CHAPTER 3
DATA COLLECTION AND ANALYSIS

3.1 General

The capacity of a signalized intersection depends predominantly on the saturation flow rate and unless a realistic estimate of saturation flow rate is made, the performance evaluation of a signalized intersection is not accurate. Data collection and analysis forms the backbone of any research study and it is apparent that any meaningful conclusion can only be drawn based on the analysis of reliable data. The procedures adopted for data collection should fit into the framework of the objectives and the surveys are to be designed keeping the analysis aspect in view. This chapter presents the survey methodology adopted, the data collected and data reduced into various parameters that are used in the analysis.

3.2 Saturation Flow Rate Study as Per HCM

The Highway Capacity Manual (2000) uses a base saturation flow rate of 1900 pcp/h/gpl and adjusts the value for prevailing roadway and traffic conditions. However, an alternative method of measuring the saturation flow rate in the field is also suggested by HCM. Saturation flow rates have been measured and researched by various groups such as City of Edmonton in conjunction with the University of Alberta, the University of Kentucky and the Australian Road Research Board (ARRB). Results of these studies have demonstrated that the saturation flow rates have a high degree of variation. The field study methodology suggested by HCM includes the recording of the arrival times of different vehicles at the stop line or any such reference point. Before the beginning of the recording of observations, the last vehicle in the queue at the moment signal turns green is to be noted. Once the vehicles start getting released during the green interval, their arrival times at the stop line are to
be recorded. The most significant observations are those pertaining to the fourth vehicle in the queue and the last vehicle at the start of green as noted in the beginning of recording. The difference of the arrival times of the fourth vehicle and the last vehicle as noted is to be computed. Suppose that $n^{th}$ vehicle is the last vehicle in queue at the start of green, then the difference in arrival times of $4^{th}$ and $n^{th}$ vehicles at the stop line is taken as the total headway for $n-4$ vehicles and this headway is projected as the average saturation flow rate in terms of vehicles per hour of green per lane. For example, if the last vehicle in queue at the start of green is $10^{th}$ vehicle and the arrival times of $4^{th}$ and $10^{th}$ vehicles at the stop line are 4.2 sec and 24.3 sec respectively, then the total headway for (10-4) vehicles is (24.3-4.2) seconds i.e., 20.1 seconds. This works out to an average saturation headway of $20.1/(10-4)$ i.e., 3.35 sec/vehicle. This value when projected to an hourly flow results in a saturation flow rate of $3600/3.35 = 1075$ vehicles per hour of green per lane.

There are certain inherent assumptions in the methodology suggested by HCM for the direct measurement of saturation flow rate in the field. It assumes a strict lane discipline where only a single file of vehicles moves in a lane. The queue formation is also in a single file in a lane and the release is in FIFO order. But for the marginal presence of heavy vehicles, almost all the vehicles in the traffic are passenger cars. There is a minimum headway between successive vehicles getting released because of the finite length of the passenger car. The Indian urban traffic in general and the traffic studied in the present study in particular, present an entirely contrasting picture to the one implied by HCM procedure. The urban traffic studied is completely heterogeneous in nature, dominated by smaller vehicles having high maneuverability and the traffic movement in a lane can be in multiple files. The queue formation has no systematic order and the smaller vehicles try to come to the front weaving through
the space gaps available in queue. The release also takes place in multiple files and
the headway between successive vehicles has no meaning in such situation. The entire
scenario needs a different kind of methodology retaining the basic concept of
measuring the average saturation headway and projecting it to the average saturation
flow rate. Hence, the saturated green time study is adopted in the present work where
overall headway is computed and projected to yield saturation flow rate in a given
cycle.

3.3 Conceptual Frame Work of the Present Study

The present study adopts a different conceptual framework from earlier studies
from the following perspective;

a) Computation of saturation flow rate in terms of vehicles per hour instead
   of PCUs/hour.

b) Classification of urban traffic into only two categories namely Highly
   Maneuverable vehicles (HMVs) and others and

c) Computing the actual saturation flow rates based on saturated green time
   and the number of vehicles released during the period.

