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Study and Review of Traffic Characteristics of Indian Intercity Highways

Ashutosh Kale[1], S. S. Sanghai[2]
[1] *M.Tech student, Department of Civil Engineering, G.H Raisoni College of Engineering, Nagpur*
[2] *Assistant Professor, Department of Civil Engineering, G.H Raisoni College of Engineering, Nagpur*

Abstract: ***The purpose of this paper is to study and review the various traffic characteristics of Indian highways. Most of the intercity highways in India are two-lane highways which are upgraded into four-lane or six-lane highways. The traffic on the Indian roads is of heterogeneous type. Due to the up gradation, there are significant changes in traffic characteristics such as Speed, Flow, Density, Capacity, and LOS. So, various research papers related to these fundamental characteristics of traffic were studied with their methodology and results. Mainly the papers related to 4 characteristics (Speed, Flow, Capacity, Level of Service) were studied. For every parameter minimum, 5 papers were studied and examined to find the best suitable methodology used to calculate these parameters.***
Keywords: Heterogeneous, Speed, Flow, Capacity, Density, Level of Service.

I. INTRODUCTION

Intercity highways are important types of uninterrupted free flow facilities. These highways are used to connect important cities within a state or region. They are of great importance to the nation as they are used for economic activities, tourist attractions, and commercial purpose and are useful to connect two diverse regions in a country like India. Most of the State and National Highways in India are made of two-lane roads. One-third of National Highways and more than half of the State Highways in India are still two-lane roads. Nowadays rapid up gradation of highways is taking place in which two-lane highways are upgraded into four-lane highways. Due to the up gradation of highways, there is a significant change in the traffic characteristics.

Indian traffic is of a different type as compared to the western. In India the traffic is heterogeneous, that is, it does not follow the lane changing technique. Also, the traffic is made up of different types of vehicles from slow-moving tractor to fast-moving cars. The speed of vehicles on the two-lane road is not more than 70 km/hr due to poor conditions of the road and mixed type of traffic. So the analysis of traffic characteristics on these types of the road is done differently as compared to the western way.

There are various methods which are developed by the researchers to calculate these traffic parameters. They are suitable for Indian traffic and vehicular characteristics. Various equations and graphs are developed to suit Indian conditions. We can refer and use these equations, formulas, and results directly for further study in this field.

II. PAPER REVIEWED

A. Speed

Speed is an important traffic characteristic as most analytical and simulation models of traffic predict speed as the measure of the performance as it relates to safety, road design, comfort, and economics. The speed distribution of a traffic stream at a particular location can be derived from spot speed. It is further used for the calculation of PCU, capacity, Flow, and LOS. Chandra and Kumar (2014) measured speeds and capacity at 10 different sites in India. The sites included both National Highway and State Highway. For the spot speed calculation videography technique was used to collect the data. Data was extracted later by playing the film on a large screen. Khan and Tarry (2018) used the stopwatch method for the spot speed calculations. Three observers were required for the survey, two at the starting point with one holding stopwatch and other pen and sheet. The third observer was standing with the flag at the end of the section. A small sample of not more than 50 vehicles was taken. Further Time means speed and space mean speed were calculated and their relationship was explained. Roshandeh, Nesheli, Othman Che Puan (2009) used Radar meter to find out the spot speed at a particular location. The range of the radar meter was from 200 feet to 2 miles. An ideal road section was selected and one observer was made to hold the radar gun. The spot speed and traffic count was done simultaneously. The data collected was used to find the 15^{th}, 50^{th} and 85^{th} percentile data using statistics. Dey, Chandra, and Gangopadhya (2006) studied the bimodality in the speed distribution curve in mixed traffic condition. A new parameter Speed ratio was introduced. They found out the parameters of the speed distribution curve to correlate with the traffic in 17 different two-lane roads in India. It does not depend upon the slow-moving vehicles. They suggested limits for unimodal and bimodal curves.

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B. Flow

Flow is to be defined as vehicles per hour. It is used to calculate the total volume of traffic in a day, week, month or year. Bhavneet Singh and Tripti goyal (2015) calculated traffic volume in Punjab University at Chandigarh. For the peak hour flow calculation the data was collected on six days from 8:00 am to 6:00 pm using the manual as well as videography technique. Later the data was analyzed for every one-hour interval. Sharma and Raval (2018) used a videographic technique for the calculation of flow. The data was collected on weekdays during the morning, evening peak hours and afternoon non-peak hours. The traffic count was done on 5 minutes interval and peak hour flow was found out for morning and evening time. Then it was converted into PCU per hour. Roshandeh, Nesheli, Othman Che Puan (2009) used the stopwatch method, radar meter method and pneumatic road tube method to find out the flow on the road. The sample was collected on Tuesday, Wednesday, and Thursday for one hour. The traffic count was done on 15 minutes interval.

