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Assesmental Study and Redesign of Rotary Intersection

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Abstract
The present paper deals with the study on design of rotary intersection at RAMALINGAPURAM junction This study leads to redesign the roundabout or to provide suitable alternative at intersections. The basic principle considered for design includes the principle of uniformity and simplicity, minimize conflict points, alignment and profile. The capacity studies of intersections of Nellore city was calculated based on the established norms of the Indian road congress (IRC: 65-1976). The performance analysis of rotaries is based on various parameters such as traffic volume, weaving traffic, capacity of weaving section. The resulting performance leads to a new model development. The traffic volume survey and geometric design survey is conducted. Different studies like spot speed, parking, and accident studies are conducted. Final design and suggestions are taken into account

Keywords: Traffic volume, spot speed study, parking studies, geometric design study, sign board and road margin study

1.0 INTRODUCTION

Traffic Engineering is comparatively a new branch of Engineering. The traffic volume is increasing drastically during the past few years in NMC and creating hazardous problems. The roads are inadequate to meet the traffic demand. However, the condition of roads has improved during recent past years. Often, the traffic gets blocked up near.

The traffic gets blocked up in Ramalingapuram junction because the size of rotary is often big and road width for present traffic flow at the junction is not enough. City buses and slow moving vehicles are the major root cause, for traffic problems in NMC.

There are many issues related to Ramalingapuram Rotary intersection as this is most busiest place in the city, Ramalingapuram intersection contain four (4) principal arterial Road namely bus stand road, BV Nagar road, VRC road and Muthukur Road. All these legs of rotary intersection are busy in all times from 8.00 AM to 5.00PM.

1.1 Rotary Intersection

The rotary intersection is defined as the special form of intersections present at the grade level which is constructed for traffic movement in one direction (Clockwise or Anti-clockwise) travelling around the central island. The vehicles entering into the rotary will converges first and travel in the stream for some distance and diverges into the different directions. This distance travelled by vehicles after converging and before diverging on

rotary intersection will be called as weaving length. The presence of Central Island will reduce the collision of vehicles entering into intersection and helps to easily manoeuvre by driver across intersection

2.0 Literature Review

All over the world, many studies on Rotary intersection or roundabouts has proven that the rotary intersections are most effective than signaliged intersection in regulating the traffic within specified volume.

S. **Vasantha Kumar, Himanshu Gulati and Shivam Arora** worked on intersection in chennai. They have found that the propostion of weaving section as 0.81, which is less than 1 and suitable to construct the rotary intersection. The observed traffic volume is 2665 PCUs/hr which is lesser than practical capacity 3020 PUCs/hr. Finally they concluded with rotary intersection proposal for the selected intersection.

Veethika Gomasta was designed rotary intersection in Bhopal.according to their design capacity of Vallabha bhawan roundabout was found to be 3017 PCUs/Hr which is greater than 3000 PCUs/Hr. Since the observed volume was greater than practical capacity, they concluded that rotary intersection is not suitable and signalized intersection to be provided

Hyden Chirster & Varhelyi Andras studies shown that rotary intersection will enhances safety, decrease in time consumption for manovering across the intersection and also importatance of roundabouts in aesthetic appearance of city. They also concluded that the fuel consumption and environmental pollution can be reduced by the use of rotary intersection

3.0 Methodology

- The methodology includes the following steps:-
- Study of existing rotary intersection
- Traffic volume survey.
- Collection of data.
- Presentation Of Traffic Volume Data
- Design of rotary intersection as per IRC-65-2017

3.1. Study of existing rotary intersection

Here we selected the Ramalingapuram road intersection as rotary intersection area. The selected area is a four legged junction i.e. where four roads are joining and the roads are BV Nagar,Atmakur Bustand,VRC and Muthukur road. We studied the details of these roads at site and are tabulated. The data of existing rotary intersection area is as follows

Type of road	Major district road
Road width	11m
Design speed	30kmph
Radius at entry	6.2m
Radius at exit	11m
Radius of rotary island	4.58m
Weaving length	21.03m
Weaving width	15m
Width of carriage way entry	11m
Width of carriage way exit	13m
Entry width	11m

Table 3.1 Data collected from existing intersection

3.2 Traffic Volume Survey

The collection of vehicle volume or traffic volume will be taken for a full of week (7 days) on the basis of hourly interval throughout the day. The data required for the calculation of capacity of rotary intersection is taken and selected at the peak hour from 5pm to 6pm.The data sheets of traffic volume were analyzed and we have found that maximum traffic volume accumulated at the selected junction was maximum at the time of 5pm to 6pm. A manual method of data collection was adopted for this study. Two persons per each direction were allowed to take the traffic volume count and the same volume was converted into PCU with respect to IRC SP-41 guidelines. This traffic volume count is converted into Passenger car unit (PCU) as per IRC 106:1990. By using these PCU values vehicles per hour is converted to PCU per hour. The total PCU during the peak hour of the day is 3106 PCU/hr Since this value is less than 5000 PCU/hr as per guidelines Rotary Intersection can be designed at the selected junction.

