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Analysis and Design of Rotary Intersection at Yanam

Dangeti Aravind[1*], Rajulapudi Harshini Lakshmi[2], Deva Ananda Priya[3],
Dommeti Mahendra Venkata Suresh[4], Beera Venkata Suresh[5], Kanakala Siva Kumar[6]
[1]*Assistant Professor, Department of Civil Engineering, Srinivasa Institute of Engineering and Technology, Amalapuram, India*
[2,3,4,5,6]*Student, Department of Civil Engineering, Srinivasa Institute of Engineering and Technology, Amalapuram, India*

***Abstract*: This project involves Analysis and design of Rotary Intersection at Yanam for smooth flow of traffic and also to avoid conflicts at the intersection. In recent years, the intense growth of vehicles has caused heavier traffic congestions on the roads and intersections, which are even worse during the peak traffic time. An intersection which is not proper designed as per IRC guidelines, will increase the travel time of the vehicles cause delays and also cause more traffic accidents or conflicts. Traffic volume is incrementing at an alarming rate, so it becomes extremely difficult for traffic police to control the traffic manually at the intersections. For proper management of traffic stream at the Yanam intersection and to reduce the accidents at the crossing, there seems to be an urgent need to design a rotary intersection at the junction.**

***Keywords*: Rotary intersection, Heavy traffic, Traffic congestions, Traffic volume.**

1. Introduction

A traffic rotary or a roundabout is a special form of at-grade intersections wherein a unidirectional flow of traffic takes place around a large central island before the vehicles can weave out of traffic flow into their respective directions radiating from the central island. In India, 'keep to the left' regulation is followed and also clock-wise direction of flow around the central island is followed.

The area of study for this project is Kapulapalem junction, Yanam, Andhra Pradesh. There exists a four-way intersection in which one road stretches towards Amalapuram, the second one towards Kakinada, the third one towards Draksharamam and fourth one towards Yanam town.

From site observations, we see that the intersection of Yanam and the highway is an uncontrolled intersection. Neither of the intersecting points has a rotary for controlling the traffic movement. Due to the improper unchanneled intersection results in the greater number of conflict points between the vehicles, traffic congestions of the vehicles, a greater number of traffic accidents. There are no proper pavement markings and traffic signals. Moreover, physical dividers and channelizing islands would be required after the widening of the national highway. The situation is also affected by the encroachments and temporary vendors like tea stalls, shops on the intersection.

The scope of this project is to design an efficient rotary intersection to deal with the increasing traffic volume and reduce the number of conflicts, accidents and their severity at the junction of the highway and Yanam town. It extends up to taking into consideration the changes in the geometry of the roads at the junction and increased traffic volume.

The project extends up to the determination of the capacity of the intersection in terms of traffic volume. The capacity of the junction is more so it is necessary to design an efficient rotary intersection (if the traffic volume is increased abnormally).

2. Project Activities

A. Preliminary Site Survey

A preliminary inspection was conducted at the Kapulapalem junction, Yanam to gather information for a design or an estimate to complete the initial tasks required for an outdoor activity. Different traffic manoeuvre was studied and major conflict points were established.

Preliminary survey includes gathering geospatial data about the proposed route and the project requirements for data outputs. This includes the establishment on the ground of the proposed route and location of terrain and physical features (both man made and environmental). An estimate of land use for the construction of the rotary was planned through the survey. The restricting areas and encroachments were also established.

Preliminary Site survey is conducted to collect adequate data to prepare plan/map of the area to be used for planning and design. The purpose of the survey was to determine the feasibility of a rotary intersection at site. The importance of preliminary site assessments includes: Determine land boundaries and land-use patterns, provide crucial information of the environmental impact of the proposed project, provide a body of knowledge on the site that can be adopted during project planning and execution. A rough traffic survey was conducted to determine a gross traffic volume and verifying them with the provisions of IRC65:1976. Different traffic manoeuvres were studied and major conflict points were established.

*Corresponding author: 63aravind@gmail.com

Fig. 1. Kapulapalem Junction, Yanam

B. Traffic Volume Studies

Traffic volume is defined as the number of vehicles crossing a section of road per unit time at any selected period. Traffic volume studies are conducted to collect data on the number of vehicles and/or pedestrians that pass a point on a highway facility during a specified time period.

The traffic survey was conducted at week days and weekends. The traffic volume was analysed manually and the average traffic volume was calculated by taking the average of the values obtained during peak hours of weekends and weekdays. The traffic volume is collected at kapulapalem junction, Yanam for 7 days during the peak hours. From the collected data, the average daily traffic calculated which is useful for calculating the capacity of the rotary.

