

Prediction of Level of Service (LOS) based on Volume Speed Relationship for an Urban Road Widening Project

Breeten Singh Konthoujam
PG Student
Department of Civil Engineering
DSCE, Bengaluru

Dr. M. R. Rajashekara
Professor and PG Coordinator
Department of Civil Engineering
DSCE, Bengaluru

Abstract

The road network of any city is its lifeline and the evaluation of their performance is very necessary for future traffic planning, design, operation and maintenance, etc. Traffic flow in most cities of India is a mixed traffic characteristics and also the traffic congestion is the common problem in most major cities in India. In Bengaluru city, most of the roads are congested and operate in Level of Service E or F. The objective of the present study is to improve the performance operation of the urban road network by proposing the proper alternatives to enhance the traffic capacity. To achieve this objective, a complete methodology for analyzing the mixed traffic flow in 2 km long stretch from Koli Farm Gate to Jalli Machine Bus- stop in Bangalore city, along the Bannerghatta road, is selected and analyzed. Traffic studies were carried out before widening of the road in the form of volume and speed and speed flow relationship was established to understand LOS and traffic volume for future years projected to know the drop in LOS.

Keywords: Highway capacity manual (HCM), level of service (LOS), traffic studies, traffic volume, volume count

I. INTRODUCTION

Scope of transportation system has developed very largely. This led to the increase in vehicular traffic especially in private transport network. Thus road space available was becoming insufficient to meet the growing demand of traffic and congestion started. The population of Bangalore is growing day by day. The intensity of the traffic and pedestrians crossing has increased significantly and there is no scope for increasing the road length and widening due to land acquisition problem especially at junctions in multiple directions. For a variety of reasons such as population, economic and auto ownership growth, increasing traffic demand can exceed the carrying capacity of the road during peak periods. As a consequence, traffic condition deteriorates and safety risk worsens. Capacity of a road is represented by the maximum rate at which vehicles can pass through a given point in an hour under prevailing operational conditions. Intersection capacity or volume-to-capacity ratio is one of the operational measures of effectiveness used in measuring L

II. REVIEW OF LITERATURE

C.C. Bhattacharya⁽⁵⁾ considered safety as a key objective and introduced traffic calming techniques. The sole idea for this study is to enforce a speed control to 15 to 20 km/hr., which is considered as a safe speed of travel. Methods performed and designed in this study are changed in street alignment, installation of barriers and installation of other traffic control devices as the situations demands. Reduction in number and severity of accidents, improve facilities for non- motorized modes, increased in property values etc. are the benefits of traffic calming

P.K Sahoo et. al⁽³⁾ conducted a study on traffic flow characteristics which included traffic speed, volume, density, etc. on two stretches of national highway No – 5 touching Bhubaneswar , capital of Odisha. The field study was carried out for 1km length on each stretches. The first stretch was between Bhubaneswar to Cuttack and the second was between Bhubaneswar and khurda. The experiments were conducted between the average peak periods on week days. The traffic densities and vehicular speeds were observed through regression equations. The speed – flow relationships were drawn and concluded that the speed decreased with the increased in volume. On the Bhubaneswar –Khurda stretch at a traffic volume of around 750 veh/hr , the lowest average speed is 30 kmph and 33 kmph on the Bhubaneswar – cuttack stretch at about 850 veh/hr.

III. OBJECTIVES

- To study the existing traffic situation for the selected 2 km road stretch of Bangalore City.
- To study the level of service for selected road stretch.

- To evaluate the traffic performance operation and transport scenario of mixed traffic in urban stretch of Bangalore.
- To propose the traffic improvement measures for the selected road stretch.
- Prediction of Level of Service (LOS) from Koli Farm Gate to AMC College and AMC College to Jalli Machine Bus Stop based on volume-speed relationship of an urban road widening project.
- Apart from managing traffic on the road, this study also aims to maintain the road infrastructure in good condition.

IV. RESEARCH METHODOLOGY

The methodology involved for the study is as follows.

