Comparative Study of Methods used for a Capacity estimation of Road

Pratik U. Mankar  
M. Tech Student  
Department of Civil Engineering  
G. H. Raisoni College of Engg, Nagpur

Dr. B.V Khode  
Project Associate  
Department of Civil Engineering  
G. H. Raisoni College of Engg, Nagpur

Abstract

Nowadays the traffic is increasing rapidly and traffic volume on roads exceeds the normal limit. The traffic conditions on Indian roads are highly heterogeneous in nature due to variety of vehicles with different static and dynamic characteristics. Study of various characteristics of road traffic is necessarily required for the planning, design and operation of roadway facilities. For an increased vehicular it requires better roadway infrastructure with higher capacity. For the capacity analysis of road it is quite difficult to estimate the traffic volume and capacity of roadway facilities under heterogeneous traffic condition. This paper discusses and reviews the Capacity estimation of roads under heterogeneous traffic condition by various authors and the factors influencing the capacity of roads and parameters affect the capacity of roads is reviewed and studied. This paper can be used for analyzing different methods used for Capacity analysis of roads to improve the roadway and traffic condition. 

Keywords: Traffic volume, PCU, Traffic speed, Simulation model, Traffic capacity

I. INTRODUCTION

In India presently 4.2 million km length of total road network is available but Still India is facing enormous difficulties in providing better vehicular traffic flow and operations. The main source of transportation in India is by road. Rapid and continuous increase population is major problem for Highway engineers. Due to increase in population the different modes of transportation are increases in cities which are resulted in jammed traffic condition on the road. Roads play the important role in the transportation of goods and passengers for short to medium distances and Road transport is more flexible than other modes of transport. Road transport plays important role in percent share in India’s GDP. But now a day's the traffic conditions on Indian roads are highly heterogeneous in nature due to variety of vehicles with different static and dynamic characteristics. The vehicle proportion is much more diverse with many poorly performing vehicles, slow moving vehicles and non-motorised vehicles. For an efficient and increased vehicular traffic it requires better roadway infrastructure with higher capacity. Thus for effective planning analysis and operation there is a need to find the traffic volume and estimate roadway capacity. Capacity of a road is greatly influenced by roadway, traffic condition and driver condition. Roadway conditions consist of geometric parameters such as lane width, shoulder width, Horizontal geometry and vertical geometry. Out of which lane width and shoulder width have a significant impact on the traffic flow. The capacity estimation of roads is done by using various traditional models as well as by using Microscopic simulation model. This paper mainly focuses on the review on comparative study of methods used for capacity estimation.

II. LITERATURE SURVEY

There are number of studies which are carried for the capacity analysis of roads, effects of influencing factors on the capacity and various methods for capacity estimation.

Satish Chandra et.al, (2004) provides the process for capacity estimation of two-lane roads under mixed traffic conditions and calculated the influencing factors which affect the capacity of road and adjustment factors for each of this condition are proposed. Capacity of a two-lane road based on these adjustment factors under heterogeneous traffic conditions is determined. Chandra et.al, (2003) studied the effect of lane width on capacity of roads in mixed traffic conditions. The author carries the work on different roads with varying road width and the analysis of study shows that PCU values for a different vehicle category increases linearly with increase in the lane width. Shreya Pahuja et.al. Provides the capacity estimation method on a four lane divided inter urban hill road by use of traditional models and compared it with the simulation model. Arpan Mehar et.al, (2014) Generates a traffic simulation model for traffic flow and speed data for different types of vehicles at different LOS for different traffic composition and propose PCU values for different types of vehicles at different LOS. V.Thamizh Arasan et.al, (2005) provides Method for Modeling Highly mixed Traffic Flow. He simulates the flow of heterogeneous traffic with vehicles of different ranging static and dynamic characteristics and considers absence of lane discipline. The result satisfactorily replicates heterogeneous traffic flow on roads where vehicles move without lane discipline. Arpan Mehar et.al, (2013) Author determined the capacity of multilane highways under heterogeneous traffic flow conditions by the applicability of VISSIM software and compared the data with field capacity. Author also modified some driver behavior parameters which affect the simulation. V.
Thanizh Arasan et.al, (2010) the author used a microscopic simulation model (HETEROSIM) to estimate PCU values in Heterogeneous traffic condition and result specify that the PCU value of a vehicle significantly changes with change in traffic volume and width of roadway. Many study shows that PCU values have considerable effect on traffic volume as this change regards to varying traffic composition on different roads and which affects the capacity of a road

### III. Comparative Study of Authors

**SATISH CHANDRA (2004):**- Provides a capacity estimation process for two lane roads and advised a method to evaluate PCU values for mixed traffic condition

\[
PCU = \frac{V_c}{V_i} \frac{A_c}{A_i}
\]

Where,
- 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 vehicle (m²)

Author provides the capacity estimation procedure for two lane roads and parameters which influence the capacity are described and based on this adjustment factors for each parameter are proposed.

