

Assessment of Capacity and Level of Service for Urban Arterial Road in Jabalpur City

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Abstract - India is a growing nation, and as a result, its cities are also going through significant urbanisation and modernization. As a result, the amount of traffic on the roads has increased significantly. One of the largest and fastest-growing cities in central India is Indore. The city's metropolitan roadways have experienced a constant growth in vehicle traffic as a result of which they are approaching their intended capacity, which has led to a particularly complicated traffic pattern. In the study four Road Stretches are considered and the data should be collected from all the four stretches. At the end Road level of Service is determined and the values are compared with the values in Highway Capacity Manual and the deductions are drawn.

Key Words: Capacity, Level of Service, Roads, Jabalpur, Indian Road Congress, Highway Capacity Manual

1.INTRODUCTION

Jabalpur is one of central India's most significant and fastest growing cities. In the state of Madhya Pradesh, it is the sole metropolis. In recent years, the city's traffic has been more intense due to the emergence of an industrial sector and commercial expansion, as well as the increase in population. The city's metropolitan highways have experienced an unrelenting growth in automotive traffic, resulting in a slew of issues such as reduced lane width, traffic congestion, insufficient parking places, signal delays, reduced road capacity, air pollution, and road accidents, to name a few. Because the city's roadways are approaching their planned capacity, the nature of traffic is becoming increasingly complicated. Lack of lane discipline, a broad variety of vehicle sizes and types, and a wide range of vehicle speeds are some of the other primary essential elements impacting traffic flow on the roadways. As a result, it is necessary to comprehend the nature of traffic flow while taking into consideration the current traffic flow on the roads, as well as to modify the traditional elements that were used to construct the roads in order to enhance the traffic condition of the existing roads to some level.

There are various research done over the Road level of Service and Capacity, **Patel and Joshi (2012)** In Surat, Gujarat, India, done Cluster Analysis to determine service level thresholds based on volume to capacity ratio. The

findings of this study are extremely valuable in assessing traffic quality on access-controlled urban arterials with mixed traffic. **Janwari et al. (2014)** determine Road Level OF Service and Roadway Congestion Index for 22 road linkages. The study also discovered that the IRC 106:1994 and HCM methods for determining LOS are not relevant in urban road scenarios. According to the study, the speed parameter and pedestrian flow in establishing LOS on urban roadways need to be revised in the code. **Gajjar and Mohandas (2014)** In Mumbai, Maharashtra, a rigorous study of road capacity on important metropolitan routes was carried out. According to the research, numerous main highways in Mumbai have well exceeded their capacity in terms of throughput per lane. Interestingly, despite the high volume, no serious congestion difficulties were discovered on these roadways. **Raval et al. (2017)** finds that the recommended capacity value given by the Indian Road Congress (IRC) based on design service volume is less than the actual capacity established in the field.

The Highway Capacity Manual is a compilation of cutting-edge methods for assessing capacity and defining the level of service for transportation assets. The notion of "Level of Service" was originally established in the Highway Capacity Manual (HCM). The Highway Capacity Manual (HCM) (1965) was the first to offer the notion of LOS and certain accompanying performance measurements that accurately reflect a roadway's operational characteristics. Six LOS were proposed based on performance indicators such as average traffic speed, peak hour factor, v/c ratio, load factor at intersections, and flow conditions (stable, unstable or forced). In HCM (1985), density was chosen as the major criterion for evaluating performance, and five LOS were recommended as a result. HCM (2000) proposed using average travel speed (ATS) as the only criterion for determining the LOS of a city roadway. Six LOS criteria were provided based on the ATS value for each of the four urban street classes, whereas the free flow speed was used to identify the urban street class. Six LOS were proposed in the most current edition of HCM (2010), along with threshold levels of percentage free-flow speed, which was presented as the principal performance metric for LOS evaluation of urban streets for automobile mode.

