REVIEW OF STUDIES ON TRAFFIC PARAMETERS FOR HETEROGENEOUS CONDITION

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ABSTRACT

The traffic circumstances in developing economies are primarily different from that of the developed economies. Traffic density of motorized and non-motorized of two-wheelers and three-wheelers along with numerous other vehicles with no-lane discipline are termed as heterogeneous. This heterogeneous traffic is without a doubt different from the one with the occurrence of trucks which has also been termed as heterogeneous traffic. The concluding is mostly tranquil of passenger cars and can be aptly termed as ‘‘homogeneous’’ traffic, whereas the previous is composed of vehicle types with a wide range of static and dynamic characteristics, which reside in the identical right of way, follow-on in an unsynchronized association of the vehicles. Another individual characteristic of this traffic is the lack of lane-discipline, resultant from the wide difference in sizes and maneuvering abilities of any motorized or non motorized vehicles. These distinctions result in some phenomena like vehicle creeping, which are missing in the homogeneous traffic. Therefore, this type of traffic can be referred to as ‘‘heterogeneous disordered’’ or ‘‘mixed’’ traffic. An evaluation of the literature has shown that most of the studies in such traffic make use of the methods and concepts developed for heterogeneous traffic. A small amount of studies have attempted to capture and understand the distinctive characteristics of the mixed traffic. The main purpose of this paper is to provide a review of the studies on different mixed traffic characteristics in developing economies, identify their limitations and provide guidelines for the future research. In addition, a detailed methodology of the recreation process for the mixed traffic is given, reflecting the ‘‘gap filling’’ rather than the conventional ‘‘car-following’’ behavior. An assessment of the past modeling approaches is also presented and the accuracy of their implementation is discussed.

Keywords ***Heterogeneous · Traffic characteristics, Modeling · PCU · Area occupancy***

INTRODUCTION

Road traffic flow in India displays a heterogeneous mix condition where in vehicles possessing distinguished physical and operational attributes constitute the vehicular flow. The behavior of homogeneous flows, commonly observed in the developed Western nations, is characterized by a strict lane discipline and single-file motion of vehicles with restricted movement across the lanes. A heterogeneous flow, on the contrary, is differentiated by the presence of a loose lane discipline and use of the entire road space without any confinements for maneuvering. The lateral movement of vehicles, apart from usual longitudinal motion, results in mass queue formations that operate two-dimensionally. Furthermore, wide ranging vehicle types moving in these traffic flows add to the dynamic quality of the flow. With considering behavior of such traffic is ensued by the existence of flow variables that change over space and time. Knowledge about these parameters is, therefore, essential for understanding the nature of a heterogeneous traffic mix moving on the road. Information consequential from parametric studies can provide an important base for accomplishing tasks like road design, planning and operation. In India, facilities of traffic flow control carry a high volume of traffic comprising a variety of public, private and commercial vehicles. They serve a wide range of traffic requirements concerned with infrastructural potential and indirectly affect the economy and commerce of the country.

LITERATURE REVIEW

Significant effort has been devoted, in the last several decades, for accident reduction particularly at intersections. This literature review has examined many of those proposed countermeasures designed to either prevent crashes or reduce injuries in the event of crash at unsignalized intersection. In accumulation, the need of improvements to the effectiveness or methods of execution of current counter measures has been assessed. This research paper presents a review of relevant literature to bring out the background of the study undertaken. The research contribution which have a direct relevance are treated in a greater detail and major findings summarized briefly. Some of the historical work which has contributed greatly to the understanding of the safety concerns of the unsignalized intersections. First, a brief review of the past background is presented. The concept of safety of the unsignalized intersections and work on advance methodologies to improve safety of unsignalized intersections carried out in this research, are then discussed. The amount of the literature on the subject has increased rapidly in recent years, particularly to improve safety of intersection, several of this is available in the proceedings of the conferences which are very helpful to understand the recent developments in traffic engineering.

applied to quantitatively evaluate highway intersection traffic safety. The present study planned that conflicts of different cruelty classes can be used in traffic safety evaluation when accident data are hard to obtain and the sample size of stern conflicts is not large enough. TTC (time to collision) was selected as index to judge the severity of conflicts. Evaluation method based on Gray theory had been developed to calculate the grade of intersection safety, using data of common conflicts, serious conflicts, and traffic volume. The method can be useful to estimate protection condition of highway intersection and to identify the safety improving sequence of regional intersections.

