

# Effect of Improper Bus Stop Locations on Capacity and Speed-Flow Relations on Urban Roads



Madhu K A, Rajakumara H N.

**Abstract—**India is a developing nation which faces different traffic issues. Among which side friction is one of the serious issues in many urban communities. Side friction can be characterized as every one of the exercises which are going on or alongside the roadway office, it incorporates moderate moving vehicles, roadside seller, on-street parking, walker intersections, inappropriate bus stops, and so on so this paper is for the most part centered around how improper bus stop areas influences the capacity and speed-flow for urban roads. The present work goes for breaking down the effect of roadside frictions on traffic attributes of urban streets in India. The investigation was led on urban streets in a portion of the thickly populated urban communities. The side friction elements were restricted to improper stops. We have conducted a floating car method from Yelahanka NES to Banashankari. From this survey, we got the congestion index value. Along with this we have also conducted a spot speed survey at both ideal and non-ideal bus stops and got the modal speed. The outcome demonstrated that there was a noteworthy effect of side friction on vehicular speed on urban streets and could likewise realize the degree of the effect of individual factors on speed. The outcomes feature the need to incorporate side friction factors on all traffic-related examinations for appropriate planning of urban street

**Index Terms—**Side friction, improper bus stops, public transport, speed flow, capacity, ideal bus stops, modal speed

## I. INTRODUCTION

The urban transportation is acting as a key to each economical communication in all urban over the world. The increase in urban population growth tends to increase vehicular growth and travel demand. Typical urban transportation facilities include railways, waterways, airways and roadways. Among all categories, the big proportion consist of roads. Logically, most planning and research techniques are focused on road system. Many arterial roads exhibit deteriorated capacity and poor performance. Many researchers have studied about urban traffic problem in some developing countries and found that because of urbanization, there is often great deal activity on and along the roadsides which influences the performance of smooth traffic flow and capacity of the road network which is known as side friction.

The urban roadway capacity is influenced by various factors like speed of the vehicles, width of road, structure of the road, construction work on roads, shoulder and roadway width, access points, terrain etc. How ever for urban roads, the impact of side friction i.e.,

bus stops, encroachments, on street parking, pedestrian crossing, entries and exit from major roads etc are also much significant by reducing the side friction like improper bus stops can effectively enhances the capacity of roads.

Transportation infrastructure is one of the back bones of any country. For sustainable development, an economy has to ensure proper supply of transportation facilities. One of such facility is the public transportation system of the city. More efficient use of urban spaces, and space allocated to transport in particular can improve operational conditions for public transport. In this work, primary concern is bus stop locations on the urban roads and the consequences for traffic stream properties. A bus stop is a designated place where buses stop for passengers to board or alight the bus. Bus stops primarily conflict with other passing vehicles when buses maneuver to pull into and out of the stop. When bus stops located on the carriageway, buses blocking the curbside traffic lane during their occupancy period or dwell period due to reduced width of the roadway or due to erratic behavior of driver. This bus stop also creates problems when attempting to re-enter the traffic, especially during the peak-hour period of high roadway traffic volumes

## II. ABOUT BENGALURU CITY TRANSPORTATION SYSTEM

### Transportation system in Bangalore city

Bangalore transportation system can be classified into two ways,

- External Transportation system
- Internal Transportation system

### External Transportation system

External transportation system is the one which connects the Bangalore city with other cities/states. Kempegowda International airport (formerly known as Bangalore international airport) connects Bangalore to majority countries of the world directly. These external transportation systems affect considerably the mobility of the city.



Manuscript published on 30 September 2019

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## Internal Transportation system

Internal transportation system is the one which is considered as local streets of the Bangalore city which carries the daily traffic of the city.

