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# Sustainable Highlights and Impact of Non Motorized Vehicle on Indian Mixed Traffic

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**ABSTRACT:** In India, we can usually find a mixed traffic, that is, a flow of traffic that constitutes all types of vehicles. Each transport mode of public transport implies access journeys by non-motorized transport at each end. Therefore, non-motorized traffic mode plays a very important role in meeting the travel demand in countries like India. This thesis mainly analyses the impact of non-motorized traffic on the overall performance of traffic parameters. To design a traffic installation, it is necessary to understand the behaviour of the traffic flow. Understand the behaviour of a traffic stream with mixed traffic in quite complex. In this thesis an attempt is made to study the highlights of the non-motorized vehicle and the impact on mixed traffic. In India, it is left on the left side, so it can cause a side collision while driving too much. Also at some point this may end up with a traffic jam condition. In the experimental part, a study was made on the variation of speed with respect to various parameters. It was observed that the speed decreases with increasing number of PCU of the passenger unit in the same strip, the speed decreases with the increase in the number of PCU in the adjacent strips and the speed increases when the distance from the edge of the highway.

**KEYWORDS:** Non-Motorized Transport, passenger car unit, traffic stream, etc.

### I. INTRODUCTION

In nations like India we can usually find a mixed traffic, that is, a flow of traffic that constitutes all types of vehicles, such as cycle, rickshaw, automobile, bus, etc. In Indian cities, the share of non-motorized transportation during peak hours is almost more than 50 %. This figure is even higher in medium and small cities. Different cities have different NMT usage patterns. Each transport mode of public transport involves access journeys by NMT at each end..

The flow of mixed such as conflicts at intersections when the number of non-motorized vehicles increases, when the number of non-motorized vehicles increases, affects the speed and flow of other vehicles. Decreases or significantly reduces the capacity also leads to various security problems. Therefore, there should be a separate route for the flow of non-motorized traffic as it is used in several developed countries like the United States, in nations like India this is practically not possible. Then, in that case, an adequate study of the impact of the non-motorized vehicles must be carried out together with the study of how these NMVs affect the mixed traffic.

According to the World Bank survey (1990), about 53% of the poor are there in Asian countries. These people depend on non-motorized traffic mode for a complete trip (for example, going to work, going shopping). The demand for bicycles and rickshaws is therefore considerable at present and is likely to continue to be so. Therefore, the study of the NMV movement and its effect on the motorized mode are taken into account in the project. Fundamental diagrams of traffic flow

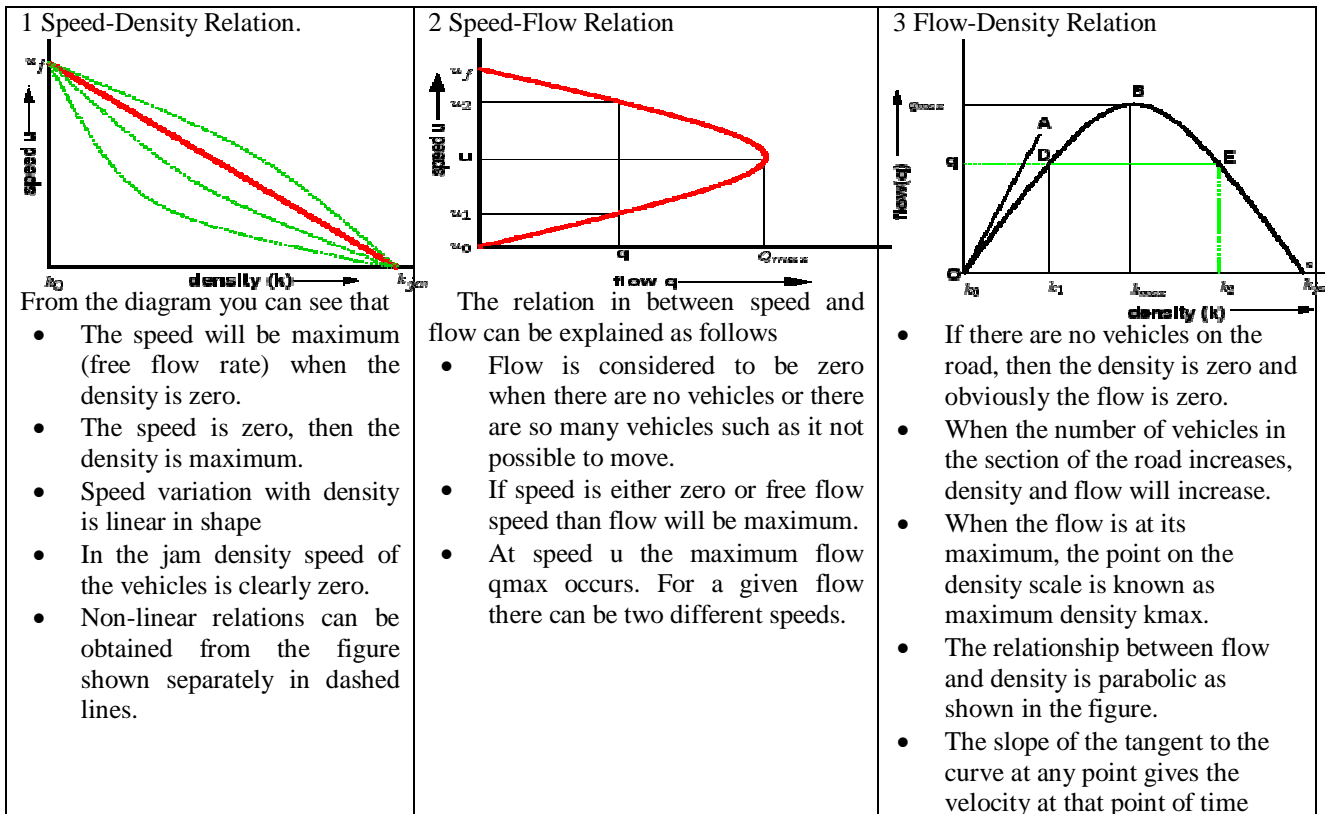
There are three curves that show the relationship between density vs. speed, speed vs. flow, flow vs. density. These are explained as follows.

