Study of Traffic Charactristics Between Two Adjacent Urban Intersections

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***Abstract*— A significant effort has been expended to reduce traffic congestion. It is a well established fact that the intersections, particularly in urban areas, are the most frequent sites of congestion and hence accidents. One of the most useful applications of traffic engineering in this case is to study the existing faulty intersections with a view to suggest changes in their design to ensure that they are able to handle the present traffic volume safely and efficiently while keeping sufficient allowance for the future growth in traffic. Chandigarh, a very well planned city has its roads laid out in grid-iron pattern having more than 200 intersections incorporated in it. More than half of these intersections are of the roundabout type and are particularly situated in those areas where the traffic volume is comparatively high. This study is about the traffic characteristics of an urban stretch between two rotary intersections in Chandigarh. However, certain physical and operating characteristics of roundabouts such as continuous flow, curvilinear layout, longer paths for pedestrians and no stopped phase roundabouts give rise to problems for pedestrians with vision impairment.**

Keywords—traffic; intersection;design;planning;roundabout

I. INTRODUCTION

New advances in the technology of road vehicles have not only brought benefits to the public at large but also increased human mobility to and from urban regions. However, the unprecedented growth of vehicle ownership and use, combined together with population increase in urban areas in the latter half of this century and resulted in considerable traffic problems like congestion and causalities, particularly at road intersections. The usual solution to the problem of congestion or increase in the junction capacity requires coordination of traffic regulation and either to enlarge and remodel the intersection or to adopt grade separation. In order to scientifically redesign a faulty intersection, therefore it is essential to acquire factual knowledge of traffic characteristics and to carry out study and analysis for relieving congestion at the intersection, thereby increasing the capacity of the intersection as well as safety of traffic operations at the junction.

The population of **C**handigarh **U**rban **C**omplex (CUC) comprising Chandigarh, Mohali (Punjab) and Panchkula (Haryana) has been growing fast at a rate of over 5% per year in the last decade (as per RITES report, July 2009). There has been a phenomenal growth in the population of vehicles as well especially the two and four wheelers in this period and their rising use due to rising household incomes.

The analysis of collected data from primary and secondary sources has brought the following major issues regarding the transport system of CUC (Chandigarh Urban Complex).

1. Road network capacity in CUC is adequate for now but major travel corridors are beginning to become congested.
2. At present, modal split in favor of public transport is only 16% of total motorized person trips.
3. Every day more than two lath vehicles from Panchkula, Mohali, Zirakpur (Punjab) and other adjoining cities enter Chandigarh and add to the already high traffic density.

II. OBJECTIVE

The objectives of this study found pertinent to the present day traffic situation are as under:

- To analyze traffic volume data of road stretch between two major intersections of Chandigarh.
- To adopt selective traffic management measures as per site conditions/location to reduce threat of congestion.

III. METHODOLOGY

The methodology for arriving at the set objectives of the study required the following efforts:

- Factual data on increase of population and vehicular traffic both as on date as well as futuristic.
- Road stretch between two main heavily congested intersection of Chandigarh have been studied i.e. junction 34 and junction 49, in terms of traffic volume.
- Data has been analyzed for the road stretch between two major intersections.

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. When vehicles are fully stopped for periods of time, this is colloquially known as Traffic jam or traffic snarl–up.

IV. GENERAL REVIEW OF JUNCTION NO.34

It is one of the most important roundabouts of Chandigarh on crossing of Himalaya Marg and Dakshin Marg, serving as a connection of NH–21. It is junction of road coming from Delhi, Ambala(Haryana) highway and a road leading to Mohali(Punjab). This junction adjoin the most commercialized sectors i.e. sectors 21-22-34-35. Figure.1 shows the general layout plan of this junction.