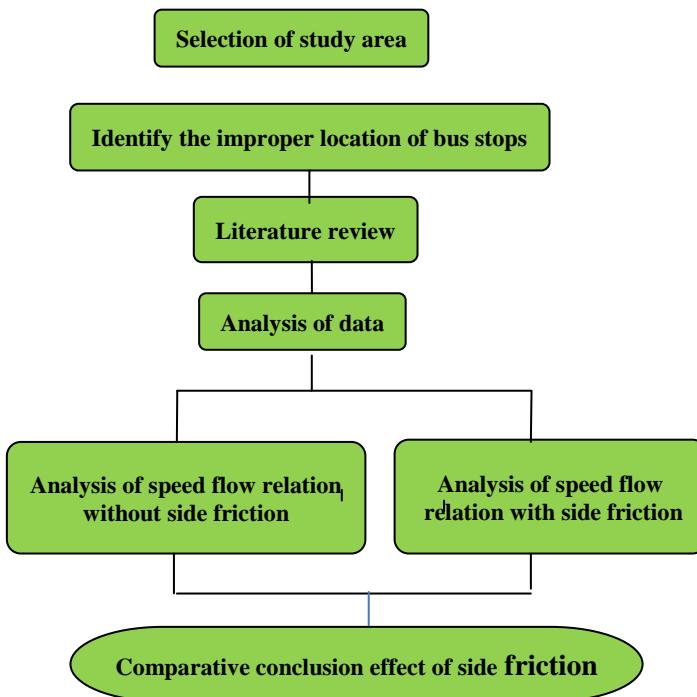
Bangalore city has 1000 Sq. km of area 4500 km of road, 40,000 intersections, 330 signalized intersections, 660 manned intersections.

## Bangalore City Traffic:

Bangalore is one of the fast developing urban communities on the planet, which is because of the expanded improvement in the city, for example, IT parks, increment in number of instructive foundations and because of accessibility of better offices. This fast increment in the populace builds the vehicle populace development in the city. Extra to this, Bangalore city has exceptionally contract lanes and degree for further broadening and increment in area use for the transportation is extremely hard to accomplish. This effect straight forwardly on the vehicles handling out and about i.e, clog out and about expansions hence diminishing travel time, increment in fuel utilization, increment in number of mischance's and other increment in impalpable impacts. Ampleness of the present activity in the city is measured by volume to limit proportion known as V/C ratio.

## III. DATA & METHODOLOGY

### A. Methodology adopted



- **Selection of study area:** The study area should be such that it includes some problem so that a solution can be found with the knowledge of the problem, consequences in future and effects of the solution.

➤ **Identify the improper location of bus stops.:** This process comprises the identification of bus stops in study area and categorized in two ideal and non-ideal bus stops based on IRC specifications

➤ **Traffic Surveys and collection of data:** Traffic surveys such as a) Origin – destination survey, b) Time and delay study, c) Speed study d) inventory on roads has conducted on the selected study area so that the volume of vehicles ,capacity of roads ,modal speed can be obtained and effect improper bus stops on capacity and speed flow relation in terms of statically approach is found out.

➤ **Analysis of data :** based on the data obtained the speed flow relations are drawn to analysis the effect of side friction i,e improper bus stops on speed flow relation

### B. Study area

The selected stretch of the city originating from Bangalore North(Yelahanka) to Bangalore South (Banashankari) passing through Central Business

- District(C.B.D) is assessed through the set of performance indicators known as Mobility Indicators.
- Study area is selected based on the key issues like presence of IT parks, small scale industries, connection of zone to other higher road network like National / State highway. The study area is divided into two zones based on the distance to the C.B.D
- Zone 1 originates from Bangalore North (Yelahanka) and this zone ends at C.B.D of the city.
- Zone 2 originates from C.B.D of the city and ends at Bangalore South (Banashankari).



Figure.1: Study area (Zone 1)

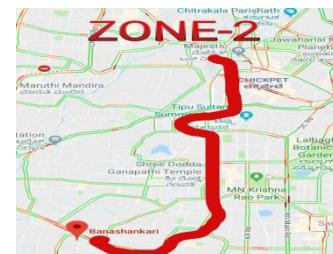


Figure.2: Study area (Zone2)

### C. Side friction

Side friction variables are characterized as those exercises which happen on the sides of carriageways or even on the carriageways that are probably going to influence the normal traffic moving through the carriageways. Side friction is a composite variable portraying the level of association between the traffic stream and exercises along the side(s) and in some cases crosswise over or inside the traveled way.

