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Characteristics of Development and Dissipation of Queue Length Under Mixed Traffic Conditions

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Abstract--The traffic flow composition on Indian roads is most of the time mixed in nature having different classes of vehicles with different percentage of composition this gives rise to complicated nature of queue development and dissipation in many practical situations like at signalised junction. Depending on the effective road width available and composition of traffic stream the length of queue varies with respect to volume of traffic. An attempt has been made in the present investigation to understand, the factor contributing for development and dissipation of queue length under mixed traffic condition under variable road width at one of very big and important signalized junction in Bangalore city. Analysis has been carried out with PCU and mixed composition of vehicles in both development and dissipation of queue length.

1.INTRODUCTION

Heterogeneous or mixed traffic systems operate very differently compared to homogeneous traffic systems, due to the wide variation in the operating and performance characteristics of the vehicles. The traffic in mixed flow is comprised of fast moving and slow moving vehicles or motorized and non-motorized vehicles. The motorized vehicles include cars, buses, trucks, auto-rickshaws (three-wheelers), scooters, and motorcycles (both two-wheelers); and the non-motorized vehicles include bicycles, human-powered or cycle-rickshaws, and animal-driven carts. The vehicles also vary in size, maneuverability, control, and static and dynamic characteristics. Traffic is not segregated by vehicle type and therefore, all vehicles travel in the same right of way. Lane markings are typically not provided for heterogeneous traffic conditions. Mixed flow traffic does not move in single files. On the contrary, there is a significant lateral movement, primarily by the smaller sized motor vehicles (bicycles, motorcycles, mopeds, and scooters). At intersectionsSpecifically, smaller vehicles use the lateral gaps between larger vehicles in an attempt to reach the head of the queue.

These types of traffic possess various problems to traffic engineers and traffic management authorities and city planners. This due to the fact most of vehicles do not confirm to the design standard vehicle like passenger car as adopted has in homogenous traffic condition. One of the main traffic problems in urban areas and their surroundings is the occurrence of Oversaturation at traffic signals. Traffic flow is vulnerable to disruption, therefore when a Traffic signal is oversaturated queues of traffic build up behind the signalized intersection. The effect is then potentially quite serious. If flow exceeds the capacity considerable Congestion is inevitable, resulting in excessive delay. The cause of oversaturation at traffic signals can be seen as two reasons; firstly, congestion is caused by the enormous traffic demand compared to the signal capacity, secondly, it is caused by an incident occurring in the traffic signal area which causes signal capacity Decreases significantly. To come across such problems this project aims to investigate queue length formation as Part of traffic congestion, and therefore the result could contribute in congestion Management.

1.1 Objectives of the Study

The objectives of the present study are as follows:

- To conduct an preliminary to survey of the road for determining the feasibility of the project work
- To develop the relationship between development and dissipation of queue length under mixed traffic condition based on arriving vehicles and departing vehicles
- To arrive at queue length development and dissipation for provided green time and red time respectively
- To do the regression analysis for the arrived relationship

- To check the development and dissipation of queue length for another junction having different road width

1.2 Scope of the Study

This study is aimed to recognize the characteristics of development and dissipation of queue length under mixed traffic condition. The main aim of this work to improve the traffic flow, to reduce travel time, safety to the users and optimization of traffic signal in an appropriate way.

2. LITERATURE REVIEW

2.1 General

To start with any project, it is necessary to have general and detailed information regarding the subject content, strategic approaches, available research in the subjected area, interpreted results and drawn conclusions. Impact of the increased in the population and the increased in growth of the vehicles and other activities.

2.2 Queuing theory

Queuing theory studies congestion phenomena, i.e., the behavior of objects passing through a point at which there is a restriction on the maximum rate at which they can get through.

A queuing system can be represented schematically as follows:

