of intersections, One way or two way traffic and number of lanes, Drivers and vehicular characteristics, Speed regulation, Heterogeneity of traffic, etc. These studies also help to understand the effect of lane width, lane change behavior on capacity in each class of vehicle categories. This study shows how to calibrate data and data validation in VISSIM and simulation is best way to understand traffic parameter. So, this study method was also used to understand the capacity of multilane highways in urban roads with the mixed traffic condition.

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