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Analysis of Traffic Behaviour at Controlled Intersection during Long Term Interruption

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Abstract

With the increase in the population in the metropolitan cities has rapidly increased the usage of vehicles and this has led to a major traffic problem. In order to overcome this traffic congestion elevated corridors, metro, underpass etc. are being constructed. In this paper an attempt has been made to study the traffic behavior at the intersection during the construction of the flyover. And the remedial measures to overcome the traffic congestion are discussed. The Level of Service, Saturation flow, delay and queue length are found out. Based on this the quality of the traffic on road is determined and junction improvements methods are recommended. It was found that LOS of RD1 and RD2 before construction of flyover is "C" and during construction of the flyover is "F".

Keywords: *Delay studies, LOS, Queue Length, Saturation flow rate, Traffic congestion*

Introduction

Bangalore is the capital of Karnataka. Bangalore has a masses of more than ten million, making it a megacity and the 1/3-most crowded city and fifth greatest crowded city agglomeration in India. It is situated in southern India, at a rise of more than 900 m above ocean degree that is the absolute top notch among India's most significant towns. Bangalore is depicted on account of the Silicon Valley of India as its far residential to the IT.

General Traffic Problems

Vehicle ownership and car usage have continued expedient blast into the current day in Bangalore. Most city regions are tortured by unmaintained externalities comprehensive of extreme excursion occasions, air poisons, futile power admission, and even basic money related misfortune because of the stunning traffic blockage. The previously mentioned marvels also have evoked urban transportation issues in various gigantic urban communities in Bangalore. Fast turn of events and an expansion in vehicle use result in initiate traffic clog in Bangalore

About location

Koramangala is placed within the southern part of the metropolis, its residential locality with wide, tree-coated and an aggregate of steeply-priced houses, industrial structures, and posh bungalows. It is split into 8 blocks unfold over approximately 1800 acres. Koramangala which have grown to be at the left even as going to the economic suburbs.The distance from Koramangala to Kempagowda International Airport is forty one.Three Km and the distance from Koramangala to Majestic Railway station is 10 Km

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Figure 1: Major junctions on Intermediate Ring Road

Study Area

Koramangala, the hub of fundamental start-ups, IT and BT businesses, surprisingly lacks Metro connectivity. The site site visitor's congestion hassle has been considered as a vital hassle inside the Koramangala Ejipura Sony signal. To reduce congestion, the BBMP decided to assemble a flyover to lessen adventure time due to an unendurable delay inside the intersection . The 2.4km-lengthy Ejipura-Kendra Sadan flyover seems to have ruined the tony locality's chances of getting most of the people transit facility for some time come.

Figure 2: Ejipura Signal

Objectives

- To establish volume to capacity ratio at peak and non-peak hour
- To determine the level of service of the road
- To determine the spot speed and travel time during peak hour and non-peak of the vehicle
- To determine LOS of RD1 and RD2 before and during construction of flyover
- To recommend the necessary measures to overcome the traffic during flyover construction

Literature Review

Traffic Condition with road upgrading during construction and operation stages based on LOS (A C Tay and H H Lee) Published on Jan 2018

In this editorial, a site guest's overview has become accomplished on the signalized crossing point of the two closures of a redesigning street sooner or later in the first part of the day and evening stature hours during the improvement term. This examination expected to investigate the site guests' conditions for the signalized crossing points. The optional street that being moving up to the standard interstate over the span of eight hours for assembling and activity levels. Information collected from these locales have been broke down in accordance with Highway Capacity Manual (HCM) 2010. From the outcomes, the degree of-contributions (LOS) street convergence progressed from Level F to Level E at the activity degree for a weekday eventually of tallness hours inside the morning. Street crossing points at the development recognition had been Level C throughout eight hours inside the morning and Level D toward zenith hours inside the evening for quite a long time.

Improving Traffic Flow at Long-term Roadworks. (Christoph and Michael Fledge) Published on 2016 Volume 15

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Long Long-lasting period roadworks on interstates are critical as a major aspect of street and scaffold redesigns. They create bottlenecks and may in this way reason blockage and wounds. On the off chance that the assortment of paths is diminished, this will cause a significant abatement in potential. Regardless of whether all paths might be kept operational, smaller paths and street exchanging will lessen the capacity. Keen answers for help the site guests accept the way things are at long-term period roadworks, consequently, need to be assessed. The "Traffic Change" (TC) contraption was advanced for this rationale. This device permits paths to be progressively appointed to the street with the better interest. It might be done inside the instance of scaffold safeguarding, road reemerging and fix (whole street), burrow redesign with - route traffic inside the operational bore, or brief adaption of the quantity of operational paths, contingent upon the traffic request. Thusly, the workspace wanted for street works might be broadened.