A. A Detailed Site Investigation Which Includes Reconnaissance and Topographical Studies

A reconnaissance survey was done to identify the issues pertaining to the intersections, parking, black spots, etc as well as identify the traffic circulation pattern in and around the study area. This was followed by the data collection effort in the form of primary and secondary surveys where primary surveys like traffic volume counts, bus boarding & alighting. Bus passenger opinion, parking surveys, etc were carried out to obtain an idea of the traffic scenario of the study area

B. Traffic Survey and Analysis

The collected data was analyzed to identify the Roadway Segments capacity and Level of Service (LOS), based on the Indian Roads Congress (IRC) standards sourced from Guidelines for Capacity of Urban Roads in Plain Areas IRC 106-1990.

C. Preparation of Conceptual Design

The next step was to propose section specific interventions to the identified issue and prepare their of implementation plan. Based on the need of urgency, the interventions were classified as short, medium and long term measures

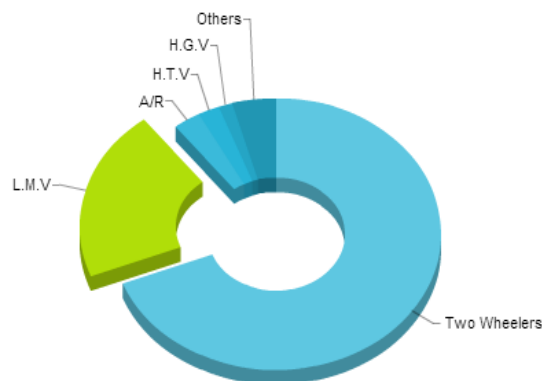
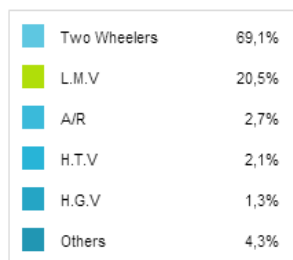
V. ADVANTAGES OF THE PROPOSED PROJECT

- Reduces travel time, thus reducing the pollution levels, fuel consumptions along with stress and strain.
- Improves the existing junctions to streamline traffic flow at grade level.
- The movement of inter-zonal traffic will be improved.
- Improves environmental conditions of the corridor by reducing idle time.
- Reduces the vehicle operation cost of the road users.

VI. CURRENT SCENARIO IN BENGALURU CITY

With the increased in population in the city there is also a corresponding increased in the number of vehicles in the city. For example, from the study by Bangalore Traffic Police (1), the traffic growth in Bangalore is highlighted as Management of more than 53, 00,000 vehicles and annual growth of 7-10 % in traffic

- 1) Most of the roads operating above their capacity
- 2) Travel speed less than 15 kmph during the peak hours in central areas
- 3) Insufficient or no parking spaces for vehicles



VII. MATHS

Early Capacity Studies and Theoretically Derived Formulae

To determine the capacity, early attempts were made on the basis of the following theoretical formula:

$$C = \frac{1000V}{S}$$

Where C = Capacity in vehicles per hour per lane

- V= Speed, in K.P.H.
- S = Average spacing in meters of moving vehicles.

A number of early studies were concerned with measurement of S in an actual traffic stream and values of V. from the relation obtained by Greenshields (1933)⁽³⁾ connecting S and V was:

$$S = 21 + 1.1 V$$

Where,

- S = Spacing in feet
- V = Speed in M.P.H

VIII. DATA COLLECTION AND ANALYSIS

A. General

The various data collected for the studies are:

- Geometrical condition of the road, which includes collection the lane width and shoulder width. The road width was measured at night time and the geometric conditions of the roads are shown in the snapshots.
- Volume count for mixed traffic, the data was collected by manual method.
- The spot speed data was also collected simultaneously using baseline method manually.
- All the relevant data were collected by manual method at the selected stretch in three different areas along the Bannerghatta road for 14 hours (7:00 am to 9:00 pm) during the working days.

Table 1:

Selected area for the Study in Banerghatta Road, Bangalore City.

