International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 09 | Sep 2024 www.irjet.net p-ISSN: 2395-0072

VOLUME AND LEVEL OF SERVICE STUDIES IN UNCONTROLLED ROAD INTERSECTION

Mousumi Manna[1], Bodhisattwa Mahata[2], Srijan Mukherjee[3]

[1]*Student (B.Tech), Department of Civil Engineering, OmDayal Group of Institutions, West Bengal, India.*
[2]*Student (B.Tech Department of Civil Engineering, OmDayal Group of Institutions, West Bengal, India.*
[3]*Assistant Professor, Department of Civil Engineering, OmDayal Group of Institutions, West Bengal, India.*

Abstract – *Uncontrolled Road intersections encounter with unique challenges for traffic management and safety. Understanding the volume of traffic and the resulting level of service at these intersections are crucial for effective transportation planning and decision-making. The study utilizes a comprehensive data collection process, including classified traffic volume counts, video recording of traffic movements, and manual observations, to gather information on traffic volume and geometric design parameters at selected uncontrolled road intersection. Classified volume count survey was conducted during peak hours using the videography method. This project aimed to determine the capacity and level of service (LOS) provided by the road to the users and also to identify the causes of congestion problems in this intersection. By assessing critical gap, follow-up time, conflicting flow rate, heavy vehicle percentage and various others traffic parameters and analyzing these data, the study intended to provide insights into the existing traffic conditions and also to determine the level of service experienced by road users as per HCM 2010 in Indian condition. This information can guide the development of effective strategies to improve traffic flow and also to reduce congestion in the area.*

Key Words: **Critical gap, Follow-up time, Conflicting traffic flow, Movement capacity, Control delay, Capacity, Level of service (LOS)**

1.INTRODUCTION

Unsignalized intersections are defined as the intersections where traffic operates on the basis of the priority of traffic movements. Capacity at unsignalized intersections is defined as a result of the basic capacity within ideal traffic conditions related to various adjustment and correction factors, which included the impact of road environment, geometric design, and traffic conditions. The right-turning movement (in contrast with the through or left-turn movements) from the minor street has the lowest priority according to the corresponding traffic laws in countries like India. The performance of an unsignalized intersection is strongly influenced by the delay caused by low-priority movements on minor roads. In this project our aim is to study the traffic movement from all approaches in the selected uncontrolled road intersection. Various parameters that influence the capacity and Level of Service will also be analyzed in detail. Finally, the Traffic Flow Condition will be evaluated along with capacity under conflicting flows for an uncontrolled intersection in Indian Condition.

2. SCOPE AND OBJECTIVES

The scopes of the work carried out are:

- To evaluate the Potential Capacity and Level of Service in terms of Control Delay of the studied road intersection.
- To calculate the Movement Capacity of the intersections from Critical Gap and Follow up time calculation using Highway Capacity Manual 2010
- To observe the condition of the intersection under heterogeneous traffic flow.

A 3-legged road intersection is to be selected after map study and reconnaissance survey as the part of the preliminary objective of the project. Afterwards, video graphic data should also be collected along with the Geometric data of the selecting intersection. Following parameters are to be computed:

- Hourly turning movement volumes.
- Heavy vehicle percentages and pedestrian data.
- Conflicting traffic flow rate as per the priority rank of the movements.
- Critical gap and Follow up time as per HCM.

Lane Capacity (veh/hr) and Level of Service in terms of Control Delay (s/veh) of the studied road intersection are to be worked out.

3. LITERATURE SURVEY

According to Highway Capacity Manual [1] (2010) each movement at a Two Way Stop Control Intersection (TWSC) faces a different set of conflicts that are directly related to the nature of the movement. The Conflicting Flow Rate, (Vc,x) for movement x, that is the total flow rate that conflicts with movement x (veh/hr). John M. Samuels et al [2] (2002) analyzed the minimum time interval in the major-street traffic stream that allows intersection entry for one minor street vehicle. Also observed that Critical Gap can be made on the basis of observation of the largest rejected and smallest accepted gap for a given intersection. B Prasanta Kumar Bhuyan and K V Krishna Rao [3] (2011) adopted HCM (2000). P.G. Kumar et al [11] (2020) studied LOS of Urban and rural roads in Bhimavaram. The vehicles were classified into six catagories. They defined LOS mainly by using V/C ratio and average speed in selected corridors as follows. B. Someswara Rao, T. Rambabu et al [9] (2017) derived that the maximum capacity i.e., 900 veh/hr during morning and evening peak hours and has highest performance with LOS A and the capacity of minor right is varying between 293 veh/hr to 456 veh/hr in the morning peak hour and it is reduced to 235 veh/hr to 384 veh/hr during evening peak hours when calculated with four critical gap methods. The capacity of minor left turn is almost 1000 veh/hr in the morning and peak hours and minor right and major right have capacity is varying between 900 to 1000 veh/hr. This intersection has highest performance with LOS A when compared to other two intersections.

