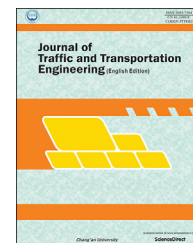


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## Original Research Paper

# Overtaking behaviour of vehicles on undivided roads in non-lane based mixed traffic conditions



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## HIGHLIGHTS

- Overtaking characteristics of vehicles on undivided roads in mixed traffic were studied.
- Flying and accelerative overtaking types were observed.
- Mean overtaking time and overtaking distance for heavy vehicles is higher.
- Vehicles generally do not follow larger size vehicles and often try to overtake them.
- Number of overtaking decreases with increase in flow in opposite direction.

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## ABSTRACT

Traffic on Indian roads is highly mixed in nature with wide variations in the static and dynamic characteristics of vehicles. These vehicles do not follow strict lane discipline and occupy any available lateral position on the road space. Overtaking is one of the most complex and important manoeuvre on undivided roads where the vehicles use the opposing lane to overtake the slower vehicles with the presence of oncoming vehicles from opposite direction. They are unavoidable especially in the case of mixed traffic conditions where there is always a speed difference between the fast and slow moving vehicles. Overtaking process involves lane-changing manoeuvres, acceleration and deceleration actions and estimation of relative speed of overtaking and overtaken vehicles, and also, estimation of speed and distance of the oncoming vehicle. The main objective of the present study is to study the overtaking characteristics of vehicles on undivided roads under mixed traffic conditions. For this purpose, details of overtaking data were collected on a two-lane two-way undivided road using moving car observer method and registration plate method. The overtaking characteristics of all types of vehicles under mixed traffic conditions were observed and mathematically modelled.

The data extracted and analysed were the acceleration characteristics, speeds of the overtaking vehicles, overtaking time, overtaking distances, safe opposing gap required for overtaking, flow rates, overtaking frequencies, types of overtaking strategy, and types of overtaking and overtaken vehicles. Two types of overtaking strategies were observed in the field such as flying overtaking and accelerative overtaking. Graphs were plotted between the relative speed of the overtaking and overtaken vehicles against the overtaking time and negative correlation was found between the speed differential and total overtaking time for all categories of vehicles. It was observed that the number of overtaking increases with

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increase in the flow rate in the on-going direction and decreases with increase in flow in the opposite direction. The results obtained from this study will be useful to understand the overtaking behaviour of vehicles in mixed and non-lane discipline traffic conditions. These parameters will be useful in the development of traffic simulations models for undivided roads and thereby for estimation of capacity. The findings from the study can also be used to estimate potential collision times which will be helpful to improve the road safety.

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## 1. Introduction

In Indian roads, traffic is highly mixed in nature with lack of lane discipline. Traffic compositions mostly comprises of motorized vehicles such as two-wheelers, three-wheelers (auto rickshaw), cars, trucks, buses and non-motorized vehicles like bicycles, etc. Characteristics like the dimensions, speed, acceleration, deceleration, clearances and manoeuvrability of these vehicles vary widely and hence, traffic speed is the most important factor affecting the safe movement of vehicles. In mixed traffic, vehicles use the road space more effectively and their movement depends on lateral and longitudinal gaps. Overtaking and lane-changing manoeuvres on a road traffic facility occur when traffic does not move at the design speed. Therefore, these operations become essential when some vehicles in the traffic stream move faster while others move slowly. They are unavoidable especially in the case of mixed traffic conditions where a speed differential always exists between the fast and slow moving vehicles. Also, overtaking is one of the most complex and important manoeuvre on undivided roads where the vehicles use the opposing lane to overtake the slower vehicles with the presence of oncoming vehicles from opposite direction. The ability to pass is influenced by a variety of parameters including the volumes of through and opposing traffic, speed differential between the overtaking and overtaken vehicles, highway geometry particularly available sight distance, and human factors. These manoeuvres play a vital role in simulation of a traffic facility. They are also important factors considered in the analysis of road traffic accidents. Hence, the knowledge of overtaking and lane-changing behaviour of vehicles is essential in understanding of traffic behaviour on undivided roads.

This study was motivated by several considerations. There were only limited studies which focus on overtaking behaviour of vehicles on mixed traffic compared to studies on homogeneous traffic in developed countries. Unfortunately, the literature on overtaking behaviour of vehicles on undivided roads in mixed traffic conditions is sparse. Hence, the present study aims to study the overtaking behaviour of vehicles on undivided roads with the following specific objectives.

- (1) To determine the acceleration and overtaking characteristics of different types of vehicles during overtaking.
- (2) To develop relationships between relative speed of overtaking and overtaken vehicles and the overtaking time for different classes of vehicles.

- (3) To develop relationships between overtaking frequency with traffic flows in the ongoing direction, opposite direction and traffic flows in both the directions.

Empirical traffic data were collected from an undivided road on a selected section of road in Mangalore, India, to investigate these objectives. For the first and second objectives, the overtaking data obtained from moving observer method were analysed in detail to obtain the overtaking characteristics of vehicles. For the third objective, the data obtained from registration plate method was analysed to develop relationship between frequency of overtaking and flows.

The rest of the paper is structured as follows: Section 2 presents the review of important literature related to this research study. Section 3 discusses about the methodology for data collection on overtaking behaviour of vehicles on undivided roads. Section 4 explains the procedure for data extraction and analysis. Section 5 presents the results and discussion of the study followed by summary and conclusion in Section 6.

## 2. Review of earlier studies

There are only limited studies which focus on overtaking behaviour of vehicles on undivided roads in homogeneous and lane based traffic conditions. Polus et al. (2000) developed models to quantify the major components of the passing process and compared the results with existing highway-design models. The components of the passing manoeuvre were evaluated on the basis of real passing times and distances for which data were collected for about 1500 passings on two-lane rural highways. A model showing the relationship between the speed of the impeding vehicle and the passing distance was calibrated, and the implications for highway-design procedures were discussed. Hegeman et al. (2005) had introduced instrumented vehicle method and presented a detailed analysis on observations of overtaking manoeuvres on two-lane rural roads to understand the driver behaviour prior to, during and after an overtaking manoeuvre. The differences in duration of overtaking manoeuvres between different overtaking strategies and different speeds of the vehicles were observed. The mean headway at the start of the manoeuvre is  $17.8 \text{ m} \pm 9.8 \text{ m}$  and at end of the manoeuvre is  $32.5 \text{ m} \pm 12.2 \text{ m}$ . Four overtaking strategies were defined as “normal”, “flying overtaking”, “2+”

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