Evaluation of right-turn lanes at a signalized intersection in non-lane based heterogeneous traffic using a microscopic simulation model
A. Gowri & R. Sivanandan, The International Journal of Transportation Research, 2015
This paper is focused on the study of site visitors that is characterized via a loss of queue and lane area (lane-less movement) primarily based on the availability of areas close to intersections. Moreover, at intersections, instantly-thru, left-, and right-turning vehicles are seeking for to occupy the same physical area. In such conditions, the via motors are liable to delays inside the absence of flip lanes for the left-turning and proper-turning automobiles and vice versa. Models appropriate for evaluation of such traffic go with the flow hardly ever exist, and most of the available fashions are restricted in scope. In the modern take a look at, a microscopic visitor's simulation model for signalized intersection is developed specially for heterogeneous visitors.

A study on the traffic impact of the road corridors due to flyover construction at Surabaya intersection, Banda Aceh of Indonesia
Sofyan M, Saleh et.al, Published on Nov 2017
The urbanest locales are influenced by unmaintained externalities comprehensive of unbalanced visit time, superfluous gas consumption or even outrageous monetary misfortune in light of outstanding increment in vehicle traffic (i.E. Motorbike and vehicle), and because of car possession and use has endured expedient development into late days comprising of in Banda Aceh, capital of Aceh Province. An expansion in vehicle utilization closes in set off rush hour gridlock clog inside the city offices comprising of in Surabaya convergence.

Methodology and Data Collection
Surveys are important to understand the existing scenarios of the selected study area. For the current study, the required surveys are listed below,

- Road Inventory survey
- Classified vehicles count by videography
- Speed studies
- Field delay and travel time studies at intersection

Classified vehicle volume count by videography
Volume count survey was carried out by videography method for a 6-hours duration from 8.00 am to 11.00 am in the morning and 5.00 pm to 8.00 pm in the evening. Data were recorded at all 4 legs of the intersection video cameras in such a manner that the camera should cover the vehicular movements from all approaches of that particular intersection. If the camera lacks to cover the whole intersection then two cameras can be used by setting in different locations. The survey was conducted for 5 days duration with 3 weekdays and 2 weekends. Classified as turning traffic volume extracted manually for every 2mins interval to get accurate values

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Figure 3: Ejipura junction – Top view

Road Inventory Survey

Road inventory survey has been carried out at the Ejipura junction to understand the geometry of all approaches connected to an intersection to get the parameters like-

- Approach width
- Number of lanes
- Distance between adjoining intersections
- Width of the median and
- Other details which control the handling capacity of the intersections.

The sequence of intersections along the corridor and distance between successive intersections and carriage width of all approaches respectively. And figure 5.1 shows the geometrical representations of the three intersections. Description of approach roads from all intersections

RD1 = Koramangala to Indiranagar
RD2 = Indiranagar to Koramangala
RD3 = Ejipura to Srinivagilu
RD4 = Srinivagilu to Ejipura

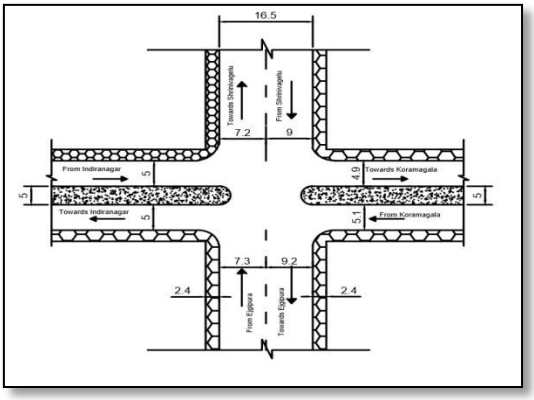

Figure 4: Intersection details of Ejipura junction

Spot Speed Studies

Spot speed studies were conducted at midblock between intersection using Videography method during peak hour and non-peak hour. Spot speeds of different classes of vehicles are tabulated below for all the 4 leg roads approaching the intersection

Field delay time and travel time studies at the intersection

Field delay studies were conducted at all 4 legs of the intersections by moving the observer method. A total of 5 runs were made during the peak hour periods for both directions from Sony Signal Junction to Ejipura Signal Junction and Indiranagar to the Ejipura signal. And travel time also measured from each intersection