They influence the speed stream attributes, diminish the limit of streets and are inconvenient to the wellbeing of workers and other street clients.

#### Road side friction like

- Improper bus stoppage.
- On street parkings.
- Pedestrian traffic.
- Frequent side roads.
- Turning movements.
- Trading activities

#### ➤ Improper stopping of bus stop

At most of the curbside bus stops in India, a rectangle with width 3.3 to 4 m (nearly equal to the outer lane width) and length of around 15 to 20 m (1.5 to 2 times bus length) is marked to designate the bus stopping region. When buses stop within a single lane width (the designated area), it can be considered as a proper stop.

Reasons for improper bus stopping: From the collected traffic videos, various reasons were identified for the improper stopping of buses. These reasons are elaborately discussed below

#### ➤ Passengers waiting for the bus on the roadway:

It has been observed that just before the stopping of a bus at the designated bus stop, passengers step out from the bus stop platform onto the road. It is one of the most common sights during peak hours in a developing country like India. This happens when the bus stop platform is over-crowded or when there is a rush of passengers to find a seat on the bus. This situation does not allow the bus driver to halt the bus near the designated stopping region.

#### ➤ Standing vehicles near the bus stop:

On-street parking is restricted by law on both the road sections considered in this study. However, many standing vehicles (often stayed for less than a couple of minutes, hence not termed as parked vehicles) were spotted near the bus stops. Most of these vehicles are auto-rickshaws or taxis which stop momentarily to either pick up or drop off passengers. Although not quite frequent, in some cases we observed that some passengers were accompanied by their friends or family members to the bus stop. These people park their vehicle near the bus stop and wait till the companion boards the bus.

#### ➤ Presence of previously stopped bus:

There are a few cases when two or more buses stop one after another almost at the same time near the bus stops. In such situations, even when the first bus dwells correctly in the designated area, the next buses may not exactly stop behind the first bus.

#### ➤ Erratic behaviour of bus drivers:

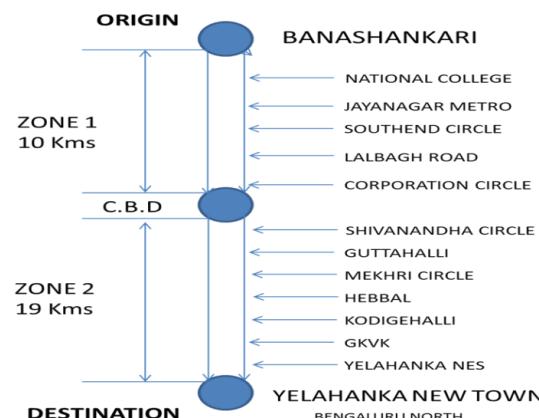
In some situations, bus drivers stop the bus outside the designated area, although there is no specific reason. Such situations are considered as erratic bus driver behavior. This erratic behavior could be due to multiple reasons. Bus drivers have a general tendency to stop the buses away from the bus stop so as to merge back into the traffic stream quickly. This happens during the peak hour traffic when the buses are running behind the schedule and drivers try to offset the delays. In some cases, passengers request the bus driver to stop

Name of bus stops	Facility of separate bus bay
YELANKHA NES	YES
GALLERIA RESIDENCE	NO
ALLASANDRA FLYOVER	NO
GKVK	NO
BYATRANPURA	NO
KODIGEHALLI	NO
ESTEEM MALL	NO
HEBBAL	NO
CBI	NO
MEKHRI CIRCLE	NO
PALACE GROUND	NO
GUTTHALI	NO
SHIVANANDHA STORES	YES
CENTRAL	NO
KEMPEGOWDA BUS STOP	YES
POLYTECHNIC COLLEGE	NO
K R CIRCLE	YES
CORPORATION CIRCLE	YES
BBMP BUS STOP	YES
LALBHAG MAINGATE	NO
LALBHAG ROAD	NO
LALBHAG WEST GATE	NO
R V TEACHERS COLLEGE	NO
VIJAYA COLLEGE	NO
SOUTHEND CIRCLE	NO
JAYANAGAR METRO	NO
NATIONAL COLLEGE	NO
BANASHANKARI BMTC	YES

at the moment their bus is passing the bus stop. These passengers do not typically realize that their destination bus stop has been approached. Even in those cases, bus drivers find it difficult to stop closer to the designated stopping region.