2. Objectives of the Study

Following are the objectives of the present study:

1. To conduct a traffic volume, capacity, and space mean speed study on the selected segments.
2. To determine vehicle composition in each stretch.
3. To ascertain peak and off-peak traffic flow.
4. To determine the speed, density, and flow relationship for the research area.
5. To propose improved Level of Service standards for the entire section's observed traffic.

3. Study Area

Following are the routes considered in the study at Jabalpur City in Madhya Pradesh. The Route taken under consideration is initialized from “Bada Phuhara” to “Rampur Chowk” (4.4 Km) stretch. “Bada Phuhara” is the major flea market of the city near Hanuman taal. Due to flea market and temples near Bada Phuhara there is major traffic congestion in this area. The next area to be covered is “Malviya Chowk”, the book market of the city is located at the “Malviya Chowk”, sandariya mall and police control room are also the important places near this area. After that bloom chowk is the important spot to be covered, the Bloom Chowk covers Showrooms like Lotus, Reliance digital, etc, Bloom chowk is also considered as the medical hub of the city. Further we move towards chotiline square and Rampur Chowk. These covers small flea markets and temples these places directly connect to the Railway station of the city.

Due to heavy traffic and mixed vehicle composition along this section's route, the road's traffic handling capacity was reduced, leading vehicle travel times to be delayed, especially during peak hours. The majority of intercity and local buses utilise this road, resulting in frequent traffic jams and delayed traffic movement, ultimately affecting the road's traffic handling capability.

The 4.4-kilometer span is broken into four pieces. For clarity, the route from Bada Phuhara to Rampur Chowk is regarded down, whereas the direction from Rampur Chowk to Bada Phuhara is considered up.

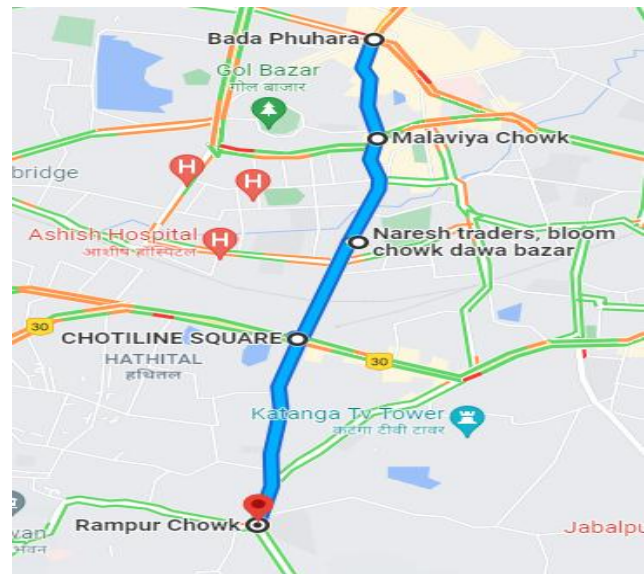


Fig. 1- Map of Area into Consideration



Fig. 2 Site Photos

4. Data Collection and Methodology Adopted

The cameras positioned in the middle of each of the four sections were used to conduct the traffic volume analysis. Videography of traffic levels was used to obtain flow data throughout peak and off-peak weekday hours. Slow motion playback of recordings is used to manually count and categorise various automobiles in the traffic, which is a time-consuming task. According to this, the section's evening peak hour is between 6 and 7 p.m., while the morning peak hour is between 10 and 11 a.m.

All of the data gathered in the field is aggregated and calculated to better understand the variations in traffic and vehicle composition throughout peak and off-peak hours in

both directions. The data includes Number of Vehicles, Trip Time, Average Journey Time and Average Flow Speed for 5-Minutes Interval for both peak and off-peak hours. Following are the steps involved in the study:

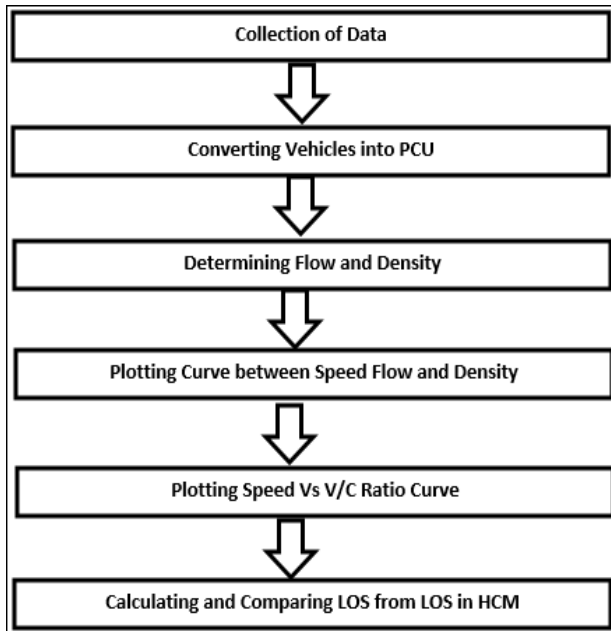


Fig. 3- Methodology Adopted

5. Results

The Greenshields' Speed-Flow relationship is in the form of a parabolic curve. In the speed vs flow domain, this parabolic curve is employed as a conceptual representation of Level of Service. The Highway Capacity Manual divides the operating range on this curve up to LOS E into three levels of service (HCM). The speed-flow relationship was used to calculate the level of service ranges, and the thresholds for each level of service were established and compared to the Highway Capacity Manual's standards (HCM). For each segment, the volume to capacity ratio is calculated, and graphs of speed versus V/C are drawn. For determining level of service ranges, the maximum and lowest seen on the upward curve are separated into equal intervals. The graphs, which show multiple ranges of speed and V/C ratios for defined LOS, were used to define LOS 'A-F.' Following are the results obtained from the study for all the sections:

5.1 Rampur Chowk - Choti Line Square Section

The capacity of this segment in the up direction is 3654.6 PCU/hr, while the capacity in the down direction is 3016.2 PCU/hr.

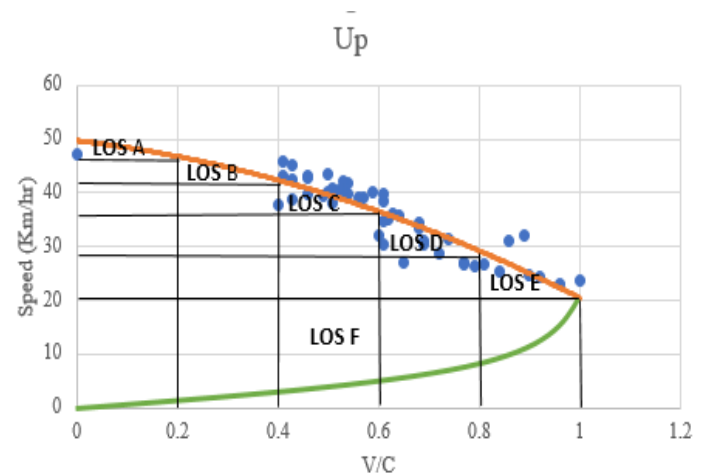


Fig. 4- Revised Los Criteria for Rampur Chowk to Choti Line Square (Up)

Table 1- Speed and V/C Ranges for Rampur Chowk to Choti Line Square (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>46
B	0.20-0.40	41-46
C	0.40-0.60	36-41
D	0.60-0.80	29-36
E	0.80-1.00	20-29
F	>1	<20