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Table 3: Average Travel Time Studies by moving car observer method during the non-peak hour - 5trials

Average travel time							
Direction	**Distance(m)**	**Time Taken (Sec)**					
		1	**2**	**3**	**4**	**5**	**Average**
From Sony Signal to Ejipura Signal	**600m**	53	49	57	55	61	**55**
From Indiranagar to Ejipura Signal	**1200m**	118	125	123	112	121	**120**

Average Delay at the intersection							
Direction	**Distance (m)**	**Time Taken (Sec)**					
		1	**2**	**3**	**4**	**5**	**Average**
From Sony Signal to Ejipura Signal	**600m**	435	560	512	467	610	**517**
From Indiranagar to Ejipura Signal	**1200m**	1395	1645	1543	1683	1861	**1625**

Data Analysis

There are several types of vehicles (also called Classes) available on roads like car, truck, bus, motorbike. It is very difficult to deal with such a variety of vehicles from the design and engineering point of view. Therefore, a standard vehicle unit has been defined known as Passenger Car Unit, PCU.

Table 4: IRC: 86 – 1983 Geometric design standards for urban roads in plains - As per table-6.5.1

Sl. No.	Vehicle type	Equivalent factor
1.	Passenger car, tempo, auto rickshaw, jeep, van or agricultural tractor	1.0
2.	Truck, bus, agricultural tractor – trailer	3.0
3.	Motor cycle, scooter and cycle	0.5
4.	Cycle Rickshaw	1.5
5.	Horse draw vehicle	4.0
6.	Bullock – cart	8.0*
7.	Hand – cart	6.0

Hourly distribution of vehicles of the 4 legs of the intersection

Table 5: RD1 – Koramangala to Indiranagar

	Car	**Bike**	**Auto**	**Bus**	**Truck**	**Total**
8:00 to 9:00	810	593	285	118	199	2005
9:00 to 10:00	1340	746	440	134	292	2951
10:00 to 11:00	1017	691	400	119	254	2481
17:00 to 18:00	1015	661	411	109	232	2429
18:00 to 19:00	1048	687	402	133	259	2528
19:00 to 20:00	1065	680	347	107	223	2423

Table 6: RD2 – Indiranagar to Koramangala

	Car	**Bike**	**Auto**	**Bus**	**Truck**	**Total**
8:00 to 9:00	830	530	217	113	197	1888
9:00 to 10:00	1056	548	274	126	232	2235
10:00 to 11:00	948	556	252	107	213	2077

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17:00 to 18:00	1085	561	287	134	313	2380
18:00 to 19:00	1016	614	266	139	269	2303
19:00 to 20:00	1043	765	296	144	263	2512

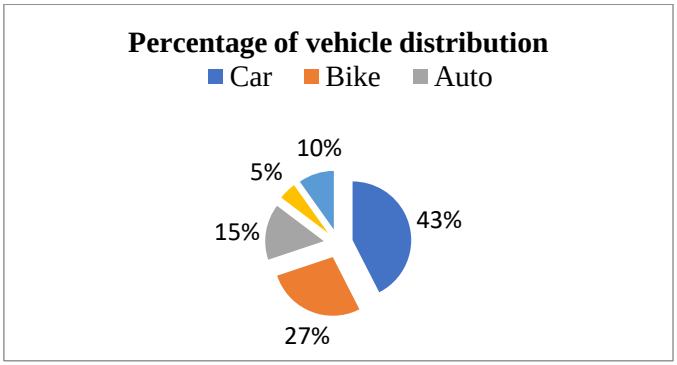
Table 7: RD3 –Srinivagilu to Ejipura

	Car	Bike	Auto	Bus	Truck	Total
8:00 to 9:00	46	503	137	1	4	692
9:00 to 10:00	67	729	205	0	0	1001
10:00 to 11:00	83	560	139	0	13	794
17:00 to 18:00	75	625	201	0	8	909
18:00 to 19:00	91	562	146	1	4	803
19:00 to 20:00	77	479	169	0	2	726

Table 8: RD4 –Ejipura to Srinivagilu

	Car	Bike	Auto	Bus	Truck	Total
8:00 to 9:00	109	266	185	1	16	578
9:00 to 10:00	143	465	237	0	21	867
10:00 to 11:00	188	365	148	0	22	723
17:00 to 18:00	136	286	234	0	23	679
18:00 to 19:00	170	420	242	0	22	853
19:00 to 20:00	154	394	186	2	25	759