#### D. Inventory on bus stops

The details of the study area, indicating origin, destination, roads and intersections of higher importance and the distance of two zones from the Central Business District (C.B.D) of the city along with various bus stops. In this study if bus stops is having separate bus bay facility those stops will be considered as ideal bus stops which is not having dedicated bus bays those will be treated as non ideal bus stops

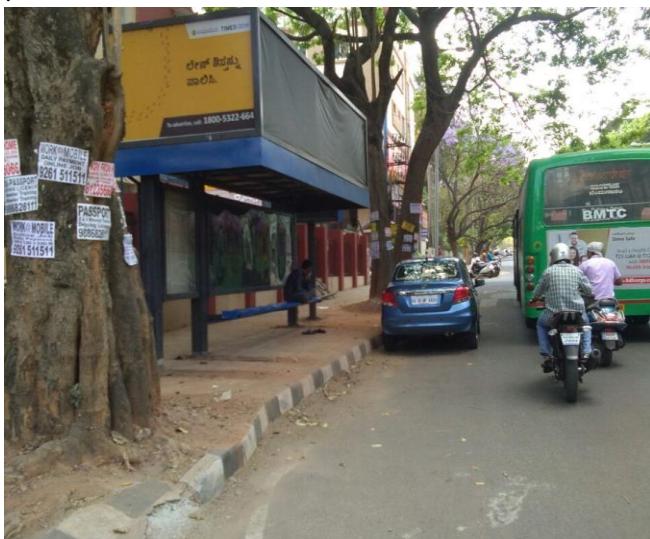


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## E. Bus stop details



**Figure.3 ( Non –ideal) RASTRIYA VIDYALAYA ROAD , JAYANAGAR BUS STOP**



**Figure.4 MAIN ROAD JAYANAGAR BUS STOP(A car passing through the gap between bus and bus stop)**

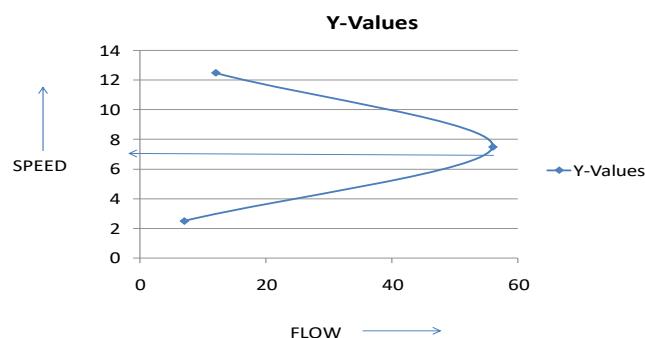


**Figure.5 ( ideal bus stop ) BBMP BUS STOP**

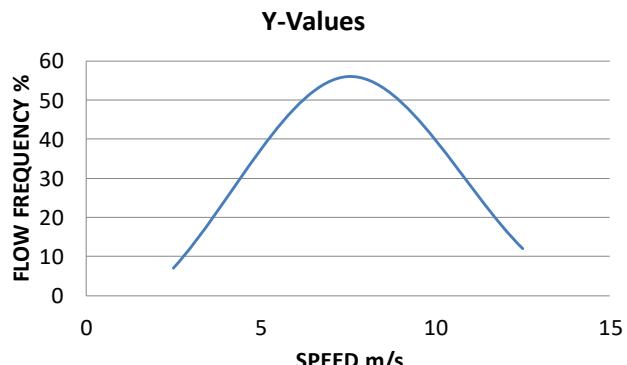
## IV. RESULTS AND DISCUSSIONS

### A. Spot speed study at nes ( ideal bus stops)

SPEED (m/s)	MID SPEED (m/s)	FREQUENCY(f)	FREQUENCY(%)	CUMULATIVE FREQUENCY%
0-5	2.5	7	9.33	9.33
5-10	7.5	56	74.66	83.99
10-15	12.5	12	16	99.99