Level of measurement of Traffic Volume are Average annual flow (vehicle/year), Annual average daily traffic (AADT) or Average daily traffic (ADT) represents the total traffic for a year divided by 365, or the average traffic volume per day. (vehicle/day), Hourly average traffic: (vehicle/hr)

Traffic volume is mentioned in PCU/hr. The traffic volume is shown in form of the Graphs for peak hour's traffic for 7 days and in form of the Bar charts for 7 days traffic volume at peak hours. Rotaries are suitable when the traffic entering from all the four approaches are relatively equal. Methods of traffic volume studies are Manual counting, Automatic recorders or counters. Automatic recorders includes Permanent counting recorder, Portable recorders, Moving car method of counting.

Fig. 2. Traffic flow at the junction

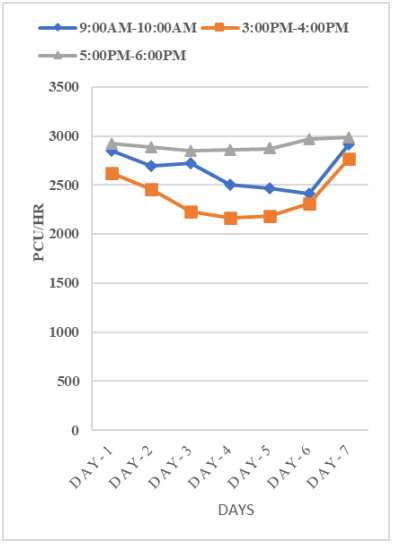

Fig. 3. Graphical representation of traffic volume at the junction

Table 1
Average daily traffic volume

Date	Day	Time	PCU/Hr	Average Daily Traffic
27-03-2022	Sunday	9:00AM-10:00AM	2846.5	2797.67 PCU
		3:00PM-4:00PM	2620.5	
		5:00PM-6:00PM	2926	
28-03-2022	Monday	9:00AM-10:00AM	2695	2681 PCU
		3:00PM-4:00PM	2459	
		5:00PM-6:00PM	2889	
29-03-2022	Tuesday	9:00AM-10:00AM	2720	2597.5 PCU
		3:00PM-4:00PM	2226	
		5:00PM-6:00PM	2846.5	
30-03-2022	Wednesday	9:00AM-10:00AM	2501.5	2507.8 PCU
		3:00PM-4:00PM	2163.5	
		5:00PM-6:00PM	2858.5	
31-03-2022	Thursday	9:00AM-10:00AM	2467	2507.17 PCU
		3:00PM-4:00PM	2183.5	
		5:00PM-6:00PM	2871	
01-04-2022	Friday	9:00AM-10:00AM	2416.5	2568 PCU
		3:00PM-4:00PM	2316	
		5:00PM-6:00PM	2971.5	
02-04-2022	Saturday	9:00AM-10:00AM	2917.5	2890.34 PCU
		3:00PM-4:00PM	2467	
		5:00PM-6:00PM	2986.5	

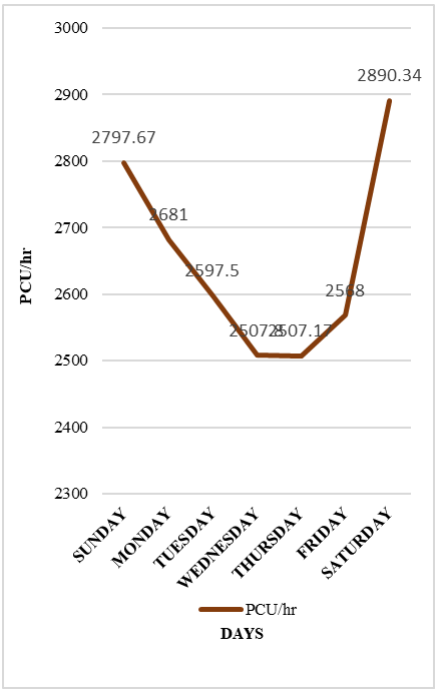

Fig. 4. Average daily traffic volume

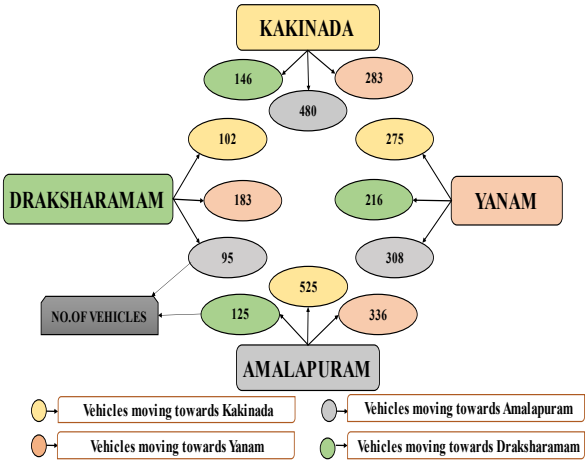

Fig. 5. Traffic volume entering and leaving the junction

Design Parameters of the Rotary:

The design elements include design speed, radius at entry, exit and the central island, weaving length and width, entry and exit widths. In addition, the capacity of the rotary can also be determined by using some empirical formula.

