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ESTIMATION OF PASSENGER CAR UNIT AT URBAN INTERSECTION USING PLATOON DISPERSION MODEL

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ABSTRACT - ***Passenger car units or passenger car comparisons (PCUs) play a crucial role in the study of the traffic flow of different types of vehicles in the traffic flow and are used to transform traffic flows of different vehicle types into traffic flows consisting solely of passenger cars and which have been developed to analyse the effect of different types of vehicles on the road. In the present study we have discussed about platoon dispersion. Modelling of dispersion of vehicle platoon is an important consideration for coordinated operation of closely spaced traffic signals. This analysis is based on video photographic data collected at signalized intersection. The study of platoon dispersion is to a certain extent associated to driver manners and car following is one key component of driver behaviour. In this study, field investigation is made by means of videotapes which record traffic flows at several locations. After collection of video data extraction by any platoon dispersion software. This is used to accurate data collection from any intersections. Two-wheelers (2W) establish a most important proportion of urban traffic and consequently their consequence on the saturation flow could be significant. Passenger car unit is an important factor which is used to convert traffic volumes containing proportions of heavy good vehicles (HGVs) to a unify measure containing only passenger cars units (PCU).***

Keywords: *Platoon, Platoon dispersion, Passenger car unit, Congestion*

I. INTRODUCTION

Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increases vehicular queuing. Traffic congestion wastes time, energy and causes pollution. There are broadly two factors, which effect the congestion; micro-level factors and macro-level factors that relate to overall demand for road use. Congestion is 'triggered' at the 'micro' level (e.g. on the road), and 'driven' at the 'macro' level. The micro level factors are, for example, many people want to move at the same time, too many vehicles for limited road space. On the other side, macro level factors are e.g. land-use patterns, car ownership trends, regional economic dynamics, etc.

The clear mixing of various classes of vehicles beside a road creates many difficulties to the traffic engineers and planners. One kind of vehicles in the traffic stream cannot be reflected corresponding to any other type, as here is large difference in their vehicular and flow characteristics The space of the carriage way is shared by vehicles dependent upon their size, speed, headway and lateral gap sustained by them. The non-uniformity in the static and dynamic characteristics of the vehicles is usually taken into account through changing all vehicles in terms of common unit. The furthermost conventional one such unit is passenger car unit (PCU).

The traffic movement in India and in other developing countries is more complex due to heterogeneous characteristics of the traffic stream. Traffic consists of both motorized and non-motorized vehicles with lack of lane discipline. "Platoon of road traffic can be defined as a set of vehicles or pedestrians travelling together as a group, either freely or compulsorily, because of signal control, road geometry or other factors". In the Highway Capacity Manual (HCM), a vehicle platoon is defined as a group of vehicles travelling together.

Platoon dispersions the occurrence in which vehicular traffic free from, for example, an upstream signal, will get segregated, as they move over the distance towards the downstream signal. It is common, on urban roads, that the timing of successive traffic signals (when these are closely located) are planned in such a way that the main traffic stream gets the green when arriving at the downstream signal, thus, avoiding stopped delay for the stream of traffic. The study of platoon dispersion is to a certain extent associated to driver manners and car following is one key component of driver behaviour. In this study, field investigation is made by means of videotapes which record traffic flows at several locations.

The aim of this study is to investigate the nature of queue discharge headways, which may provide better information, and, reduce vehicle congestion at selected location of Ahmedabad.

The specific objectives of this research were to,

[1] To study the traffic flow characteristics at selected signalized intersections.

[2] To Approximation the passenger car equivalent unit values of different categories of vehicles at signalized intersections.

[3] To study the influence of platoon dispersion at signalized intersections and to compare with any platoon dispersion model.

[4] To find progression quality of platoon with help of platoon ratio.