Sl.No.	Area of study	Category of Road
1	Gottigere to Koli Farm Gate	Sub Arterial
2	Koli Farm Gate to AMC College	Sub Arterial
3	AMC College to Jalli Machine Bus Stop	Sub Arterial

B. Data Collection and Analysis of Gottigere to Kolifarm Gate Stretch

The traffic volume and spot speed was collected for both directions by manual method near the Indian Oil Petrol Bunk of Koli Farm Gate and the data's were shown in the annexure. The Google map of Koli Farm Gate Intersection is shown in Fig 1.

The vehicles movement of both directions is tabulated in the Table 4.2. The period of the volume counting is divided into 15 minutes intervals.

Table 4.2:
List of direction

Direction	Direction of traffic
Direction 1	Gottigere to Koli Farm Gate
Direction 2	Koli Farm Gate to Gottigere

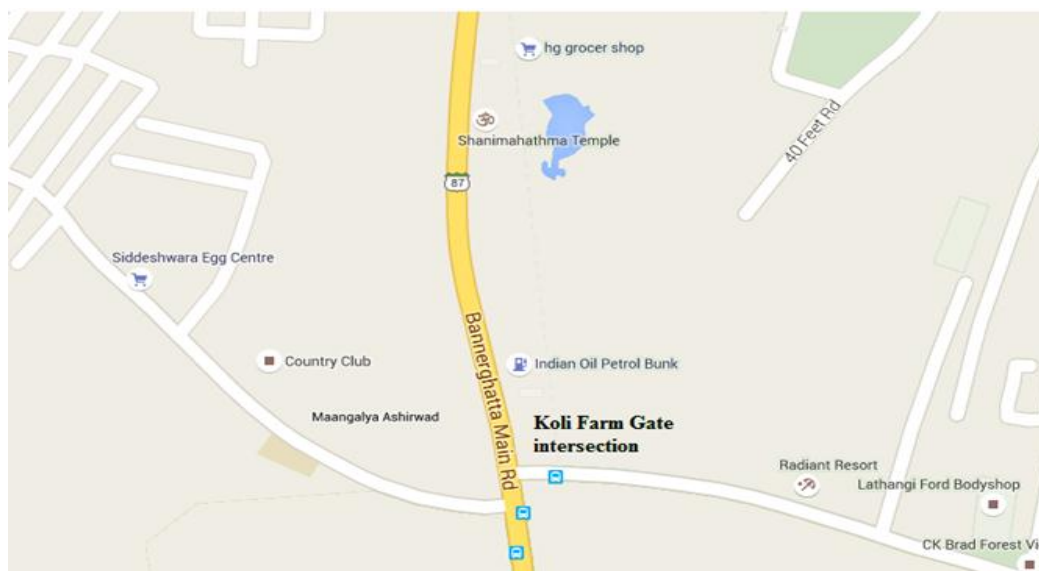


Fig. 1: Google map of Kolifarm intersection.

The following table shows the collected classified traffic volume and spot speed at the above mentioned area.

Table 2:

Traffic volume for all directions

Sl. No.	Direction	Total PCU for 14 hours
1	Gottigere to Koli-Farm Gate	17212
2	Koli-Farm Gate to Gottigere	19100

The data required to determine the LOS is tabulated in Table 3

Table 3:

Data required for analysis

Sl. No	Direction	Total Avg. Vol, PCU /hr. (refer annexure)	Avg. Speed for 14 hr. (refer annexure)
1	Gottigere to Koli-Farm Gate	2151.5	28.9 K.P.H
2	Koli-Farm Gate to Gottigere	2387.5	28.74 K.P.H

The level of service for the junction is calculated using the data collected and tabulated in the Table 4

Table 4:

Obtained LOS for Gottigere to Koli Farm Gate

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
Gottigere to Koli-Farm Gate	2151.5	28.9	0.9	D

Table 5:

Obtained LOS for to Koli Farm Gate to Gottigere

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
Koli Farm Gate to Gottigere	2387.5	28.74	1.0	E

C. Data Collection and Analysis of Koli- Farm Gate to AMC College

The traffic volume and spot speed was collected for both directions by manual method near the Sakalavara road diversion and the data's were shown in the annexure. The Google map of Koli Farm Gate to AMC College is shown in Fig.2.