Table 1.1

Traffic volume count at junction (No.34)

Vehicle Class	Kisan Bhawan Approch			Tribune Chowk Approch		
	L	ST	R	L	ST	R
Cycle	390	376	224	256	300	260
Cycle Rickshaw	40	91	75	40	54	81
Tractor Trolley	5	4	4	5	3	2
Buses/Trucks	42	77	80	53	59	58
Cars	401	370	350	321	344	280
3-Wheelers	110	160	167	172	150	90
2-Wheelers	280	295	398	402	470	300
Total Vehicle	1268	1373	1298	1249	1380	1071
G. Total vehicle	3939			3700		

L: LEFT, R: RIGHT, ST: STRIGHT

Table 1.1(a)

Traffic Volume count at junction No. 34 (continue)

Vehicle Class	Bus stand Approch			Mohali Approch		
	L	ST	R	L	ST	R
Cycle	136	375	225	355	370	250
Cycle Rickshaw	96	140	55	65	70	80
Tractor Trolly	3	2	5	3	4	3
Buses/Trucks	50	50	40	30	59	48
Cars	170	440	250	269	558	450
3-Wheelers	72	190	130	50	60	49
2-Wheelers	298	300	225	303	610	555
Total Vehicle	825	1497	930	1075	1731	1435
G. Total vehicle	3252			4241		

L: LEFT, R: RIGHT, ST: STRIGHT

V. GENERAL REVIEW OF JUNCTION NO.49

This intersection is formed on the Himalaya Marg. It is also the meeting point of the corners of sectors 34, 35, 43 & 44 and can be said to be located almost in the southern part of the city. Figure.2 shows the general layout plan of this junction.

Table 1.2

Traffic volume count at junction No.49

Vehicle Class	Bus stand Approch			Mohali Approch		
	L	ST	R	L	ST	R
Cycle	115	380	270	388	390	268
Cycle Rickshaw	98	117	67	65	46	62
Tractor Trolly	4	5	3	1	5	2
Buses/Trucks	30	50	18	14	44	28
Cars	165	545	268	275	610	468
3-Wheelers	69	158	148	25	30	20
2-Wheelers	320	348	345	333	535	555
Total Vehicle	801	1603	1119	1101	1660	1403
G. Total vehicle	3523			4164		

L: LEFT, R: RIGHT, ST: STRIGHT

Table 1.2(a)

Traffic volume count at junction No.49 (continue)

Vehicle Class	Kisan Bhawan Approch			Tribune Chowk Approch		
	L	ST	R	L	ST	R
Cycle	283	410	225	240	288	250
Cycle Rickshaw	29	59	47	23	22	55
Tractor Trolley	3	5	2	1	3	2
Buses/Trucks	22	48	60	34	19	15
Cars	395	381	418	382	432	266
3-Wheelers	92	140	104	132	129	59
2-Wheelers	280	238	410	460	476	241
Total Vehicle	1104	1281	1266	1272	1369	888
G. Total vehicle	3651			3529		

L: LEFT, R: RIGHT, ST: STRIGHT

VI. TRAFFIC STUDIES

Traffic studies are conducted with the aim to analyzing the existing traffic characteristics. The following field studies have been conducted for the purpose of this study: -

1. Traffic volume studies
2. Traffic speed studies

VII. TRAFFIC VOLUME STUDIES

According to study done on the junction 34 and junction 49, following results were obtained. The junctions were divided into four phases and under this study the saturation flow for phase I, II, III and IV were found out as following;

Calculation of Saturation Flow

Saturation flow expressed in terms of PCU/hr is calculated with the help of formula given by the Transport & Road Research Laboratory, U.K.

PHASE I (for right and straight stream)

Mohali / Bus Stand

Saturation, $S_1 = 525 \times W$ (W=7.5m)

i.e. $525 \times 7.5 = 3937$ PCU/hr

PHASE II (for left turning stream) Mohali / Bus Stand

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Saturation S_2 = 1800/ (1+1.52/r) (r= 15-25m for urban design)
Radius of curvature, r = 15 m
S_2= 1634 PCU /hr
PHASE III (Attawa / Airport Side)
S_3 = 525 × W
= 3937 PCU / hr
PHASE IV (Attawa / Airport side)
S_4 = 1800/ (1+1.52/r)
= 1634 PCU / hr

