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Traffic Improvement for Urban Road Intersection, Surat

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Abstract – *This paper presents improvement of intersection at Simada Naka Junction, Surat which is one of the fastest growing city of India. Surat is a rapid growing city suffering from traffic congestion. The aim of this paper is to investigate problem and to provide necessary solutions. The analysis is based on video graphic method, data has been collected of peak hours at the selected intersection. Volume conversion is carried out by adopting PCU values from IRC recommendations. Various other traffic flow characteristics are calculated from empirical formula proposed by Transportation Road Research Lab (TRL). Various alternatives has been referred for the solution and out of various alternatives rotary design is taken into account which will be helpful in managing traffic flow on intersection. List of various other proposals has been enclosed in this paper.*

Key Words **: Intersection Improvement, Rotary, Capacity of Rotary, Traffic Congestion, Weaving, Lane capacity**

1. INTRODUCTION

The Increase in the vehicular traffic is becoming sever problem. And this problem is arriving due to owning of personal motor vehicles. To effectively controlling of this increasing traffic on road some traffic control measures are used on road i.e. traffic rotary, traffic signal, channelization of road etc. but there are some limit of traffic which can be handled by this measures.

India is developing country with population of about 125 crores and with that ranking 2nd in world. As traffic flow in India is heterogeneous, so to carry out analysis of traffic is difficult. Surat has been selected as the study area located on the bank of Tapi River. Simada Naka is situated on Western side of Surat. It is a 5 leg intersection, but currently one leg has already been blocked as a measure to reduce traffic congestion. At Simada Naka Junction the traffic volume data are collected for the week day on morning and evening peak times by manual counting method using videography method. Simada Naka Junction is one of the busiest intersections in Surat located on the two important cross roads one is from Surat Station to Kamrej (National Highway 8) and another is from Mota Varachha to Canal Road.

A rotary intersection or Traffic rotary is an enlarged road intersection where all converging vehicles are forced to move around a large central island in one direction (clock wise direction) before they can weave out of traffic flow into their respective direction radiating from the central island. Rotaries are suitable when the traffic entering from three or more approaches are relatively equal. A total volume of about 3000 vehicles per hour can be considered as the upper limiting case and a volume of 500 vehicles per hour is the lower limit. Rotaries are suitable when there are more approaches and no separate lanes are available for right-turn traffic thus making intersection geometry complex.

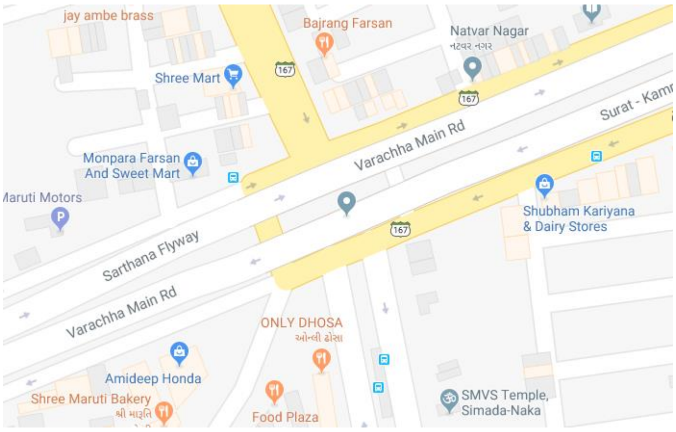

Figure 1 : Map of Simada Naka Junction (Source : Google Maps)

The traffic operations at a rotary are three; diverging, merging and weaving.

- Diverging : when the vehicles moving in one direction is separated into different streams according to their destinations.
- Merging : is referred to as the process of joining the traffic coming from different approaches and going to a common destination into a single stream
- Weaving : is the combined operation of both merging and diverging movements in the same direction.

