Capacity Analysis of traffic on NH48 Vadodara-Bharuch

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Abstract— The traffic condition of populated countries and Behavior of traffic flow is unpredictable compared to established country. The vehicles static and dynamic characteristics, is depend on vehicle type, uncertain flow of vehicle is observed here. Lane discipline is not possible in this case. Most of the study on traffic flow parameter is done on homogeneous condition so gap remains as it is with respect to actual traffic condition. This results unsynchronized traffic condition. Application of homogeneous traffic coefficients in heterogeneous space has limited effect on field. This review specifies the homogeneous and heterogeneous condition of traffic.12 hours of video recording is taken for two stretches of NH48.The data is taken from video extraction. The traffic composition is taken common for two sets of data. This attempt was made by keeping the current traffic condition in mind. The base condition for the study is taken from newly developed code Indo HCM 2017.

Keywords— Homogeneous, Heterogeneous, dynamic characteristics, observed.

I. INTRODUCTION

As an enhancement of humankind is going on new challenges come across the world. The social economy of any country changes frequently with respect to time. In this scenario the role of transportation facility becomes much powerful compared to others. Development of transportation is work like pouring oil in development. Construction of roadway play important role in free migration and fast mobility. As the use of the roadway is on the top challenges are starting from the ground zero. In fastest mobilized world the free, fast and furious transportation gives right momentum to developers. In fastest developing country like India modern and efficient transport plays a key role. It has been seen throughout the history of any nation that a proper, extensive and efficient Road Transport had played a major role. 'Transporters' are playing an importance performance in activities, at every stage of advancing civilization. Where roads are considered as the veins and arteries of a nation, passenger and goods transported are comparable to blood in circulation in the human body. The Passenger Road Transport Service (PRTS) is an essential connected to the economic development. Transport is the essential convenience with which people don't just connect but progress. Road transport will occupy a primary place in today's world as it provides a reach unparalleled by any other contemporary mode of transport.

Connectivity through highways is not the only requirement, capacity of highways is equally Important for achieving the envisaged economic growth of the nation. A scientific and systematic procedure to estimate Speed - Flow relationships on the roadway. Capacity is required. In which Microscopic Simulation Techniques can help in improving the accuracy of Capacity Estimation procedure. Realizing the present shortcomings in the transport sector, the Government of India during the last decade has drawn up huge road capacity augmentation measures through the implementation of various on-going National Highway Development Program projects. National highway is made for handling the goods and passenger traffic all over India. About 58.98 lakh km of network this is largest in world after America.

TABLE- I:

NATIONAL HIGHWAYS DEVELOPMENT PROJECT AT A GLANCE

National Highways / Expressway	1,32,500 km
State Highways	1,56,694 km
Other Roads	56,08,477 km
Total	**58,97,671 km**

The homogeneous method of capacity estimation is not recommended for country like India, to overcome from it Indian government decided to build new code in 2012. Council of scientific and industrial Research (CSIR) sponsored project of "Highway Capacity Manual" which is known as INDO HCM. Central road research institute (CRRI) worked for the project with the seven prominent academic Institutes from different parts of our country. Each chapter of INDOHCM 2017 explained with capacity estimation and level of service of different segment of roadway condition.

Day by day traffic on highway increased, but the road capacity is as it is. Due to industrialization transportation of goods are in demand. The capacity estimation is one of the most important parameters for any Highway. To reach the projected traffic demand capacity must be known. The geometric parameter of highway like lane width, number of lanes, and numbers of intersections is dependent on capacity. For improvement of geometric elements and to set traffic control device's capacity is required. A capacity study governs planning, managing and operating of highway.

II.   IMPORTANT TERMINOLOGY FROM INDOHCM 2017

I.   **Traffic volume** is the numbers of vehicles that pass a point on a highway on a particular lane on particular direction in unit time, generally in per unit hour.

II.   **Traffic capacity** is expressed as the maximum number of vehicle in a lane or a road that can pass a given point in unit time.