Vehicle Distribution



The above pie chart shows the overall vehicle composition at the intersection. It can be observed that cars contribute nearly 43% of the overall traffic on the road and bikes contribute 27% of the overall traffic

Table 10: Capacity and Recommended Design Service Volume of Base sections of Urban Roads [13]

Sl. No.	Typology of the road	Capacity (PCUs/hr)	Lane Capacity (PCUs/hr)	Design Service Volume (PCUs/hr)
1.	Two-lane undivided	2400	1200	1680
2.	Four-lane divided	5400(2700)	1350	3780(1890)
3.	Six-Lane divided	8400(4200)	1400	5880(2940)
4.	Eight-Lane divided	13600(6800)	1700	9520(4760)
5.	Ten-Lane divided	20000(10000)	2000	14000(7000)

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Results

Level of Service

Level of Service of the junction is found out to know the quality of the road during the construction of the flyover. The impact of the construction of a flyover on the traffic can be determined. The below-mentioned table shows the LOS of the intersection with 4 legs during the construction of the flyover

Table 11: LOS before construction

Morning Peak				
Lane Name	**Volume(PCU/hr/lane)**	**Capacity (PCU/hr/lane)**	**V/C Ratio**	**LOS**
RD1	983	1350	0.728	**C**
RD2	745	1350	0.558	**B**
RD3	501	1200	0.417	**B**
RD4	434	1200	0.361	**B**
Evening Peak				
RD1	842	1350	0.623	**C**
RD2	793	1350	0.587	**C**
RD3	455	1200	0.380	**B**
RD4	427	1200	0.355	**B**

The LOS on RD1 and RD 2 is “C” & “B” respectively which means there was a considerably

Table 12: LOS during construction

Morning Peak				
Lane Name	**Volume(PCU/hr./lane)**	**Capacity (PCU/hr./lane)**	**V/C Ratio**	**LOS**
RD1	1476	1350	1.093	**F**
RD2	1118	1350	0.828	**D**
RD3	501	1200	0.417	**B**
RD4	434	1200	0.361	**B**
Evening Peak				
RD1	1264	1350	0.936	**E**
RD2	1190	1350	0.881	**D**
RD3	455	1200	0.380	**B**
RD4	427	1200	0.355	**B**

The LOS on RD1 and RD 2 is “F” & “D” respectively which means there is a worst condition of traffic flow with heavy congestion.

Suggestions

From the above study, it was found that the LOS of intersection is "C" due to the construction of the flyover. This construction of flyover will be carried out for the next 2 years where the traffic at this junction is unable to handle the traffic volume

To overcome this situation, several solutions are suggested below depending on the ground condition

- Optimization of Signal timings
- Shifting of Bus stop
- Maintenance of road surface

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Optimization of Signal timings

Details of the existing signal design

The Signal cycle length of the intersections during peak hours and non-peak hours was found. Regular pre-timed signal timings and cycle length were noted. And it was found that traffic police operates the signal timings based on the demand during the peak hours

The existing cycle length of the signal is 120 secs, where the traffic queue length and delay was more and traffic management was very difficult, hence the signal was operated manually by the traffic police. The total timing provided during peak hours is 240 secs

Signal Design using the Webster method:

Table 13: Saturation flow values [12]

Saturation Flow (PCU/Hr)	Road width (m)
1850	3.0
1890	3.5
1950	4.0
2250	4.5
2550	5.0
2990	5.5

The above table is valid up to road width of 5.5m and width above 5.5m can be assumed as 525 per meter road width up to 18 meters

C0 = $(\mathbf{1.5}\boldsymbol{L}+\mathbf{5})\ /(\mathbf{1}-\boldsymbol{y})$

Where,

L = Lost time per cycle = (Amber+inter green+lost time for initial delay for 3 phases)

Y = Volume / Saturation flow for critical approach in each phase

C0 = Optimum Cycle length

The total lost time is calculated from amber time, inter green time, initial delay of 4 secs for the first vehicle on each leg

Lost time per cycle = Amber+inter green+lost time for initial delay for 3 phases = (2+2+4)*3 = 24secs