4. STUDY AREA

After obtaining permission for video data collection from the competent authorities, an important step in conducting a comprehensive analysis of the traffic movements at the chosen intersection has been performed. The collected video data for the morning peak hours (9.30 am to 12.30 pm) and evening peak hours (4.00 pm to 6.00 pm) provides valuable insight into the traffic patterns during these crucial periods. In addition, collected geometric details also contributed to a more accurate analysis. The information on carriageway width, shoulder width, gradation of approach road, number of lanes, and the north direction helped in understanding the layout of the intersection, which is crucial for assessing traffic operations. With the combination of video data and geometric details, subsequent steps of the analysis are accomplished, such as determining levels of service, computing control delays, flow rates, identifying conflicting traffic flows, and calculating queue lengths.

Priority order of Traffic Movements of a 3-legged or T-intersection in Indian condition is demonstrated in the following diagram**:** Stop controlled sign is considered in the South bound Minor Street approach.

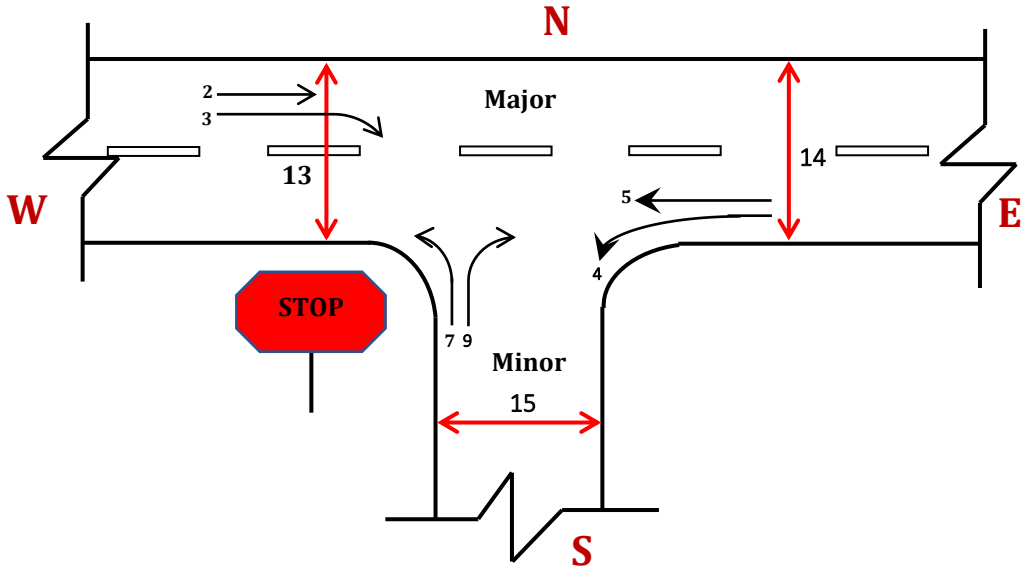


Fig -1: Traffic streams at a 3-legged Stop controlled intersection in Indian Condition

Table -1: Details of the Traffic and Pedestrian movements are as follows

Movement Number	Types of Movement
2-5	Major Traffic Movements
7,9	Minor Traffic Movements
13-15	Pedestrian Movements

Table -2: Priority order of Traffic Movements in Indian Condition

Priority order or Rank	Traffic Stream
1	2,4,5,15
2	3,13,14,7
3	9

5. SITE SELECTION AND DATA COLLECTION

An uncontrolled T-intersections at Goruhata More, Uluberia, Howrah has been chosen. Following are the Major and Minor roads in this intersection for collecting the videographic traffic data:

Major road: "NH7 - Uluberia Police Station Road" and
Minor road: "Shyampur - Gadiara road".
Details of the co-ordinate of this intersection:
Latitude - 22.468404232405494, Longitude - 88.10417879162601

