A REVIEW ON EFFECT OF SIDE FRICTION ON URBAN ARTERIALS

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Abstract: India's transport sector is large and diverse but it faces various traffic problems. Side friction is one of the major problem in metro cities. Side friction can be defined as activities along the sides or going on the travelled way which disrupt traffic flow. It includes but not limited to pedestrian, non-motorized vehicles (NMV), on road parked vehicles, slow moving vehicles (SMV), roadside vendors. The all factors are frequent in developing countries but they are sparse and inconsequent. But in day to day life everyone is interacting with the factors of side friction. This paper is mainly focused on various studies reported with regards to the effect of side frictions in a capacity of urban arterial and gives a suitable measure.

Index Terms **- Road Side Friction, Capacity, NMV, Passenger Car Unit, Traffic, Shoulder activities.**

1. INTRODUCTION

India is experiencing tremendous growth in vehicle and travel demand due to rapid urbanization. Increase in vehicular population along with shortage of urban road space is occur roadside frictions. Roads are the dominant mode of transportation. Road side friction is one of the factor of roadway which affected the capacity of an urban road include lane width, gradient, lateral clearance, capacity and traffic flow. Road side friction can be illegal on-street parking, pedestrian movement, presence of street hawkers, roadside bus stop, encroachment by shop owners, slow moving vehicles and so on. Activities likely to disrupt traffic flow include the following;

1. Blockage of the travelled way (i.e. reduction of effective width):
   - » Public transport vehicles which may stop anywhere to pick up and set down passengers
   - » Pedestrians crossing or moving along the travelled way
   - » Non-Motorized vehicles and slow-moving motor-vehicles
   - » On road parking
2. Shoulder activities:
   - » Parking and un-parking activities
   - » Pedestrians and non-motorized vehicles moving along shoulders
3. Roadside activities:
   - » Roadside accessibility including vehicles entering and leaving roadside premises via gates and driveways
   - » Trading activities (i.e. food stalls, vendors), and movement of vehicles and pedestrians depending on land use type.

1.1 IRC Guidelines

Urban roads in India are characterized by mixed traffic conditions, resulting in complex interaction between various kinds of vehicles (IRC-106, 1990). In urban roads speed difference among the different classes of vehicle is generally low, and as such the PCU factors are predominantly a function of physical dimensions of the various vehicles. The suggested values for PCU are given in table 1.

Table 1 The suggested values of PCU factors

Sr. No	Vehicle Type	Equivalent PCU factors	
		Percentage composition of vehicle type in traffic stream	
		5%	10% and above
	Fast Vehicles		
1	Two-Wheeler, Motor cycle, Scooter	0.5	0.75
2	Passenger Car, Pickup vans	1	1
3	Auto Rickshaw	1.2	2
4	Light Commercial Vehicle	1.4	2
5	Trucks or Bus	2.2	3.7
6	Tractor Trailer	4	5
	Slow Vehicles		
7	Cycle	0.4	0.5
8	Cycle Rickshaw	1.5	2
9	Tonga (Horse Drawn)	1.5	2

10	Hand Cart	2	3

Capacity of urban roads is another function of the roadside fringe conditions, e.g. parking, extent of commercial activities, frontage access and so on. IRC has defined the types of urban roads as arterials, sub-arterials, collectors. Design service volumes for different categories of urban roads as suggested in IRC: 106, 1990 are given in Table 2.

Table 2 Design service volumes for different categories of urban roads

Sr. No.	Type of Carriageway	Total Design Service Volumes for Different Categories of Urban Roads		
		Arterial	Sub- arterial	Collector
1	2-Lane (One-Way)	2400	1900	1400
2	2-Lane (Two-Way)	1500	1200	900
3	3-Lae (One-Way)	3600	2900	2200
4	4-Lane Undivided (Two-Way)	3000	2400	1800
5	4-Lane Divided (Two-Way)	3600	2900	-
6	6-Lane Undivided (Two-Way)	4800	3800	-
7	6-Lane Divided (Two-Way)	5400	4300	-
8	8-Lane Divided (Two-Way)	7200	-	-

1.2 Need of Study

Roadside markets, vendors and food stalls are common problems in every Indian city. It will attract people to stop by, which reduce the effective road width due to roadside parking of vehicles. Due to the lack of pedestrian facilities, people used to walk on or along the road which disturbs the traffic flow. Another problem of SMV and NMV on urban roads also contributes to side frictional events. Many of the above-stated problems are arises due to lack of facilities such as parking, pedestrian and terminal facilities on urban road links. Also, commercial development on roadside, the market area also contributes to these factors.