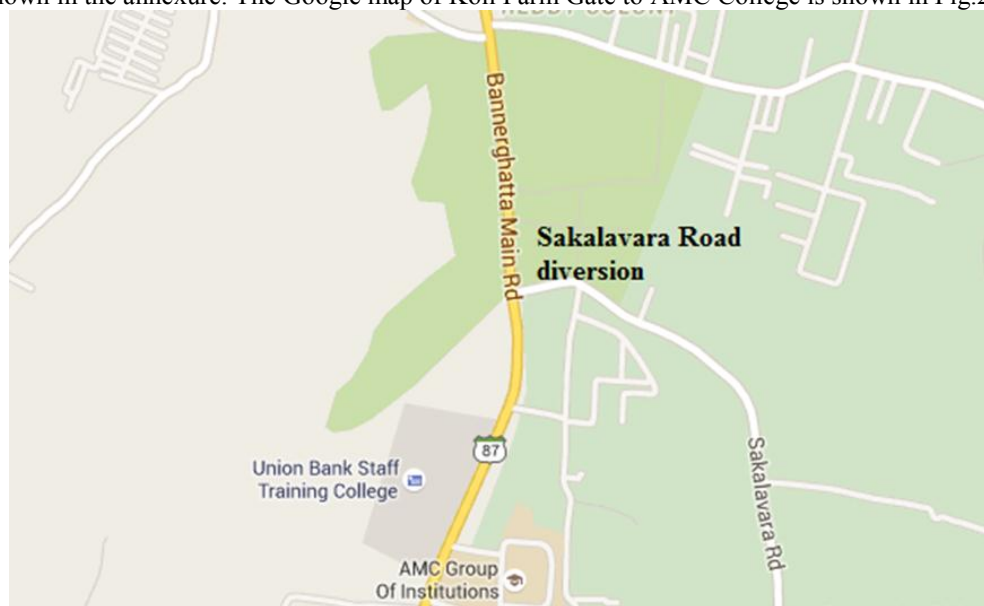


Fig. 2: Google map of Sakalavara Road diversion

The following table shows the collected classified traffic volume and spot speed at the above mentioned area..

Table 6:

Traffic volume for all directions

Sl. No.	Direction	Total PCU for 14 hours
1	Koli-Farm Gate to AMC College	13281
2	AMC College to Koli-Farm Gate	13554

The level of service for the junction is calculated using the data collected and tabulated in the Table 4.5.

Table 7:
Obtained LOS for Koli-Farm Gate to AMC College

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
Koli-Farm Gate to AMC College	1660.12	29.15	0.71	C

Table 8:
Obtained LOS for to AMC College to Koli-Farm Gate

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
AMC College to Koli-Farm Gate	1694.25	28.79	0.72	C

D. Data Collection and Analysis of AMC College to Jalli Machine Bus-Stop

The traffic volume and spot speed was collected for both directions by manual method near the Jalli Machine Bus -Stop and the data's were shown in the annexure. The Google map of AMC College to Jalli Machine Bus -Stop is shown in Fig.3.



Fig. 3: Google map location of Jalli Machine Bus Stop

The following table shows the collected classified traffic volume and spot speed at the above mentioned area.

Table 9:
Traffic volume for all directions.

Sl. No.	Direction	Total PCU for 14 hours
1	AMC College to Jalli Machine Bus -Stop	13150
2	Jalli Machine Bus -Stop to AMC College	11279

The level of service for the junction is calculated using the data collected and tabulated in the Table 10.

Table 10:
Obtained LOS for AMC College to Jalli Machine Bus -Stop

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
AMC College to Jalli Machine Bus -Stop	1643.75	28.62	0.70	B

Table 11:
Obtained LOS for Jalli Machine Bus -Stop to AMC College

Direction	Avg. Volume PCU /hr.	Avg. Speed, K.P.H.	V/C Ratio	LOS
Jalli Machine Bus -Stop to AMC College	1409.87	29.25	0.60	A

IX. RESULTS

A. Gottigere to Koli Farm Gate:

The traffic volume and existing capacity of Gottigere to Koli Farm Gate road is 2151 PCU/hr and speed of 28.9 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 0.92, thus the LOS of the road is 'D'