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## II. RELATED WORK

Tiwari (1999) analyzes the level of segregation of motorized and non-motorized traffic in Delhi, India; both in a single lane and in multi-lane roads. The investigation revealed that bus stops force non-motorized vehicles towards the center of the road, thus decreasing lateral segregation with motorized vehicles and increasing accidents. Again, the study in separate lanes for buses and cycles reveals the importance of bicycle lanes for the successful use of bus lanes.

Oketch (2003) the effects of several non-conventional vehicles on the flow performance including rail capacity and saturation flows. This document says that for such heterogeneous flows it had reduced the link capacities and lane saturation flows compared to the homogeneous flows only with private automobiles, although the trends were not always consistent.

Rahman et al. (2003) conducted a study on the effect of non-motorized vehicles on the characteristics of urban traffic. They collected data from four sections of the central block of Dhaka, Bangladesh.

Rahman et al. (2004) conducted a study on the effect of the rickshaw and the automatic rickshaw on the capacity of the urban signaling intersection. For capacity analysis, to convert mixed traffic flow into basic traffic flow, passenger cars play an important role. The objective of this study was also to develop a method to estimate the equivalent of passenger cars of rickshaws and auto rickshaws at intersections signaled by a macroscopic approach.

Tiwari et al (2007) analyzed the difference between homogeneous traffic flows with a strict lane discipline in Western countries and heterogeneous traffic flows found in Indian cities. The basic parameters of traffic and curves are studied by classifying vehicles into: four motorized wheels, three motorized wheels, two motorized wheels and non-motorized vehicles.

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Pan and Kerali (2007) conducted research on the effects of non-motorized traffic flow on motor vehicle speeds based on field observations of vehicle speeds on Chinese roads. They observed a linear relationship between motor vehicle speeds and a range of motorized traffic flow volumes. They developed a congested general speed model to predict vehicle speeds under various road characteristics and traffic flow volumes, using the relationships of the non-motorized flow effects obtained in their study along with the free speed and flow relationships investigated in other studies.

Oketch (2007) studies the characteristics of heterogeneous traffic in Kenya and developed a model based on fuzzy logic rules. The model takes into account the overtaking of motorized vehicles by two-wheelers in congested regions with almost no movement of motorized vehicles. The effects of the partial use of two lanes simultaneously and the change of lanes gradually are also analyzed in the model.

Dianhai et al. (2007) conducted a study on the calibration of the bicycle conversion factor at two-phase intersections in mixed traffic flows. His study is based on data collected from eight locations in several cities in China. They proposed a model to calculate the traffic through the bicycle and the factors of conversion of the traffic of bicycles to the left in the intersections where the bicycles and the motorized vehicles share the same way. The results indicate that the conversion factor of the passing bicycle is 0.28 and the conversion factor of the bicycle to the left is 0.33. This conclusion differs from the values used in China.