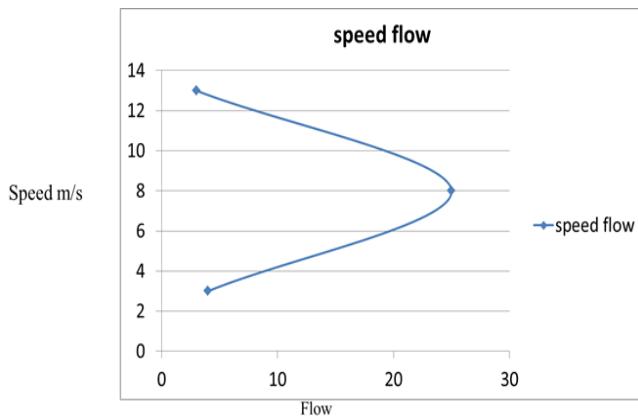
**Figure.6 speed flow relation at NES bus stop**



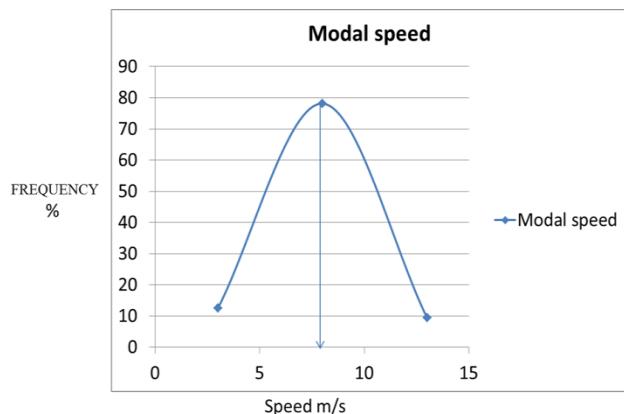
**Figure 7 Modal speed curve at NES bus stop**

### B. Spot speed study at Nrupatunga road (ideal bus stop )

SPEED(m/s)	MID SPEED(m/s)	FREQUENCY(f)	FREQUENCY(%)	CUMULATIVE FREQUENCY%
1-5	3	4	12.5	12.5
6-10	8	25	78.13	90.63
11-15	13	3	9.375	100



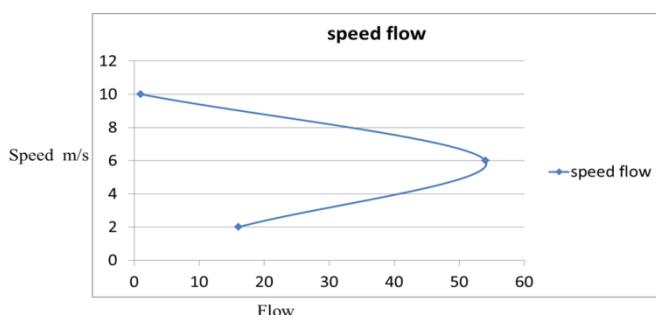
**Figure 8 Speed flow curve at nrupatunga road ( ideal bus stop)**



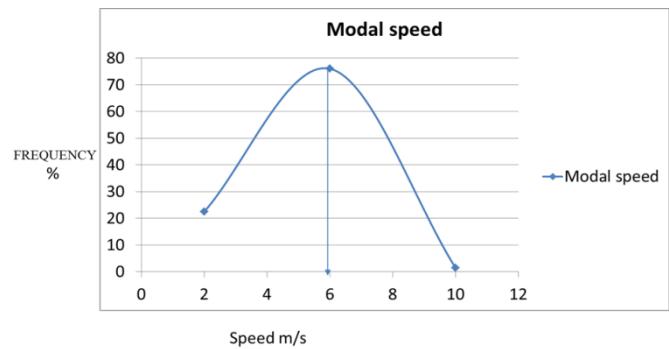
**Figure 9 Modal speed curve at the Nrupatunga road**

**C. Spot speed at r v teachers college(non ideal bus stop)**

SPEED (m/s)	MID SPEED (m/s)	FREQUENCY(f)	FREQUENCY(%)	CUMULATIVE FREQUENCY%
0-4	2	16	22.53	22.53
4-8	6	54	76.06	98.59
8-12	19	1	1.42	100