Though the intention behind the PCU equivalent factors was to convert
different flows into uniform units for comparative analysis, the unit fails to reflect the
quality of flow realistically. The conversion may be appropriate in situations where
traffic is dominated by the presence of passenger cars; but in cases such as Indian
urban traffic same value of PCU/hr can denote a multitude of traffic compositions
thereby failing to throw light on the quality of flow. It is felt that it is appropriate to
treat each vehicle as a unit and to use the composition as an indicator to reflect flow
quantity. The approach adopted can facilitate the use of volume counts directly for
computation of saturation flow rate without the aid of PCU factors. Many researchers
have suggested a variety of PCU factors and the ambiguity of suitable factors can be effectively eliminated if vehicle is treated as an entity.

The heterogeneous traffic is classified into two basic categories namely vehicles with high maneuverability and others which have restricted lateral movement. This classification helps in more realistic modeling of traffic behaviour, especially at signals, when the release takes place during green time. The actual situation flow rate in the field is computed based on the saturated green time and the number of vehicles releasing during the time. The saturated green time is considered as that portion of green in each cycle where the vehicles get released in a dense platoon continuously, utilizing the entire width available for the movement to the maximum extent possible.

3.4 Saturated Green Time Study

The basic philosophy behind the saturated green time study is noting down the green time during which release flow moves as a continuous dense platoon, utilizing the entire width available for the subject lane group and projecting the flow in that duration to hourly flow. Naturally, the saturation flow starts 2 to 3 seconds after the start of the green time due to start up delays. The width over which release takes place is to be identified with utmost care, especially in the absence of lane markings and lane discipline. There are certain peculiarities associated with Indian urban traffic while forming a queue at a signal. The width of the queue formed, or to be more precise, the road width used for queue formation is observed to be more at the front as the smaller vehicles encroach upon the left side of the carriageway at the stop line, while waiting to be released. But once the queue is released, after 2 to 3 seconds, it is observed that the release takes place over a more or less uniform width, depending on the intersection geometry. At each of the intersections selected for surveys, sufficient
time is spent in observing the release flows and the width over which release is taking place in each cycle. A clear reference marking is made at the stop line indicating the width to be taken into consideration for the study.

The methodology adopted is simple in nature. In each of the cycles, after 2 to 3 seconds from the start of green phase, when the releasing flow stabilizes into a dense continuous platoon moving over the marked width, an observer starts the stop watch, signaling to other enumerators to record the observations. The enumerators record the mode wise details of the vehicles crossing the stop line over the marked width. The first observer who starts the stop watch is expected to observe the release flow closely and he stops the stop watch at a point when he finds a discontinuity in the flow leaving much of the road width unused. At this instant, he also signals to the enumerators to stop the recording. The number of observers needed to record the data depends on the traffic intensity and at a busy intersection, at least six observers are needed for one approach. The duration of green time over which observations are recorded is termed here as saturated green time because it is the green time over which a continuous stable flow, that makes use of the entire available width to the maximum extent, is observed from the approach under consideration. The format used for the study is shown as Table 3.1.
Table 3.1 SATURATED GREEN TIME STUDY FORMAT

<table>
<thead>
<tr>
<th>Date</th>
<th>Intersection Name</th>
</tr>
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<tbody>
<tr>
<td>Day</td>
<td>Approach Name</td>
</tr>
<tr>
<td>Weather</td>
<td>Width at stop line</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>Green Time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cycle Number</th>
<th>Saturated Green Time (Sec)</th>
<th>Buses/Trucks/HCVs</th>
<th>Cars/Jeeps/LCVs</th>
<th>Auto Rickshaws</th>
<th>Motorized Two Wheelers</th>
<th>Bicycles</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