1.1 Objectives

- To improve the intersection and reduce traffic congestion
- To provide suggestion for modification of intersection

1.2 Design Speed

All the vehicles are required to reduce their speed at a rotary. Therefore, the design speed of a rotary will be much lower than the roads leading to it. Although it is possible to design roundabout without much speed reduction, the geometry may lead to very large size incurring huge cost of construction. The normal practice is to keep the design speed as 30 and 40 kmph for urban and rural areas respectively.

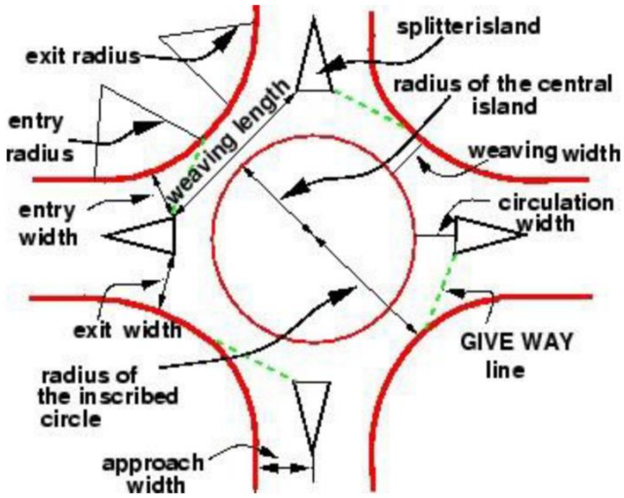

Figure 2 : Design parameters of Rotary
(Source : NPTEL)

1.3 Entry, Exit and Island Radius

The radius at the entry depends on various factors like design speed, super-elevation, and coefficient of friction. The entry to the rotary is not straight, but a small curvature is introduced. This will force the driver to reduce the speed. The speed range of about 20 kmph and 25 kmph is ideal for an urban and rural design respectively. The exit radius should be higher than the entry radius and the radius of the rotary island so that the vehicles will discharge from the rotary at a higher rate. A general practice is to keep the exit radius as 1.5 to 2 times the entry radius. The radius of the central island is governed by the design speed, and the radius of the entry curve. The radius of the central island is about 1.3 times that of the entry curve for all practical purposes.

1.4 Shape of Central Island

The shape and disposition of central island (control island) depend upon various factors such the number and disposition of intersecting roads and traffic flow pattern. The conditions under which a particular shape is favored are discussed below:

- **Circular Shape :** Equal Importance to all roads
- **Square with Rounded legs :** Suitable for predominantly
- **Irregular Shape :** Shape is decided by existence of large number of approaches

1.5 Width of Rotary

The entry width and exit width of the rotary is governed by the traffic entering and leaving the intersection and the width of the approaching road. The width of the carriageway at entry and exit will be lower than the width of the carriageway at the approaches to enable reduction of speed. IRC suggests that a two lane road of 7 m width should be kept as 7 m for urban roads and 6.5 m for rural roads. Further, a three lane road of 10.5 m is to be reduced to 7 m and 7.5 m respectively for urban and rural roads. Weaving width is given as

$$W = weaving = \left(\frac{e_1 + e_2}{2}\right) + 3.5$$

e_1 is the width of the carriageway at the entry and e_2 is the carriageway width at exit. Weaving length determines how smoothly the traffic can merge and diverge

1.6 Weaving Length

The weaving length determines the ease with which the vehicle can maneuver through the weaving section and thus determines the capacity of the rotary. The weaving length is decided on the basis of the factors, such as, the width of weaving section, average width of entry, total traffic and proportion of weaving traffic in it. It is desirable to prevent direct traffic cuts and this can be achieved by making the ratio of weaving length to weaving width large enough. A ratio 4:1 is regarded as minimum. The minimum values of weaving lengths as recommended by IRC are given below:

Table 1 : Design Speed and Weaving Width

Design Speed (kmph)	Minimum weaving length(m)
40	**45**
30	**30**

2. TRAFFIC SURVEY AND DATA COLLECTION

The traffic data is collected video graphic method by counting the number of different types of vehicle approaching to the intersection from all the four directions and then converting the values in to the common factor called Passenger Car Unit (PCU).