Tamil Nadu India, Kanchumurty Anusha, et. al, has presented traffic flow behavior is a complex phenomenon and need better understanding and concepts for its analysis. The mathematical models developed for quantifying the traffic flow are very well knowingly used for prediction of capacity and level of service. The roadway geometric elements plays important role for efficient and safe traffic system design and speed-flow modeling. The highways in India normally operate under mixed traffic conditions and the driving behavior varies from one place to another. Macroscopic models which are quite suitable for describing the behavior of entire stream and further accepted worldwide for estimation of capacity. The present study analyses the macroscopic traffic flow behavior such as capacity estimation and speed flow modeling on multilane highways. Traffic flow data collected on a section of four lane divided highway are used to develop speed-flow curve. A microscopic traffic simulation model VISSIM has been used in present study for generating traffic flow data which is sometimes very difficult to obtain from field survey. The similar set of field data is used in VISSIM and imitation speed-flow curve is compared with field curve. The VISSIM model parameters those were sensitive to capacity are calibrated based on the traffic composition observed in field by taking measure of effectiveness as traffic volume, speed and capacity. Driver performance parameters CC0 and CC1 are first resolute for homogeneous traffic conditions and then results are aggregated to get the values of these parameters for a mixed traffic stream. Additional analysis of field data with calibrated values of CC0 and CC1 indicated a high-quality match between field and simulated capacity. The procedure is shown to work on another section of four-lane divided highway and validation of model was also performed by the same methodology with the help of VISSIM . The precise determination of relationship between speed and flow is essential under heterogeneous traffic conditions for arriving the capacity of road and to evaluate speed-flow relationships.

2003: Satish Chandra et. al, has presented a new concept to estimate the passenger car unit PCU of dissimilar types of vehicles below mixed traffic conditions is presented. Mixed traffic flow utilizes the area, as opposed to only the length, and speed of a vehicle. Data were collected from ten sections of two-lane roads in disparate parts of India. The width of carriageway this term is normally used in India for the whole width of the paved face of a road excluding its shoulders ranged from 5.5 to 8.8 m. All vehicles categorized in nine part and their PCU's were estimated at each road section. It was establish that the PCU for a vehicle type increases linearly with the width of carriageway. This is recognized 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 traffic flow in a two-lane road also increases with total width of the carriageway and the connection between the two follows a second-degree curve. This connection is used to derive the modification factors for substandard lane widths and the results are compared with literature.

2014: NCHRP 500, Vol.5, Transportation Research Board, has presented Guidelines for Addressing Unsignalized Intersection Collision; The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities by 5,000 to 7,000. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This fifth volume of NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan provides strategies that can be employed to reduce the number of unsignalized intersection collisions[7]. The description will be of exacting interest to safety practitioners with accountability for implementing programs to reduce injuries and fatalities on the highway system

2003: Yuan Li, Yuan Heweiet. al, presented Stop-controlled intersection represent potential hazards because of the priority of movement on the main road.

1999: Preston, H., et. al, research of preston explores the potential safety effects of dynamic signing at rural horizontal accomplish this by asking two key questions. Primary, is there a relationship between a vehicle's speed on the move toward to a curve and the ability to successfully navigate the curve? Secondly, there is a difference between static and dynamic signing in the ability to or reduce the speed of high-speed vehicles? Researchers of traffic flow assembled an off-the shelf hardware and software package and deployed it at a four degree curve along CSAH 54 in rural Dakota County.

VEHICLE CHARACTERISTICS

The traffic in developing economies is composed of vehi- cles with wide variation in physical and performance characteristics. These vehicles include cars, buses, trucks, auto-rickshaws (three-wheelers), and motorized two wheelers and other non-motorized vehicles like bicycles, human and animal-driven carts. The information that these vehicles share the same right of way results in some characteristic features that are missing in the homogeneous traffic conditions. all along with the most important weak lane-discipline behavior, these features include the differences in driver behaviors of different types of vehicles and impacts of these vehicles on the traffic stream as a whole. Hence, the study a heterogeneous or mixed traffic in developing economies, it is essential to understand the characteristics of each vehicle type and their resulting behavior in the traffic stream.