3.5 Study Locations

As the present study is confined to the performance of the four legged signalized intersections, where the signal plan has a combined green phase for straight and right flows from an approach, the study locations are selected accordingly, to satisfy the required criteria. The approaches selected for saturated green time study are based on the varied widths, varied green times and the convenience for recording the data. Four intersections in the city of Hyderabad are selected and six of their approaches are considered for the study. All these four intersections lie on a major corridor of the city and they form part of the CBD of Secunderabad and Hyderabad. The details of the intersections and the approaches are selected are as follows:
The details of these four intersections including the geometrics at the stop line and the signal plans are presented through figures 3.1 to 3.4.

### 3.5.1 Barkatpura Intersection

The geometrical details and signal plan at this intersection is presented in Figure 3.1. The intersection is a four-legged intersection controlled by a pretimed signal having a cycle time of 103 seconds with four phases. The four approaches are indicated as Baglingampalli approach, Kachiguda approach, Nallakunta approach and Narayanaguda approach. In each of the four phases, straight and right flows from a given approach are released simultaneously. The left turns are permitted uninterruptedly from all approaches. The width over which the combined straight and right release takes varies from approach to approach and the details are given in Figure 3.1. The saturated green time study is conducted at this location on two approaches namely Baglingampalli approach and Kachiguda approach.
3.5.2 Musheerabad Intersection

Figure 3.2 presents details of Musheerabad intersection. This is also a four-legged intersection controlled by a pretimed four phase signal. The signal cycle is 101 seconds. The four approaches are Secunderabad approach, Tank bund approach, RTC X roads approach and PadmaRao nagar approach. All the four phases have combined right and straight movement and left turns are permitted uninterruptedly. The widths over which release takes place varied considerably from approach to approach. On Secunderabad approach it is found to be 8 m and on Tank bund approach it is 5.53 m. The approaches selected for saturation green time study are Secunderabad approach and Tank bund approach.

3.5.3 Patny Intersection

The geometric details and signal plan at this intersection are presented in Figure 3.3. This intersection is a four legged intersection controlled by a permitted signal having a cycle time of 162 seconds with four phases. The intersection is located in a highly commercial area and all the approaches have intense commercial activity on either side. The four approaches are indicated as Plaza approach, YMCA approach, SBH (State Bank of Hyderabad) approach and JBS (Jubilee Bus Station) approach. In each of the four phases, straight and right flows from a given approach are released simultaneously. The left turns are permitted uninterruptedly from all the approaches. The width over which the combined right and straight release takes place varies from approach to approach and details are given in Figure 3.3. The saturated green time study is conducted at this location on SBH approach.

3.5.4 Sangeet Intersection

The details of this intersection are presented in Figure 3.4. This is yet another four-legged intersection controlled by a pretimed four phase signal with a cycle time
of 108 seconds. The left turns are permitted uninterruptedly from all the approaches, out of the four phases. Phase I provides for combined straight and right lane group movements from Railnilayam approach. Similarly phase II provides for combined straight and right lane group movements from Sangeet approach. Phase III permits straight flows from Secunderabad and Maredpally approaches and phase IV is exclusive right turning phase from Secunderabad and Maredpally approaches. Out of 108 seconds cycle time, 20 seconds green time is allocated for exclusive right turning phase. Phase III accommodating straight flows from Secunderabad and Maredpally is allotted a green time of 26 seconds. The Railnilayam approach and Sangeet approach are allocated a green time of 26 seconds each in phase I and phase II respectively. All the phases have an amber period of 3 seconds at the end of green. The width over which release takes place from Sangeet approach is 6.15 m and that corresponding to Railnilayam approach is 7.65 m. Saturated green time study is carried out on Railnilayam approach at this intersection.