Classified volume count : After studying the traffic congestion at the site, classified volume count survey is carried out. Data obtained after carrying survey in morning peak hours from 8 to 10 am and evening peak hours from 8 to 10 pm are as shown in table below :

Table 2 : Classified Volume count of Vehicles

From	To	Vehicles(PCU/hr)	
		Morning	Evening
Surat Station	Mota Varachha	682	681
	Kamrej	1171	777
	Canal Road	272	388
Mota Varchha	Kamrej	749	778
	Canal Road	1083	527
	Surat Station	1217	804
Kamrej	Canal Road	664	719
	Surat Station	1500	1448
	Mota Varachha	734	595
Canal Road	Surat Station	517	351
	Mota Varachha	759	1254
	Kamrej	1217	262
Total PCU		10565	8584

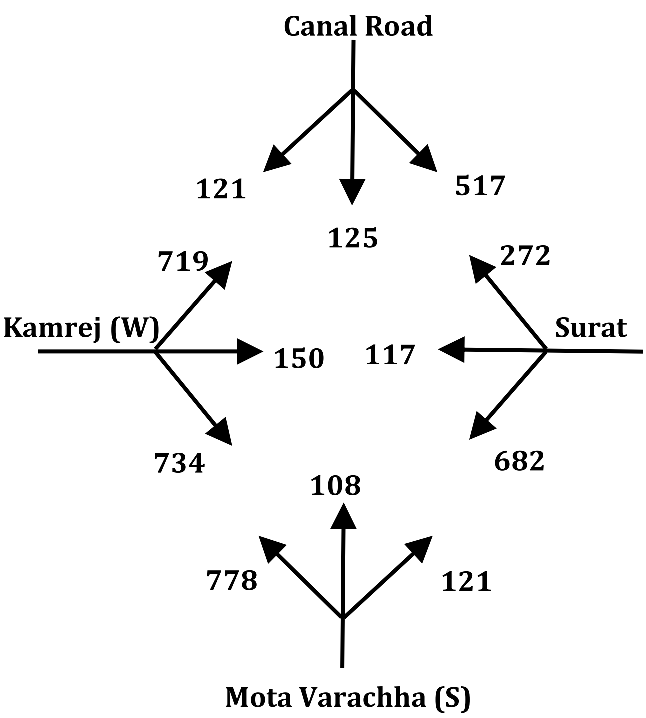

Figure 3 : Traffic approaching the rotary

3. CAPACITY OF INTERSECTION

Radius of Rotary = 21 m, from the formula

$$R = \frac{V^2}{127f}$$

V = design speed of rotary = 30 kmph

f = 0.43 (friction facor)

Capacity of rotary is calculated by the Empirical formula proposed by Transportation Road Research Lab (TRL)

$$Q_p = \frac{280\,W\,(1 + \frac{e}{W})(1 - \frac{p}{3})}{1 + \frac{W}{L}}$$

Q_p = practical capacity of rotary

W = width of weaving section

$$W = \frac{e_1 + e_2}{2} + 3.5\,m$$

e = average width of entry e_1 and width of non – weaving section e_2

$$e = \frac{e_1 + e_2}{2}$$

L = length of weaving section

L = 4 * W

p = proportion of weaving section given by

$$p = \frac{b + c}{a + b + c + d}$$

a = left turning traffic moving along left extreme lane
d = right turning traffic moving along right extreme lane
b = crossing/weaving traffic turning toward right while entering the rotary

c = crossing/weaving traffic turning toward left while leaving the rotary

3.1 Parameters of various phases

a) Canal to Surat (N – E)

$$e = \frac{8.3 + 17.18}{2} = 12.74\,m$$

$$W = \frac{8.3 + 17.18}{2} + 3.5 = 16.24\,m$$

$$L = 4 * 16.24 = 64.96\,m$$

b) Surat to Mota Varachha (E – S)