Table 1.3

FROM	MOHALI SIDE			BUS STAND SIDE			AIRPOR T SIDE			ATTAW A SIDE		
TO	L	S T	R	L	ST	R	L	ST	R	L	S T	R
Present Traffic flow PCU/hr	308	405	359	333	446	420	305	457	435	331	372	330
Correction for Left turners (+25%)	77			84			77			83		
Phase -I Total Flow(q)	790						863					
Saturation Flow(S)	3937						3937					
"Y" value Y= q/s	Y= 790/3937= .200						Y= 863/3937= .219					
Phase -II Total Flow(q)	359						420					
Saturation Flow(S)	1634						1634					
"Y" value Y= q/s	Y=359/1634 = .259						Y= 420/1634 =.289					
Phase -III Total Flow(q)	839						786					
Saturation Flow(S)	3937						3937					
"Y" value Y= q/s	Y= 839/3937 = .214						Y = 786/3937 = .199					
Phase -IV Total Flow(q)	435						330					
Saturation Flow(S)	1634						1634					
"Y" value Y= q/s	Y= 435/1634 = .300						Y =330/1634 = .201					

A. *MAXIMUM VALUE OF "Y"*

Y_1 = 0. 219
Y_2 = 0. 289
Y_3 = 0. 214
Y_4 = 0. 300
Y = Y_1 + Y2 + Y3 + Y4
= 0.219 + 0.289 + 0.214 +. 300
= 1. 022

As the value of "Y"exceed the limit i.e. '1.00', this shows that the traffic on this intersection is oversaturated. Therefore some preventive remedial measures have to be taken into account so as to control the traffic.

To overcome this oversaturated flow some remedial measure are to adopted, as widen the road up to 10.5 m, 3 lanes.

B. *CALCULATION OF SATURATION FLOW WITH WIDEN ROAD*

PHASE I Mohali / Bus Stand
S_1 = 525 × W (W = 10.5 m)
= 5512 PCU/hr
PHASE II Mohali / Bus Stand
Saturation S_2 = 1800/ (1+1.52/r)
= 1634 PCU /hr
PHASE III Attawa / Airport Side
S_3 = 525 × W (W = 10.5 m)
= 5512 PCU / hr
PHASE IV Attawa / Airport side
S_4 = 1800/ (1+1.52/r)
= 1634 PCU / hr

Table 1.2

FROM	MOHALI SIDE			BUS STAND SIDE			AIRPORT SIDE			ATTAWA SIDE		
TO	L	ST	R	L	ST	R	L	ST	R	L	ST	R
Present Traffic flow PCU/hr	308	405	359	333	446	420	305	457	435	331	372	330
Correction for Left turners (+25%)	77			84			77			83		
Phase -I Total Flow(q)	790						863					
Saturation Flow(S)	5512						5512					
"Y" value Y= q/s	Y= 790/5512 = 0.143						Y= 863/5512 = 0.156					
Phase -II Total Flow(q)	359						420					
Saturation Flow(S)	1634						1634					
"Y" value Y= q/s	Y=359/1634 = 0.219						Y= 420/1634 =0.257					
Phase -III Total Flow(q)	839						786					
Saturation Flow(S)	5512						5512					
"Y" value Y= q/s	Y= 839/5512 = 0.152						Y = 786/5512= 0.142					
Phase -IV Total Flow(q)	435						330					
Saturation Flow(S)	1634						1634					
"Y" value Y= q/s	Y= 435/1634 = 0.266						Y =330/1634 = 0.201					

C. *MAXIMUM VALUE OF "Y"*

Y_1 =. 156
Y_2 =. 257
Y_3 =. 152
Y_4 =. 266
Y = Y_1 + Y2 + Y3 + Y4
= 0. 156 + 0. 257 + 0. 152 + 0. 266
= 0. 831

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D. LOST TIME

Based on the approach speed at the intersection and as per British Practice, the following assumptions can be made:

Intergreen period "I " 4 seconds
Red / Amber period "R " 2 seconds
Amber period "a " 3 seconds
Time lost due to starting delays = 2 seconds / phase

Lost Time "L " $= \sum (I - a) + \sum R$
$= 4 (4 - 3) + 4 \times 3$
$= 16$ seconds

E. OPTIMUM CYCLE LENGTH

$C_o = 1.5L+5/ (1-Y)$
= 171 seconds

F. GREEN TIME APPORTIONMENT

Now we shall compute apportionment green time for each phase . It has been found that least delay occurs when the effective green time for each phase is proportional to its " Y " value . The above rule gives:

G1 = Y1 / Y (Co - L)

Effective green time = Co - L
= 171 - 16
= 155 seconds

This will apportioned between the phases as follows:

For Phase I
$G_1 = Y_1 (C_o\text{-}L)/Y$
= 29 second

For Phase II
$G_2 = Y_2 (C_o\text{-}L)/Y$
= 47 second

For Phase III
$G_3 = Y_3 (C_o\text{-}L)/Y$
= 28 second

For Phase IV
$G_4 = Y_4 (C_o\text{-}L)/Y$
= 49 second

Minimum green period is governed by the need of the pedestrians at the intersection. Therefore, taking the widest approach of the intersection, this is calculated as follows: -

Taking pedestrian speed = 1.2 m / sec
Time to cross 10.5 m road = 10.5 / 1.2
= 8.75 sec ~ 9 second

As,
G1 = 29 sec   G2 = 47 sec
G3 = 28 sec   G4 = 49 sec

Cycle length = (29 + 47 + 28 + 49) + 12
= 165 seconds

Total green time including Red / Amber:
G1 = 29 + 3 = 32 sec
G2 = 47 + 3 = 50 sec
G3 = 28 + 3 = 31 sec
G4 = 49 + 3 = 52 sec

VIII. CAPACITY OF THE ROTARY

The practical capacity of a rotary is determined on the basis of minimum capacity of each weaving section, which is determined by geometric layout including entry and exit and percentage of weaving traffic. The capacity of the rotary is determined by the following formula pioneered by TRRL, London. The capacity of junction 34 and junction 49 is calculated in table 1.3 & 1.4 respectively.

$Q_p = 280w [1+e/w (1\text{-}P/3)]/ (1+W/L)$

Where,
Q_p = Practical capacity of the weaving section of the rotary in PCU/hour
W = Width of weaving section in meter
e = Average entry width of rotary in meter
L = length of the weaving section in meter between the ends of the channelizing islands
P = Proportion of weaving traffic i.e. ratio of sum of crossing streams to the total traffic on the weaving section.

$P = b + c/(a+b+c+d)$

Where,
a = left turning traffic moving in extreme left lane
b = crossing/weaving traffic turning towards right while entering the rotary
c = crossing/weaving traffic turning towards left while leaving the rotary
d = right turning traffic moving along extreme right lane

IX. RESERVE CAPACITY

The reserve capacity "Q p" is calculated.