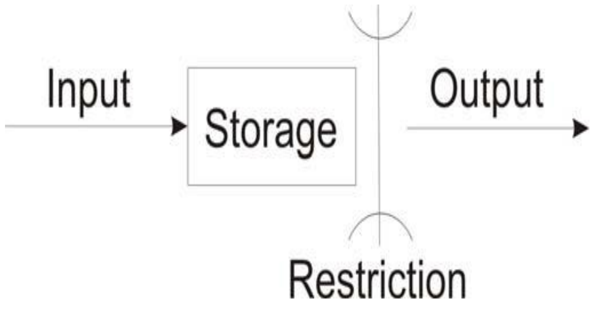

Fig 2.1 Basic queuing theory

Most queuing systems have a storage area upstream of the restriction where the objects thathave arrived but have not yet passed through the restriction are queued up. The collection of an object in the storage area is called a queue. Because queuing theory was developed with a certain type of application in mind (such as the analysis of waiting lines at check-out counters) the objects are referred to as customers and the restriction as a server (or service station if it contains more than one server).Examples of transportation queuing problems are aircraft requiring taking off, Automobiles arriving at a toll gate, passengers waiting for elevators, and ships calling at a port. In all these examples the customers are transportation vehicles (except in the elevator case where the passengers are the objects) and the restrictions to flow are respectively the runway, the toll gate, the elevator doors, and the entrance to the port. With queuing theory one can study the behavior of a queue over time if the input stream (Or arrival process) of customers and the characteristics of the restriction (or service Mechanism) are known. One is usually interested in the maximum queue length over a period of time and on typical waiting (or queuing) times.

In many daily life situations, one is faced with the problem of providing services for randomly originating demands. Take the simple case of motorists arriving at a toll booth and signalized intersection. If the arrival rate is heavy and the rate of servicing is not able to cope up with it, it is inevitable that a queue builds up. Delays occur as a consequence. The pioneer, investigator of the queuing theory was A .K. Erlang (1909). Since then the subject has been approached by many investigators. Queuing is one of the problems studied in the subject of operations. Research which has been developed in recent times. The literature available is very fast. For a beginner, an elementary book on operations research should serve the purpose of an introduction. Exhaustive presentations are also available.

2.3 Applications to Traffic Engineering

Most traffic engineering problems concern themselves with the provision of adequate capacity for the average flow of vehicles in the system, so as to avoid congestion and delay under the average conditions. With the capacity designed only for the average conditions, it is inevitable that congestion occurs in most of the peaking situations. Examples of the occurrence of queues in traffic flows are: signalized intersections, car park, toll booths, bottleneck situations and so on. Because of the easy applicability of the queuing theory to these problems, traffic engineers have been evincing great interest in these subjects recently. A useful introduction would be Cleveland and Capelle`s excellent summarization of the queuing theory approaches to traffic engineering problems and a T.R.B.publication

The Indian Roads Congress has given set of PCU values or Equivalency factors for use on urban roads are represented in table below and same Equivalency factors are used in the calculation of PCU values

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TABLE 2.1 Equivalency factors suggested by the IRC 86-1983:

Sl no.	Vehicle class	Equivalency Factors
1	Passenger car, tempo, auto rickshaw, agricultural tractor	1
2	Bus, truck, agricultural tractor-trailer unit	3
3	Motor cycle, scooter and pedal cycle	0.5
4	Cycle rickshaw	1.5
5	Horse drawn vehicles	4
6	Small bullock cart and hand cart	6
7	Large bullock cart	8

3 DATA COLLECTION

3.1 Selection of study area

Devegouda petrol bunk junction is one of the busiest junctions in indian Bangalore city south region. This intersection is also known as Kittur Rani Chenamma Circle and it's a four arm signalized intersection. This intersection connects major roads like mysore road, 100 feet outer ring road, kadrinahalli, banashakari bmtc bus stand ,padmanaba nagar , utarahalli road etc

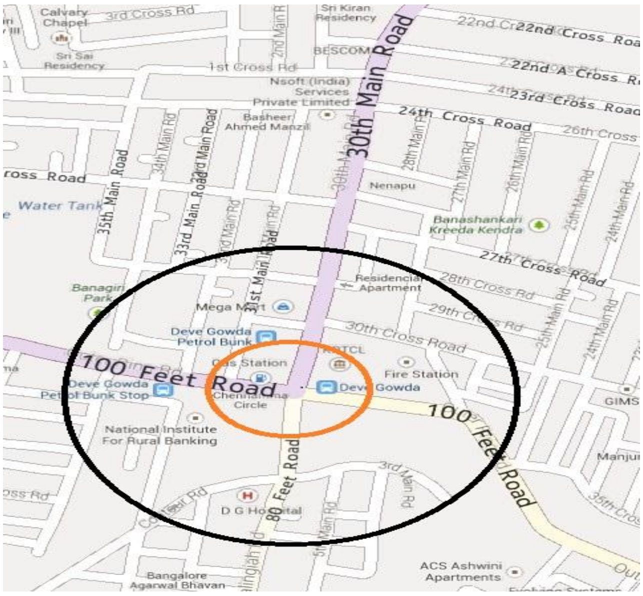

Fig 2.1 Google map location of study area

3.2 Preliminary study

Preliminary survey involved the measurement of the width of road at the selected intersection using measuring tape .the width of roads are measured including dividers. The details of intersection is shown in fig 2.2