$$e = \frac{11.5 + 13.4}{2} = 12.45\,m$$

$$W = \frac{11.5 + 13.4}{2} + 3.5 = 15.95\,m$$

$$L = 4 * 15.95 = 63.8\,m$$

c) Mota Varachha to Kamrej (S – W)

$$e = \frac{12.56 + 17.18}{2} = 14.87\,m$$

$$W = \frac{12.56 + 17.18}{2} + 3.5 = 18.37\ m$$

$$L = 4 * 18.37 = 73.48\ m$$

d) Kamrej to Canal (W - N)

$$e = \frac{13.3 + 13.4}{2} = 13.35\ m$$

$$W = \frac{13.3 + 13.4}{2} + 3.5 = 16.85\ m$$

$$L = 4 * 16.85 = 67.4\ m$$

$$P_{NE} = \frac{1217 + 1254 + 1217 + 1500}{1217 + 1254 + 1217 + 1500 + 517 + 734} = 0.81$$

$$P_{ES} = \frac{272 + 1171\ 734 + 1254}{272 + 1171\ 734 + 1254 + 682 + 1217} = 0.64$$

$$P_{SW} = \frac{1083 + 1217 + 1217 + 1171}{1083 + 1217 + 1217 + 1171 + 778 + 272} = 0.81$$

$$P_{WN} = \frac{1500 + 734 + 272 + 1083}{1500 + 734 + 272 + 1083 + 778 + 1217} = 0.64$$

3.2 Capacity of various approaches

- **Capacity of rotary for Canal Road to Surat**

$$Q_P(NE) = 280 * \frac{16.24\left(1 + \frac{12.74}{16.24}\right)\left(1 - \frac{0.8057}{3}\right)}{1 + \frac{16.24}{64.96}}$$

$\boldsymbol{Q_P(NE)}$ **= 4748 PCU/hr**

- **Capacity of rotary for Surat to Mota Varachha**

$$Q_P(ES) = 280 * \frac{15.95\left(1 + \frac{12.45}{15.95}\right)\left(1 - \frac{0.64}{3}\right)}{1 + \frac{15.95}{63.8}}$$

$\boldsymbol{Q_P(ES)}$ **= 4998 PCU/hr**

- **Capacity of rotary for Mota Varachha to Kamrej**

$$Q_P(SW) = 280 * \frac{18.37\left(1 + \frac{14.87}{18.37}\right)\left(1 - \frac{0.81}{3}\right)}{1 + \frac{18.37}{73.48}}$$

$\boldsymbol{Q_P(SW)}$ **= 5418 PCU/hr**

- **Capacity of rotary for Kamrej to Canal**

$$Q_P(WN) = 280 * \frac{18.37\left(1 + \frac{13.35}{16.85}\right)\left(1 - \frac{0.64}{3}\right)}{1 + \frac{16.85}{67.4}}$$

$\boldsymbol{Q_P(WN)}$ **= 5316 PCU/hr**

The capacity of intersection is the minimum of the capacity of all the weaving section. As observed from the above results that the maximum capacity of the intersection is 4748 PCU/hour and total traffic entering the intersection is 10565 PCU/hour in morning peak hour and 8584 PCU/hr in evening peak hour. According to IRC, rotary can handle the traffic upto 3000 PCU/hr efficiently.

4. RESULT AND CONCLUSIONS

Above result shows that traffic approaching the intersection is very high, 10565 PCU/hour during morning peak hour and 8584 PCU/hour during evening peak hour. The capacity at intersection as calculated above is 4748 PCU/hour. As per IRC recommendation rotary can handle the traffic capacity up to 3000 PCU/hour efficiently. Design of rotary has been given as an solution for the above mentioned problem. But providing rotary will not be sufficient to manage traffic at an intersection efficiently. Some solutions are required to reduce congestion at junction. Possible solutions are shown below.

- Providing signalized rotary
- Providing flyover
- Providing underpass
- Providing subway, etc

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