III.   **Base capacity** is the maximum number of vehicle that can pass a given point on a lane or roadway during one hour under the base condition of traffic flow.

IV.   **Adjusted capacity** is the maximum number of vehicle that can pass a given point on lane or roadway during one hour under the prevailing roadway and traffic conditions. It is obtained by adjusting the base capacity for roadway and traffic conditions present at site.

V.   **Design Hourly Volume** is usually the 30th highest hourly volume which means that this hourly volume is exceeded only during 29 hour in a year.

VI.   **Design service volume** is maximum service volume at which vehicle can reasonably be expected to traverse a point or uniform section of a lane or roadway during one hour under prevailing roadway, traffic and control condition s while maintaining a designated level of service. Current condition of the country is to consider DSV in terms of daily volume of passenger car on one section.

VII.   **Design speed** depends on the function of the road and terrain conditions. It is basic parameter, which determines all other geometric design features.

VIII.   **Gradient** the rate of rise and fall of the road surface along its length with respect to the horizontal is called gradient.

IX.   **Level of service** is a qualitative measure describing operational condition within a traffic stream and their perception by diver/passenger.

X.   **Annual Average Daily Traffic (AADT)** is annual average daily traffic when traffic measurements are taken for entire 365 days of the year and therefore their average is taken.

XI.   **Average Daily Traffic** is the volume of daily traffic measurements are taken for a few days (less than one year such as monthly or weekly) averaged by the number of days for which measurement have been taken.

XII.   **Carriageway Width** is part of the road that is intended for actual movement of vehicular traffic. In the case of multilane divided highways, the carriageway is bounded by a shoulder on one side and physical median on the other. The carriageway is depending on the number and the width of traffic lanes.

XIII.   **Operating speed** theoretically it is the average speed in km/hr of the traffic stream comprising only passenger cars when the traffic density is approaching zero i.e. there are negligible number of vehicles are present on the road. It is the 85th percentile speed of the standard car measured under low volume condition.

XIV.   **Passenger car unit (PCU)** is it the relative interaction between vehicle and traffic stream with respect to the standard passenger car under specified set of roadway and traffic conditions.

XV.   **Peak Hour Factor (PHR)** the percentage of AADT and ADT that passes through a given section in peak hour can be readily ascertained through field observations. In absence of the field observations, however default value of PHR may be adopted as 10%.

XVI.   **Traffic simulation** is a widely used method applied in the research on traffic modelling, planning and development of traffic networks and systems. There are three type of simulating model microscopic, macroscopic modelling and mesoscopic.

XVII.   **Roughness** is aggregated deviations of a pavement surface from a true planer surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads and drainage.

XVIII. **Shoulder type** paved shoulder or unpaved shoulder

XIX. **Shoulder Width** the width of the shoulder should be adequate for providing working space around a stopped vehicle.

XX. **Speed** is the rate of motion of individual vehicle or of traffic stream.

XXI. **Traffic composition** refers to the relative proportion of each of the various vehicle type in a traffic stream at a point or a section of roadway at a given point of time or within specified interval of time.

XXII. **Traffic Flow** The amount of traffic on road generally measured as either traffic volume or traffic flow.

XXIII. **Terrain** is classified by the general slope of the country across the highway alignment.while classifying a terrain, short isolated stretches of varying terrain should not be taken into consideration.

III. LEVEL OF SERVICE CONCEPT (LOS)

XXIV. Level of service A Parameter decided for determinationation of capacity of roadway.

XXV. Level of Service A free-flow conditions (traffic operates at free flow speeds).

XXVI. Level of Service B allows speeds at or near free-flow speeds, but the presence of other users in the traffic stream begins to be noticeable.

XXVII. Level of Service C speed near free-flow, but the free to manoeuvres is noticeably restricted (lane changes require careful attention on the part of drivers).

XXVIII. Level of Service D the conditions where speed begins to declines lightly within creasing flow.

XXIX. Level of Service E LOS E represents operating conditions at or near the roadway's capacity.

XXX. Level of Service F describes a breakdown in vehicular flow.

IV. BASE CONDITION FOR CAPACITY ESTIMATION AS PER INDOHCM 2017

- Plain and level Terrain

- No horizontal curvature or vertical gradient.

