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Strategy for Freeway Lane Utilization Analysis

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1. INTRODUCTION

The issues related to freeway flow models are needed not only for better understanding of the collective traffic behaviour, but also for analysing flow conditions in a dynamic style, initiating efficient control strategies, evaluating the effects of geometric or control strategy improvement, determining the adequacy of existing or proposed geometric configuration, simulation, etc. Despite recent advance in macroscopic and microscopic modelling of freeway traffic flow characteristics, a sufficient mathematical model that could describe and treat the lane utilization process is still lacking for a free flow segment.

In a single direction uninterrupted traffic flow condition, if there are two or more lanes available for traffic then, the amount of lane usage by motorized was widely varying in each lane. Traffic flow in some individual lanes is much higher than it for other lanes. Last decade researches recognised that in a one-way two lane freeway, the capacity of the shoulder lane is much lesser than it for the right most lane (left-hand driving). Some finding shows that this different is about 25 percent nearly at maximum flow rate condition. Further, results shows that this differences in lane utilization even more than 25 percentage for one-way three lane freeway. Further, Chen C. C (1986) and Wemple et al (1991) found that under higher flow rate conditions the middle lane is the primary carrier, while the shoulder lane carries the smallest percentage of traffic. Therefore at present, the distribution of traffic volumes into the individual lanes in multilane freeway has become an important aspect in traffic flow analysis. Thus, in order to have a better understanding of the traffic flow phenomena in a freeway segment, research on lane utilization analysing process become a crucial portion in traffic flow modelling.

2. STATEMENT OF PROBLEM

Although, at present a few works on lane utilization are available, still a sufficient complete mechanism to show the lane distribution in an uninterrupted flow is still lacking. There is either no typical theory which representing the lane utilization or no typical value for it. Therefore, it is very important to identify the mechanism for lane utilization by recognize the suitable elements, which become main objective of this on going research. Because finding from this would be very useful in many ways such as improving capacity of the multilane unidirectional freeway by balancing the lane utilization, designing freeway geometry, planning a better pavement maintenance scheme (example : pavement deterioration is not uniform to all lane), imposing a optimized traffic regulation (example : five lane directional flow can be change to three + two lane by introducing median road marking), analysing the traffic jam behaviour and useful for tunnel section design progress.

Therefore this paper deals with a simplified analytical strategy for lane utilization in an uninterrupted free flow. The ultimate objective of this paper is to lead a methodology, which could use to develop a mechanism for lane utilization by identify the suitable influencing elements, and find an illustrative typical value for lane utilization based on these elements.

3. REVIEW

In past, there are few researches have been carried out to treat lane utilization process, and among those available literature's, by Heidemann (1994) for freeway and by John at el (1995) for highway are more descriptive for the lane utilization analysis. First research is from the view of probability approach while the second is by analytical approach.

Dirk Heidemann (1994) developed a model for describing a stable probability of lane distribution and lane changing of the total traffic volumes into the individual lanes of two and three-lane unidirectional roadway based on probability of the traffic using the freeway lanes. The model had based on two equations. The first of these contains the condition of equilibrium for the balance of changeovers between two lanes based on the lane

usage probabilities, and the second is the differential equation which describes the change in the proportion of the traffic volume on a single lane as a result of an infinitesimally small growth in the overall traffic volume. His suggested models applicable for free traffic flow condition, and also need field validations. John at el (1995) developed simple macrolevel models by multi and single variable regression analysis to estimate the traffic volume distribution in highways' lanes.

4. STRATEGY FOR ANALYSING LANE UTILIZATION

The lane utiliazation analysis in the past shows that, in one way two lanes or three lanes freeway, the amount of lane utilization is widely varying with total traffic flow. Also, the traffic volume of each lane increases as the total volume increases, but at a different rate. Therefore in general, by looking these results on lane distribution behaviours, it can be say that the motorized are utilizing the lanes in a freeway, in order to maximize their desires.

Mainly the driver's desire on a freeway is depending on his characteristic such as his risk acceptance and reaction ability etc., subject to the traffic condition. Because, with various traffic condition, such as freely flowing traffic, partly constrained traffic or constrained traffic, diver's behaviour will be changed. Therefore, it can be assume that motorized desire on a freeway is to have a safe movement with his desire speed by maintaining a safe lag-spacing from his front vehicle to satisfy the emergency needs. Specially, in this last two traffic conditions, drivers accelerate or de-accelerate the vehicles either for suitable gap searching and squeezing into acceptable gap in order to maintain his desire speed or in order to follow the leader.

Therefore *a multi-phase model of traffic flow* is useful for the analysis of lane utilization in partly constrained traffic condition while *deterministic spacing model*, which can be obtained from an analysis of relationship between the speed and the spacing in each lane, is useful for constrained traffic condition. Further, *a probabilistic approach* is useful for free traffic condition by which a transition matrix can be obtained.

Further, the following traffic descriptive parameters also were suggested for analysis such as relative speeds, front/rear spacing, distribution of headway for each lanes. Basically these variables are closely related to each other. Thus, interrelationship among these variables also targeted for analysis. Results from these analyses also could be helped to explaining the required mechanism.

5. CONCLUSION

At present, analysing and modelling of lane utilization is an important aspect in freeway traffic behaviour analysis in many ways. This proposed strategy for lane utilization modelling seems to predict an adequate lane utilization in a freeway segment, for different traffic condition, by identifying influencing traffic parameters. These traffic parameters can be proven to be very useful tools for improving the capacity and level of services for a freeway segment.

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