Xiao et al. (2011) conducted a study to calculate straight lane capacity in mixed traffic conditions, in China. The first high-pass (FDH) was applied as a novel to improve the model of the Stop Line method, and the influence factors of FDH were analyzed.

To calibrate the FDH probability distribution, research data from four intersections in Beijing were used.

## III. METHODOLOGY

### Study Area

Jaipur is the capital of the state of Rajasthan in India and was founded in 1727 (by Maharaj Jai Singh II). It is also known as the pink city. The city of Jaipur has a population of 3.10 million (2011 Census). Its annual-decadal growth rate is 4.6 percent and the city is one of the cities with the most millions of growth. The transport of the city is done in both personalized and free mode. The personalized travel mode includes private cars, two-wheeled vehicles, cycles. Public transport modes include MRTS (Metro) from Mansarovar to Chand Pol, BRTS from Sikar to Pani Pech, buses operated by Rajasthan State Road Transport Corporation (RSRTC) on 22 routes, minibuses operated by private operators, automatic rickshaws, Vikram (Tempos ) and cycle rickshaws in the form of Intermediate Public Transport. The existing transportation quota in the city of Jaipur consists of public transportation 19 percent, taxi service 8 percent, automatic service 6 percent, automobile 8 percent twenty-seven percent and rest is non-motorized transportation. The details of the public transport system as shown.

### Data collection

Data collection refers to the collection of video coverage from various locations. The entire project is about the data collected for various locations of Jaipur city. All in all five locations were selected each with different roadway conditions and different traffic compositions. The five locations on which the survey work was done are as follows;

1. Road near Badi Chopad, Jaipur
2. Road near Choti Chopad, Jaipur.
3. Road near Johri Bazar, Jaipur.
4. Road near Ramganj Bazar, Jaipur.
5. Road near Chandpol, Jaipur.

### Data extraction

Data extraction or data decoding refers to the experimental part of the project. As per the objectives defined in chapter 2, the experimental part comprises of the following;

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1. To study the variation in speed of NMV with respect to
  - Number of PCUs in the same strip.
  - Number of PCUs in the alternate strip.
  - Distance of the test vehicle from the road edge.
2. To study of fundamental diagram of the traffic flow from the data obtained from various locations.
3. To study the effect of density and fraction of NMV on lateral occupancy of
  - Non-motorised vehicles.
  - Motorised vehicles.

### Study of fundamental diagram of the traffic flow

Fundamental diagram means the diagrammatic representation of the relationship between the various traffic parameters, that is, the relationship between speed, flow and density. The definitions together with the supposed fundamental diagram of speed, density and flow are already given in chapter 1. For this study, data was collected for four locations, namely;

1. Road near Badi Chopad, Jaipur
2. Road near Choti Chopad, Jaipur.
3. Road near Johri Bazar, Jaipur.
4. Road near Ramganj Bazar, Jaipur.
5. Road near Chandpol, Jaipur.

If the data obtained from a 2 way road, data decoding was done for both way separately i.e. for upward flow or downward flow.

### Study of the variation of speed with respect to various parameters

This part actually shows how the speed of an NMV varies with respect to several parameters like

- PCU number on the same strip.
- Number of PCU in both adjacent strips.
- Distance of the test vehicle from the edge of the road.

Procedure followed here are

The video was played in KM player and the cellophane paper was stuck on the screen. The 4 corners were marked and joined. The area was divided into the same number of strips. Then with respect to test vehicle (NMV), the number of vehicles of different class in it and the two contiguous bands of strip on which test vehicle was scored. This process begins when the test vehicle enters the section and this ends when the test vehicle leaves the section. All kinds of vehicles were converted to a unit, that is, PCU. The speed of the test vehicle was calculated by the relation between the times passed by it in 24 the section at the distance traveled. (That is, length of the section + length of the test vehicle) Then graph between the speed of the test vehicle and the three parameters were plotted. All results are shown below.

## IV. EXPERIMENTAL RESULTS

### Data Collection

Below is a table showing the width and length of several sections along with their data collection time.

Table 4.1 Dimensions of several sections and time of data collection.