- Traffic lanes 3.5m wide {As per IRC:SP-84(2014) and IRC:Sp-87 (2013),the standard lane width of highway in India should be 3.5m.

- Minimum 2.5m median.

- No pavement defect that can adversely affect traffic operations. Roughness in terms of international roughness index (IRI) is less than 2.7 m/km.

- No Direct access point.

- No side friction in terms of public transport stops, bus bays and truck bay coupled with absence of significant pedestrian activity or slow moving vehicles such as bicycles, rickshaws and animal carts.

- No work zone activity near the section

- No incidents or crashes at the time of observation at or near the section.

V. INFORMATION ABOUT SITE SELECTED

Selected site is follows above all the base condition .One base condition which is not suited for our condition that is presence of slow moving vehicles such as bicycles, rickshaw and animal carts. Site is situated at Vadodara national Highway, Sai palash apartment near Dawat restaurant.

VI. DATA COLLECTION

The data is collected for these studies were collected at multi lane divided national highway road spread over 12 hour period with the help of videography technique in order to determine capacity of six lane divided carriageways. The sections is selected in such manner were effect of each parameter could be studied individually. The detail of the selected section is given below

TABLE II   Location of site

Section No.	Type of section	Location	Carriage way width in one direction of travel (m)	Trap length in (m)	Remarks
1	Six Lane Divided	Sai Palash Appartment Near Dawat restaurant NH 48 Vadodara, Gujarat	12 m	Flexible paved road shoulder of 1.2 m	
2	Six Lane Divided	Jambua GEB Substation NH 48 Vadodara	12 m	Flexible paved road shoulder of 1.2 m	

VII. METHOD OF CAPACITY ESTIMATION

There are two methods are there to calculate the capacity of highway. The description of that method is given below. Here we are going with the stream Equivalency Factor equivalency for finding the capacity of Highway and deciding level of services.

VIII. ANALYSIS OF EXISTING FACILITY

It is necessary to determine the performance of existing traffic and projected future traffic demand. The effect of some other design factor is there on capacity and level of services. These types of analyses, the aim is to assess the suitability of minor, typically low-cost, corrective measures that can be implemented quickly to help prevent a segment, a corridor, or an entire network from reaching over saturation or an undesirable LOS.

IX. OPERATING SPEED

Operating speed means a speed taken after finding spot speed study and plotting a simple graph at 85 % level. It is denoted as (VOS). Below operating speed vehicle is considered as low speed vehicles. Operating speed is directly taken from code in our condition

C.   Stream Equivalency factor (Se)

PCU is important to traffic composition and traffic volume on the road and hence the use of a single set of PCU factors for different vehicle types may lead to erroneous results. To overcome this problem, a new concept of Stream Equivalency Factor (Se) is being introduced in Indo HCM 2017 manual. The Stream Equivalency Factor (Se) is simply defined as the ratio between the equivalent flow (PCU/h) and the observed flow (veh/h). The relationship is also illustrated as under in below equation for six lane divided highway.

For Si

Se = 1 + 0.7pBC – 2.1 pTW+ 3.3pLCV +4.8 pTAT + 7.5pMAT + 1.2 pAUTO + pBUS + 59.8 1/N   (1)

Where,

S_e =is the Stream Equivalency Factor,

p_{BC} = Proportion of Basic Cars in total traffic.

p_{TW} = Proportion of two wheelers in total traffic.

p_{TAT} = Proportion Of three exle truck in total traffic

p_{MAT} = Proportion of multi exle truck in total traffic

p_{AUTO} = Proportion of Auto rickshaws in total traffic.

PBUS = Proportion of Bus

N is the traffic volume in the period of analysis 'T', and estimable coefficient.

Here no coefficient is taken for tractor as tractor are less than 2% of our traffic so the impact of tractor traffic is less on our traffic flow that is why neglecting a factor not make big difference.