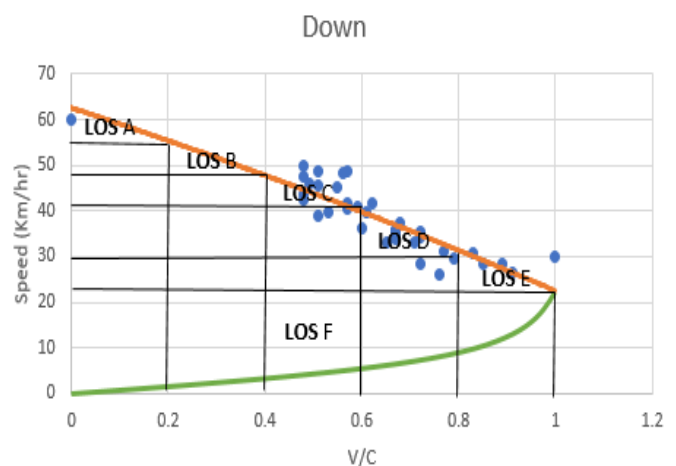


Fig.5- Revised LOS Criteria for Rampur Chowk to Choti Line Square Section (Down)

Table 2- Speed and V/C Ranges for Rampur Chowk to Choti Line Square (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>55
B	0.20-0.40	49-55
C	0.40-0.60	41-49
D	0.60-0.80	30-41
E	0.80-1.00	23-30
F	>1	<23

5.2 Choti Line Square – Bloom Chowk Section

The capacity of this segment in the up direction is 4161 PCU/hr, which is the maximum capacity of this segment during evening peak hours, and the capacity in the down direction is 2892 PCU/hr.

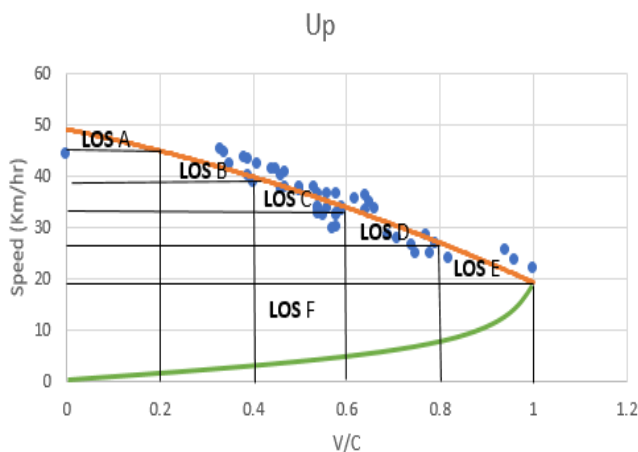


Fig. 6- Revised LOS Criteria for Choti line Square to Bloom Chowk Section (Up)

Table 3- Speed and V/C Ranges for Choti line Square to Bloom Chowk (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>46
B	0.20-0.40	38-46
C	0.40-0.60	33-38
D	0.60-0.80	27-33
E	0.80-1.00	19-27
F	>1	<19

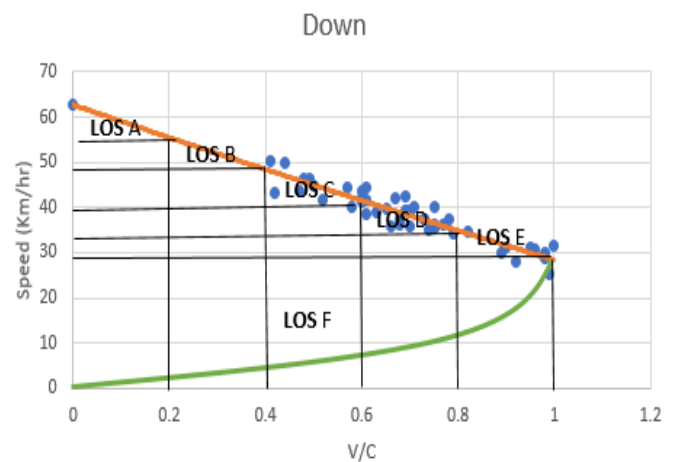


Fig.7- Revised LOS Criteria for Choti line Square to Bloom Chowk Section (Down)

Table 4- Speed and V/C Ranges for Choti line Square to Bloom Chowk (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>54
B	0.20-0.40	49-54
C	0.40-0.60	40-49
D	0.60-0.80	32-40
E	0.80-1.00	29-32
F	>1	<29

5.3 Bloom Chowk – Malviya Chowk Section

In the evening peak hour, the capacity reached is 3221.4 PCU/hr in the up direction, and 3774.6 PCU/hr in the down direction.

