# TRAFFIC CHARACTERISTICS OF NON-MOTORIZED VEHICLES IN MIXED TRAFFIC

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## ABSTRACT

*In present day scenario, in countries like India we can find mixed traffic conditions, i.e. traffic flow constituting of all sorts of vehicles like cycles, rickshaws, auto and so on. During the peak hours, the flow of NMVs is high. The presences of NMV in the traffic stream affect the traffic characteristics like speed, density and flow of the stream. In order to design a traffic facility, the traffic behavior has to be understood. For the mixed traffic conditions, it is difficult to understand the behavior of the stream. In this paper, an endeavor is kept to study the traffic characteristics of NMVs in mixed stream.*

*The entire project work is consists of two parts. The former is the experimental part and the latter is the statistical testing part. The former part of study includes the study of the fundamental diagrams, finding the capacity of the section and the lateral occupancy of the section for the data obtained from the various parts of the Hyderabad City. It was seen that with the change in the NMV percentage an adversity is found in the parameters like speed, density and flow. In the study of lateral occupancy, it is observed that in one way divided traffic flow, the maximum number of NMVs are occupying the left two strips and the MVs are occupying the right most strips as our Indian traffic behavior is left handed and it is easy for the MVs to overtake the slow moving vehicles. In the case of undivided two way traffic, the maximum number of traffic is found in the middle portions but a minimum on the right and left strips in the light of fact that the vehicles are present in the opposite directions. The first step is of stating the null hypothesis, it is followed by test static, P-value and conclusion and finally decision making. The decision is made on the basis of Z observed and the obtained P-value. The results indicate that the percentage NMV is decreased from 2011 and the speed and flow got increased from 2011.*

## INTRODUCTION

In the present day scenario almost all the road traffic consists of mixed traffic, i.e. the combination of both Non-Motorized and Motorized traffic. The mixed traffic affects the characteristics of the traffic stream to a great extent.

Non-Motorized Vehicles are the vehicles which will run with the power of human beings or animals. The non-motorized vehicles include bicycles, rickshaws, and hand drawn vehicles, pull carts and so forth.

Motorized vehicles are those vehicles which run with the power of the engines. The motorized vehicles are divided into light motorized vehicles and heavy motorized vehicles. Light motorized vehicles consist of auto rickshaws, jeeps, taxis, motorcars, three-wheeler conveyance vans and so forth. Motorcycles do not come under this category. Heavy motorized vehicles consists of vehicles with number of wheels more than six. This Heavy Motorized Vehicles consists of Buses, Lorries, and Trucks etc.

As per the World Bank survey about 50 percent of the non-motorized vehicles are present in the south Asian nations like India, Bangladesh. In Bangladesh, the maximum number of trips generated during peak hours is due to non-motorized vehicles like bicycles, rickshaws.

The presence of non-motorized vehicles affects the capacity of the section. With the increase in the Non-Motorized vehicle capacity, the total capacity of the section will be reduced, affects the safety of the total stream and the declining of energy resources (petrol, diesel etc.). In order to minimize the consequences of Non-Motorized vehicles there should be a separate track for Non-Motorized vehicles like in U.S.A. or else proper study should be made on the Non-Motorized vehicles and its effects on the traffic stream.

In India practically it is not possible to lay a separate track for Non-Motorized vehicles, so proper study has to be conducted on Non-Motorized Vehicles and its characteristics along the mixed stream. Hence Non-Motorized vehicular movement and its effects on traffic characteristics are taken into account in the paper.

## LITERATURE REVIEW

- Rahman et al (2005) conducted research on "The Effect of Rickshaws and Auto Rickshaws at Signalized Intersections" in Dhaka city. He collected data from four signalized intersections where there is minimum proportion of turning vehicles, no parking, and high traffic volume. Later he developed a model for finding passenger car equivalents of rickshaws and auto rickshaws at signalized intersections do not affect the PCE of rickshaws and auto rickshaws, the vicinity of rickshaws and particles. He concluded the outcome as the green light time, the width of the signalized intersection and auto rickshaws in the mixed traffic lane affects the traffic stream a lot. The number of rickshaws is more the effect is less and vice versa.