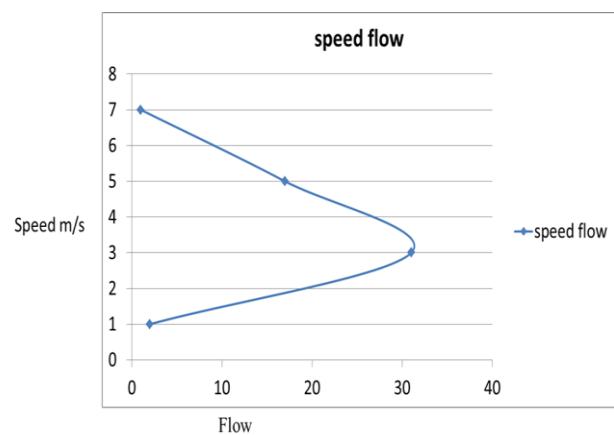
**Figure 10 SPEED FLOW CURVE AT THE RV TEACHERS COLLEGE,**



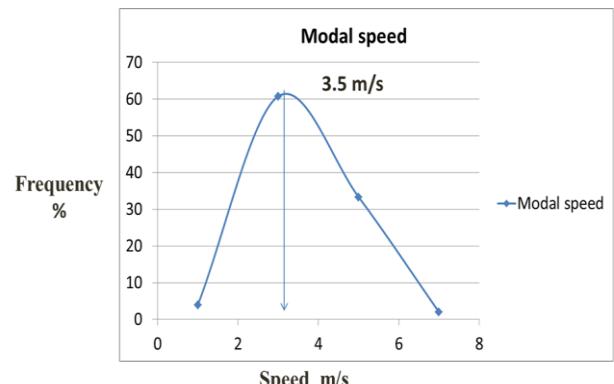
**Figure 11 Modal speed at the Rv teachers college**

**D. Spot speed at palace ground (non ideal bus stop)**

SPEE D(m/s)	MID SPEE D(m/s)	FRE QUE NCY(f)	FREQUENCY(%)	CUMULATIVE FREQUE NCY%
0-2	1	2	3.92	3.92
4-Feb	3	31	60.78	64.7
6-Apr	5	17	33.33	98.03
8-Jun	7	1	1.96	99.99



**Figure 12 Speed flow curve at palace ground**



**Figure 13 Modal speed curve at palace ground**

- The modal speed at NES YELAHANKA bus stop (ideal bus stop) is 8.5 m/s.



## **Effect of Improper Bus Stop Locations on Capacity and Speed-Flow Relations on Urban Roads**

- The modal speed at RV TEACHERS COLLEGE bus stop (non ideal bus stop) is 6 m/s.
- The modal speed at NRUPATHUNGA ROAD near reserve bank (ideal bus stop) is 8 m/s.
- The modal speed at PALACE GROUND stop is 3.5 m/s.
- The occupancy at the ideal bus stop is 52 vehicles.
- The occupancy at the non ideal bus stop is 38 vehicles.



**Dr. Rajakumara H N**, professor & head, civil dept, Sri Venkateshwara college of Engineering, Bangalore. Published 24 papers in various international and national journals. Received AICTE research grants, Department of Science & Technology Research Grant, ISRO research grants also received CAREER AWARD FOR YOUNG TEACHERS (CAYT) from AICTE with a grant of Rs. 10.50 Lakhs for the period of 2003-06.

### **V. CONCLUSION**

The obtained results in terms of model speed and speed flow relation clearly shows the effect of improper bus stops on speed flow relation the modal speed or most preferable speed is reduced when buses stops at non ideal bus stops from the analysis of data we can judge that On-street bus stops will interfere with vehicles movement if bus demand exceeds the bus stop capacity, resulting in some buses queuing and congestion. All the bus stops are on-street bus stops which are heavily congested during peak hour. To overcome this problem, this work suggesting proposal are Providing proper Bus Bay of suitable design. On street Parking should be restricted on both opposite side bus stops, curbs should be extended in order to Increase on-street parking by eliminating need for taper associated with bus pullouts ,Increase space for bus stop amenities

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