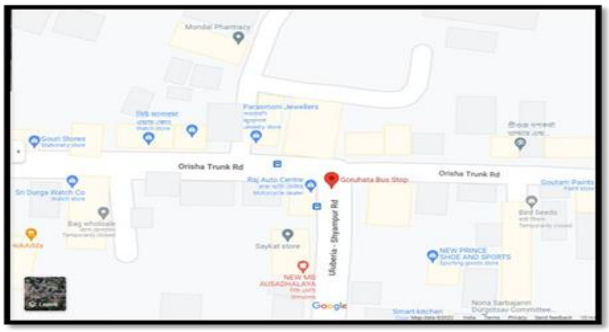


Fig -2: Site Selection and Data Collection

5.1 Geometric Data of the Intersection

• **Towards Shyampur Road:** Carriageway width- 7.106 m, Shoulder width- 0.274 m, Marginal Strip - 0.173 m, Total road width- 8.0 m., Grade at 8.96 %

• **Uluberia Station Road:** Carriageway width- 6.178 m, Shoulder width- 0.305 m, Marginal Strip - 0.106 m, Total road width- 7.0 m., Grade at 8.96 %

• **Uluberia College Road:** Carriageway width- 6.038 m, Shoulder width- 0.254 m, Marginal Strip - 0.127m, Total road Width - 6.8 m., Grade at 6.70 %

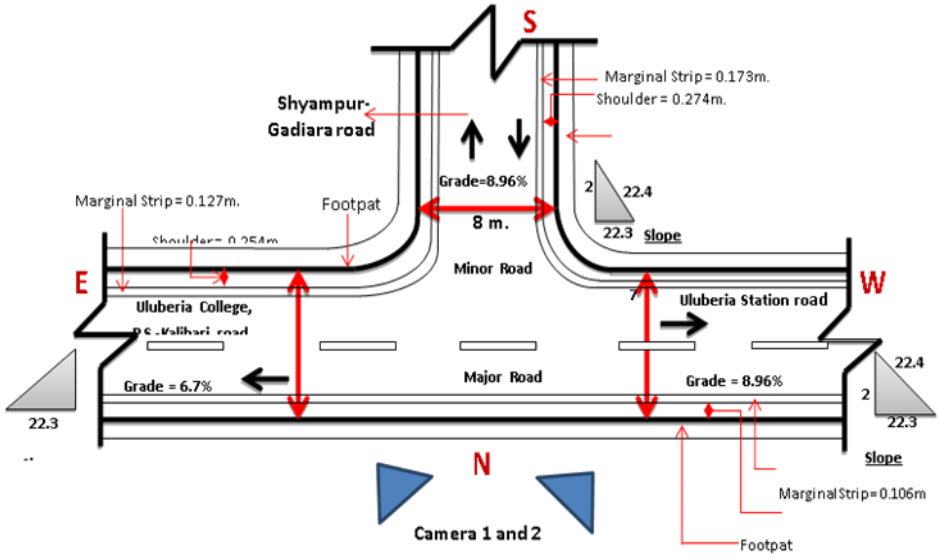


Fig -3: Schematic Diagram of 3- Legged Intersection

(A) **(B)** **(C)**

Fig -4: Goruhata More Intersection

6. OBSERVATION OF TRAFFIC VOLUME AND DATA EXTRACTION

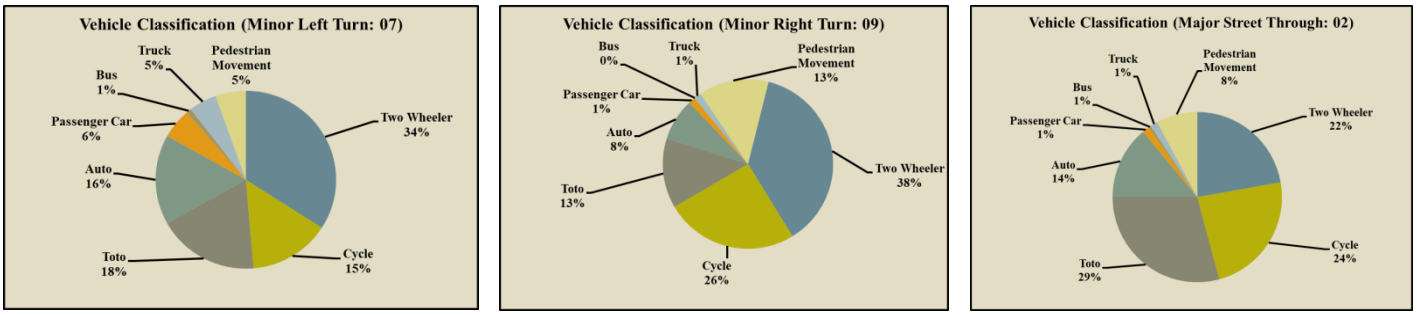
Observation of Number of Vehicles from each approach: Vehicular data during observed peak time period are represented in the following tabular form.