Sr. no	Location	Length of section (in m)	Time of data collection	Date
1	Road near Badi Chopad, Jaipur	5	10:15 am to 10:45 am	20.03.2018
2	Road near Choti Chopad, Jaipur.	5	11:00 am to 11:30 am	20.03.2018
3	Road near Johri Bazar, Jaipur	5	10:15 am to 10:45 am	21.03.2018
4	Road near Chandpol, Jaipur	5	06:00 pm to 06:30 pm	21.03.2018

All the data was collected with a video camera for an interval of 30 minutes. A section was selected on each road that has a sufficient amount of non-motorized traffic. A 5 m long section was selected and with the use of some marking tools the four corners of the area should be marked. And the video of the section was taken. All the

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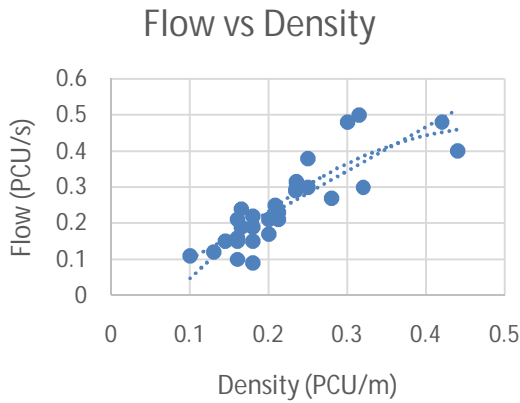
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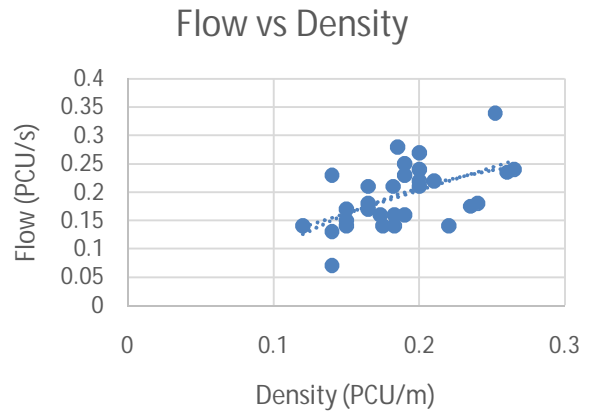
information was recorded using a video camera and then decoded on the when playing the video with the help of the KM player. A cellophane tape was pasted on the laptop screen. And the four corners were marked and joined with the whiteboard marker. This was done because although rectangular is the current shape of the section, but when captured in a camera, its shape is deformed (the figures are shown below). Then, the data was decoded at the rate of per second or frame rate (25 frames = 1 second) according to the requirement.

### Capacity Analysis

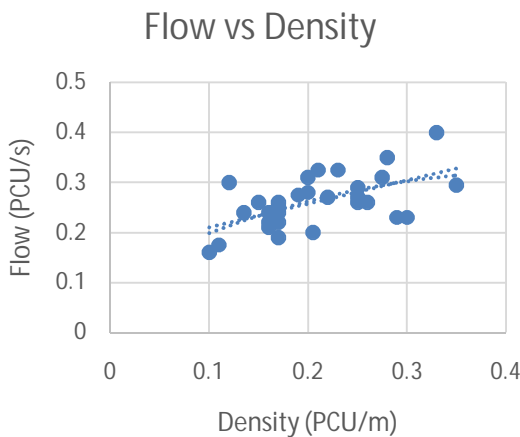
The flow-density relations are analyzed and capacity for all locations are evaluated as well as compared with the percentage share of non-motorized vehicles in total density.



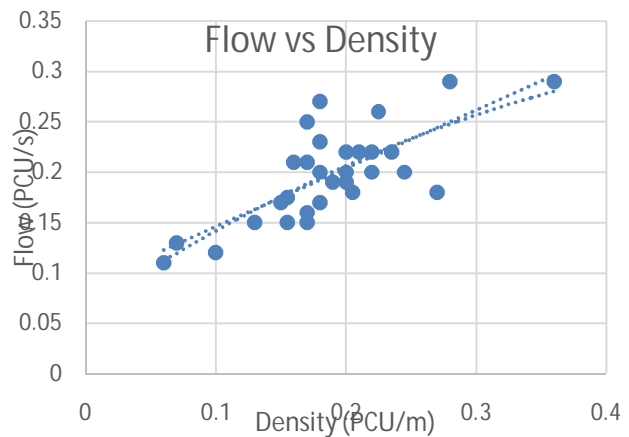
**Graph 4.1** Flow-Density Curve for Downstream flow in Badi Chopad