X. BASE CAPACITY ESTIMATION

The most powerful factor effecting speed (v),Density(K) and Flow(Q). Here Greenshield's traffic flow theory forms the basis for the macroscopic traffic flow models. Some methods require simulation of the traffic using computer based software while others are based on guidelines provided in standards like Highway Capacity Manual (US-HCM, 2010) or Indian Roads Congress (IRC: 64, 1990). It has been noted during the field studies as well as in other reported studies (Velmurugan, et al, 2010) that most of the multilane divided highways rarely operate at volumes near capacity in India except for specified time period either in the day or nighttime. It seems intuitive that the capacity for all sections of a given type i.e. four lane or six lane divided that are operating under base conditions for traffic flow would be similar. However, owing to the variation in traffic composition and pavement roughness, variations have been observed in capacity values of multilane divided highways even under base conditions.

It was observed that within the range of obtained capacity results, a relationship can be established between Operating Speed under base conditions (VOSbase) and Base Capacity (C).

For Six Lane Highway
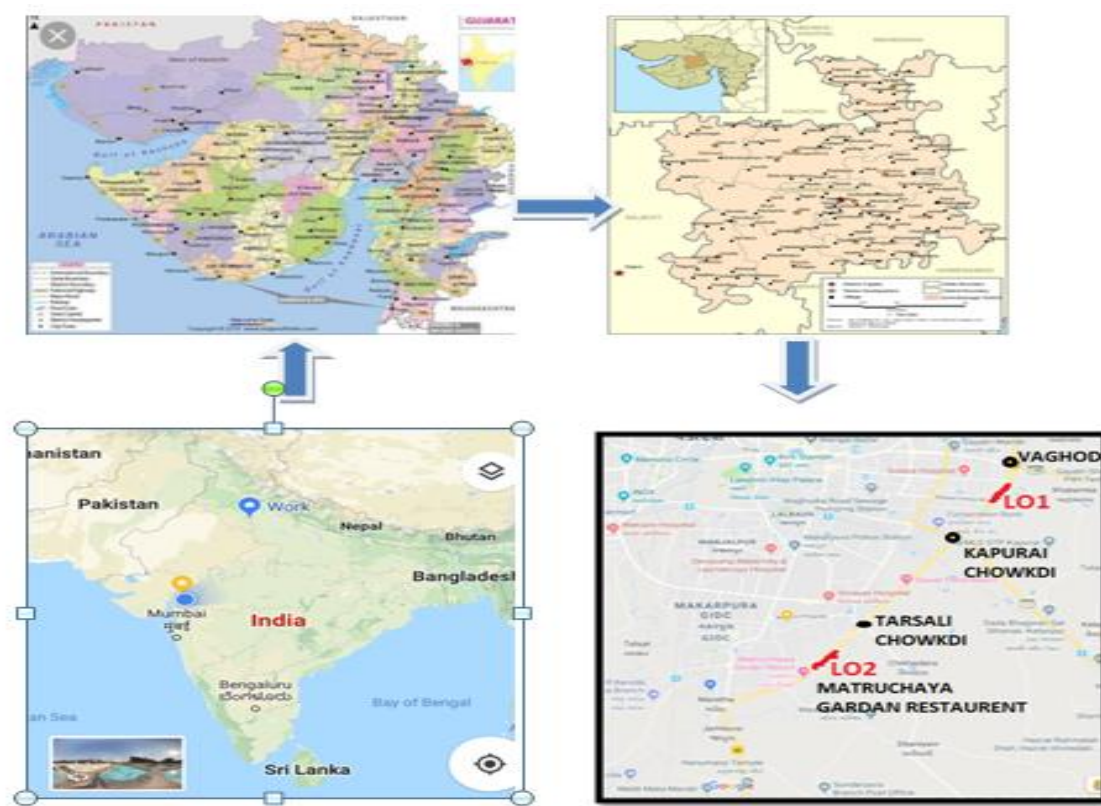
$$C = 43 * VOS + 2490 \qquad (2)$$