C. Density

Density is one of the fundamental characteristics used to define the number of vehicles occupying a unit length of road at an instant of time in a traffic stream. It is defined in terms of length, which is vehicles/km. It is used to calculate jam density. It is normally represented by 'K' in speed density relationships. As per IRC: 64-1990 the following relationship exists between speed, flow, and density. Q= K.V

Where, Q= Volume

K= Density

V= Speed

D. Capacity

An important factor in traffic engineering is capacity. It is the maximum hourly rate at which vehicles can travel over a roadway section during a given time under prevailing traffic, roadway conditions. Chandra and Kumar (2014) measured capacity at 10 different sites in Northern and Eastern India. The site had a varied width with more than 1.8m shoulder. The data was analyzed using speed volume relationship and it was found out that PCU for a vehicle type increases with an increase in lane width. The capacity increases by 14% for 0.3m of lane widening and increases by 24% for 0.6m lane widening. Roy, Talukdar, and Saha measured capacity at three different sections on intercity roads in Western, Eastern and Northeastern part of India. The site had good pavement condition with 7m width and 1m shoulder. Speed-flow relations were developed using Greenshields model. In this study, it was found out that the operating characteristic of traffic is affected significantly in the event of heterogeneity in the traffic mix. Chandra and Ghosh (2016) measured the capacity of 9 different two-lane roads in India. Minimum 1.8m of the shoulder width was available at the site without any side friction. Greenshields model was used to calculate capacity. A relationship was developed between the operating speed of the passenger car and capacity. It was found that capacity increases with an increase in operating speed. The minimum capacity increase was 75 PCU/hr with every 2 km/hr increase in the operating speed.

E. Level of Service (LOS)

Level of service (LOS) is a quality measure describing operational condition within a traffic stream. Boora Ghosh and Chandra (2017) used four follower related parameters to evaluate the performance of 2 lane highways that are Number of followers, Percent followers, Follower Density, Number of followers as a proportion of capacity. They found out that for a highly heterogeneous traffic headway is not a suitable parameter. So the gap value between the two vehicles is used as a parameter in this study. Some relationships were introduced to investigate the effect of different categories of vehicles on critical gap values. In order to define different LOS ranges clustering analysis technique was used in this study. A Speed Difference limit of -4 to +10 km/h is identified which defines the followers if vehicles travel within this limit. Vehicles traveling beyond this range of Speed Difference are identified as non-followers. For all the sites selected for the study, a gap threshold value of 10 s is observed beyond which vehicles will not be in the following condition. Singh and Goyal (2015) calculate Level of Service at the Punjab University. A traffic count survey was done on two gates of Punjab University on weekdays for 10 hours from 8:00 am to 6:00 pm. From the hourly data, peak hour was calculated and flow data was converted into PCU/hr. LOS was defined from the V/C ratio. For all the peak hour data the LOS obtained was 'C'. Sharma and Rawal (2018) calculated Level of Service on a signalized 6 lane road in Ahmedabad city in Gujrat. The traffic survey was done on weekdays in the morning, evening and afternoon peak hours. The speed-flow relationship was used to calculate capacity. V/C ratio and space mean speed was used to calculate LOS. New V/C ratios were introduced to define LOS of that particular stretch.