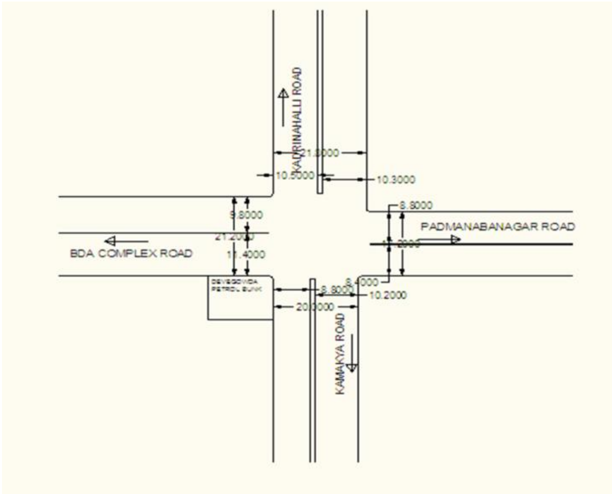

Fig 2.2 Geometric details of intersection

The preliminary studies involved the preparation of data sheets for both development and dissipation of queue length under mixed traffic condition. In data sheet passenger car and pick up van both are considered as one unit and agricultural tractor and light commercial vehicles are also considered as one unit and named as others. Sample of data sheets is shown in tables 3.1, 3.2 and 3.3

The sample data collection for development of queue length involved two observers each at 10meters intervals from stop line, marking a point at 10metres intervals using tape and chalk on the foot path and standing at the point as soon the signals turns red counting the number of vehicles joining the queue in that particular stretch, only three cycles readings were noted in the preliminary survey.

TABLE 3.1sample of 3trails for development of queue

Length in meters	Bike	Car	Bus	Auto	Truck	Others
L10	6	4	1			
L20	10	6	2	1	2	
L10	7	3		1		1
L20	11	5	1	2		1
L10	4	2	1	1		
L20	12	6	1	1		

The sample data collection for dissipation of queue length involved two observers each standing at 10m intervals from stop line, marking a point at 10metres intervals using tape and chalk on the foot path and as soon the signals turns red counting the number of vehicles joining the queue and as the signals turns green stopwatch was started as soon all the vehicles crosses the stop line stopwatch was stopped and the time required for dissipation is noted for the 10metres length of queue dissipation then same procedure was repeated for three times. For 10metres and 20metres length of queue. The studies were carried out to get an idea regarding field exposure for actual data collection.

TABLE 3.2 Sample of 3trails for dissipation of queue at 10 meters interval

10m interval length	Bike	Car	Bus	Auto	Truck	Others	Time for dissipation in seconds
Trail 1	12	3		5	1		7
Trail 2	8	3	1	4		1	6
Trail 3	10	4		2	1	1	5

TABLE 3.3 Sample of 3trails for dissipation of queue at 20 metersintervals

20m interval length	Bike	Car	Bus	Auto	Lorry	Others	Time for dissipation in seconds
Trail 1	12	4	1	5	2	3	12
Trail 2	16	6		1		1	10
Trail 3	14	5		2	1	1	14

3.3 Actual data collection

Actual data collection for development of queue length involved four observer, marking a point at 10metres intervals using tape and chalk on the foot path, first observers standing at 10metres intervals point from stop lineas soon the signals turns red,counting the number of vehicles joining the queue from stop line point to 10metres interval point, first observer will also count the vehicles joining from 10metres interval to 20metres interval stretch, second observer will count the number of vehicles joining the queue from 20metres point to 30metres interval stretch and 30metres to 40metres interval stretch, third observer will count the number of vehicles joining the queue from 40metres point to 50metres interval stretch and 50metres to 60metres interval stretch, fourth observer will count the number of vehicles joining the queue from 60metres point to 70metres interval stretch and 70metres to 80metres interval stretch and rest of vehicles joining the queue will also observed by fourth observer.

Actual data collection for dissipation of queue length involved two observer, marking a point at 10m intervals using tape and chalk on the foot path, as soon the signals turns red counting the number of vehicles joining the queue and as the signals turns green stopwatch is started as soon all the vehicles crosses the stop line stopwatch is stopped and the time required for dissipation is noted for the 10m length of queue then same procedure repeated for five times. For 10metres, 20meters, 30meters, 40meters, and 50meters length of queue.