**Graph 4.2** Flow-Density Curve for Upstream flow in Badi Chopad



**Graph 4.3** Flow-Density Curve for Downstream flow in Choti Chopad



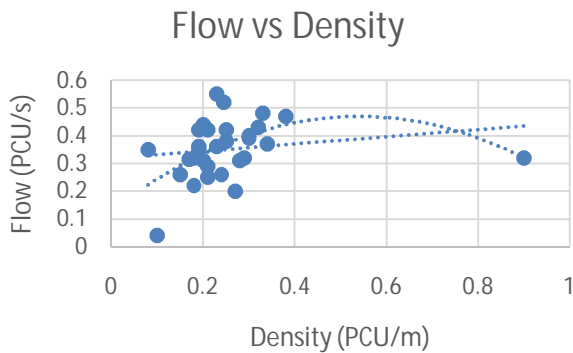
**Graph 4.4** Flow-Density Curve for Upstream flow Choti Chopad

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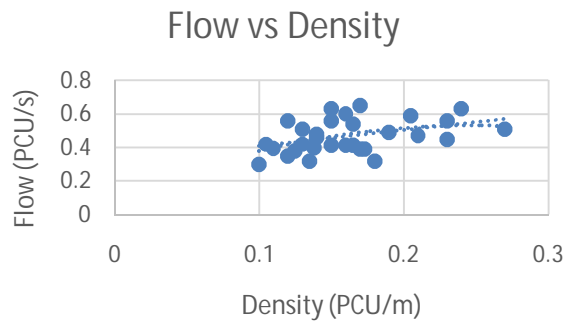
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Graph 4.5 Flow-Density Curve for Johri Bazar



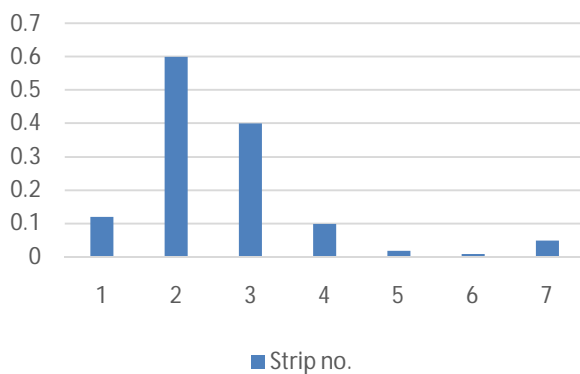
Graph 4.6 Flow-Density Curve for Chandpol

The capacity values obtained from the curves are adjusted for to represent capacity of a single lane for forward moving traffic.

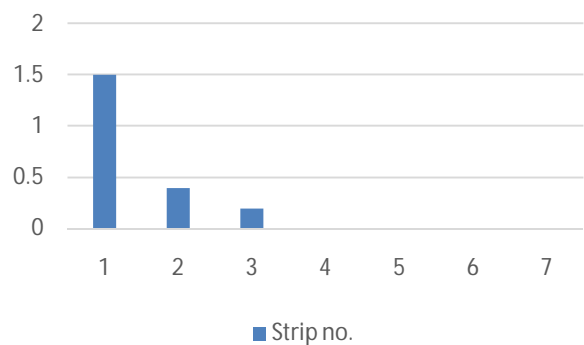
$$\text{Adjusted Capacity} = \text{Capacity} * 3.5$$

$$(\text{Roadwidth}) * (\text{Traffic Type})$$

### Lateral Density Distribution



Graph 4.8 Lateral Density Distribution of NMV for Downstream Flow in Badi Chopad



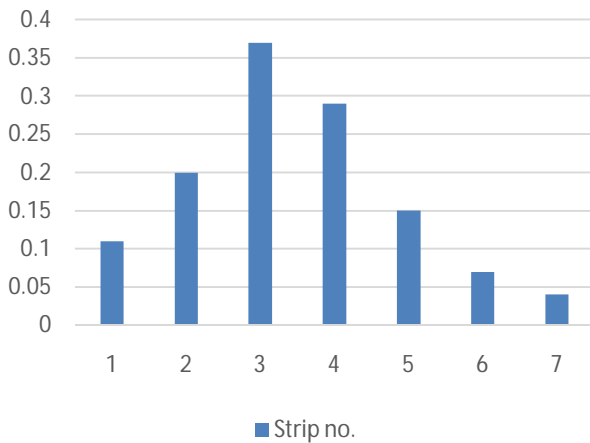
Graph 4.9 Lateral Density Distribution of NMV for Upstream Flow in Badi Chopad