B. Koli Farm Gate to Gottigere:

The traffic volume and existing capacity of Koli Farm Gate to Gottigere road is 2387 PCU/hr and speed of 28.74 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 1.02, thus the LOS of the road is 'D'

C. Koli Farm Gate to AMC College:

The traffic volume and existing capacity of Koli Farm Gate to AMC College road is 1660 PCU/hr and speed of 29.15 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 0.73, thus the LOS of the road is 'C'

D. AMC College to Koli Farm Gate:

The traffic volume and existing capacity of AMC College to Koli Farm Gate road is 1694 PCU/hr and speed of 28.79 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 0.72, thus the LOS of the road is 'C'

E. AMC College to Jalli Machine Bus – Stop:

The traffic volume and existing capacity of AMC College to Jalli Machine Bus - Stop road is 1643 PCU/hr and speed of 28.62 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 0.70, thus the LOS of the road is 'B'

F. Jalli Machine Bus – Stop to AMC College:

The traffic volume and existing capacity of Jalli Machine Bus - Stop to AMC College road is 1409 PCU/hr and speed of 29.25 K.P.H. respectively. Therefore the volume to capacity ratio obtained from the analysis is 0.60, thus the LOS of the road is 'A'

X. FUTURE ENHANCEMENT

In view of rapid urbanization, the city is experiencing change in environmental conditions and disintegrated physical developments. Thus, there is a need to approach the entire galaxy of urban problems in a more comprehensive manner and plan for its orderly development. The study aims at achieving sustainable transport, increased public transport ridership, safe and comfortable walkways, etc by minimizing the traffic impact on the study area. To improve the traffic performance, it is important to adopt several alternatives to reduce the stopped delay time and improve the level of service. To attain a better LOS we can recommend the following:

- 1) The presence of pot holes & cracks on the surface layer of the pavement should be treated so that the operating speed at the junction can be increased.
- 2) Wherever necessary overlaying of the surface layer should be done.

XI. CONCLUSION

- The present investigation concludes that the Gottigere to Koli Farm Gate of Bannerghatta road has a LOS of 'D' which means the vehicle approaches unstable flow, with tolerable operating speeds being maintained though considerably affected by changes in operating conditions.
- Koli Farm Gate to Gottigere stretch has also a LOS of 'D'. Approaching unstable flow, affected by changes in operating conditions.
- Koli Farm Gate to AMC College has a LOS 'C' which means the number of vehicles stopping is significant, though many vehicles still pass through without stopping.
- AMC College to Koli Farm Gate has also the LOS 'C' which means the number of vehicles stopping is significant, though many vehicles still pass through without stopping.
- AMC College to Jalli Machine Bus – Stop has a LOS 'B' which means the numbers of vehicles are still in the zone of stable flow, but speeds and manoeuvrability are mostly controlled by higher volumes.
- Jalli Machine Bus - Stop to AMC College has a LOS 'A' which means most vehicles do not stop. There is free flow, with low volumes and high speeds.

REFERENCES

- [1] Bangalore City Traffic Police (2010) "Traffic Management Centre" <http://www.bangaloretrafficpolice.gov.in> (2012) , accessed on 10th nov.2012.

- [2] "Traffic and System Under Mixed Traffic Conditions" by Srinivasan N.S., Indian Highways Vol. 65, pp 33-36, Nov. 1995.
- [3] "A Study of traffic Flow characteristics on two stretches of national highway (NH-5)" by P.K Sahoo, S K Rao and V M Kumar, Indian highways, pp. 11-17, April 1996
- [4] "Strategic Urban transport Planning- A System Dynamic approach" by Dr. M Satya Kumar and G. Arunkprakash, Indian Highways Vol 29 No. 11 pp 43-51, Nov 2001
- [5] Transportation Research Board, Highway Capacity Manual, 2000.
- [6] IRC: 106-1990. "Guidelines for Capacity of Urban Roads in Plain Areas". Indian Road Congress, New Delhi.
- [7] Dr. L.R. Kadyali. "Traffic Engineering and Transportation Planning". Khanna Publishers, Seventh Edition 2007.