3.6 Data Reduction and Analysis

After collecting field data it is necessary to reduce it to an understandable form through the usage of some parameters. In view of the objectives of the present study and also to have certain quantifiable measure reflecting traffic behavior, the data obtained in saturated green time study is processed to yield the following parameters:

a) Proportion of HMV: This is a measure of the share of the smaller vehicular group, consisting of two wheelers and three wheelers. This group is termed here as Highly Maneuverable Vehicles (HMV). This parameter is obtained for each cycle by adding the number of auto rickshaws, motorized two wheelers
and the bicycles released in each cycle and expressing it as a proportion of total vehicles released in that cycle.

b) **Overall Headway:** This is an important indicator that reflects the placement adjustments within the releasing traffic stream, both laterally and longitudinally. This parameter is obtained by dividing the saturated green time with the total number of vehicles getting released during that time, for each of the cycles. Lesser the value of overall headway, denser would be the traffic stream. The overall headway very much depends on the proportion of highly maneuverable vehicles.

c) **Saturation Flow Rate (veh/hour):** This is the hourly flow rate obtained by projecting the total vehicular flow released during the saturated green time to one hour. This can also be obtained as the inverse of overall headway. The saturation flow rate in veh/hr can fluctuate from cycle to cycle because of variation in queue composition and the vehicle dynamics.

d) **Saturation Flow Ratio (veh/hr/m):** The term “Saturation Flow Ratio” is used here to denote a parameter that quantifies the saturation flow rate per unit width. This parameter is obtained by dividing the hourly saturation flow rate with the corresponding width over which the flow rate is exhibited. This factor reflects the lateral and longitudinal adjustments of vehicles with in the traffic stream over a given width. The reduction of saturation flow rate to veh/hr/m also serves another purpose of comparing the saturation flow rate fluctuations at different locations having different widths for combined straight and right phase. The Webster’s equation of 525 W PCU/hr has got an underlying assumption that, beyond a width of 5.5m, every additional meter of width facilitates 525 more passenger cars to move in one hour. Understanding such
kind of incremental influences under Indian mixed traffic conditions is possible through this parameter.

The analysis carried out for the SBH approach of Patny intersection is presented in Table 3.2. Similar analysis is carried out for all the approaches studied and has exhibited similar trends. The variation of the saturation flow ratio and the overall headway at different proportions of HMV is presented graphically for all the approaches. The significant observations from these tables and graphs are discussed approach wise in the subsequent articles.

### 3.6.1 Patny Intersection-SBH Approach

The analyzed data for this approach is presented in Table 3.2. This approach provides a combined width of 8.85m for the straight and right movements. The signal is operating with a cycle length of 162 sec and a green time of 40 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) ranged from 0.44 to a maximum value of 0.95 with a mean value of 0.75. The entire data is presented in a sorted form based on the proportion of HMV, arranging it in ascending order. This sorting is done so as to understand the effect of proportion of HMV on the overall headway more clearly. The saturated green time also varied from cycle to cycle, within a range of 16 seconds to 38 seconds with an average of 29 seconds. The overall headway ranged from a minimum value of 0.37 sec to a maximum of 0.78 sec with a mean value of 0.53 sec. The saturation flow rates varied from a maximum of 9771 veh/hour to a minimum of 4593 veh/hr, with a mean of 7062 veh/hr. The saturation flow rate in terms of veh/hr/m ranged from a minimum of 519 to a maximum of 1104 with a mean of 798. A close observation of the data results in some interesting findings.
For the same value of saturated green, the number of vehicles getting released is changing from one cycle to the other obviously because of the change in composition. Though there is a clear indication of increase in saturation flow rate with increase in proportion of HMV in most of the cycles, some exceptional observations could also be seen in the data. For example, in cycle number 30 and cycle number 56, the saturation green time is same with 36 seconds. In cycle number 30, the proportion of HMV is 0.75 and the total vehicles released are 67. In cycle number 56, in the same green time 80 vehicles are released with the proportion of HMV as 0.85. These variations in data may be attributed to the dynamic characteristics of vehicles such as speeds and acceleration rates which are not considered in the study due to complexity involved in measuring the same at the signalized intersection. Obviously these dynamic characteristics have their own influence on platoon density and the number of vehicles releasing in a green time.

