EFFECT OF HETEROGENEOUS TRAFFIC ON SATURATION FLOW

Momin Safabanu Fazalmohammed, H.K.Dave

***Abstract*— Saturation flow rate is a fundamental parameter to measure the intersection capacity. The composition of vehicle of urban traffic on developing countries and their effect on the Saturation flow at signalized intersection could be substantial as traffic movement in Ahmedabad is more complex than other developing countries as traffic is heterogeneous. This paper attempts to study and analyze the effect of heterogeneous traffic on the saturation flow at signalized intersection by collecting data and determine saturation flow rate for through traffic at a signalized intersection in Ahmedabad, India. Two wheelers, due to their size use small gaps between the heavy vehicles like Bus, truck etc. so that saturation flow will then be increased. So it can be said that two wheeler adversely affect the saturation flow rate.**

***Index Terms*— Heterogeneous traffic, Saturation flow, Signalized intersection**

I. INTRODUCTION

Traffic on the existing road increasing day by day as rapid urbanization and industrialization have caused extremely growth of vehicles all over the world and also vehicle ownership increases which causes delay, pollution etc. The saturation flow rate (S) for a lane group is the maximum number of vehicles from that lane group that can pass through the intersection during one hour of continuous green under the prevailing traffic and roadway conditions. The maximum flow value through an intersection is very significant for the traffic signal analysis and delay calculation. Saturation flow describes the number of passenger car units (PCU) in a dense flow of traffic for a particular intersection lane. This paper deals with the effect of heterogeneous traffic on saturation flow and to estimate saturation flow at signalized intersection for mix traffic condition.

A. Saturation flow:

Saturation flow can be defined as the maximum flow that can occur during the "go" period of a signal cycle. That is, the amount of traffic that can pass through a signalized intersection from a given approach depends on the green time available and the maximum flow of vehicles pass the stop line during the green period. The value of saturation flow is affected by the following factors at an intersection:

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Momin Safabanu Fazalmohammed, Student, M.E. Civil (Transportation) – 4rth Sem L.D.College of Engineering, Gujarat Technological University, Navrangpura, Ahmedabad.

H.K.Dave, (Associate Professor, M.E. Civil (Transportation) – 4rth Sem L.D.College of Engineering, Gujarat Technological University, Navrangpura, Ahmedabad.

i. Location of parking
ii. No of lane in each
iii. Composition of heavy vehicles
iv. Approach grade
v. Blocking effect of local transit
vi. Lane group (through left, right)
vii. Driver and road characteristics

The saturation flow of an approach is best determined by actually counting; however if not actually measured, it can be found by a linear relationship given by TRRC based on approach width.

$$S = 525\ W\ PCU/hr$$

When (W≥5.5 m)
W = width of the approach in meter
For width less than 5.5 m, the following table is used:

Table-1: Saturation flow corresponding to width

Approach width (m)	3	3.5	4	4.5	5	5.5
Saturation Flow (PCU/hr.)	1850	1875	1975	2175	2550	2900

The above figures have to be adjusted for gradient, environment and curves.

i. **Gradient:** The gradient of an approach is defined as the average slope between the STOPLINE and a point 61 m before it. The saturation flow is decreased or increased by 3% for every 1% uphill or downhill gradients.

ii. **Environment:** The above figures can be increased or decreased in following situation of environment:

Very Good junction
Good visibility, two lanes,
No interference by pedestrians
Adequate turning radius
(Increase saturation flow by 20%)

Poor Junction
Low speed, poor visibility,
Poor alignment
(Reduce the saturation flow by 15%)

iii. **Curves:** Where a separate right turn phase is provided for vehicles and where vehicles are crossing the stop line has then to travel immediately around a curve. The saturation flow on curves may be obtained by:

$$S = \frac{1800}{1+1.52/r}$$ PCU/hr. for single file streams

$$S = \frac{3000}{1+1.52/r}$$ PCU/hr. for double file stream

Where, r = radius of curvature (in meter) of the right turning stream

II. Study Area:

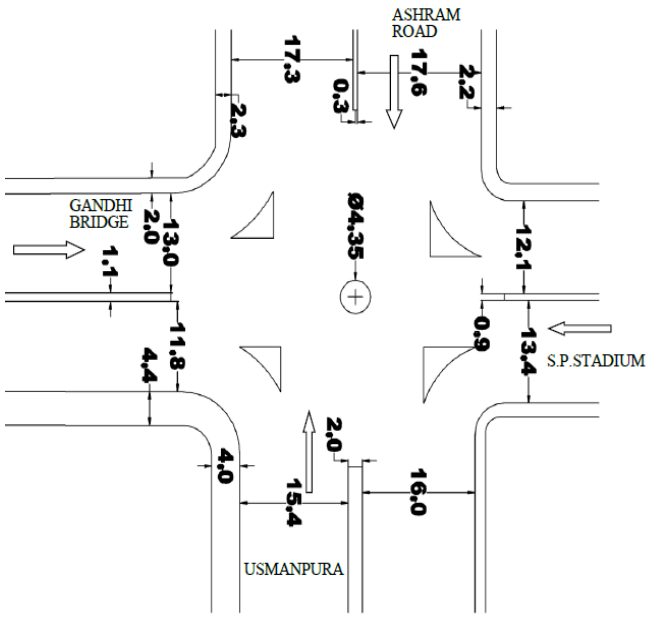
For present study one intersection that is called Incometax cross Road of four armed of Ahmedabad city has been selected which is shown in fig.1.