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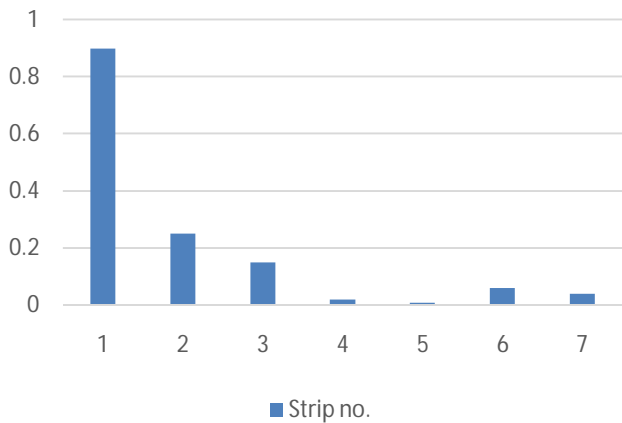
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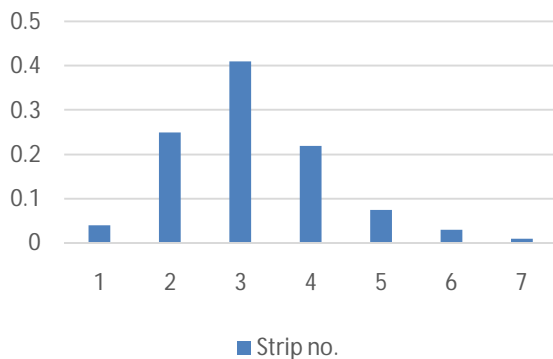
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**Graph 4.10 Lateral Density Distribution of NMV for Chandpol**



**Graph 4.11 Lateral Density Distribution of NMV for Downstream Flow in Choti Chopad**



**Graph 4.12 Lateral Density Distribution of NMV for Upstream Flow in Choti Chopad**

There is a linear relationship between speed and distance, however, there is a lot of dispersion due to the effect of non-motorized vehicles and the incorrect lane change in both traffic directions.

Now, the speed is linearly related to the advance of distance of motorized and non-motorized vehicles in traffic moving forward and backward.

$$V = C_0 + C_1D_1 + C_2D_2 + C_3D_3 + C_4D_4$$

Where :-

V is speed

D1 is distance headway of non-motorized traffic in forward direction

D2 is distance headway of motorized traffic in forward direction

D3 is distance headway of non-motorized traffic in backward direction

D4 is distance headway of motorized traffic in backward direction

The regression technique is used to obtain the value of all the constants for upstream and upstream traffic flows in Badi Chopad and in the Choti Chopad. The justification of the constant values can be provided by comparing the original velocities and velocities evaluated from the distance advance by using the constants.

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## V. CONCLUSION

In the fundamental diagram, the plot is similar to the one expected. The graph shows the partial density of the region, because within 30 minutes the video obtains free flow and congested at the same time, practically it is not possible. In any case, a congested flow point is also achieved in one place. When comparing the flow versus density curve for several locations with respect to various NMV percentages, it was found that with the increase in the NMV percentage, an adverse effect on the mixed traffic flow was noted. The density decreases at a particular flow rate when the NMV percentage increases.

In the lateral occupancy chart it can be seen that the NMVs try to stay on the left side of the road. As in India, we follow the left side, the MVs try to overtake them and they are mainly on the right side of the road. In addition, the first strip or 1 m from the left edge remains almost empty because the vehicles usually try to avoid moving on the edge when there are no shoulders or there are high curves. The roads on which there are shoulders the vehicles are also in the first strip on the left side.

The density data obtained from the entire location are almost equal, so it is not possible to predict the trend of lateral occupancy.

With less percentage of NMV, motorized vehicles do not face any problems and are distributed evenly throughout the flow space in that direction. With moderate NMV, motorized vehicles are trying to overcome NMV but there is also a flow from another direction, so they occupy half of their flow space, that is, strips 3 and 4. When the percentage of NMV is high, try the motorized vehicle to overtake them and they are on the right side of the road, that is, lanes 4, 5 and 6 that occupy the space for flow from another direction as well.

From the graph of speed versus graphs of several parameters, it can be concluded that the speed of non-motorized vehicles

1. It decreases when the number of PCUs on the same strip increases.
2. It decreases when the number of PCUs in the adjacent strip increases.
3. Increase when the distance from the edge of the road increases.

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