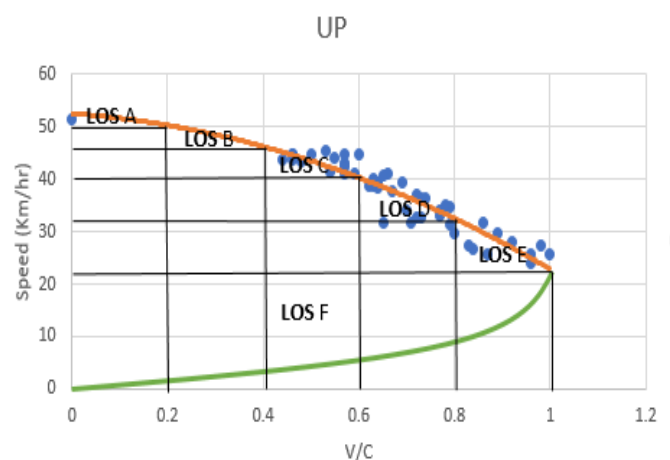


Fig.8- Revised LOS Criteria for Bloom Chowk to Malviya Chowk Section (Up)

Table 5- Speed and V/C Ranges for Choti line Square to Bloom Chowk (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>50
B	0.20-0.40	46-50
C	0.40-0.60	40-46
D	0.60-0.80	32-40
E	0.80-1.00	22-32
F	>1	<22

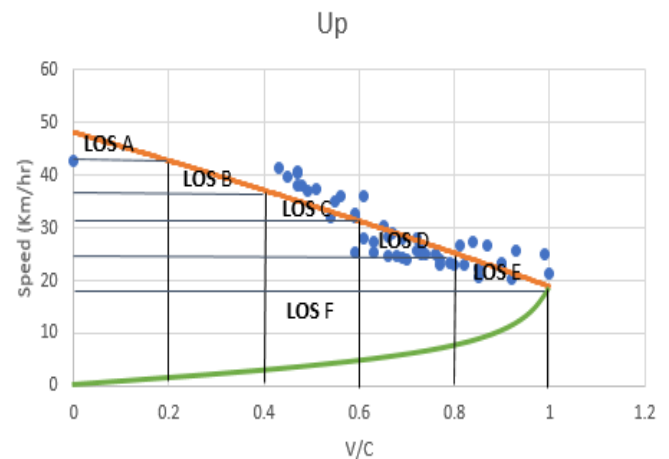


Fig. 10- Revised LOS Criteria for Malviya Chowk to Bada Phuhara Section (Up)

Table 7- Speed and V/C Ranges for Malviya Chowk to Bada Phuhara section (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>43
B	0.20-0.40	37-43
C	0.40-0.60	31-37
D	0.60-0.80	24-31
E	0.80-1.00	18-24
F	>1	<18

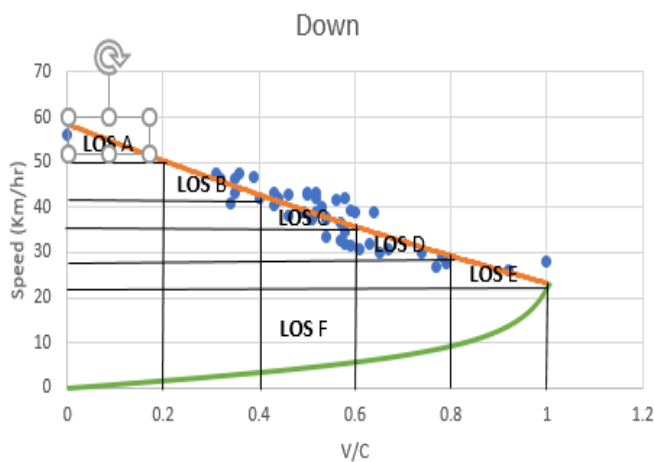


Fig.9- Revised LOS Criteria for Bloom Chowk to Malviya Chowk Section (Down)