CLASSIFICATION AND SIZES OF THE DIFFERENT VEHICLE TYPES

The traffic flow characteristics and its composition is depending on the study location, researchers classify the vehicles into different categories. This classification serves two purposes:

To compare a set of vehicles with characteristics which reduces the extra burden of each vehicle type with less significant share in the traffic flow?

1. Toallowtheusageofstandardvaluesfortheircharacteristicsavailableintheliterature.

On the other hand, care must be taken to let alone vehicles with significantly different characteristics to be grouped into the same category. Auspiciously, these values agree with each other strengthening their reliability. Vehicle dimensions given by Chandra and Kumar have been widely adopted in the studies of various developing economies.

SPEED AND ACCELERATION CHARACTERISTICS

Speed and acceleration is a fundamental measure in determining various performance and operational characteristics of a highway system like, quality of service, parameter and control of traffic, etc. cooperatively with density and flow, speed forms the essential relation which is the basis for many traffic flow models for homogeneous conditions. However, the idea is not as straight-forward in the mixed traffic. To start with, the average speeds of unlike categories of vehicles vary significantly. A comparatively high variation is found even with in a particular category, because of the different vehicle models present in it. Homogeneous and lane-disciplined traffic are different, where the car-following theory is generally used to determine a vehicle's speed, in mixed traffic, the effect of the interaction of other vehicles on the subject vehicle is hard to quantify, as it is affected by the traffic stream as a whole and the road conditions.

Table 1: Vehicle categories and their dimensions

Category	Vehicles included	Average dimension (m)		Projected rectangular area on ground (m2)
		Length (m)	Width (m)	
Car	Car, jeep	3.72	1.44	5.39
Bus	Bus	10.1	2.43	24.74
Truck	Truck	7.5	2.35	17.62
LCV	Mini bus, vans	6.1	2.10	12.81
Tractor	Tractor trailer	7.4	2.20	16.28
Three-wheeler	Three wheeler	3.2	1.40	4.48
Two-wheeler	Scooter, motorbike	1.87	0.64	1.2
Cycle	Bicycles	1.9	0.45	0.85
Rickshaw	Pedal rickshaw/cart	2.7	0.95	2.56

All the same, several attempts have been made in the pastto include these effects, whose summary is given below.

Hossain and Iqbal conceded out a deterioration analysis to explore the relationship between free-speed and the shoulder width. It was observed that in the case of buses, this do esnotstoutly compare with the shoulder width. Sarna et al. and Kumarand Madhu observed that the traffic stream speed decreases with an increase in the proportion of auto-rickshaws. The 85th percentile speed is taken as a better estimate of the free speed in some studies. New measures is defined as the ratio of the difference between 85th percentile and the signify stream speed to the difference between mean stream speed and the 15th percentile speed. The speed data is creating to follow the unimodal curve only when the spread ratio is within certain range. As different vehicle categories follow normal distribution with different mean speeds, it is not surprising to see the speed data with multiple peaks. However, researchers have observed that, at higher volumes, the high performance vehicles are obstructed by low performance ones and the stream behave as a single platoon, with relatively constant speed. Other modeling attempts of speed include Dhamaniya and Chandra, who proposed a set of simultaneous equa-tions, relating speeds of each vehicle type to all the indi- vidual densities.