The Capacity of two lane road is given by

\[
C_a = C_b \cdot f_g \cdot f_w \cdot f_ds \cdot f_smv \cdot f_s \cdot f_ui
\]

Where,
- \( C_a = \) actual capacity under prevailing roadway and traffic conditions
- \( C_b = \) basic Capacity and
- \( f_g, f_w, f_ds, f_smv, f_s, f_ui \) Are modification factors for gradient, lane width, directional split, slow moving vehicles, shoulder conditions and unevenness index?

**Satish Chandra et.al, (2003):**- To find the capacity of a road instead of spot speed or space mean speed the author suggest mean stream speed as it suit the mixed traffic condition and speed volume relationship is used to find the capacity

\[
V_m = \frac{\sum_{i=1}^{K} n_i V_i}{\sum_{i=1}^{K} n_i}
\]

Where,
- \( K = \) total number of vehicle categories present in stream,
- \( V_m = \) mean stream speed
- \( V_i = \) Speed of vehicle,
- \( n_i = \) Number of vehicle.

![Fig. 1: Speed volume relationship at section](image)

The stream speed Volume relationship is used to find the capacity at all sections. Author find the Capacity of a 7.2 m road is 2818 PCU/hr. which is shown in figure 1. which somewhat greater than the value stated in HCM (1994) but lower than value of 3200 PCU/hr. advised in HCM (2000) and effect of lane width on the capacity of a road is studied and result shows that the
capacity of two lane road is likewise increases with rise in width of carriageway. The variation in Capacity as related to width of carriageway width is as shown in figure 2.

![Graph showing variation of capacity as related to total width of carriageway](image1.png)

Fig. 2: variation of capacity as related to total width of carriageway

Shreya Pahuja : For the capacity estimation of four lane divided interurban hill road author compares traditional models like Green shield, Greenberg, Underwood and Modified Greenberg with Microscopic simulation model (VISSIM) and the obtained results are analysed. The Capacity of road is find out through Speed, Flow Rate relationship. The study shows that the Modified Greenberg model is fit great with field data as well as Vissim data. Capacity of a straight segment is find out to be 2126 PCU/hr/direction and 1809 PCU/hr/direction from curved portion. Result shows considerable reduction of 14 to 15 % in capacity if traffic moves from straight to curved portion.

Arpan Maher et.al, (2014) the study is done by author to provide PCU values for different vehicles typically found on highways with different LOS. The traffic simulation model is used to generate speed and flow data. Author compares field data with simulated data and find the near about same capacity obtained from field data. The speed volume relationship for four lane highway and six lane divided highway is as shown in Fig.3 and Fig.4

![Graph showing comparison of field data with simulated data for four lane highway](image2.png)

Fig. 3: comparison of field data with simulated data for four lane highway
The estimated Capacity of Four lane highway and six lane divided highway is given below:

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Section</th>
<th>Field Capacity</th>
<th>Simulated Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Four lane Highway</td>
<td>4950 PCU/hr</td>
<td>4950 PCU/hr</td>
</tr>
<tr>
<td>2</td>
<td>Six lane divided Highway</td>
<td>6700 PCU/hr</td>
<td>6850 PCU/hr</td>
</tr>
</tbody>
</table>

The major objective of the research is to enumerate effect of total traffic volume and composition on PCU values and study shows a considerable effect on PCU values and researcher successfully proved it.

V. Thamizh Arasan et.al, (2010) developed a traffic simulation model (HETEROSIM) to study the traffic flow conditions. The model is used as to develop volume and speed relationship to enumerate the influence of presence of different vehicle on flow by assessing PCU values under mixed traffic situation for different vehicles.

Arpan Mehar et.al, (2013):- Author presented a study to reveal the applicability of VISSIM software for define the capacity of multilane highways under heterogeneous traffic conditions. To analyze the performance of roadway, the traffic data is collected on four lanes divided highway section are used to form speed flow curve. Some driver behavior parameters as CCO (stand still distance) and CC1 (time headway) are modified by using field data and traffic condition. This parameters are important in heterogeneous traffic condition. Author generate speed flow curve from VISSIM software and compared it with field curve which is as shown in figure:

**IV. CONCLUSION**

1) PCU values for different vehicles are changed depending upon the traffic composition on road due to mixed traffic condition
2) PCU values have considerable effect on traffic volume and composition which affect the capacity.
3) Lane width has substantial effect on capacity and capacity of road section increases with increase in carriageway width.
4) HETEOSIM software replicate the field condition of a mixed flow appropriately and useful for modelling heterogeneous traffic condition.
5) VISSIM software is useful for capacity estimation of roads as it is capable of simulating heterogeneous traffic flow and classifies the performance and gives accurate result.
6) VISSIM software can also be useful for simulating large network.

REFERENCES