Saturation flow for RD1 of width of 9m = 525*9 = 4725PCU/hr

Saturation flow for RD2 of width of 7.2m = 525*7.2 = 3780PCU/hr

Saturation flow for RD3 of width of 7.2m = 525*7.5 = 3938PCU/hr

Saturation flow for RD4 of width of 4m = 1950PCU/hr

Y1 = 2951/4725 = 0.624

Y2 = 2235/3780 = 0.591

Y3 = 1001/3938 = 0.254

Y4 = 867/1950 = 0.444

C0 = $(\mathbf{1.5}\boldsymbol{L}+\mathbf{5})\ /(\mathbf{1}-\boldsymbol{y})$

C0 = (1.5*24+5)/(1-.624) = 109secs

Three-phase signal design is observed in the intersection

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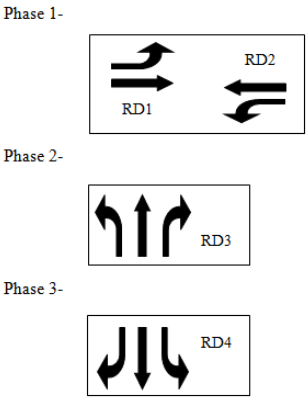

Figure 5: 3 Phase diagram details of Ejipura junction

Existing signal design phase diagram –

The overall cycle length of the existing signal is 120 secs

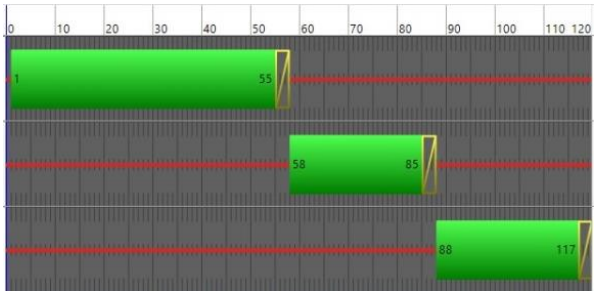

Figure 6: Existing signal design phase diagram

Suggested signal design phase diagram –

The overall suggested cycle length of the signal is 240secs. The below-shown phase diagram represents inter green and red time of the signal cycle

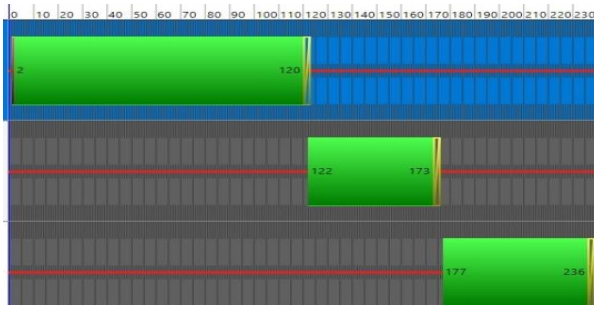

Figure 7: Suggested signal design phase diagram

Shifting of bus stop

Location and design of bus stop play an important role as it affects the movement and pattern of the road. [11]As per IRC-86 bus stops should not be located too close to the intersection; they should be located 75m from the intersection on either side far from the intersection. This also results in traffic

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queued in the intersection when a bus is stopped in the travel lane.

Figure 7: Location of Ejipura Bus Stop near intersection

To reduce the traffic created in the intersection, the location of the bus stop can be shifted to 200m to 300m from the intersection. This results in a considerable reduction of traffic and blockage of vehicles in the intersection

Maintenance of road surface

Maintenance of road surface is one of the major factors which affect the movement of the traffic where delay and travel time of the vehicle increases.By regular maintenance of surface delay, travel time, vehicle operation cost, traffic at the intersection can be reduced. Road surface maintenance is crucial. Necessary safety measures should be taken during the construction and spillage of materials should be cleared off immediately

Conclusion

1. From the above study, it was found that the LOS of the intersection at RD1 & RD2 is “C” before construction
2. During the construction of the flyover, it was observed that the LOS is “F”. This shows that there is an impact of the flyover construction on the traffic
3. This impact is because of the reduction of the lane width, where the RD1-Koramangala to Indiranagar and RD2 – Indiranagar to Koramangala roads were narrowed for the construction purpose
4. One of the solutions to reduce the traffic at the intersection is the redesign of signal timings. The other solution is shifting bus stop by 200m to 300m from the intersection.
5. Due to the construction, there is a spillage of concrete materials on the road, this also indirectly impact the traffic
6. The roads are being damaged and many potholes were observed on the road surface, because of this the speed of the vehicle decreases and there is a considerable increase in the travel time of the road users
7. Necessary safety measures should be taken during the construction and spillage of materials should be cleared off immediately
8. A new road surface should be laid to minimize the travel time, delay, and increase in the comfort and safety of the road users

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