4. ANALYSES OF DATA

Analyses of data for development of queue length include calculating the number of total mixed vehicles for every 10 meters interval for development of queue as shown in table 4.1 and number of mixed vehicle versus queue length in meters graph is plotted and it is shown in figure 4.1 from regression value and equation is obtained. For the same data PCU values are calculated by using Equivalency factors suggested by the IRC 86-1983 shown in table 2.1 and then vehicles in PCU verses queue length in meters is plotted and it is shown in fig 4.2

Analyses of data for dissipation of queue length include calculation of total number of mixed vehicles and total PCU values as shown in table 4.3 and table 4.4 respectively. and number of mixed vehicles versus time for dissipation in seconds graph is plotted and is shown in fig 4.3 similarly vehicles in PCU versus time for dissipation in seconds graph is plotted and it is shown in figure 4.4.

Similarly the analysis were done for all four roads connecting the intersection but detail analyses of only one road is shown in this report.

TABLE 4.1 Actual data for development of queue length mean of 36 cycles and showing total mixed vehicles at each interval

Length in meters	Bike	Car	Bus	Auto	Truck	Others	Total mixed vehicle
L10	10.69	3.24	0.44	0.86	0.11	0.35	15.69
L20	19.99	6.46	0.54	3.16	0.11	0.98	31.24
L30	28.51	8.79	0.59	5.21	0.13	2.39	45.62
L40	35.56	11.95	0.81	6.51	0.29	2.86	57.98
L50	39.56	14.92	1.05	7.11	0.89	3.49	66.99
L60	43.58	17.44	1.13	8.61	0.97	3.82	75.52
L70	46.68	20.07	1.57	9.52	1.02	3.84	82.67
L80	48.18	22.01	1.62	10.87	1.02	4.36	88.03
L90	48.59	22.51	1.72	11.10	1.10	4.44	89.47

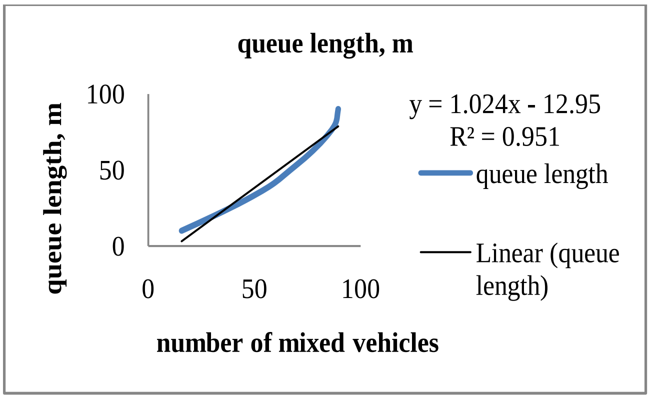

Fig 4.1 Shows number of mixed vehicle v/s queue length in meters

TABLE 4.2 Actual data for development of queue length mean of 36 cycles and showing total PCU at each interval

Length in Meters	Bike	Car	Bus	Auto	Truck	Others	Total PCU
L10	5.34	3.24	1.32	0.86	0.33	0.52	9.61
L20	9.99	6.46	1.62	3.16	0.33	1.46	23.02
L30	14.25	8.79	1.77	5.21	0.39	3.57	33.98
L40	17.77	11.95	2.43	6.51	0.87	4.27	43.08
L50	19.77	14.92	3.15	7.11	2.67	5.21	52.8
L60	20.78	17.44	3.39	8.61	2.91	5.71	59.81
L70	23.33	20.07	4.71	9.52	3.06	5.74	66.40
L80	24.08	22.01	4.86	10.87	3.06	6.52	71.37
L90	24.28	22.53	5.10	11.14	3.30	6.64	72.96

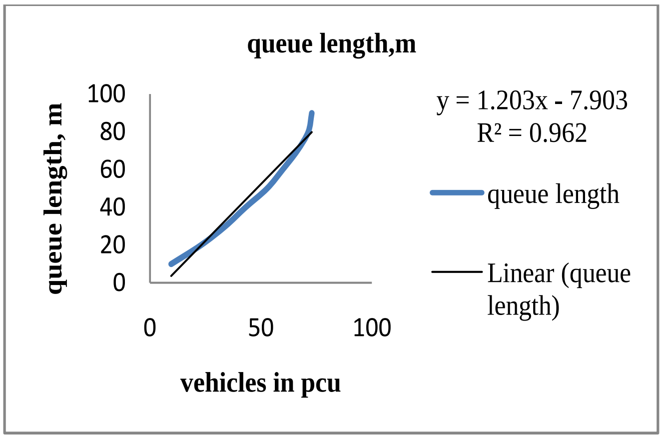

Fig 4.2 Shows vehicle in PCU v/s queue length in meters

TABLE 4.3 Actual data for dissipation of queue length mean of 5 cycles and showing total mixed vehicles at each interval and time for dissipation in seconds