Table -3: Traffic Data of various movements for Major and Minor Roads at 15 min time intervals

Volume (veh/h)				
Order of 15min Interval	**Left Turn Movement 7**	**Right Turn Movement 9**	**Through Movement 2**	**Right Turn Movement 3**
9.30-9.45 AM	880	300	864	548
9.45-10.00 AM	868	408	968	508
10.00-10.15 AM	1140	384	1128	624
10.15-10.30 AM	856	448	864	588
10.30-10.45 AM	908	356	924	544
10.45-11.00 AM	544	244	748	404
11.00-11.15 AM	816	372	816	672

11.15-11.30 AM	988	380	944	560
11.30-11.45 AM	900	388	880	508
11.45-12.00 AM	844	348	928	552
12.00-12.15 AM	884	352	824	504
12.15-12.30 AM	772	252	464	376
04.30-04.45 PM	524	376	664	488
04.45-05.00 PM	872	512	896	608
05.00-05.15 PM	448	416	696	536
05.15-05.30 PM	876	516	788	568
05.30-05.45 PM	912	632	812	596
05.45-06.00 PM	944	636	744	612
06.00-06.15 PM	932	580	856	736
06.15-06.30 PM	896	336	912	664

Chart -1: Traffic Movements for Minor Left turn 07, Minor Right turn 09 and Major Through 02



This Graph represented the Vehicular and Pedestrian data in percentage form for the total observation period. Following are the notable observations-

i) Two wheelers are predominant traffic in South Minor Left turn (07). **ii)** Significant number of pedestrian movements is observed across South Minor Right turn (09) and (04). **iii)** Large percentage of Toto's and Autos are moving along West Bound Major Through (02) and (05) respectively. **iv)** Percentage of Buses and Trucks are comparatively low in all these approaches during the observation period.

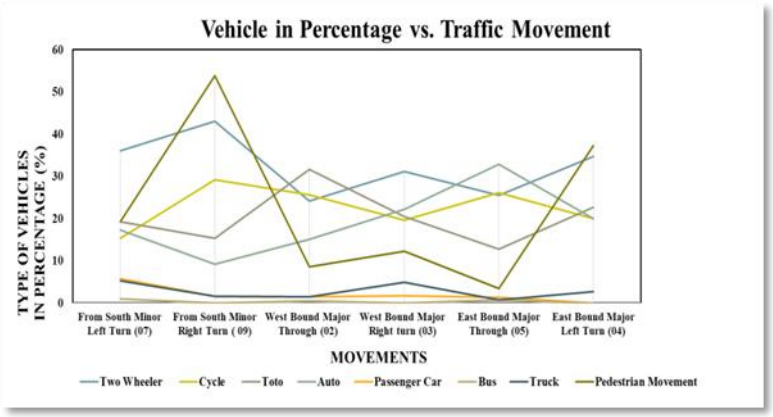


Chart -2: Vehicle in Percentage vs. Traffic Movement

7. Traffic Data Analysis

Traffic Data for the whole 5 hours observation period has been analyzed. All the parameters like Critical Gap, Follow-up Time, have been calculated and represented in the following tables:

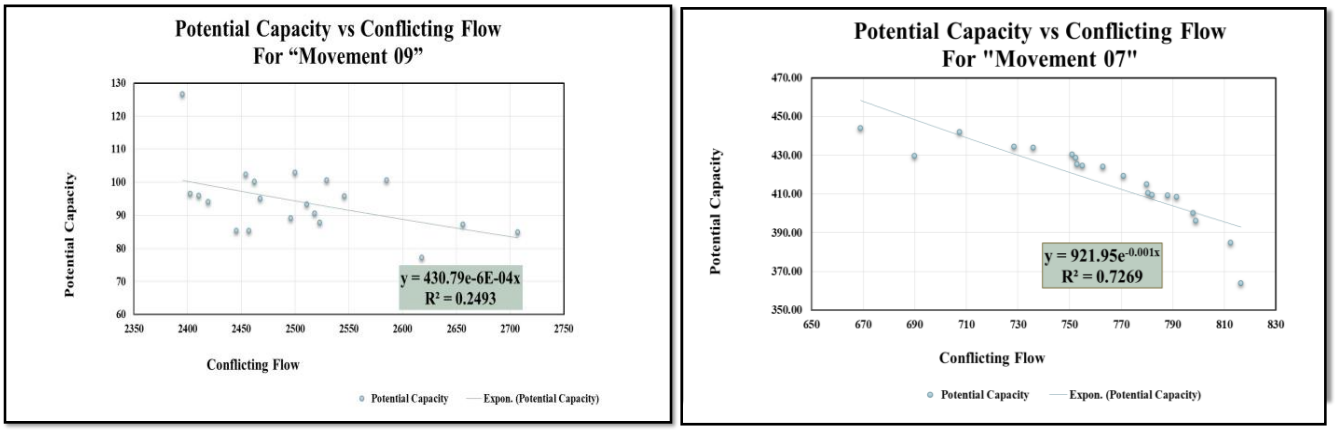


Chart -3 and **Chart 4**: Conflicting Flow rate and Potential Capacity for Movement 09 and 07 respectively

Chart -3 represented, **i)** The conflicting flow rate increases as the potential capacity decreases. **ii)** A graph is being generated using an exponential function. **iii)** The equation is being created. The equation is Y = 430.79e $^{(-6E-0.4x)}$ and also R^2 value is 0.2493 for minor street right turn "09". **iv)** Similarly, from Chart- 4, the equation for minor street left turn "07" is also developed, Y = 921.95e $^{(0.001x)}$, and the R^2 value is 0.7238. **v)** The equation for major street right turn "03" is Y = 149e$^{(-6E-0.4x)}$ and also the R^2 value is 0.3608.

8. RESULT AND DISCUSSIONS

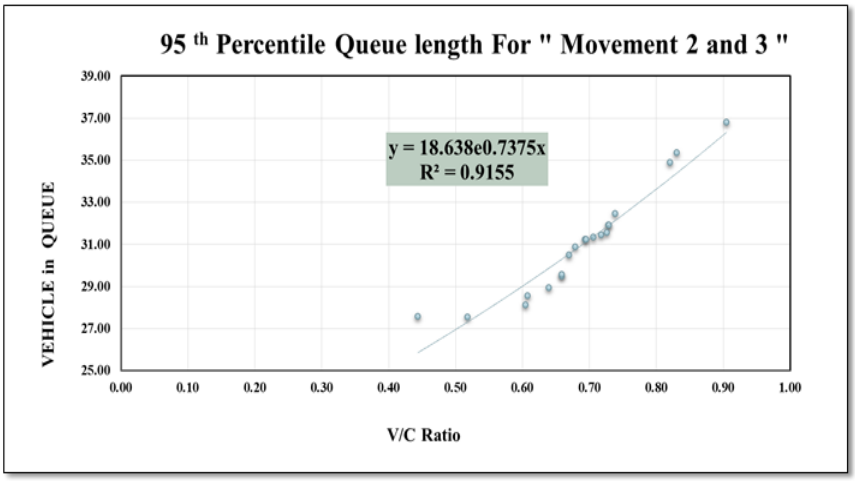


Chart -5: Volume Capacity Ratio and Queue Length for Movement 02 and 03

Chart -5 represented, **i)** As the volume-to-capacity ratio increases, the queue length also increases. **ii)** The volume-to-capacity ratio begins between 0.4 and 0.5, while the queue length starts from almost 27 vehicles. **iii)** The equation Y = 18.638e$^{(0.7375x)}$ represents the relation in between these two parameters and associated R^2 value is 0.9155. **iv)** It has also been developed for the movements "07" and "09". Here the volume/capacity ratio starts in between 1.5 to 2 and the queue lengths are varying in between 14 to 15 vehicles. **v)** The best fit equation is Y = 12.244e$^{(0.1185x)}$ and the R^2 value is 0.8282.