As per IRC-65:1976 guidelines design elements are designed.

1. Shape of Central Island

The shape of Central Island provided for rotary intersection should not contain any corners. It should be formed by curves to allow the comfortable rotations around it. The shape is particularly dependent upon number of roads meeting at that particular junction. The shapes generally provided are circular, elliptical, turbine and tangential.

2. Design Speed of Rotary Intersections

For Rural areas, V=40 Kmph.

3. Radius of Rotary Roadway

Normal radius of roadway in curves,

$$R=\frac{V^2}{127(e+f)}$$

But super elevation (e) is neglected i.e., e = 0

Hence, radius of rotary,

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

Where f = coefficient of friction= 0.43 to 0.47
f=0.43 for v=40 kmph.
f=0.47 for v=30 kmph.

$$R=\frac{V^2}{127(f)}=29.3\text{m.}$$

4. Curves at Entrance and Exit

As per the IRC Guidelines for V=40 Kmph,
Radius of Entry Curve=20 m.
Radius of Exit Curve = 1.5×Radius of Entry Curve
= 30 m.

5. Radius of Central Island

Radius of Central Island=1.33×Entry curve radius
= 26.6 m.

7. Width of Carriage way at Entry and Exit (e_1)

For Rural areas, 2-lane road with each 7 m width,
Width of the Entry(e_1)= 6.5 m.

8. Width of Non-Weaving Section (e_2)

Width of the Non-Weaving Section(e_2)=6.5 m.

9. Width of Weaving Section (W)

Width of Weaving Section,

$$W=\frac{(e_1+e_2)}{2}+3.5=10\text{m.}$$

10. Weaving Angle and Weaving Distance of Rotary Intersections:

The weaving angle should be small but minimum of 15^o is maintained.

Weave length(L)=4×W=40m.

11. Radius of Inscribed Circle:

Radius of the Inscribed Circle= 36.6 m.

12. Channelizing Islands:

Channelizing islands are provided at entrance or exit of road way to prevent the vehicle from undesirable weaving.

13. Capacity of Rotary Intersections:

Capacity of the Rotary,

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

Where, W = width of weaving section

e = average width of entry and width of non-weaving section for the range of e/W=0.4-1.0.

L = weaving length for the range of W/L

$$W/L = 0.12\text{-}0.4.$$

Where, p = proportion of weaving traffic,

$$P = \frac{(b+c)}{(a+b+c+d)} = (0.4 < p < 1.0)$$

a = left turning traffic moving along left extreme lane.

b = weaving traffic turning toward right while entering the rotary.

c = weaving traffic turning toward left while leaving the rotary.

d = right turning traffic moving along right extreme lane.

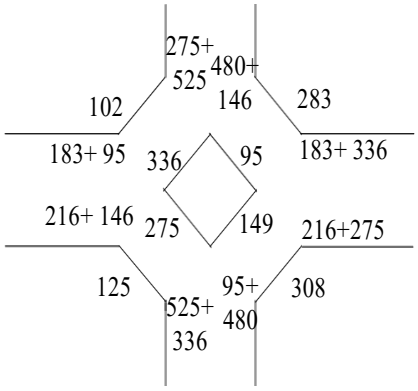

Fig. 6. Amount of traffic weaving

Weaving ratio in East-South Direction,

$$P_{ES} = \frac{(95+480)+(216+275)}{(95+480)+(216+275)+308+146}$$

$$= 0.595$$

Weaving ratio in West-North Direction,

$$P_{WN} = \frac{(183+95)+(275+525)}{183+95+275+525+102+336}$$

$$= 0.711$$

Weaving ratio in North-East Direction,

$$P_{NE} = \frac{(480+146)+(183+336)}{480+146+183+336+283+95}$$

$$= 0.751$$

Weaving ratio in South-West Direction,

$$P_{SW} = \frac{(525+336)+(216+146)}{525+336+216+146+125+275}$$

$$= 0.753$$

Weaving ratio P = 0.753.