NEED FOR PCU VALUES

Different vehicle types occupy different spaces on the road, move at different speeds and start at different speeds. Moreover, the behaviour of drivers of the different types of vehicles can also vary considerably. This poses a problem when designing roads, intersections and traffic lights. A uniform measurement of vehicles is therefore necessary to estimate the traffic volume and the capacity of roads with mixed traffic. This is rather difficult to achieve unless the different vehicle types are expressed in terms of a common standard vehicle unit. For these reasons, the concept of Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) was developed and it became a common practice to convert the other vehicle types into PCUs. It is usually expressed as PCU per hour, PCE per lane per hour or PCE per kilometre length lane. The main purpose of this document is to assess the estimation of passenger car units for motorcycles, tricycles, trucks and buses at a signalled crossing point.

FACTORS AFFECTING PCU VALUES

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PCU values depends on the following factors

1. Vehicle Characteristics Physical and mechanical, such as length, width, power, accelerations, deceleration andbraking characteristics of the vehicles.

2. Stream Characteristics a) Mean stream speed. b) Transverse gap or lateral clearance distribution of vehicles at different speeds of flow. c) Longitudinal gap distribution of vehicles at different speeds of flow. d) Speed characteristics of the stream such as speed distribution, dispersion and speed differences between differentadjoining vehicles in longitudinal and transverse directions. e) Stream composition, i.e. percentage composition of different classes of vehicles. f) Traffic volume to capacity ratio. g) Pedestrian volume. h) Flow conditions.

3. Roadway characteristics a) Horizontal alignment. b) Location: rural, urban, and semi-urban. c) Stretch: mid-block, signalised intersection, police controlled intersection, uncontrolled intersections, and rotary. d) Skid resistance of pavement surface. e) Traffic flow regulations such as one-way, two-way, divided and undivided roads. f) Number of lanes and pavement width g) Sight distance. h) Pavement surface unevenness, type and structural condition.

4. Environmental characteristics a) Surroundings and local factors. b) Obstructions. c) Roadway location - embankment, cut, underpass, overpass, tunnel. d) Terrain conditions: plain, rolling, hilly, mountainous.

5. Climatic conditions a) Fog, mist. b) Rainy, dry.

6. Control conditions a) Posted speed limit. b) Segregation of slow and fast moving vehicles. c) Free access, control of access.

TABLE: 1 PCU equivalency factor for different vehicles

SR NO.	VEHICLE TYPE	PCU equivalency factor
1	Cycle, Motor cycle, Scooter	0.5
2	Passenger car, Auto rickshaw.	1.0
3	Agriculture tractor, Light commercial vehicles.	1.5
4	Cycle rickshaw.	2.0
5	Truck, Bus, Hand-cart	3.0
6	House-driven vehicles.	4.0
7	Truck, trailer.	4.5
8	Bullock carts.	8.0

II. LITERATURE REVIEW

This chapter assessments the literature concerning the work, which has been carried-out on the Platoon dispersion behaviour of vehicular traffic. Estimation of correct saturation flow rate for specific condition is very important for the calculation of capacity, delays and LOS at signalized intersections. Platoon dispersion models simulate the dispersion of traffic as they move from upstream to downstream. They estimate the downstream flow on the basis of the upstream vehicle departure profile and the average travel time in the link. Devangi hattimare used videographic method for data collection. They were selected pallav cross road, in shastry nagar Ahmedabad as study area. The passenger car units (PCUs) values was derived for different types of vehicles in the traffic stream by different approaches. They find the actual dispersion on that site, compare it with the dispersion given by Robertson's model and thus evaluate model for heterogeneous traffic condition.

Jijo Mathew was take a 1.3 km section of an urban arterial in Chennai for his study area. Digital video cameras were placed at three control points along the study section. The observations were carried out for five days in May 2013. The video data were collected for a period of two hours during the morning peak. The data collected was processed in order to extract the required data on the vehicle passing time at each control point. The vehicles were classified into four classes Two-wheelers (2W), Three-wheelers (3W), LMV and HMV. The extraction was carried out manually by recording a macro in Excel which gave the vehicle class along with the timestamp, as the vehicle passed the point. The timestamp had a least count of millisecond, thus giving more precision. The process was carried out for the 2 hour data from all the three control points. The main aim of that study was to find the actual dispersion in that site, compare it with the dispersion given by Robertson model and evaluate for heterogeneous condition.