PASSENGER CAR EQUIVALENTS

The concept of passenger car equivalents (PCE) was introduced in the Highway Capacity Manual 1965, to account for the effects of trucks and buses.PCE, also known as Passenger Car Unit (PCU), was defined in HCM

1965 as ‘‘the number of passenger cars displaced in the traffic flow by a truck or a bus, under the prevailing roadway and traffic conditions’’. These methods include Walker’s method, headway ratio method, density method, simulation based methods and multiple regression methods. It found that the PCE values suggested by HCM are only applicable for free-flow conditions and attempted to derive PCE values for congested conditions. They are, in fact, shown to behave as random variables that generally follow the normal distribution. Moreover, as pointed out by Van Aerde and Yagar, the assumption that a single set of PCE values being suitable for capacity, speed, platooning and other types of analysis appears to be incorrect and it is perhaps the main source of discrepancies among the vari- ous PCE studies. Hence, those methods cannot be appli- cable to the mixed traffic, without the necessary modifi- cations. As will be seen in later sections, PCUs are almost exclusively used in capacity and saturation flow studies. Though, because of the complexity in their estimation, some researchers preferred using the traffic composition inthe PCU values. Tana boriboonand Aryal classified the vehicles observed in Thailand intothree major types, namely: small, medium and large vehicles and used headway based method advocated by Krammes and Crowley to calculate PCUs, with small sized vehicle as the design vehicle. Arasan and Krishnamurthy studied the effects of varying traffic composition, volume to capacity ratio and road width on PCUs using a simulation model. In this study of Passenger Car Equivalents of a vehicle is estimated as the ratio of the number of cars that need to replace the subject vehicles in the traffic such that the average speed of cars remains the same. Significant differences are observed with the varying road and traffic conditions.A few other attempts to give modified PCU estimation methods are discussed below.

MODIFIED DENSITY METHOD

HCM 2000 used concentration method for the estimation of various PCE values. Tiwari et al. modified this method to be suitable for Indian traffic conditions. They also gave an adjustment factor to convert passenger cars in heterogeneous traffic into its homogeneous traffic counterpart. This difference may be a result of the intrinsic differences in the driver behavior and road conditions. The basic idea of this method is to compare densities of various traffic entity types at the same speed. The car density is estimated at different speeds of other vehicles using a car density vs. car speed graph. Thus, PCE value of each traffic type is given by: kcar = W85 car/dx their analyses. PCU still remains among the most exten- sively studied parameters in the developing economies [5]

Several researchers have attempted to derive PCUs based on different traffic characteristics. Some of these studies are aimed at studying the effects of specific vehicle types. Rahmanand Nakamura attempted to derive PCUs of rickshaws using the average speed reduction in the passenger car caused by their presence for the traffic in Dhaka metropolis, Bangladesh. They showed that these PCU values increased with an increase in their proportion in the traffic and the total volume. Rongviriyapanich and Suppattrakul used time headways between different combinations of cars and two wheelers and calculated PCU values using three different approaches. Data for this study was collected at a mid-block section in Bangkok, Thailand. Traffic in developing economies usually consists of various other types of vehicles in significant proportions. Hence, other studies have used more general method to estimate where for the highway type j, qxi is the flow of traffic entity group Xi in heterogeneous traffic (entities/h)

METHOD BASED ON AREAS AND SPEEDS OF VEHICLES

The new method proposed by Chandra and Kumar ‘‘heuristic’’ method to estimate the PCE values in the mixed traffic conditions. This method does not have an equivalence criterion to estimate the effects of the other traffic entity types in terms of passenger cars. Instead of these compares the area and speeds of each vehicle type

with those of passenger cars. Note that the usage of projected area of a vehicle is a more appropriate indicator in weak lane-

SUMMARY AND CONCLUSIONS

The study discussed in this research paper was performed in order to understand primary traffic parameters and their features pertaining to vehicle behavior on the two-lane road. The objective of this research is threefold: to provide a comprehensive review of the studies on Heterogeneous conditions traffic in developing economies, to identify the limitations and gaps in the current understanding of the traffic characteristics and to supply a background and guidelines for the researchers in planning their future studies. All the reviewed studies have been organized in some sections, namely vehicle characteristics, passenger car equivalents, lateral characteristics, capacity and level of service, except the final section on 'modeling', every of the sections present a evaluation of the previous studies on that topic, under a few subsections, as needed. It is generally observed that the concepts of Heterogeneous traffic have formed the basis for many of these studies. The shortcomings of those concepts in Heterogeneous traffic conditions have been emphasized, along with other gaps in the knowledge of those traffic characteristics and thus, identifying the possibilities of the future research. Finally, a general outline of a micro-simulation model for Heterogeneous mixed traffic is described, along with a review of the previous models.

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