The survey methodology induces certain level of subjectivity in judgment of saturated green time and the apparent discrepancy can also be attributed to the micro level analysis where human discretion played a significant role. In order to have a more comprehensive, objective and broad based aggregate relationship between saturation flow rate and proportion of HMV, all the cycles are given as input in the regression model development, as discussed in later articles.

Figure 3.5 represents the correlation exhibited by the graphical relationship between the saturation flow rate in terms of veh/hr/m and the proportion of HMV from this approach. A distinct positive correlation is exhibited by the upward trend line supported by reasonably good value of coefficient of determination, 0.7587. The behaviour exhibited suggests that as the proportion of smaller vehicles increases, the saturation flow rate also increases for the obvious reason that smaller vehicles can get
released in a short time. The highly maneuverable vehicles use the available road space to the maximum extent possible by adjusting themselves laterally and longitudinally there by resulting in a higher saturation flow rate. Figure 3.6 shows the variation of overall headway in seconds in relation to the proportion of the highly maneuverable vehicles. A good degree of negative correlation is observed between the two variables as indicated by a downward trend line with an $R^2$ value of 0.8121. Both the figures 3.5 and 3.6 establish the general trend that if the proportion of smaller vehicles increases in the traffic stream, they try to move closely in clusters there by making use of every space gap available in the carriageway resulting in smaller overall headway and higher saturation flow rate.

Fig. 3.5 Saturation Flow Chart Panty Intersection – SBH approach

\[
y = 1099.4x - 24.639 \\
R^2 = 0.7622
\]

Fig. 3.6 Overall Headway Chart Panty Intersection – SBH approach

\[
y = -0.7874x + 1.1168 \\
R^2 = 0.805
\]
3.6.2 Barkatpura Intersection-Baglingampalli Approach

This approach provides a combined width of 5.5m for the straight and right movements. The signal is operating with a cycle length of 103 sec and a green time of 25 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) ranged from 0.63 to a maximum value of 0.98 with a mean value of 0.87. The overall headway ranged from a minimum value of 0.37 sec to a maximum of 0.95 sec with a mean value of 0.62 sec. The saturation flow rates varied from a maximum of 9800 veh/hr to a minimum of 3789 veh/hr, with a mean of 6245 veh/hr. The saturated green time also varied from cycle to cycle, within a range of 12 seconds to 19 seconds with an average of 17 seconds. Figure 3.7 shows a positive correlation between the saturation flow ratio and the proportion of HMV. The coefficient of determination is 0.412. Figure 3.8 indicates the variation of overall headway with respect to the proportion of HMV. Though negative trend is observed, the dispersion of certain observations about the trend line seems to be high. Nevertheless, the traffic behaviour is same as that observed in the case of other approaches.
3.6.3 Barkatpura Intersection-Kachiguda Approach

This approach provides a combined width of 5.0m for the straight and right movements. The signal is operating with a cycle length of 103 sec and a green time of 22 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) varied from 0.39 to a maximum value of 0.9 with a mean value of 0.75. The overall headway varied from a minimum value of 0.43 sec to a maximum of 0.92 sec with a mean value of 0.62 sec. The saturation flow rates varied from a maximum of 9000 veh/hr to a minimum of 3927 veh/hr, with a mean of 6082 veh/hr. The saturated green time also varied from cycle to cycle, within a range of 10 seconds to 18 seconds with an average of 13 seconds.