Priya rai was worked on Saturation Flow Modelling and Level of Service Analysis of Signalized Intersections at Kolkata. That study proposes a new PCU values for different classes of vehicles for the heterogeneous traffic condition of Kolkata. The analysis is based on video photographic data collected at three selected intersections of the city. Firstly dynamic PCU values for each vehicle at the study approaches are obtained and then saturation flow for each survey approach is calculated using the average PCU values.

III. STUDY AREA

The study area identified was a 2.2 km section of a Sarkhej – Gandhinagar highway in Ahmedabad, from kargil petrol pump intersection to cambay circle intersection. The Sarkhej–Gandhinagar Highway colloquially the S.G. Road or S.G. Highway, connects the city of Ahmedabad with Gandhinagar, the capital of the state of Gujarat, India. It forms the major part of NH8C that connects Sarkhej with Chiloda near Gandhinagar. The length of Sarkhej–Gandhinagar Highway is 44.5 km (27.7 mi). It is a major artery road for commercial and public transport and is witnessing a major construction boom along its route towards Gandhinagar.

In this study area two intersection consider i.e. kargil petrol pump intersection and cambay intersection. The intersections are attractive to many traffic users and very high motorcycle volume. Both intersection traffic movement is more complex and heterogeneous. Traffic consists of both motorized and non motorized vehicles with lack of discipline. Both intersection having huge traffic on peak hour and it is one of the busy route of the Ahmedabad because that route also link the Ahmedabad and Gandhinagar. In study area, there are many approach ways are there which provides huge number of traffic and the public transportation and high number of traffic of two-wheeler. When the traffic is low, signalized control system is operated as pre-time control, otherwise police are controlled the traffic by themselves. Due to the great fluctuation in traffic flow, the signalized intersections based on the scope of work are selected in which,

I) Advantage location for conducting survey,
ii) Large motorcycle volume and
iii) Little interference from other factors such as pedestrians, left and right turning and bus stops, etc.