2. LITERATURE REVIEW

Indian urban cities are generally overcrowded which faces problems due to side friction activities. Activities are often going on or along the carriageway of the road which interacts with ongoing traffic flow and affects traffic flow parameters. These activities are also presented on a rural road but its severity is less. The studies conducted in the literature to assess the side friction on the urban roads and analyze the service performance of the roadways which are explained below.

- **Analysis of Side Friction on Urban Arterials**

(Guvindala & Mehar, 2018) analyzed the effect of side friction activities on the speed of vehicles. They suggest model to estimate average speed of vehicular stream with the effect of side friction and volume on the road section for Warangal city of Telangana state. For measurement of side friction, procedure given by Pal and Roy (2016) was adopted. According to that the pedestrian influencing area as standard parameter to calculate equivalent pedestrian units for the events other than pedestrian. Speed prediction model was developed taking flow and side friction as independent parameters. RMSE found as 14% and Chi-square test was performed to validate the model on the test site and found the speeds predicted were statistically significant.

(Shalini, George, & Ashalatha, 2016) worked on impact of roadside friction in traffic characteristics of urban roads of India. Their study was conducted at major cities of India like Mumbai, Bengaluru and thiruvanathapuram. They concluded that roadside friction was limited to bus-stops, pedestrian crossing & on street parking of vehicles. Multiple liner regression carried out by them & analyse the all stretch to study of effect of roadside friction to all stretches. They carried out video footage from it speed & classified volume is defined at frictional parameters. They done their work in two phases, in first part side friction considering individually & in second part combine effects on all three frictions were considered. The multiple liner regression models were derived for speed prediction based on individual side friction as well as combine situation. Detailed analysis was made from speed prediction models to access variation in friction parameters.

- **Analysis of Side Friction by Capacity on Urban Arterials**

(Islam, et al., 2018) identified the factors which contribute in the reduction of roadway width, to categorize the factors into several groups and also to find the average effective width loss due to side friction. They were performed only for the commercial areas of Dhaka city. To resolve the side friction, they gave recommendations.

(Rao, Velmurugan, & Lakshmi, 2017) reviewed the literature on the impact of different types of fictional activities on urban roadway capacity and speed. They used video graphic technique to collect traffic data. Number plate survey is conducted for every 15min during morning and evening peak hours to find intensity of the on-street parking. Global Positioning System (GPS) were used to collect the segmental speeds over the selected sections using floating car technique. They concluded that; Road side friction also caused capacity reduction because of temporary bottlenecks created by on-street parking, entering exiting bus from bus bay and bus present at kerb side bus stop. In some study section considerable variation in capacity reduction is seen using static and dynamic PCUs because of high percentage heavy vehicles.

(Gajjar & Mohandas, 2016) studied critical Assessment of road capacities on major arterial, sub-arterial and collector roads spread across Mumbai through manual as well as video graphic techniques. Based on the collected data, the existing traffic volume per lane was ascertained during peak morning and evening hours. It has been compared with the maximum road capacity values specified as per IRC 106-1990 for urban roads to critically analyzed the existing capacity potential of major roads in Mumbai. From all the consideration, they were suggested to update urban road capacities in order to bridge the gap between predicted capacities and observed volumes.

(Munawar, 2011) carried out survey at congested urban roads (with high side friction) in the city of Yogyakarta during peak hours, to analyze the effects of the characteristics of urban roads. He compared the results to the capacity and speed predicted by Indonesian HCM. He was also compared the actual speed-flow relationship and that predicted by Indonesian HCM. It was found that the capacity and speed predicted by Indonesian HCM are too high. The effects of side frictions, e.g.: on street parking, city bus stopping anywhere on the roadway (there is no specific bus stop for city bus), exit/entry vehicles and U-turn vehicles were higher than those predicted by Indonesian HCM. He recommended a new formula to improve the Indonesian HCM in calculating the speed and capacity for urban roads with high side friction.

(Chandra & Kumar, 2003) presented new concept to estimate the passenger car unit (PCU) of different types of vehicles under mixed traffic conditions. Data were collected at ten sections of two-lane roads in different parts of India. The width of carriageway ranged from 5.5 to 8.8 m. All vehicles were divided into nine different categories and their PCU's were estimated at each road section. It was found that the PCU for a vehicle type increases linearly with the width of carriageway. It was attributed to the greater freedom of movement on wider roads and therefore a greater speed differential between a car and a vehicle type. The capacity of a two-lane road also increases with total width of the carriageway and the relationship between the two follows a second-degree curve. This relationship is used to derive the adjustment factors for substandard lane widths and the results are compared with literature.