- Rahman et al (2003) conducted a study on the "Effect of Non-Motorized Vehicles on Urban Road Traffic Characteristics." The target of this paper is to present analytical procedure of traffic flow and to create models of passing, surpassing and lane utilization for heterogeneous traffic flow. All the data were collected at the mid-block sections located in Dhaka. The vehicle movements were recorded using a portable video camera and the data was decoded using a time code reader software. The data were recorded in five minute interval. The results are shown in the speed-density, speed-flow, and flow-density diagrams. With the increase of non-motorized vehicles the speed, density and flow reduces significantly at a certain rate.

- Rahman of Bangladesh and Fumihiko of japan (2004) conducted a study on "Passing Overtaking Characteristics and Level of Service of Heterogeneous Traffic Flow." This study was conducted in the city of Dhaka, Bangladesh. In this study he developed a passing-overtaking model on heterogeneous traffic flow in urban cities with undivided lanes having more proportion of rickshaws. He attempted to provide level of service (LOS) for this type of roads. He categorized level of service into six categories (A, B, C, D, E and F). Based on the traffic characteristics of the road, he classified into four groups, LOS 1 indicates a free flow condition, LOS 2 shows that it is a partial flow condition where as LOS 3 and LOS 4 represents constraint flow and congested flow conditions respectively. The traffic characteristics considered in this study are average speed of the

passenger car and the number of passing and surpassing vehicles in the stream along the section. The results showed that the presence of the rickshaws has an adverse effect on the passing overtaking characteristics.

- T. Oketch (2003) developed a model on the "Performance Characteristics of Heterogeneous Traffic Streams Containing Non-Motorized Vehicles." In this paper he classified the vehicles into two sorts in particular, standard vehicles and non-standard vehicles. He built up the model to investigate the impact of various non- conventional vehicles in stream performance including lane capacity and saturation flow. The presence of heavy and non-standard vehicles affects the traffic stream performance because of speed capabilities, poor acceleration, etc., this paper says that for heterogeneous traffic streams has the reduced link capacities and saturation flows for traffic stream containing homogenous flow with private cars only. This model was used in the study of speed flow relationships of the stream and the saturation flows in the traffic stream containing nonmotorized vehicles. It was found that the presence of these vehicles results in traffic density and scattered volume. He concluded that the heterogeneous streams have different flows that may not conform fully to the basic theories. In addition, heterogeneous flows are generally associated with higher number of lateral movements as the faster vehicles try to overtake the slower ones.

- Dianhai et al (2007) made a study on bicycle conversion factors. The factors are researched under various traffic conditions. They made a conversion factor model based on motorized vehicles and bicycles and converted into PCU. These bicycle conversion factors are converted and are calculated under four different situations in china. The through and left turn conversion factor is 0.28 and 0.33 respectively at mixed conditions, whereas in the road section with physical separation is 0.22 and without physical separation is 0.24.

- Tiwari, Fazio and Pavitravas developed "Passenger Car Units for Heterogeneous Traffic Using a Modified Density Method." This method is very useful for Indian traffic conditions. At first all the traffic was divided into 8 groups and Indian roads into 6 groups. The camcorder recorded traffic on the video tape along with a time stand during peak hours. From the video tapes the traffic characteristics were obtained on all the roads. This modified density method requires comparison of the density of various traffic types at the same speed. One should ensure that the obtained density must be divided by the lane width to obtain the PCU values.

- Fei Shi and Haiyuan Li of China conducted a study on "The Influence of Non-Motorized Stream on Capacities of Vehicular Streams at Unsignalized Intersections." Usually unsignalized intersections consist of Two Way Stop Controlled (TWSC) and All Way Stop Controlled (AWSC) intersections. The capacity of the non-motorized vehicles is calculated at TWSC and AWSC. The capacity is calculated for minor street vehicular movements at both intersections. The graphs were drawn between vehicular capacity and bicycle volume. The results shown

that at TWSC and AWSC intersections the capacity of vehicular movements reduces gradually with the increase of volumes of bicycle movements.

## METHODOLOGY

The data collection consists of video coverage of the data from various locations. The project primarily aims in and around Rourkela city. The data is collected from five different locations in

Hyderabad. The locations are selected such that they have different traffic conditions and different roadway patterns.