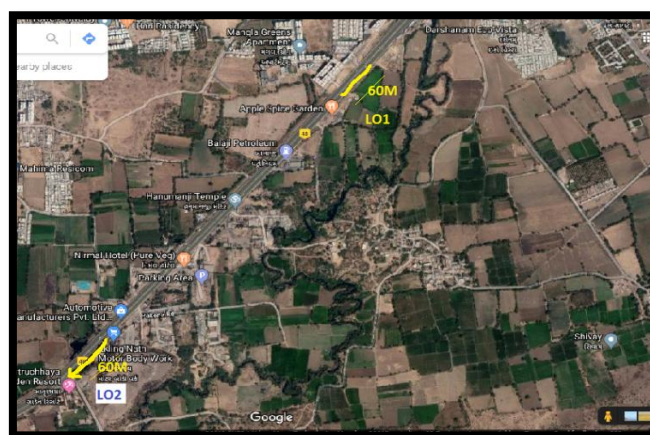*Fig. 1:Site selection. (two section are selected)*

Fig. 2: Google image of Site. (Selected section)

TABLE- III

Type of Input Data required for Capacity and LOS Analysis

Sr.No.	Required Data	Recommended Information
A	Road Geometric Data	
1	Type of Highway	Six Lane Divided Highway
2	Terrain Type	Plain
3	Type of Shoulder and Width	Paved Width 12m
4	Horizontal Curvature	Not applicable
5	Vertical Gradient	0 %
B	Traffic Data	
1	Traffic Volume and composition.	Classified traffic volume count data
2	Length of Analysis Period	Five (5) minutes
3	Space Mean Speed	Space Mean Speed (in km/h) in Five-minute (5-minute) intervals
4	Operating Speed	• Existing Facility - 85th percentile speed of the passenger cars having time headway more than 8seconds • New Facility - Any reasonable computed value or design speed.
C	Pavement Surface Related Parameters	
1	Pavement Condition	International Roughness Index (IRI) in (m/km)

TABLE- IV

Traffic composition as per collected data

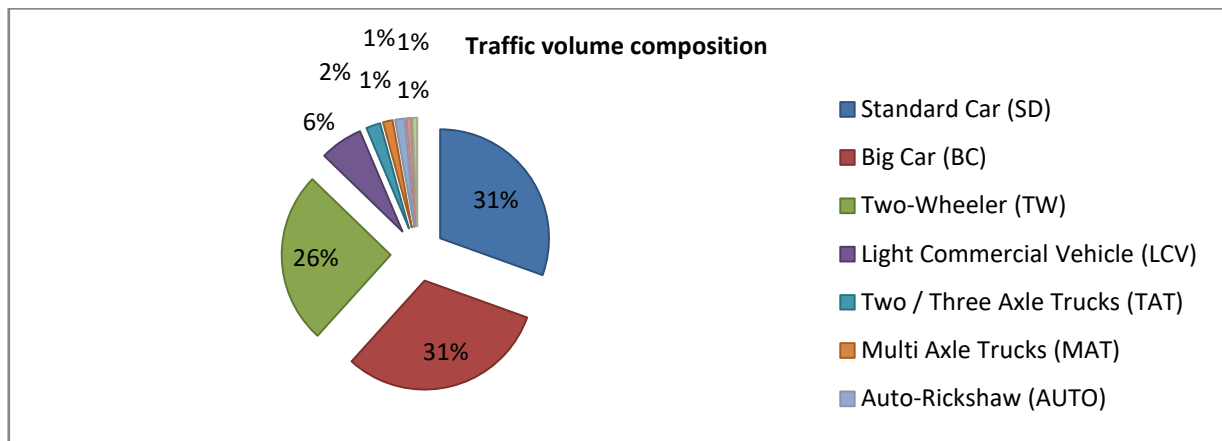| Vehicle Category	Volume *(veh/h)*	Composition *(%)*
Standard Car (SD)	620	43
Big Car *(BC)*	644	44
Two-Wheeler *(TW)*	524	36
Light Commercial Vehicle *(LCV)*	127	9
Two / Three Axle Trucks *(TAT)*	37	3
Multi Axle Trucks *(MAT)*	30	2
Auto-Rickshaw *(AUTO)*	31	2
Bus *(B)*	21	1
Tractor (T)	8	1
Total	**1455**	**100**