Table 6- Speed and V/C Ranges for Choti line Square to Bloom Chowk (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>50
B	0.20-0.40	41-50
C	0.40-0.60	36-41
D	0.60-0.80	28-36
E	0.80-1.00	22-28
F	>1	<22

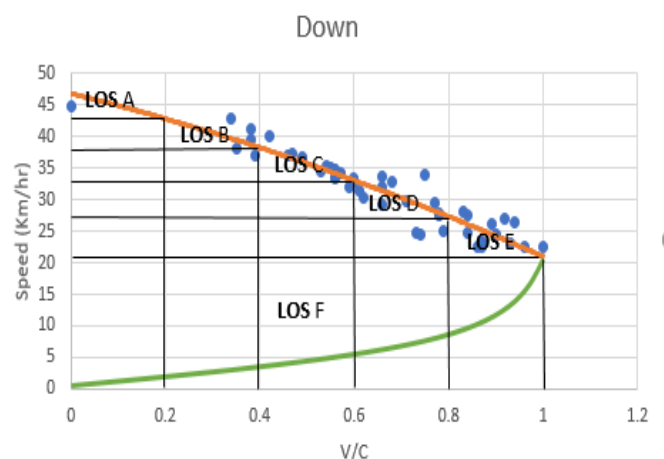


Fig. 11- Revised LOS Criteria for Malviya Chowk to Bada Phuhara Section (Down)

5.4 Malviya Chowk – Bada Phuhara Section

The capacity obtained in the evening peak hour is 3909 PCU/hr, which is also the second highest capacity observed in this full stretch, while the capacity obtained in the down direction is 3583.2 PCU/hr.

Table 8- Speed and V/C Ranges for Malviya Chowk to Bada Phuhara section (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>43
B	0.20-0.40	38-43
C	0.40-0.60	33-38
D	0.60-0.80	27-33
E	0.80-1.00	21-27
F	>1	<21

6. Conclusion

Following are the Conclusions of the study

1. A Speed-Flow relationship is constructed for the chosen urban arterial route segment. The curve exhibits a second order polynomial quadratic connection with a very high R square (0.903–0.7203), demonstrating an excellent correlation between the measured speed and flow.
2. The Speed-Density Relationship for the chosen section is also developed; it has a linear shape and a R square that falls between (0.8448-0.9384).
3. Two-wheelers and automobiles, which make up 68 percent and 24 percent, respectively, of the total volume of the stream, make up the majority of the traffic. The capacity of the chosen category has been significantly impacted by other vehicle classes including 3-wheelers, buses, and light commercial vehicles.
4. The Choti Line Square to Bloom Chowk segment (up direction) has a maximum capacity of 4161 PCU/hr at a stream speed of 22.5 km/hr during the evening peak hour of 6 to 7 pm. The Malviya Chowk to Bada Phuhara stretch also operates at a similar capacity of 3909 PCU/hr with a stream speed of 20.2km/hr during the evening peak hour, giving both segments a v/c ratio >1 and placing them both under LOS F in accordance with IRC 106-1990.
5. According to IRC 106-1990, the highest capacity reported at the Malviya Chowk to Bloom Chowk segment (down direction) falls into the LOS F category with 3774.6 PCU/hr and a stream speed of 23.5km/h.
6. The Choti Line Square to Bloom chowk leg has a density of around 188.2 PCU/km, with the evening peak hour having the maximum density.

7. The speed parameters established in this research for LOS A and LOS, which range from 51.5 to 44 kilometres per hour, are lower than those set by HCM for LOS A and LOS B, which range from 59 to 46 kilometres per hour. It's also important to remember that the allowed speed range for this urban arterial route is about equivalent to the LOS "C to F" standards.

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