- **Analysis of Side Friction by Speed & Flow on Urban Arterials**

(Patel & Joshi, 2014) studied for Sustainable urban transportation for efficient utilization of road space in cities in the most effective way while planning for any expansion or enhancement. They were carried out six lane divided urban arterial road in Patna and Pune city of India. Both the arterial roads having difference condition of the carriageway and the composition. Videography techniques were carried out for traffic data collection. Speed flow relationship was developed and capacity was determined. They concluded that the road side parking, Presence of the NMV reduced the speed and the carrying capacity of the road. Also analyzed the traffic flow characteristic, classified vehicular volume and speed behavior on midblock section of divided urban multilane arterial road of Pune and Patna cities of India.

(Dhamaniya & Chandra, 2013) demonstrated the effect of traffic composition on the speed distribution on a section of a multilane divided urban road under mixed traffic conditions. The Speed Spread Ratio (SSR) defined that is a good predictor of normality in the speed data. The effect of city size on free speed of car was also investigated and it was found that free speeds are higher in large cities. It may be attributed to more driving experience and better road surface conditions in a big city like New Delhi.

(Jungwook, 2009) studied the variability in speed patterns & congestion characteristics at freeway system especially on holiday traffic. He worked on safety improvement & congestion mitigation can be prepared for to avoid congestion in holiday schedule. The study evaluated the traffic congestion patterns during thanksgiving holiday period by Gaussian mixture speed distribution estimated by Expectation Maximization (EM) algorithm. The study suggested that the matrix model by EM algorithm can used to properly analyse & characterized suavity & variability of congestion in roadway systems.

(Aronsson & Bang, 2005) evolved research methodology which included a wide range of stationary and mobile field surveys. Controlled experiments in a driver simulator programmed to represent the studied field sites were also carried out. In a second stage of the project a microscopic simulation model will be calibrated to represent the observed driver behaviour on different types of arterials and streets. The model will then be used to produce speed patterns and speed flow relationships for the studied range of street types and conditions, which will assist traffic planners and engineers in the design and traffic management of urban streets that will be more functional for their purpose as well as safer for their respective users.

- **Analysis of Side Friction by Level of Service (LOS) & Bus Stop on Urban Arterials**

(Pal & Roy, 2016) studied on impact of side friction on travel speed and Level of Service. Mid-block sections of three rural highways adjacent to Kolkata were selected as study sections. Based on data collected from three study sections, speed-flow curves were developed for various side friction levels and five-threshold values for LOS are suggested considering operational speed and freedom of manoeuvre as measure of effectiveness. HETROSIM simulation model was used to estimate PCU factors for heterogeneous traffic for wide range of upgrades. Regression curves were analysed based on four classical models: Greenshields, Greenberg, Underwood, and Bell-shape models and compared using data collection.

- **Analysis of Side Friction by Traffic Characteristics & Performance on Urban Arterials**

(Arasan & Arkatar, 2010) developed microsimulation model of heterogeneous traffic flow named, HETEROSIM Arasan and Koshy2005 was used to study the vehicular interactions, at microlevel, over a wide range of traffic flow conditions. Field data collected on traffic flow characteristics such as free speed, acceleration, lateral clearance between vehicles, etc., were used in calibration and validation of the simulation model. They found the traffic composition & capacity of 4 lane traffic flow at one direction by, speed & volume curves & simulation model.

(Chandra & Sikadar, 2000) analyzed the common practice of mixed traffic flow was to convert all vehicles into equivalent numbers of passenger car units (PCUs). They suggested a mathematical equation relating PCU for a vehicle type to the influencing variables. The variation of PCU with traffic and geometric variables was explained graphically. A computer program suitable for running on a personal computer was developed to estimate the PCU value for a vehicle type under given conditions of composition and traffic volume per lane width.

3. CONCLUDING REMARKS

From above discussion, it can be concluded that overall performance of traffic parameters is affected due to the presence of side friction. In some study they took speed is a major factor that affects the capacity and level of service of the roads. Heterogeneous traffic which consists of slow moving vehicles and non-motorized vehicles, reduce the effective road width due to roadside parking of vehicles and other parking are some of the obstacles that degrade its performance. The side frictional parameter in the calculation of speed and capacity are already includes in Indonesian highway capacity manual and IRC 106-1990 guideline. Generally, heterogeneous traffic conditions are found in the cities such as Delhi, Pune, Patna and other cities. It will need further study to counteract the ill effect of side activity on urban roads.

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