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## Modeling of Traffic Flow on Indian Expressways using Simulation Technique

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### Abstract

Expressways in India are vastly different from other roads of the country as bicycles, two-wheelers, three-wheelers and bullock carts are not allowed to ply on these facilities and the traffic essentially consists of cars and trucks. Nevertheless, there is not much research literature specific to these categories of roads. Hence, this work aims to model traffic flow on Indian Expressways by evaluating Passenger Car Unit (PCU) or Passenger Car Equivalents (PCE) of different vehicle categories at different volume levels in a level terrain using the micro-simulation model, VISSIM. This work also aims to evaluate capacity of expressways and to study the effect of vehicle composition on PCU values. It has been found that PCU decreases with increase in volume-capacity ratio irrespective of vehicle category. The study also revealed that at a given volume level, the PCU of a given vehicle category decreases when its own proportion in the stream increases.

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### 1. Introduction

In Indian terminology, an expressway is defined as an arterial highway for motorized traffic, with divided carriageways for high speed travel, with full control of access and usually provided with grade separators/interchanges at location of intersections. These are six or eight-lane highways with only fast moving vehicles plying on them. Indian Government initiated the construction of expressways only in the

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last decade and currently there are about 600 km of these roads in the country of which Ahmedabad-Vadodara and Mumbai-Pune Expressways are salient examples. Expressways deserve to be treated separately from other categories of roads as these facilities carry only relatively large vehicles such as cars, buses and trucks. Expressways are not generally accessible by vehicle categories such as bullock carts, cycles, two-wheelers and three wheelers that typify traffic in India. Hence expressways can be considered to be in midway between freeways in the developed countries such as United States where there is a huge proportion of cars and other categories of roads in India which carry 10 or more vehicle categories inclusive of bullock carts, cycles, two-wheelers, three wheelers, cars, trucks and buses.

Traffic flow in Indian expressways is quite interesting to be studied due to two reasons. First, the traffic is multi-class with vehicles such as cars and pickups with their high maneuverability and heavy vehicles such as trucks and buses. The speeds of these vehicles may vary from 20 to over 100 km/h. Second, in spite of absence of vehicles such as two-wheelers and three wheelers that can clog the traffic during congestion, driving in expressways is said to be quasi-lane disciplined, with some vehicles following a lane-based driving and many others not. Such a lack of lane discipline can be attributed to combination of factors viz. enforcement and education. Indian drivers are not educated about the importance of sticking to their lanes other than for overtaking and improving driving speeds. There are neither video cameras mounted at select locations of the roads nor a central monitoring system that reports violations. Consequently vehicles tend to take any lateral position along the width of roadway, based on space availability. When such different types of vehicles with varying static and dynamic characteristics are allowed to mix and move on the same roadway facility, a variable set of longitudinal and transverse distribution of vehicles may be noticed from time to time. Hence expressways remain as a partially heterogeneous traffic characterized by poor lane discipline. Given this significant difference in the nature of traffic flow in expressways in relation with other kind of roads in India as explained above, there are not much research work on either design or operation of these facilities. This may also be attributed to the recent origin of Expressways in India and also lack of experience in analyzing such types of partially heterogeneous facilities.

Under heterogeneous or partially heterogeneous conditions, expressing traffic volume in terms of vehicles per hour per lane is irrelevant as there is either no or partial lane discipline. One way to represent the heterogeneous traffic flow is to express each vehicle category in terms of the interference it causes to the flow in terms of a standard vehicle category such as car. Such a measure is called the Passenger Car Unit (PCU) as known in India or Passenger Car Equivalent (PCE) worldwide. In general, heterogeneous flows are expressed as PCU per hour taking the whole width of the carriageway into account. But there are many complexities in expressing a vehicle as its equivalent PCU. PCU values of any vehicle are sensitive to factors such vehicle composition in the traffic mix and speed of the stream. Hence adopting a single PCU for a given vehicle is not accurate but rather a dynamic or stochastic PCU that accounts for all the factors should be adopted. But such a universal PCU estimation for heterogeneous traffic flow is not available considering the so many possible combinations of vehicle composition and speeds that could be observed in the field.

For correct estimation of PCU values, it is necessary to study accurately the influence of roadway and traffic characteristics and the other relevant factors on vehicular movement. Study of these complex characteristics in the field is difficult and time consuming. Also, it may be difficult to carry out such experiments in the field covering a wide range of roadway and traffic conditions. Hence, it is necessary to model road-traffic flow for in depth understanding of the related aspects. The study of these complex characteristics, which may not be sufficiently simplified by analytical solution, can be done using alternative tools like computer simulation. Simulation is already proven to be a popular traffic-flow modeling tool for developing various applications related to the traffic flow on roads. VISSIM is one of

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