Queue length	Bike	Car	Bus	Auto	Truck	Others	Mixed vehicles	Time for dissipation in seconds
L10	7.6	2.2	0.2	2.6	0.2	0.4	13.2	8
L20	12.2	5.4	0.4	3.8	0.2	0.2	22.2	12.6
L30	13.8	7.4	1.4	3.2	0.4	0.6	26.8	15.6
L40	14.6	10.6	1	4.2	0.6	1	32	20
L50	22.8	17.4	1.6	6	0.8	1.4	50	25.8

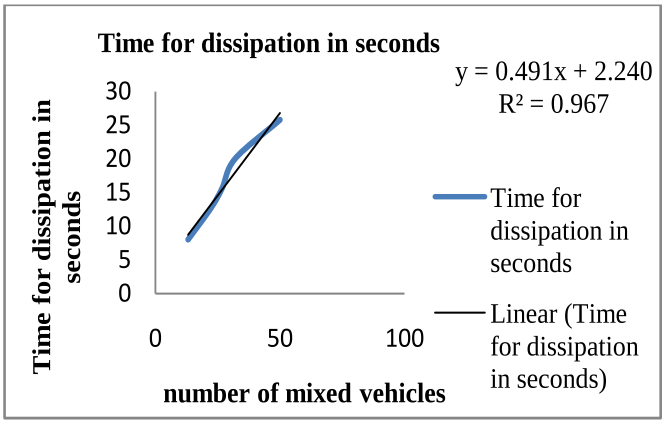

Fig 4.3Shows number of mixed vehicle v/s time for dissipation in seconds

TABLE 4.4 actual data for dissipation of queue length mean of 5 cycles and showing vehicles in PCU at each interval and time for dissipation in seconds

Queue length	Bike	Car	Bus	Auto	Truck	Others	Vehicles in PCU	Time for dissipation in seconds
L10	3.8	2.2	0.6	2.6	0.6	0.6	10.6	8
L20	6.1	5.4	1.2	3.8	0.6	0.3	17.4	12.6
L30	6.9	7.4	4.2	3.2	1.2	0.9	23.8	15.6
L40	7.3	10.6	3	4.2	1.8	1.5	28.4	20
L50	11.4	17.4	4.8	6	2.4	2.1	44.4	25.8

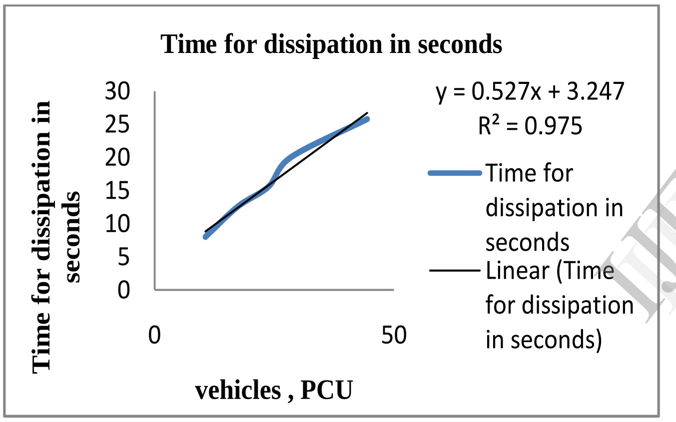

Fig 4.4 Shows number of vehicles in PCU v/s time for dissipation in seconds

5. CONCLUSIONS

- There is a good relationship between queue length development and dissipation under mixed traffic condition.
- Queue formation varies depending on arrival of mixed vehicles and also the PCU adopted for correction.
- As the analyses result indicates good relationships, the possibility of these analyses may be generalized with more studies.
- This concept may be used in designing of signal based on queue length development and dissipation for designing signal timings.
- This would result in tremendous amount of saving in time for vehicle users and fuel for vehicles.
- This may also be used for area traffic management with better junctions management

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