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Effect of Side Frictions on Traffic Characteristics of Urban Arterials

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Abstract

The urban transportation system is the hub of all economic activities in urban communities all over the world, and thus sustains livelihood of the people living there. The increase in population has led to increase in vehicular population. The land resources being constant, this vehicular growth has adverse effect on smooth traffic flow. Increase in vehicular population along with shortage of urban road space is manifested in the form of road side frictions. Side friction factors are defined as those activities which take place on the sides of carriage ways or even on the carriage ways that are likely to affect the normal traffic flowing through the carriage ways.

The present work aims at analyzing the impact of road side frictions on traffic characteristics of urban roads in India. Study was conducted on urban roads in some of the thickly populated urban cities like Mumbai, Bengaluru and Thiruvananthapuram. The side friction factors were limited to buses stopped at bus stops, pedestrians walking along sides of carriage ways and on-street parking of vehicles. Multiple linear regression analysis was chosen to relate the factors contributing to reduction in speed caused by side friction factors. Reduction in speed was studied for stretches with individual side frictions as well as stretches under the combined effect of all the factors. The result showed that there was significant impact of side friction on vehicular speed on urban roads and could also bring about the extent of impact of individual factors on speed. The results highlight the need to include side friction factors on all traffic related studies for proper planning of urban roads.

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Keywords: Side frictions; bus stops; pedestrians; on-street parking; speed prediction

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1. Introduction

Rapid urbanization has resulted in increase in vehicular growth. This increase in vehicular population along with shortage of urban road space is manifested in the form of road side frictions. Road side friction like buses stopping at bus stops, parked vehicles, pedestrian traffic, frequent side roads, turning movements, trading activities etc. which impede the smooth flow of traffic are unique features found along urban roads in developing countries. These road side friction along with heterogeneous traffic conditions prevalent in developing countries, have a detrimental effect on capacity of urban roads as well as pose a serious threat to the safety of road users. Quantification of these side friction factors is a challenging task to traffic engineers.

Urban and suburban road stretches in developing countries like India are marked by large amount of side frictions. Side friction is a composite variable describing the degree of interaction between the traffic flow and activities along the side(s) and sometimes across or within the travelled way (Bang, 1995). They affect the speed flow characteristics, reduce the capacity of roads and are detrimental to the safety of commuters and other road users. Slow moving vehicles, buses stopped at curb side bus stops, pedestrians walking along the sidewalks and crossing the roads at their whims and fancies, vehicles parked along the carriage way, entry and exit from approach roads etc., can be listed as major side friction elements seen on urban corridors of developing countries like India. In the present study, attempt was made to develop a methodology for estimating the effect of road side frictions on urban traffic flow characteristics. The scope of the study is limited to estimating the effect of the three major side friction factors identified on Indian four lane divided urban roads, buses stopped at curb side bus stops, pedestrians crossing the road at random and walking along the sides of the carriage ways and on-street parking.

2. Literature Review

Although it is widely accepted that the road side activities affect the normal traffic stream speed reduction and thereby increase in travel time, there are few studies reported which attempts to quantify them. The Highway Capacity Manual (2010) considers impact of road side frictions on urban roads and its effects are included intuitively through the classification systems of highways. The Indonesian HCM (1993) classifies side friction to high and low levels and considers side friction correction factors to be incorporated in the calculation of free flow, saturation flow and capacity. The study conducted by Bang et al. (1995) identified side friction factors commonly observed along urban roads of Asian countries especially, Indonesia as pedestrians, vehicles stopping on shoulders and carriage ways, parking and access to road side premises. Side friction classes were defined for inter urban and urban roads on the basis of weights assigned to each side friction event.

Chiguma (2007) analysed the effect of side friction factors on traffic performance including speed and capacity. He considered various factors and did a macroscopic analysis as well as a microscopic analysis. He introduced a new concept of 'FRIC' to incorporate the combined effect of all side friction factors. Since the units were not the same for the different friction factors, they were combined using a ranking process which enabled to express them using one unit coded 'FRIC'. Munawar (2011) considered side friction factors like on street parking, city bus stopping anywhere on the roadway, exit/entry vehicles and U-turn vehicles and found that their impacts were higher than those predicted by Indonesian HCM. A new formula was recommended to improve the Indonesian HCM in calculating the speed and capacity for urban roads with high side friction.

There are few studies reported from India, though limited in number in which attempts were made to analyze the effect of bus stops and pedestrians on heterogeneous traffic. Koshy and Arasan (2005) developed a simulation model to study the influence of bus stops on the traffic flow. The model simulates the non-lane based flow of heterogeneous traffic over a specified length and the width of a roadway incorporating the different types of traffic manoeuvres, at various speeds, acceleration, deceleration, overtaking, etc. The model is capable of simulating the vehicular interactions associated with curb side bus stops and bus bays. In general the reviews showed that a quantitative assessment of individual as well as combined effect of the friction characteristics would be beneficial to planners and engineers in proper inclusion of urban street facilities so as to eliminate the impact caused by them. Chandra et al. (2014) showed that capacity of 6 lane urban road reduces to almost half when pedestrian crossing volume is 1360 peds/hr. Based on a mathematical model developed, they concluded that pedestrian crossing of about 100 peds/hr would reduce the capacity by 3.52%. Indian Roads Congress (IRC) 106-1990 (1990) recognizes the impact of side friction on capacity. But no specific methodology or guidelines are given to analyze/quantify the