FiG 3.2: Study area with green and red lines at intersection

3.3 COLLECTION OF DATA

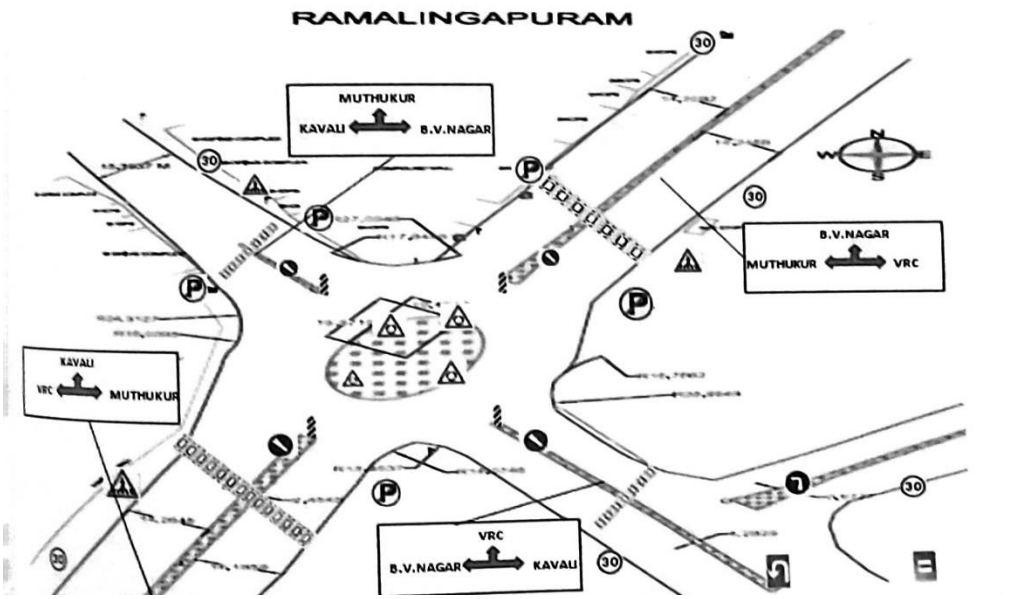
The traffic volume count obtained from the field is converted in passenger car units (PCU). The total PCU obtained in all intervals are to be determined. The total highest volume count in particular interval is taken into account. Conversion of vehicles to PCU is shown in table 4.1

Table 4.1 PCU As Per Irc 65-1976 For Rotary Intersections

VEHICLES	PCU
CAR,AUTO	1
BUS,HCV	2.8
MOTOR CYCLE,SCOOTER	0.75
CYCLE	0.5
ANIMAL DRAWN VEHICLES	4-6

3.4 DATA ANALYSIS

- The traffic survey was conducted at week days and weekend. The traffic volume in PCU was analized manually and the average traffic volume was calculated by taking the average of the values obtained during peak hours of weekends and weekdays. Tabulate above data information with help of MS-Word, MS-Excel. Then with the help of MSExcel plot the graph of Morning and evening traffic volume
- Following tables represents directional distribution of traffic across the rotary intersection by peak hours in morning and evening
- Also, after that the graph represents Morning and evening traffic volume of peak hours, analysis that Sunday evening at railway station road maximum raffic volume as 3106 PCU/hr



Cumulative Frequency Distribution Table

Table3.3 Spot Speed At Junctions At - Ramalingapuram Junction

Route name	Speed	Cumulative frequency	Speed percentile
Muthukur to Rotary	21	46.82	50th
	21.6	50.53	
VRC to Rotary	24.92	48.9582	50th
	24.92	54.7668	
BV Nagar to Rotary	25.52	47.276	50th
	26.67	56.865	
Atmakur Bus stand to Rotary	23.14	50.88	50th
	23.7	52.05	

Table 3.4 Spot Speed At Junctions At - Ramalingapuram Junction

Route name	Speed	Cumulative frequency	Speed percentile
Muthukur to Rotary	27.77	83.29	85th
	28.58	84.411	
VRC to Rotary	29.45	84.4906	85th
	30.375	85.7353	
Atmakur Bus stand to Rotary	28.58	84.411	85th
	29.45	87.05	
BV Nagar to Rotary	32.4	82.287	85th
	33.51	87.639	

3.5 Presentation Of Traffic Volume Data

The data collected during the traffic volume studies can be presented in any of the following forms depending upon the requirement.