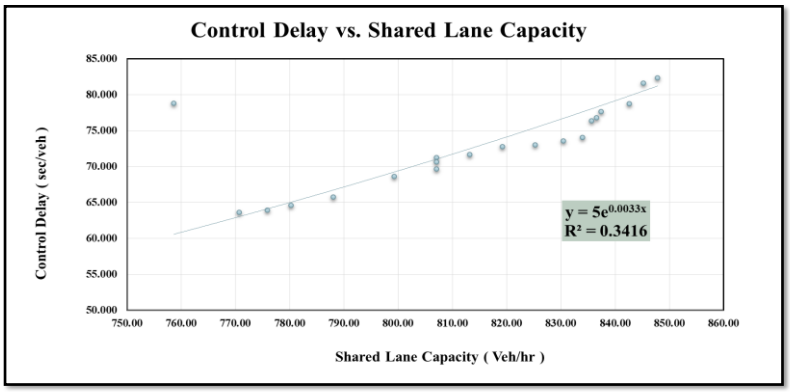


Chart -6: Control Delay vs. Shared Lane Capacity for "Movement 07 and 09"

i) Here, it is observed that the control delay ranges between 60 and 85 seconds per vehicle for movements 07 and 09.
ii) It is observed that the control delay can reach levels exceeding 80 seconds in certain situations, for a shared lane capacity of nearly 850 vehicles per hour
iii) The equation is $Y = 5e^{(0.0033x)}$ represents the relation in between control delay (sec/veh) and Shared Lane Capacity (veh/hr) with R^2 value 0.5992. A more robust model could be developed with an expanded dataset if this study is extended to additional intersections.

9. CONCLUSION

Based on the study conducted at Ghoruhata More, Uluberia, Howrah, West Bengal, the following conclusions are drawn: Approximately 55% of the total volume of vehicles at the intersection comprises 2-wheelers and 3-wheelers. The increase in E-rickshaw movement significantly impacts the overall capacity and level of service of these roads. The study indicates that minor road vehicles have a Level of Service (LOS) of "E," with a delay time ranging between 35 to 45 seconds per vehicle, while major road vehicles have a LOS of "F," with a delay time of almost 80 seconds per vehicle. At the conclusion of the project, it is determined that the Ghoruhata More intersection provides a Level of Service that leads to unstable flow (Level E) and forced flow (Level F) conditions. It is recommended that the development of micro-simulation modeling, coupled with a pedestrian, cyclist, and E-rickshaw safety awareness improvement program, be implemented to enhance the capacity and Level of Service of this intersection.

REFERENCES

[1] Highway Capacity Manual, 2010, and Indo-HCM, 2012-17, TRB, National Research Council, Washington, D.C.

[2] John M. Samules et.al., 2002, 'National Cooperative Highway Research Report', TRB, Washington, D.C.

[3] B. Prasanta Kumar Bhuyan and K.V. Krishna Rao, 2011, 'Article on Defining Level of Service Criteria of Urban Streets' in Indian context, former Research scholar, Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai - 400076, Maharashtra, India.

[4] Vivek Zalavadiyar et.al., 2009, 'International Journal of Research in Engineering, Science and Management', Volume-2, Issue-6, June-2019 www.ijresm.com | ISSN (Online): 2581-5792.

[5] S Raji et.al., 2020, 'Level of Service of Urban and Rural Roads- A Case study in Bhimavaram', Shri Vishnu Engineering College for Women (Autonomous), Vishnupur, Bhimavaram-534202, West Godavari Dist., India.

[6] S. Venkatcharyulu et.al., 2020, 'Traffic volume Analysis of Newly Developing semi- urban Road' Assistant Professor Gokaraju RangaRaju Institute of Engineering and Technology Hyderabad, India and Research scholar, Department of Civil Engineering, JNTUHCEH, Kukatpally, Hyderabad, India. Professor & Head of civil Engineering, Gokaraju RangaRaju Institute of Engineering and Technology Hyderabad, India.

[7] Mira Patel, 2014, 'International Journal of Applied Engineering and Technology' ISSN: 2277-212X (Online) An Open Access, Online International Journal Available at 2014 Vol. 4 (1) January-March, pp.37-45/Patel.

[8] N.G. Raval, Dr. P.J. Gundaliya et.al., 2017, 'Development of Relationship Between Saturation Flow & Capacity of Mid-Block Section of Urban Road - A Case Study of Ahmedabad City'.

[9] B. Someswara Rao, T. Rambabu, 2017, 'International Journal of Civil Engineering and Technology' (IJCIET), Volume 8, Issue 8, August 2017, pp. 181–190, Article ID: IJCIET_08_08_020.

Indian Highway Capacity Manual (Indo-HCM), 2012-2017, Central Road Research Institute, New Delhi -110025.