Fig. 3: Traffic composition

TABLE- V

BASE CAPACITY VALUES FOR VARYING OPERATING SPEED

OPERATING SPEED (KM/H)	CAPACITY (PCU/H/DIRECTION) FOR FOUR LANE DIVIDED HIGHWAY SEGMENTS	CAPACITY (PCU/H/DIRECTION) FOR SIX LANE DIVIDED HIGHWAY SEGMENTS
70	3640	5500
80	3940	5930
90	4240	6360
100	4540	6790

$S_e = 1 + 0.7 pBC - 2.1 pTW + 3.3 pLCV + 4.8 pTAT + 7.5 pMAT + 1.2 pAUTO + pBUS + 59.8 \cdot 1/N$

Vehicle composition is taken as per calculated data

$S_e = 1 + 0.7 \times 0.44 - 2.1 \times 0.36 + 3.3 \times 0.9 + 4.8 \times 0.2 + 1.2 \times 0.2 + 59.8 \times (1/1455) = 3.80$

So, traffic volume in terms of PCU = $1455 \times 3.80 = 5529$ or say 5530 PCU/h/dir.

Take vehicle operating speed 80 kmph as shown on board of highway. So from equation 3

$C = 43 * VOS + 2490 = (43 \times 80) + 2490 = 5930$

Compute Density

From Equation $Q = K \times V$,

Density (K) of the six lane divided facility computed is

K = volume /speed = 5530 / 80 = 69 PCU/km/dir.

Compute Volume-to-Capacity Ratio (v/c):

v/c = 5530/5930 = 0.93

Determine LOS

TABLE- VI

LOS Thresholds for Six Lane Divided Interurban Highway Segment

LOS	Density (PCU/km/direction)	Volume-to-Capacity ratio (v/c)	Service Volumes (PCU/day)	Recommended DSV Value for Upgradation (in PCUs/day)
A	≤ 27	0.00 -0.20	≤ 27000	34000 @ **LOS-B:** Suggested threshold flow for conversion from **six lane to eight lane divided road** to ensure **enhanced safety** in traffic operations.
B	28 -41	0.21 -0.30	27001 -41000	
C	42 -68	0.31 -0.50	41001 -68000	
D	69 -95	0.51 -0.70	68001 -95000	
E	91-136	0.71 -1.00	95001 -136000	
F	> 136	> 1.00	> 136000	

As per Table 4.3, corresponding to a v/c ratio of 0.91, the LOS is also 'E' and hence the operational LOS is 'E'.

XI. RESULT AND DISCUSSION

As per seen in above result getting level of service "E".As per INDO HCM 2017.The vehicle composition is main factor while calculating the while calculating the heterogeneous traffic road capacity with the help of newly form Indian code. The following factor is affected to the result of the capacity analysis from INDO HCM 2017.

1) The multi-lane highway namely six lane divided carriageways on plain terrain.

2) The vehicle composition is 42% HCV, 31% Car Jeep and 25% two wheeler.

3) The located industries side by highway affects the most in vehicles traffic composition. More will be the industries more will be the HCV composition on road.

XII.   CONCLUSION

The study shows the vehicle composition and level of serve with help of stream equivalency factor. The vehicle following operating speed so level of service is obtained will be higher but reverse happen in our case. The level of service is coming low compared to design LOS of "B". The makeable study is there that stream equivalency factor could be the wrong criteria to measure the capacity and level of service. The vehicle capacity is coming 5930 per hr is remarkable. To overcome the study limitation more parameter like vehicle characteristics, driver characteristic, Vehicle speed, Traffic and road network are to be considered for accurate result.

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