The sections should contain high traffic volume, minimum number of turning vehicles, no parking zones. The surface of the road should be even and level terrain. The section should not contain bus stops. The data are collected for a minimum of 30 minutes in each section with the help of a high resolution video camera. The camera is placed at one corner of the section so that the entire section is covered. The section is of 5 meters length and the section is fixed by placing markers at each end. A cellophane paper is placed on the monitor and the section is transferred into the cellophane paper. The video is decoded with the help of KM player software. The cellophane paper is kept because although the section is rectangular, it will get deform while recording. In order to minimize this deformation effect the section was transferred into the paper using markers. The data is decoded at the rate of 25 fps as per requirement.
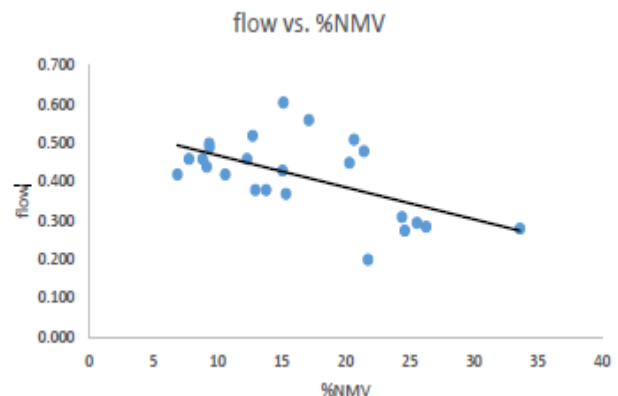
## COMPARISON GRAPHS:
### Speed vs. %NMV graph:
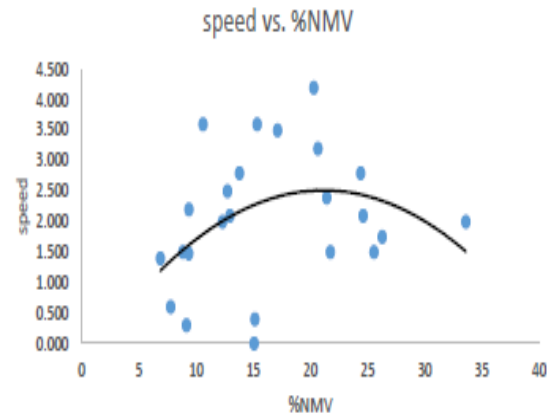


It is observed that the speed of the section is increasing till 20% of NMV and then it starts decreasing. It is due to a reason that with the increase of NMV content in the stream, traffic congestion starts increasing and it reduces the overall speed of the section.

### Flow vs. %NMV:



The flow of the section starts decreasing with the increase of percentage Non-Motorized Vehicles. This is due to the fact that the NMVs are the slow moving vehicles as compared to that of MVs and as the NMV content increases, the room for the other vehicles to pass through the section decreases and it reduces the speed of the following vehicles which results in the decreasing of the flow of the section.

