Capacity Analysis of Un-signalized Intersection: A Case Study of City Junction

Amaranatha G A
Assistant Professor
Civil Engineering
NCET
Bengaluru, India

Manjunatha N
Assistant Professor
Civil Engineering
SJCIT
Bengaluru, India

K Sanjay Bargav Reddy
Civil Engineering
NCET
Bengaluru, India

Abstract - **Traffic flow on National Highway is obstructed by cross traffic from minor roads causing conflicts to vehicular and pedestrian flow. This leads to congestion, delay, accidents, increase in Vehicle Operating cost and decrease in capacity of the intersection. The present study is on intersection between Bangalore Mysore section of NH-275 and city. The existing T-junction subjecting to more conflicts because of heavy traffic flow on main road and more percentage of Multi Axle Trucks from Minor Road. Traffic volume survey was conducted for peak hours and same data has been analyzed in order to study various alternatives. Based on existing condition and topographical features suitable proposal like Interchange, Grade Separator, Roundabout and Ramps have been studied to propose best solution.**

Key words—Grade Separator, Interchange, VOC etc

I. INTRODUCTION

Indian metropolitan cities facing crisis of Urban Transportation. In spite of investing most of the county's budget on infrastructure, most of the roads are not successful in terms of safety especially at intersection. Congestion and accidents are the major problems on National Highway intersection, causing reduction in speed, delays, queuing of vehicles and pedestrians facing problem in crossing the Road. Improper geometrics and heavy traffic at intersection leads to poor traffic flow at intersection. At Intersections, since one flow is given priority over the right of way it is clear that the secondary or minor flow is usually seeking gaps. When flows are very light , which is in case on most urban and rural roads large gaps exit in the flows and thus few situation arises when vehicle arrive at uncontrolled intersection less than 10second or at interval close enough to cause conflicts. The T-junction between Bangalore Mysore and innovative film city junction subjected same problems mentioned above because of heavy traffic on National Highway and Multi Axle Traffic from Minor Road i.e. from innovative film city junction.

II. TRAFFIC DATA ANALYSIS

Classified Traffic volume: After studying traffic congestion at the site, classified traffic volume survey is carried out.

Count. Data obtained after conducting traffic volume count for Morning peak hour from 7:00AM TO 11:00AM and Evening peak hours from 4:00pm to 8:00pm are shown in table below.

Table 1: 8 Hours Traffic volume count

From	To	Hourly Volume in No's	Hourly PCUs
7:00	8:00	1679	2348
8:00	9:00	2425	2856
9:00	10:00	2026	2429
10:00	11:00	1853	2198
16:00	17:00	2489	3069
17:00	18:00	2634	3165
18:00	19:00	2423	3008
19:00	20:00	2188	2504
Total PCUs		17717	21577

1.1 Classified Traffic Volume Count at the Junction

In order to evaluate the proportion of each category of vehicle on particular direction, traffic volume count is analyzed and details of Peak Hour Traffic flow are presented in Table 2 and also flow Diagram.

Table 2: Classified Peak Hour Traffic Volume Count

| Leg	From D1		From D2		From D3		Total Vehicles	Total PCU's
Direction	D1 TO D2	D1 TO D3	D2 TO D1	D2 TO D3	D3 TO D1	D3 TO D2		
Cars/Jeeps	140	26	595	22	112	38	933	933
Auto	16	12	32	26	1	34	121	121
Mini Bus	25	8	28	6	45	9	121	182
Bus	73	1	72	6	31	12	195	585
LCV	62	23	88	6	37	8	224	336
2 axle	74	6	31	0	2	2	115	345
3 axle	21	9	10	1	0	2	43	129
MAV	5	2	6	0	3	0	16	72
2-Wheeler	258	44	356	52	68	79	857	429
Total	675	131	1225	119	300	184	2634	3165