Reserve capacity of junction 49 = Q_p-(a+b+c+d)/ (a+b+c+d)
= - 8.91 %

Reserve capacity of junction 49 = Q_p-(a+b+c+d)/ (a+b+c+d)
= - 16.7 %

EXISTING LAYOUT PLAN OF INTERSECTIONS

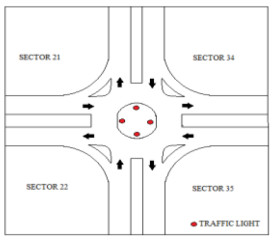

Fig. 1. Junction 34

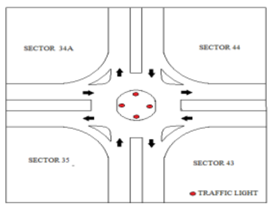

Fig. 2. Junction 49

Table 1.3 Capacity of exiting roundabout -34

Weaving	w	e	E	e+e/2	L	a	b	C	D	P	Traffic Flow (a+b+c+d) PCU	Practical Capacity
Section	m	m	M	m	m							(Qp) PCU/hr
Kisan Bhawan/Mohali	**10.7**	**3.7**	11	10.2	52	532	1132	623	613	0.739	4400	3662
							*	*				
							761	679				
							1953	1302				
Bus Stand/Kisan Bhawan	10.7	3.7	11	10.2	52	699	846	1132	761	0.704	4949	3720
							*	*				
							838	613				
							1957	1805				
Tribune Chowk/Bus Stand	10.7	3.7	11	10.2	52	335	855	846	838	0.714	4318	3700
							*	*				
							623	761				
							1478	1607				
Mohali/Tribune Chownk	10.7	3.7	11	10.2	52	716	679	855	623	0.69	4324	3739
							*	*				
							613	838				
							1292	1693				

Table 1.4 CAPACITY OF THE EXISTING ROUNDABOUT – 49

WEAVING	w	e	E	e+e/2	L	A	b	C	D	p	Traffic Flow (a+b+c+d) PCU	Practical Capacity
Section	m	m	m	m	m							(Qp) PCU/hr
MOHALI/ UNIVERSITY	**11**	**9**	10.5	9.55	42.7	424	969	525	651	0.714	3771	3435
							*	*				
							593	609				
							1562	1134				
UNIVERSITY/BUS STAND	**11**	**9**	10.5	9.55	42.7	502	569	969	593	0.703	36922	3454
							*	*				
							408	651				
							977	1620				
BUS STAND/ AIRPORT	**11**	**9**	10.5	9.55	42.7	362	711	569	408	0.756	3168	3372
							*	*				
							525	593				
							1236	1162				
MOHALI / TRIBUNE CHOWNK	**11**	**9**	10.5	9.55	42.7	495	609	711	525	0.7	3399	3458
							*	*				
							651	408				
							1260	1119				

Concluding remarks and Recommendations have been given based upon the analysis.

1. The collected traffic data and survey plan of junction 34 and junction 49 and road stretch between them gives complete idea of the problem. As the traffic calculated, shown earlier at the intersections is more than 3000 pcu/hr which is recommended by IRC.
2. The main contributing factor causing lock–up of the rotary examined in this study is the heavy traffic volume (partially weaving and crossing traffic) the higher percentage of right turning traffic lock–ups occurs at the intersections.
3. Provision of slip roads for left turning traffic in order to increase the roundabout capacity will not make any material difference to capacity. As the traffic has so increased that on intersections straight and right turning vehicles occupy the space and there is no space remains for left turning vehicles which causes lock–up situation at intersections.
4. The reserve capacity of junction 49 and junction 34 is -8.91% and -16.7% respectively as calculated earlier. The negative sign indicates that the junction is incapable of handling the peak traffic by 8.91% and 16.7% and has no reserve capacity for future traffic demand.
5. Due to lack of slip road on one leg of junction 49, congestion occurs on intersection. There is long queue of vehicles coming from sector 32 sides, causes congestion.
6. Since the main locking of the traffic is due to interference of heavy vehicles coming from sector-17 bus stand and sector–43 bus stand, therefore it is recommended that the buses coming from bus stand should use the next rotary intersection i.e. rotary at intersection of section 20, 21, 33 and 34 or any other where traffic is low.
7. It is recommended to provide separate cycle track so that cycles, cycle rickshaws will not interfere with fast moving vehicles and it should be made mandatory.
8. Parking restrictions, making motor vehicle use less attractive by increasing the monetary and non-monetary costs of parking. Most transport planning experts agree that free parking distorts the market in favor of car travel, exacerbating congestion.
9. In order to reduce traffic congestion, one of the solutions is to adjust the transportation system, this can be done by increasing the supply, in this case the supply is the number of roads or road capacity.
10. While ‘enforcement‘ and ‘education‘ are measures which can improve the attitude and behavior of road users to some extent, these can only be useful when ‘engineering‘ knowledge has been rationally applied to evolve the best intersection and road design to cater for all forms of road traffic.

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