Figure 3.9 shows a positive correlation between the saturation flow ratio and the proportion of HMV. The coefficient of determination is 0.2494. Figure 3.10 indicates the variation of overall headway with respect to the proportion of HMV. Though negative trend is observed, the dispersion of certain observations about the trend line seems to be high. Nevertheless, the traffic behaviour is same as that observed in the case of other approaches.
3.6.4 Musheerabad Intersection-Secunderabad Approach

This approach provides a combined width of 8m for the straight and right movements. The signal is operating with a cycle length of 101 sec and a green time of 23 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) ranged from 0.63 to a maximum value of 0.92 with a mean value of 0.82. The overall headway ranged from a minimum value of 0.33 sec to a maximum of 0.94 sec
with a mean value of 0.58 sec. The saturation flow rates varied from a maximum of 10800 veh/hr to a minimum of 3825 veh/hr, with a mean of 6459 veh/hr. The saturated green time also varied from cycle to cycle, within a range of 10 seconds to 19 seconds with an average of 15 seconds.

Figure 3.11 shows a positive correlation between the saturation flow ratio and the proportion of HMV. The coefficient of determination is 0.3603. Figure 3.12 indicates the variation of overall headway with respect to the proportion of HMV. Though negative trend is observed, the dispersion of certain observations about the trend line seems to be high. Nevertheless, the traffic behaviour is same as that observed in the case of other approaches.
3.6.5 Musheerabad Intersection-Tank Bund Approach

This approach provides a combined width of 5.53m for the straight and right movements. The signal is operating with a cycle length of 101 sec and a green time of 23 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) ranged from 0.73 to a maximum value of 0.96 with a mean value of 0.86. The overall headway ranged from a minimum value of 0.54 sec to a maximum of 0.93 sec with a mean value of 0.73 sec. The saturation flow rates varied from a maximum of 7720veh/hr to a minimum of 3857 veh/hr, with a mean of 5031veh/hr. The saturated green time also varied from cycle to cycle, within a range of 11 seconds to 19 seconds with an average of 23 seconds. Figure 3.13 shows a positive correlation between the saturation flow ratio and the proportion of HMV. The coefficient of determination is 0.6006. Fig. 3.14 indicates the variation of overall headway with respect to the proportion of HMV. Though negative trend is observed, the dispersion of certain observations about the trend line seems to be high. Nevertheless, the traffic behaviour is same as that observed in the case of other approaches.
This approach provides a combined width of 7.65 for the straight and right movements. The signal is operating with a cycle length of 117 sec and a green time of 30 sec is allocated for this phase. The proportion of highly maneuverable vehicles (HMV) ranged from 0.53 to a maximum value of 0.93 with a mean value of 0.76. The overall headway ranged from a minimum value of 0.27 sec to a maximum of 0.86 sec with a mean value of 0.47 sec. The saturation flow rates varied from a maximum of 13500 veh/hr to a minimum of 4200 veh/hr, with a mean of 8507 veh/hr. The saturated
green time also varied from cycle to cycle, within a range of 12 seconds to 29 seconds with an average of 23 seconds. Figure 3.15 shows a positive correlation between the saturation flow ratio and the proportion of HMV. The coefficient of determination is 0.6664. Figure 3.16 indicates the variation of overall headway with respect to the proportion of HMV. Though negative trend is observed, the dispersion of certain observations about the trend line seems to be high. Nevertheless, the traffic behaviour is same as that observed in the case of other approaches.

![Saturation Flow Chart](image)

Fig. 3.15 Saturation Flow Chart Sangeet Intersection-Rail Nilayam approach
3.7 Estimation of Saturation Flow Rate

So far the saturation flow rate from cycle to cycle for a given approach is analyzed where the width available for the lane group is unchanged and only the proportion of the highly maneuverable vehicles is changing from cycle to cycle. It has been clearly established that the saturation flow rate increases with the proportion of HMV. A point of more critical concern is the variation of saturation flow rate under different geometric conditions. For the purpose of understanding this aspect, the consolidated data of all the approaches studied is represented through the Table 3.3. This table presents the range of saturation flow rate as well as the saturation flow ratio. The overall headways for lane groups using different road widths are also presented.
Table 3.3 Consolidated Data on Saturation Flow