D1-Bangalore, D2-Mysore, D3-Innovative Film City
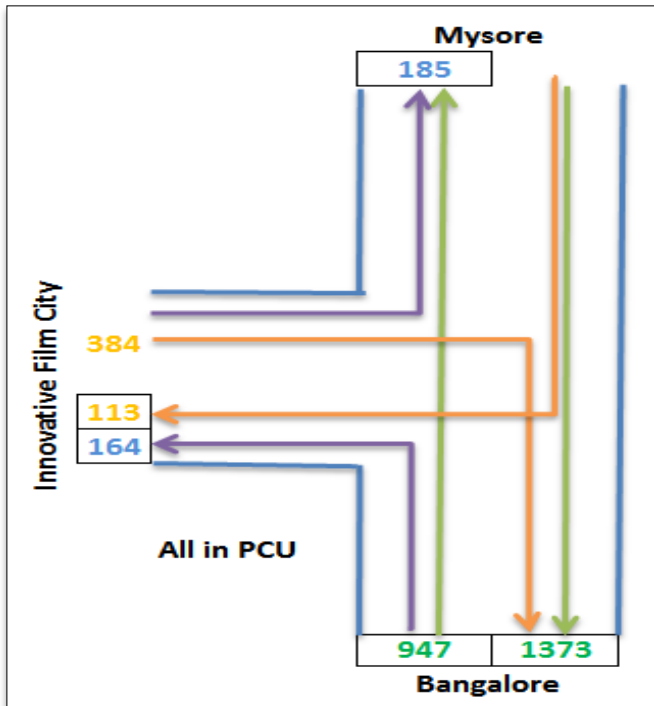
Figure 1: Traffic Flow Diagram at the Junction

Figure 1 Show directional flow of traffic , the traffic on major road is high as its 4lane road and peak hour traffic volume at this location is 3165 PCU's of which 3131 PCU's are fast moving vehicles and 34 PCU's are slow moving vehicles. The traffic on main road contributes about 72% and turning traffic is about 28%. From total turning traffic the proportion of goods vehicle is 13% which leads to major delay for main stream traffic.

1.2 Capacity Analysis of Junction

a. Directional Distribution of Traffic Volume at this Junction

> The traffic movement for 8hour duration at the junction is 17717 vehicles & 21577 PCUs and peak hour traffic movement at the junctions is 2634 Vehicles & 3165 PCUs. Details of the Directional Distribution presented at the junction are presented in Table 3. below. Vehicle Composition diagram is presented in Figure 2 below.

Table 3: Directional Distribution presented at the junction are presented

| Leg	From D1		From D2		From D3	
Direction	D1 TO D2	D1 TO D3	D2 TO D1	D2 TO D3	D3 TO D1	D3 TO D2
Type of Vehicle/PCU						
Car/jeep/vans	21%	20%	49%	18%	37%	21%
Auto rickshaw	2%	9%	3%	22%	0%	18%
Mini Bus	4%	6%	2%	5%	15%	5%
Bus	11%	1%	6%	5%	10%	7%
Light Commercial Vehicle/LCV	9%	18%	7%	5%	12%	4%
2- Axle	11%	5%	3%	0%	1%	1%
3-Axle	3%	7%	1%	1%	0%	1%
Multi Axle	1%	2%	0%	0%	1%	0%
Scooter & Motor Cycle	38%	34%	29%	44%	23%	43%
Pedal Cycle	0%	0%	0%	0%	0%	0%
Cycle Rickshaw	0%	0%	0%	0%	0%	0%
Horse Drawn Vehicle	0%	0%	0%	0%	0%	0%
Bullock for Camel Drawn Vehicles	0%	0%	0%	0%	0%	0%
Agricultural tractor	0%	0%	0%	0%	0%	0%
Agricultural tractor with Trailer	0%	0%	0%	0%	0%	0%
Others-Please Describe	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%
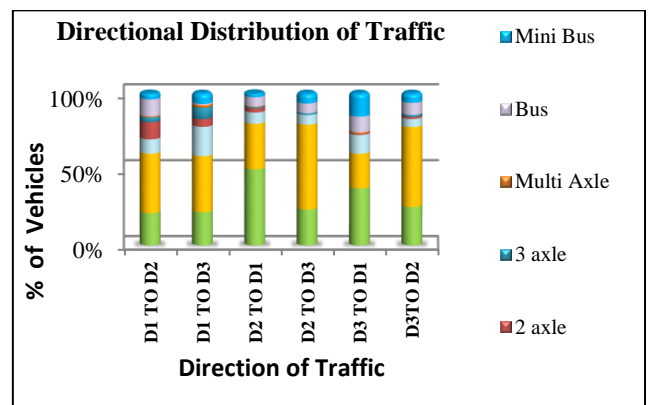
Figure 2: Vehicle Composition Diagram