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III. CONCLUSION

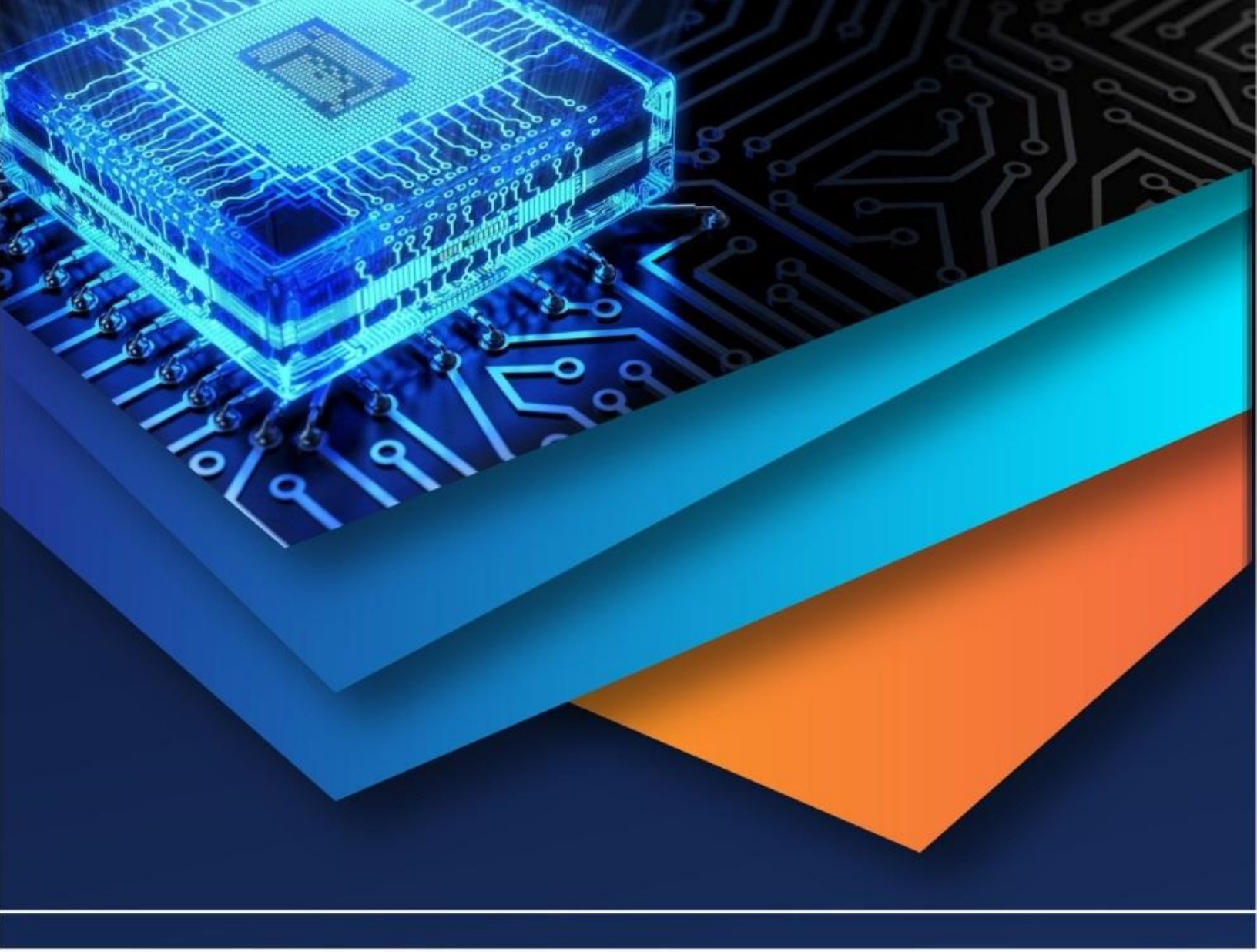
Speeds, Flow, Density, Capacity, and Level of Service are important traffic characteristics. These parameters are used for road design, planning, operation and layout of road sections. After studying these research papers some conclusions are derived.

A. For calculation of spot speed in India, video graphic technique can be used effectively. It is accurate as compared to manual methods, cheap as compared to some advanced methods which require sophisticated instruments and requires less labor work.
B. For calculation of Journey speed and Running speed, moving observer method must be used.
C. For calculation of percentile speed (85^{th}, 50^{th}, 15^{th}) frequency distribution table is an easy way.
D. For calculation of Flow or volume, video graphic technique can be used such that we are able to find out the traffic volume for every 5-minute interval or 15-minute interval as per needed.
E. For calculation of Density, the formula given above can be used.
F. For calculation of capacity, "Speed-volume" relationship graphs must be plotted. Here speed relates to mean stream speed which is given by $Vm = (\Sigma^{k}_{i=1} n_1 v_1) / (\Sigma^{k}_{i=1} n_1)$. It gives the exact capacity of the road section.
G. To find out the Level of Service of a particular intercity road, IRC: 64-1990 can be used. The design service volumes for all types of roads are provided in this IRC.

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