<table>
<thead>
<tr>
<th>Width, m</th>
<th>Saturation Flow Rate vph (Max)</th>
<th>Saturation Flow Ratio vphpm (Max)</th>
<th>Overall Head Way Sec (Min)</th>
<th>Saturation Flow Rate (vphpl)</th>
<th>Overall Lane Headway (Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>9000</td>
<td>1800</td>
<td>0.43</td>
<td>6300</td>
<td>0.61</td>
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<tr>
<td>5.5</td>
<td>9800</td>
<td>1782</td>
<td>0.37</td>
<td>6236</td>
<td>0.58</td>
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<tr>
<td>5.53</td>
<td>7720</td>
<td>1953</td>
<td>0.33</td>
<td>6835</td>
<td>0.52</td>
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<tr>
<td>7.65</td>
<td>13500</td>
<td>1765</td>
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<td>6176</td>
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<tr>
<td>8</td>
<td>10800</td>
<td>965</td>
<td>0.28</td>
<td>3377</td>
<td>0.64</td>
</tr>
<tr>
<td>8.85</td>
<td>9771</td>
<td>1104</td>
<td>0.4</td>
<td>3864</td>
<td>1.01</td>
</tr>
</tbody>
</table>

As the saturation flow rate is the maximum hourly rate of the flow possible during the green time, the maximum saturation flow rates observed at each location are used to compare their relationships with the width. The table also presents the saturation flow rate in terms of veh/hr/lane (vphpl, vehicles per hour per lane) considering 3.5m as the width of a lane.

Though the width provided in the field is not always in multiples of lanes it would be intersecting to know how much flow a lane of 3.5m can accommodate under saturated conditions. For this purpose the saturation flow rate observed is converted into vphpl. The same value is used to compute another parameter namely lane headway. The overall lane headway is the inverse of saturation flow rate in vphpl and it reflects the lateral and longitudinal adjustments of the vehicles within a lane. As the saturation flow rate is the maximum hourly flow rate possible when uninterrupted green time is given, the maximum values of saturation flow rate are used to find the graphical relationship between the saturation flow rate and the width of carriageway available for the moment under consideration. A graph drawn between the saturation flow ratio and the width as represented in Figure 3.17, endorses the observation that

the vehicles try to adjust themselves over the available width. The saturation flow ratio (vphpm) is observed to decrease with the width implying that the vehicles move closer to each other when the total available width is less and when wider road is available the vehicles try to maintain more comfortable lateral and longitudinal spacings. As can be seen from Figure 3.17, it appears that as the width goes on increasing, the saturation flow ratio stabilizes at a particular level.

It seems to be reasonable to conclude that beyond a width of 9m the saturation flow stabilizes at 1000vphpm. The saturation flow rate when converted to vphpl also indicates the point more clearly as can be observed from Figure 3.18. From this figure it can be seen that beyond 9m, each lane of 3.5m can carry a flow of nearly 3800vph. The overall lane headway also indicates the same behavior as it appears to stabilize at a value around 0.8sec and shown in Figure 3.19. However while developing the graphs mentioned in the discussion so far, the proportion of HMV is not given any consideration and only the influence of the width on the maximum saturation flow rate alone is considered. If the behaviour of the saturation flow rate variation is to be understood more comprehensively, the width available for the movement as well as the proportion of smaller vehicular group is to be considered together.
Fig. 3.17 Saturation Flow Ratio Vs Width

Fig. 3.18 Saturation Flow Rate per Lane
3.8 Summary

The methodology for saturation flow rate measurement is discussed in this chapter and the method adopted in the present study is explained. The locational features as well as the signal plans of intersections where the saturated green time study is conducted are discussed. The data collected is analyzed and the analysis is presented along with the relationships developed for the estimation of saturation flow rate. The development of regression model for computation of saturation flow rate is discussed in the next chapter.