Capacity of the Rotary,

$$Q_w = \frac{280w\left[1+\frac{e}{w}\right]\left[1-\frac{p}{3}\right]}{\left[1+\frac{w}{L}\right]}$$

$$= \frac{280\times10\left[1+\frac{6.5}{10}\right]\left[1-\frac{0.753}{3}\right]}{\left[1+\frac{10}{40}\right]}$$

$$= 2768.304 \text{ PCU/hr.}$$

Therefore, capacity of the rotary = 2768.304 PCU/hr.

14. Camber and Super Elevation

We already discussed that the super elevation for rotary roadways is neglected. But here if the vehicle is changing its direction to its opposite side it will travel around the central island and changes the direction.

While changing, the vehicle may over turn or slip, to overcome this, minimum cross slope is provided which is nothing but camber. This camber acts as super elevation in case of rotary roadways.

15. Sight Distance

The sight distance provided at rotary intersections should be as higher as possible and in no case the value must be less than the stopping sight distance.

16. Lighting of Rotary Intersections:

The edge of Central Island should be installed with lights which is mandatory. Additional lights may also be provided at the kerbs if the diameter of Central Island is more than 60 m.

Sometimes, entrance and exit curves can also be provided with lights.

17. Traffic Signs at Rotary Intersections:

Traffic signs should be installed on approaching roads to indicate the presence of rotary intersection ahead to the roadway users.

Kerbs at rotary intersections should be coated with black and white strips to improve visibility.

Traffic signs should be placed 1 meter above road level to indicate the direction of exit.

18. Pedestrian Ways at Rotary Intersections:

At rotary intersections, the vehicles will move consistently and will not stop.

So, the footpath is provided guard rails which will block the entrance of pedestrian into roadway.

Drawing Layout:

Layout of road is the design of any road taking into account the geometric shape that it will have as regards the service it will provide, its physical dimensions and its relationship with the land.

As per the IRC Guidelines the proposed design of the Rotary Intersection is completed. The layout of the proposed Rotary Intersection is drawn from design parameters values that are calculated.

The layout of the existing junction is drawn. The layout of the proposed Rotary Intersection is drawn using calculated values from the Design procedure. Drawing layout of the Junction is completed using the AutoCAD software.

3. Conclusion

Table 2
Design values of the proposed rotary intersection

1	Shape of the Central Island	Circular
2	Design Speed	40 Kmph
3	Radius of Rotary Roadway	29.3 m
4	Value of Friction Coefficient	0.43
5	Radius of Entry Curve	20 m
6	Radius of Exit Curve	30 m
7	Radius of Central Island	26.6 m
8	Width of Entry (e1)	6.5 m
9	Width of Non-Weaving Section (e2)	6.5 m
10	Width of Weaving Section (W)	10 m
11	Length of Weaving Section (L)	40 m
12	Weaving ratio (P)	0.753
13	Practical Capacity of Rotary	2768.304 PCU/hr

The average traffic volume at the junction is observed to be 2649.92 PCU/hr. The calculated Capacity of the rotary is 2768.304 PCU/hr. The observed traffic volume is less than the calculated capacity of the rotary. Hence the design of the rotary is effective.

The proposed rotary intersection which is designed will be effective for 5-8 years from construction. Based on the condition, the rotary intersection can be redesigned with reference to present proposed design.

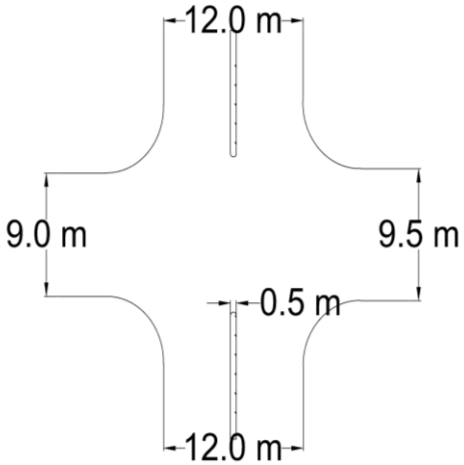

Fig. 7. Layout of the existing junction

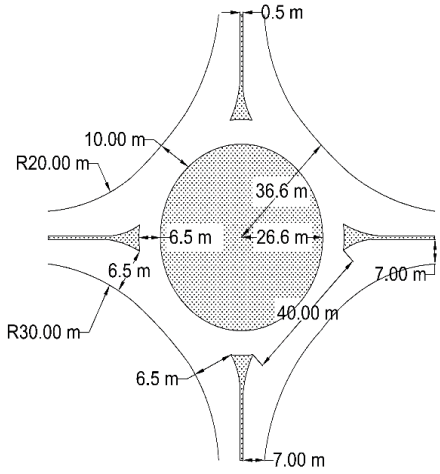

Fig. 8. Layout of the proposed rotary intersection

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