Fig.1 Incometax cross road (Source: Google maps)

III. Data Collection:

A video camera was used for classified volume count from a roof of a building at particular intersection where all four approaches should be visible properly. At the same time the cycle length, green time, amber time and queue length were collected manually. The survey was done for two hours of both morning and evening peak hours. And the measurements of all approach at Incometax intersection was taken by measure tape of 30m which is shown below.

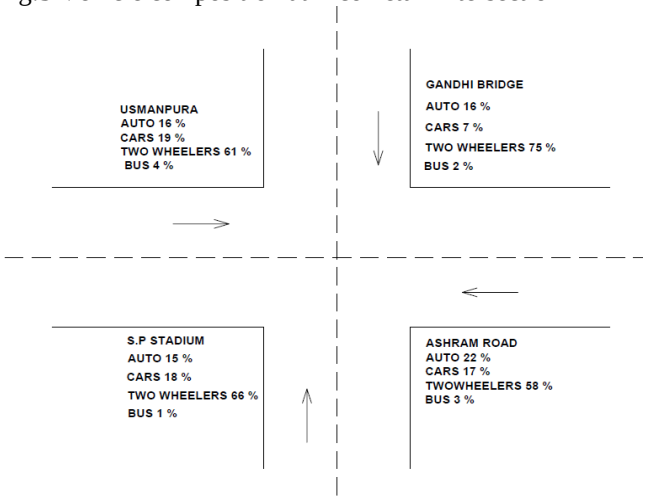
Fig.2 Measurement of incometax intersection



IV. Data Analysis:

In India the traffic situation is more complex than other developed countries as traffic is heterogeneous. From the video of volume count survey of an intersections it is obtained that there are approximately 65% two wheelers, 18% auto rickshaw, 15% four wheeler and 2% bus. The representation of composition of vehicle of an intersection is shown below:

Fig.3 Vehicle composition at Incometax intersection



Estimation of Saturation flow:

Saturation flow is obtained in PCU/hr. The width of the all approaches are more than 5.5m so designed saturation flow is calculated by HCM 2000 as

$$S = 525\ W\ PCU/hr$$

Saturation flow is measured by counting the maximum number of vehicles in each category per hour during the green signal time. But it is proved that the saturation flow which is obtained by survey in particular study area is more than the designed saturation flow due to heterogeneous flow of traffic.

Table-2: Saturation flow calculation (Incometax Intersection)

Ashram Road							
Sr. No	Category of vehicles	Width (m.)	Peak hour	Sat flow observed (PCU/hr.)	S.F (525W)	higher S.F	higher SF/width
1	Auto	17.6	10:02	8836.36	9240	9240	525
2	Car	17.6	11:58	7298	9240	9240	525
3	t/w	17.6	10:45	8116.36	9240	9240	525
4	Bus	17.6	10:52	8181.81	9240	9240	525
S.P.Stadium							
Sr. No	Category of vehicles	Width (m.)	Peak hour	Sat flow observed (PCU/hr.)	S.F (525W)	higher S.F	higher SF/width
1	Auto	13.4	10:51	8595	7035	8595	641.42
2	Car	13.4	10:00	10710	7035	10710	799.25
3	t/w	13.4	10:47	10620	7035	10620	792.54
4	Bus	13.4	10:23	8415	7035	8415	627.99
Gandhi Bridge							
Sr. No	Category of vehicles	Width (m.)	Peak hour	Sat flow observed (PCU/hr.)	S.F (525W)	higher S.F	higher SF/width
1	Auto	13	10:42	11160	6825	11160	858.46
2	car	13	11:00	11910	6825	11910	916.15
3	t/w	13	11:11	11460	6825	11460	881.54
4	bus	13	10:42	11160	6825	11160	858.46
Usmanpura							
Sr. No	Category of vehicles	Width (m.)	Peak hour	Sat flow observed (PCU/hr.)	S.F (525W)	higher S.F	higher SF/width
1	Auto	15.4	10:20	10920	8085	10920	709.09
2	car	15.4	11:25	13360	8085	13360	867.53
3	t/w	15.4	10:28	10800	8085	10800	701.30
4	bus	15.4	10:55	10280	8085	10280	667.53
AVERAGE							**713.83**

From the above table it can be seen that the designed saturation flow which is calculated as per Highway capacity manual is very different from the observed saturation flow at all approach. This difference is mainly due to the heterogeneous traffic as in study area there are approximately 70% two wheeler and mostly two wheelers, due to their size use small gaps between the heavy vehicles like Bus, truck etc. so that saturation flow will then be increased. So it can be said that two wheeler adversely affect the saturation flow rate.

V. CONCLUSIONS

Following are the conclusions drawn from the present study:

1.) The saturation flow analyzed for all approaches shows that it is not depend on width and so the equation given by HCM that is $S=525W$ is not valid for obtained saturation flow at given traffic and roadway conditions.

2.) So, from table it is said that if average of constant is taken as $S=714W$ then the saturation flow at some point may be nearer to the observed saturation flow.

3.) Higher saturation flow which causes delay and pollution, so it can be reduced by encouraging two wheeler users to mass transportation.

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