Fig: 1 Kargil petrol pump intersection

IV. METHODOLOGY FLOW CHART

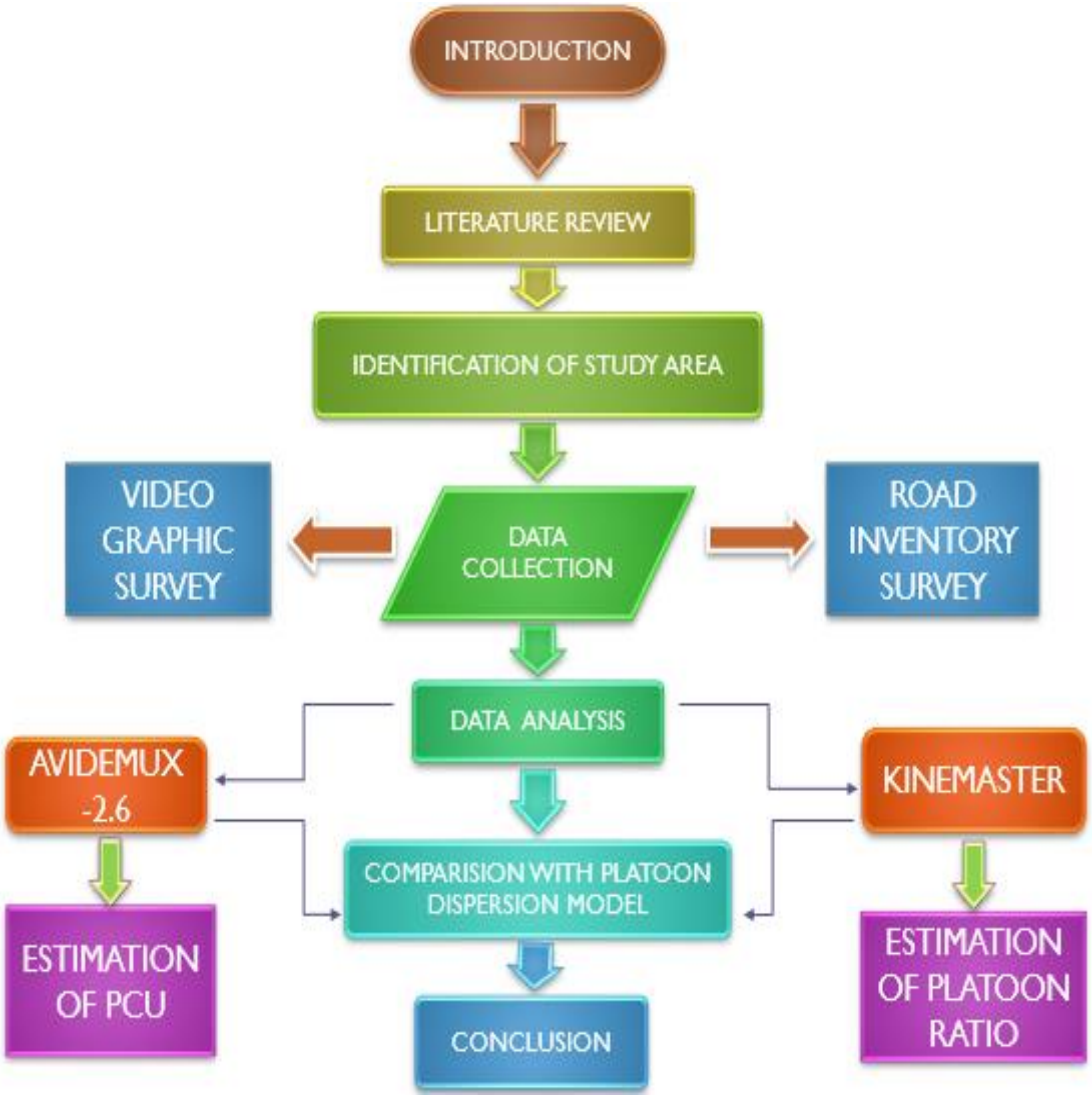

Fig: 2 Methodology flow chart

V. DATA COLLECTION

Data was collected on a typical weekday covering peak hours. During morning peak hours, substantial queue formation was observed due to which there was a considerable delay to traffic streams. This aspect was focused to get data on traffic operation at intersection over varying traffic conditions. Kargil petrol pump intersection to cambay intersection having huge traffic on peak hour and it is one of the busy route of the Ahmedabad because that route also link Ahmedabad and Gandhinagar. In study area, there are many approach ways are there which provides huge number of traffic and the public transportation and high number of traffic of two-wheeler. Data collection was carried out during peak periods from 9:30 am to 10:30 am on 15th February 2018 at satyamev - 2 complex opposite kargil petrol pump. The traffic flow at inner and middle lanes, which is mixed traffic of passenger car, bus, and motorcycle, is taken into consideration.

TABLE: 2 IDENTIFICATION OF SIGNALIZED INTERSECTION

SR NO	LOCATION	GPS COORDINATE	TIME OF VIDEOGRAPHIC SURVEY	DURATION
1	Kargil petrol pump intersection(satyamev-2 complex)	23.0769' N 72.5248' E	9:30 am to 10:30 am	1 hour (morning) 15th Feb 2018

Fig: 3 camera set up at satyamev – 2 complex

Fig: 4 footpath width measuring at study area

VI. DATA ANALYSIS

After collection of video graphic data extraction by Kinemaster and Avidemux – 2.6 software. For the present study, straight movement count was carried out manually by observing the recorded video and playing it repeatedly for various times. When vehicles move from upstream to downstream, disperse to some extent mostly due to the difference in the desired speed of different drivers in the platoon. This dispersion was captured by analysing the same platoons at upstream and downstream points. After extraction of video graphic data around 48 platoons in morning are analyzed. From the video films, vehicle types and passing time are captured later by interpreting in the traffic.