### Density vs. %NMV:

density vs. %NMV
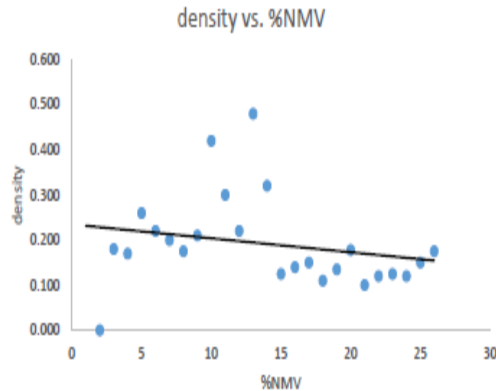
**Fundamental diagrams for different % NMV:**
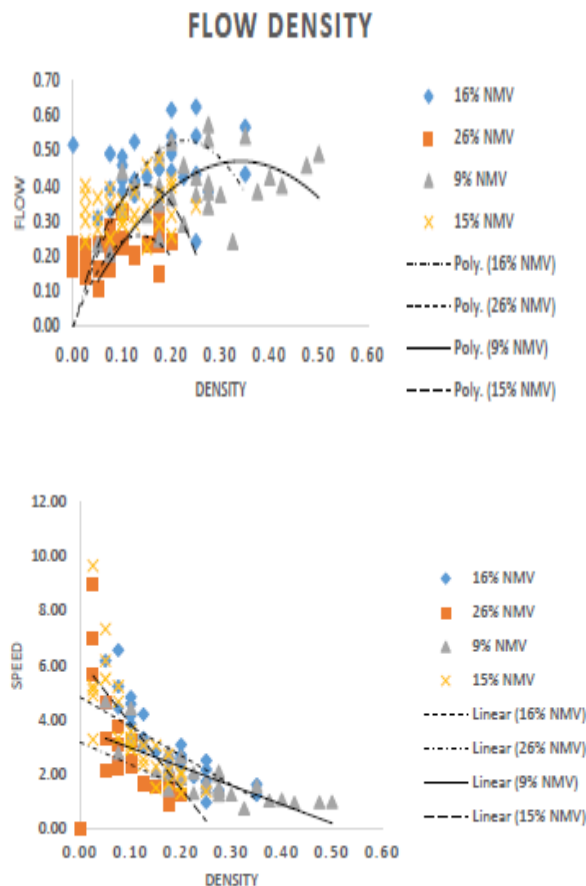


FLOW DENSITY



%NMV of 9 and 15 are for one way divided traffic and 16 and 26 are for undivided two way traffic. In the case of one way traffic, for 9 % NMV the flow, density and speed are 0.47 PCU/sec, 0.34 PCU/m and 1.6 m/sec and for 15 % NMV, 0.40 PCU/sec, 0.15 PCU/m and 3.20 m/sec respectively.

Whereas in the case of two way traffic, for 16% and 26% of NMV flow, density and speed are 0.53 PCU/sec, 0.23 PCU/m and 2.4 m/sec and 0.26 PCU/sec, 0.13 PCU/m and 2.10 m/sec respectively. For one way traffic it is observed that the flow and density decreased and the same pattern is seen for the two way traffic also.

**CONCLUSION**
- From the fundamental diagrams, it can be observed that the traffic parameters in the section are affected largely by the percentage of non-motorized vehicles in the section. For both the divided and undivided lanes the pattern remains same, i.e., as the percentage no motorized vehicles increasing the parameters like density, flow and speed of the total section decreased. In divided lanes the effect is less as compared to the undivided lanes as there exists the effect of vehicles coming in the opposite direction.
- It can be observed from the lateral occupancy graph that the NMVs are occupying the left hand side of the road. As we follow left hand side drive in India and the MVs try to overtake them from the right hand side of the road. Also in the left first strip or 1 m from the left edge no vehicles are present as the vehicles try to keep away from road edges as far as possible and it is the psychological behavior of drivers, they try to avoid moving at the edge when there are no shoulders or raised kerbs. Roads in which there are shoulders the vehicles are found in the first strip from left side also.
- In the case of divided one way traffic, the vehicles occupies in all the strips equally. As the NMVs are the slow moving vehicles they try to occupy the first two strips and the last two strips (6th and 7th) are

occupied by the overtaking vehicles. The flow is maximum in the last two strips.

- In the case of undivided two way traffic, the occupancy pattern is not the same as that of the one way divided traffic. The vehicles will try to occupy the left three strips and rarely the fourth strip as there are the vehicles coming in the opposite direction. In this in divided two way traffic the maximum occupancy is in the middle 3rd, 4th and 5th strips and the minimum in the remaining strips as they are mostly occupied by the slow moving vehicles.

- From the percentage NMV point of view, there exists a uniform pattern of distribution of NMVs if the NMV percentage is moderate, the NMV occupies the left two strips if there is less percentage of NMV and if the NMV content is high then the MVs try to overtake from the right strip of the NMVs.

- From the comparison graphs, it is observed that the speed of the section is increased up to 15% NMV and then starts decreasing. This indicates that up to a certain limit of NMV in the stream there is no effect on the traffic parameters and as the NMV content increased more than this limit, the adversity in the traffic parameters occurs. The flow and density will decrease with the increase in NMV content.

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