Annual Average Daily Traffic (Aadt)

Annual average daily traffic (AADT) is the total volume of vehicle traffic on a highway or road for a year divided by 365 days. AADT is a useful and simple measurement of how busy a road is Annual Average Daily Traffic (AADT) is a measure of the total volume of traffic that passes a given point on a roadway or highway over the course of a year, averaged over 24 hours per day.

Trend Charts

Traffic volume data of present and past is collected and is represented as trend charts. By using this charts traffic volume can be forecasted. This traffic forecasting plays major role in planning and designing highways.

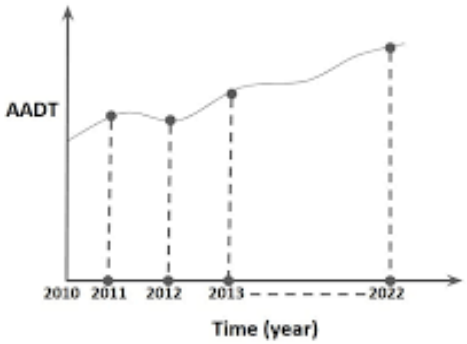


Fig3.5 Trend chart represent trafic data

Variation Charts

Hourly, daily and seasonal variations are alsoprepared. These help in deciding the facilities and regulations needed during peak traffic.

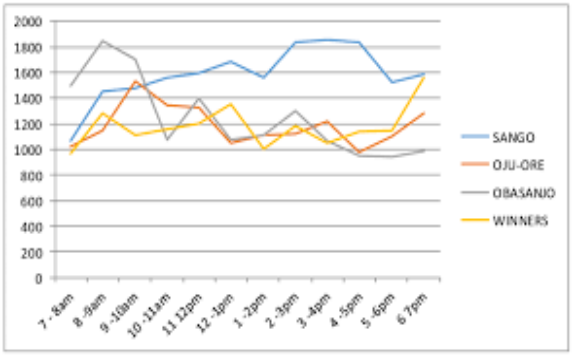


Fig3.6 Variation chart represent trafic data

Highest Hourly Volume (HHV)

The design hourly volume is found from the graph plotted between hourly volume and the number of hours in a year.The design hourly volume is found from the graph plotted between hourly volume and the number of hours in a year.

Highest Hourly Volume.it is the hourly volume that will be reached only thirty times or exceeded only 29 times in a year and all other hourly volume of the year will be less than this value.

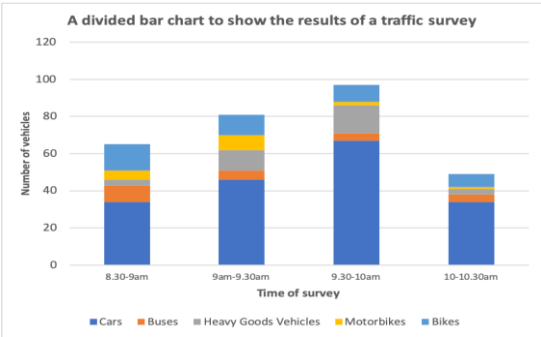


Fig3.7 Highest Hourly Volume (HHV)

Table 3.8 PCU values as per IRC

Sl.No	Vehicle Class	PCU Values
1	Passenger car, auto, tempo, agricultural tractor, rickshaw	1.0
2	Bus, truck, trailer unit,agricultural tractor.	3.0
3	Motor cycle, scooter and pedal Cycle.	0.5.
4	Cycle rickshaw	1.5
5	Horse drawn vehicles	4.0
6	Small bullock cart and handcart	6.0
7	Large bullock cart	8.0

3.6 Traffic Speed Studies Spot Speed Methods

2.5.1.1 Manual method

2.5.1.2 Radar equipment method

Radar Equipment Method

A radar meter is a commonly used device for directly measuring speeds in spot speed studies. This device may be hand-held, mounted in a vehicle, or mounted on a tripod. The effective measuring distance for radar meters ranges from 200 feet up to 2 miles (Parma 2001). A radar meter requires line-of-sight to accurately measure speed and is easily operated by one person. If traffic is heavy or the sampling strategy is complex, two radar units may be needed. Large vehicles such as trucks and buses send the strongest return signal to the radar meters and as a result smaller vehicles may not be detected. If there is a presence of large vehicles, the observer may need to record the speeds of vehicles that are alone.