For the traffic survey, the different types of vehicles in the traffic stream are classified into different groups as follows:

1. Motorcycles, scooters
2. Passenger cars, vans, Auto rickshaw
3. Buses (AMTS, BRTS, GSRTC)
4. LCV (Tempo, Tractor, Chota-hathi)
5. HCV (Truck, Water tanker)

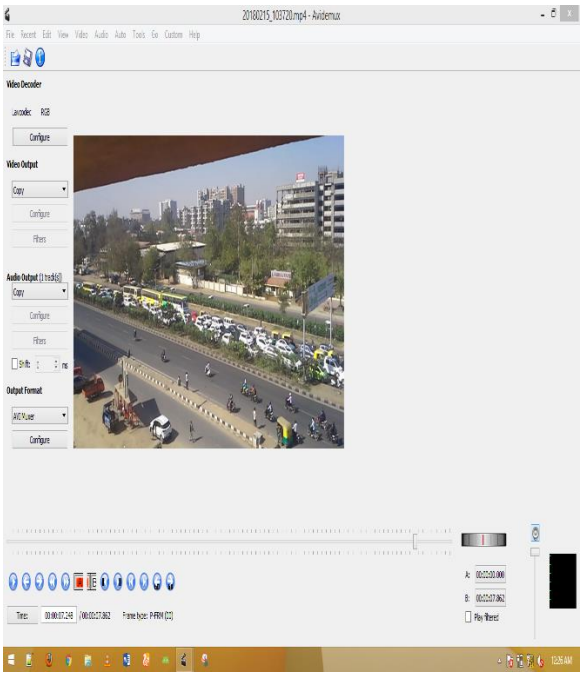

Fig: 5 screenshot of vehicle movement in Avidemux-2.6

Fig: 6 screenshot of vehicle movement in Kinemaster

CHART: 1 COMPOSITION OF VEHICLES

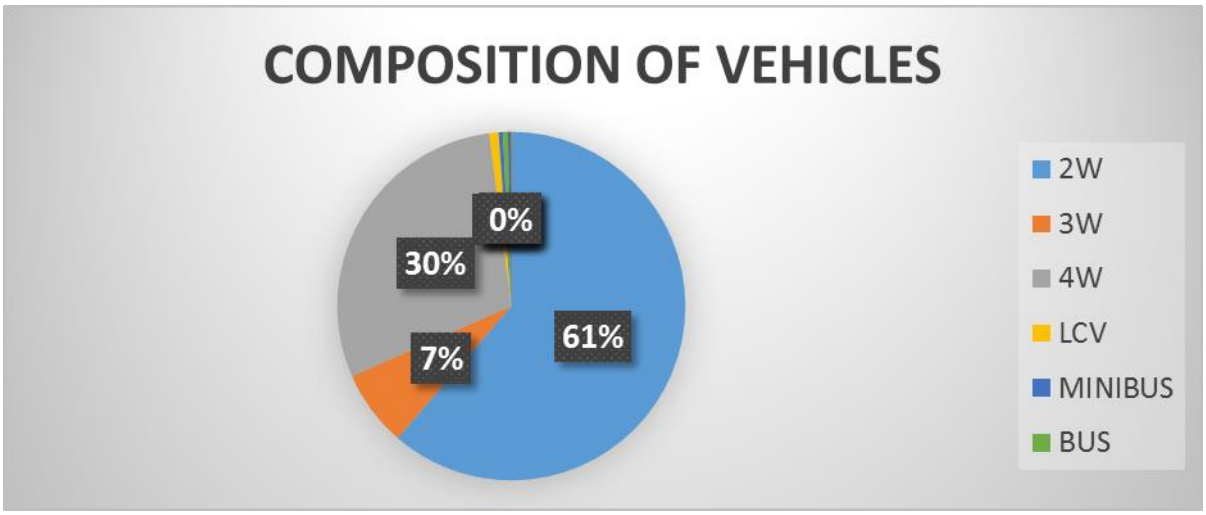

Table: 3 ROAD INVENTORY DATA COLLECTION

COMPONENT	KARGIL PETROL PUMP	CAMBAY CIRCLE
Vehicle direction	**Two way**	**Two way**
Lane	**Six lane**	**Six lane**
Carriage way condition	**Good**	**Good**
Width of carriage way	**9 m**	**9 m**
Shoulder type	**Painted**	**Painted**
Shoulder width	**1.5 m**	**1.5 m**
Median available	**Yes**	**Yes**
Median type	**Raised**	**Raised**
Width of median	**3.50 m**	**3.50 m**
Footpath condition	**Good**	**Good**
Footpath width	**2 m**	**2 m**
Type of intersection	**Four leg intersection**	**Four leg intersection**
Intersection	**Signalized**	**Signalized**
Service road	**Available**	**Available**
Width of service road	**6 m**	**6 m**
Zebra crossing	**Available**	**Available**
Sign board	**Available**	**Available**

Table: 4 Vehicle compositions each category vice Analysis

PLATOON N0	PLATOON SIZE	2W	3W	4W(CAR)	LCV	MINI BUS	BUS	HCV	CYCLE
1	246	165	18	59	3	1	0	0	0
2	139	82	10	45	0	0	0	2	0
3	213	132	17	63	1	0	0	0	0
4	111	53	13	43	2	0	0	0	0
5	147	112	6	26	0	0	0	0	3