In order to find capacity of uncontrolled intersection following parameters are to be calculated

b. *Compute the critical Gap and follow up time for Right Turn from Minor Road.*

Critical Gap,

$$t_{cx} = t_{cb} + t_{cHV}.\,PHV + t_{cG}.\,G - t_{cT} - t_{LT}$$

Follow-Up time
$$t_{fx} = t_{fb} + t_{fHV}.\,PHV$$

Where tcx is the Critical Gap for the movement 'x', tcb is the base critical gap, tcHV is the adjustment factor for heavy vehicles, PHV is the proportion of heavy vehicles, tcG is the adjustment factor for grade, G is the percentage grade, t_{LT} is the critical gap adjustment factor for intersection geometry, t_{fx} is the follow up time for minor movement 'x', t_{fb} base follow up time.

$$t_{cx} = 6.9 + 2 * 0.07 + .2 * 0 - 0 - 0$$
$$t_{cx} = 7.2 \ Secs$$
$$t_{fx} = 3.37 \ Secs$$

t_{cx} and t_{fx} are calculated by using data from Table 4 below

Vehicle Movement	Base Critical gap, t_c	Base Follow up
	4-Lane	Time
Right Turn from minor Road	6.9	3.3
Adjustment to base Critical gap& follow up		
tcHV	2	
tcG	1	
tcT	0	Four Lane Major Road
TLT	0	
tfHV	1	

c. *Compute Conflicting flow Rate*

The traffic flow process at uncontrolled intersection is complicated since there are many distinct vehicular movements to be accounted for. These conflicts results in decreasing capacity, increasing delay and increasing potentials for traffic accidents.

Conflict flow for Right Turn from Minor road can be estimated by using formula below

$$V_C = \frac{1}{2}(D1 \ TO \ D3) + (D1 \ TO \ D2) + \ D2 \ TO \ D3$$
$$V_C = \frac{1}{2}(131) + (675) + \ (119)$$
$$V_C = 860 \ Veh/hr$$

d. *Determining Potential Capacity (C_p)*

Potential Capacity is the Maximum Number of vehicles which can be accommodated under given condition with a reasonable expectation of occurrence. Once the conflicting volume ,critical gap and follow up time are known for a given movement its potential capacity can be estimated using graph given in IRC SP-41 pg 117 Figure III-2 and for existing condition the potential capacity (Cp) obtained is 90 PCU's per Hour. So actual capacity will be 299 PCU's per hour.

e. *Movement Capacity(C_m)*

Vehicles use gaps at a intersection in a prioritized manner. When traffic becomes congested in a high-priority movement, it can impede lower-priority movements. This impedance may come due to both pedestrians and vehicular sources called movement capacity. For present study we have not considered pedestrian crossing. The movement capacity for Right turn Traffic from minor can be obtained as

$$Cm = Volume \ in \ PCU(RT) - \ Actual \ Capacity$$
$$Cm = 384 - 299$$
$$\boldsymbol{Cm = 85 \ PCU's \ per \ Hour}$$

In order find the Level of Service for existing Intersection and traffic from minor Road to Major Road the table 5 gives various values.

Table 5: Level of Service for Un-Signalized Intersection

Level of Service for Un-Signalized Intersection		
Reserve Capacity	Level of Service(LOS)	Expected Delay to Minor Street Traffic
>400	A	Little or No Delay
399-300	B	Short Traffic Delays
299-200	C	Average Traffic Delays
199-100	D	Long Traffic Delays
99-0	E	Very Long Traffic Delays
–	F	Stop and Start

Source: IRC SP-41 Guidelines for Design of At-Grade Intersections

From table 5 it's concluded that the movement capacity for a traffic from Innovative film city merges with Bangalore direction with stop and start i.e. falls under Level of Service 'E'.

III. CONCLUSION

Above discussion shows that, because of heavy traffic flow on National Highway (NH 275), existing condition is not sufficient and some solution is required to reduce congestion at junction and for Right Turning Traffic from Innovative Film City. This is possible by providing either signal, flyover, under pass or Interchange. But as the main stream traffic is high it will be very difficult to provide underpass, during construction traffic diversion will be not be easy. Also traffic signal cannot be provided as it has very long Cycle time. Construction of flyover is very costly and there is a need to provide signal underneath, which causes delay and so should not be provided.

Thus, by providing separate Ramp could be the best option as the heavy traffic of National highway could be diverted under the ramp .Hence, chances of accidents, traffic jam could be considerably reduced, which would cause reduction of pollution. Also by considering future expansion of national highway, to make NH-275 as an expressway, Ramp will be best option.

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