6	132	60	11	57	2	0	1	0	1
7	158	94	15	44	2	1	2	0	0
8	157	87	13	53	1	2	1	0	0
9	158	104	17	32	3	0	1	1	0
10	133	57	10	62	2	1	0	1	0
11	151	98	13	38	0	1	0	1	0
12	133	70	9	53	0	0	1	0	0
13	159	113	7	37	1	1	0	0	0
14	150	76	15	56	0	1	1	0	1
15	192	113	17	58	2	1	0	1	0
16	156	88	13	51	3	0	1	0	0
17	206	151	7	47	1	0	0	0	0
18	140	70	15	53	0	1	1	0	0
19	159	112	9	36	1	1	0	0	0
20	158	97	13	48	0	0	0	0	0
21	166	98	8	56	2	0	1	1	0
22	147	77	7	59	3	1	0	0	0
23	142	87	13	39	2	0	0	1	0
24	173	113	6	51	0	0	2	1	0
25	234	156	13	61	3	0	1	0	0
26	142	73	16	48	3	0	1	0	1
27	228	148	12	64	2	1	1	0	0
28	225	138	12	69	3	0	3	0	0
29	130	78	8	38	2	1	2	0	1
30	189	114	17	54	1	2	1	0	0
31	144	89	12	39	3	0	0	1	0
32	216	137	13	63	1	2	0	0	0
33	194	117	15	58	1	2	1	0	0
34	186	127	12	41	0	2	1	3	0
35	171	98	17	53	0	2	1	0	0
36	176	111	8	50	2	2	3	0	0
37	144	89	11	38	3	0	3	0	0
38	176	101	9	64	0	1	1	0	0
39	166	107	8	49	1	1	0	0	0
40	198	139	15	38	3	0	3	0	0
41	176	103	9	63	1	0	0	0	0

PLATOON N0	PLATOON SIZE	2W	3W	4W(CAR)	LCV	MINI BUS	BUS	HCV	CYCLE
42	141	89	11	39	0	1	1	0	0
43	185	127	8	48	1	1	0	0	0
44	147	94	13	38	0	2	0	0	0
45	154	81	9	60	2	0	1	1	0
46	153	101	11	37	3	1	0	0	0
47	167	98	17	49	2	0	0	1	0
48	180	111	13	53	0	0	2	1	0
TOTAL	8048	4935	571	2380	68	33	38	16	7
PCU FACTOR	-	0.5	1	1	1.5	3	3	4.5	0.5
PCU	**5809**	**2467.5**	**571**	**2380**	**102**	**99**	**114**	**72**	**3.5**
COMPOSITION OF VEHICLES	**100%**	**61.32 %**	**7.09 %**	**29.57%**	**0.84 %**	**0.41%**	**0.47 %**	**0.20 %**	**0.09%**

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