Advantages:

- Accuracy
- Non-intrusive
- All-weather capability
- Long range
- Continuous operation:

Fig3.9 Rader Equipment

3.7 SIGN BOARD STUDIES

The purpose of road signs is to promote road safety and efficiency by providing for the orderly movement of all road users on all roads in both urban and non-urban areas. Road signs notify road users of regulations and provide warning and guidance needed for safe. uniform and efficient operation.

MANDATORY OR REGULATORY SIGNS

All Mandatory or Regulatory Signs are circular in shape. Mandatory/Prohibitory Signs are to indicate the prohibition upon certain kind of vehicle
"overtaking prohibited" or "U-turn prohibited" or "cycles prohibited" and restriction on parking like "parking prohibited" and limit on vehicle speed and size like "speed limit" and "maximum load limit"

Fig 3.9.1 Mandatory or Regulatory Signs

CAUTIONARY/WARNING SIGNS

Cautionary/Warning signs are triangular in shape with red border and black symbol in white background used to caution and alert the road users to potential danger or existence of certain hazardous conditions either on or adjacent to the roadway so that they take the desired action.

Fig 3.9.2 Mandatory or Regulatory Signs

INFORMATORY/GUIDE SIGNS

These signs are meant to provide information on direction, destination, roadside facilities, etc. to the road user. Following informative road signs helps a driver in saving time, reaching destination without wandering around. These signs are generally facilitators to the driver.Aluminum Informatory Sign Board, Shape: Rectangular at Rs 240/square feet in Meerut.

Fig3.9.3 Informatory/Guide Signs

3.8 DESIGN ELEMENTS

Overall, the design of a rotary intersection must take into account a variety of factors, including traffic volume, safety, and ease of use for all users, including motorists, pedestrians, and cyclists. Careful planning and design can create a safe and efficient intersection that enhances the overall flow of traffic and reduces the risk of accidents.

Following elements are

- The design elements includes
- Design speed
- Radius at entry, exit and central island

- Weaving width
- Weaving length
- Capacity
- Entry and exit width

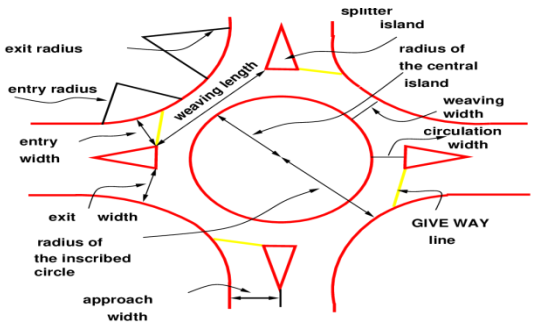


Fig 3.9.4 components of rotary intersection

4.0 RESULTS AND DISCUSSIONS

Analysis of Present Rotary Design

From geometric design of RAMALINGAPURAM junction we can take all geometric parameters for the design to find practical capacity of weaving section

From volume studies it is found that maximum weaving occurs at Muthukur to B.V nagar section.so all the design parameters are to be considered from muthukur to B.V Nagar section.

Design speed = 25kmph

Radius at entry = 6.2m

Radius at exit = 11m

Radius of rotary island = 4.58m

Weaving length = 21.03m

Weaving width = 15m

Width of carriage way entry = 11m

Width of carriage way exit = 13m

Entry width e1= 11m

Non weaving width e2 = 12m

Average width e = (11+12) / 2 =11.52m

Practical capacity of weaving section **Qp =3106** PCU/hr

Internal angle = 75°

Entry angle 42°

Exit angle = 125°

According to IRC 65-1976 following adjustments in the practical capacity is to be made

When internal angle is more than 95° we have to deduct 5% from capacity.

When entry angle is more than 30° deduct 2.5% from capacity

When exit angle is greater than 75° then deduct 5% from capacity.

From above obtained angles totally we have to deduct (5% +2.5%)=7.5%

Now practical capacity of weaving section is QpQp-7.5% & **Qa = 2873 PCU/hr.**

Therefore **Qp < Qa**

Design is insufficient to hold present traffic volume so we must redesign the rotary intersection. The design parameters in the RAMALINGAPURAM junction are not as per IRC 65-1976. The parameters are

- Radius of entry should be between 15-25m
- Radius of rotary should be 1.33 times the radius of entry curve..
- Minimum weaving length should be 30m.

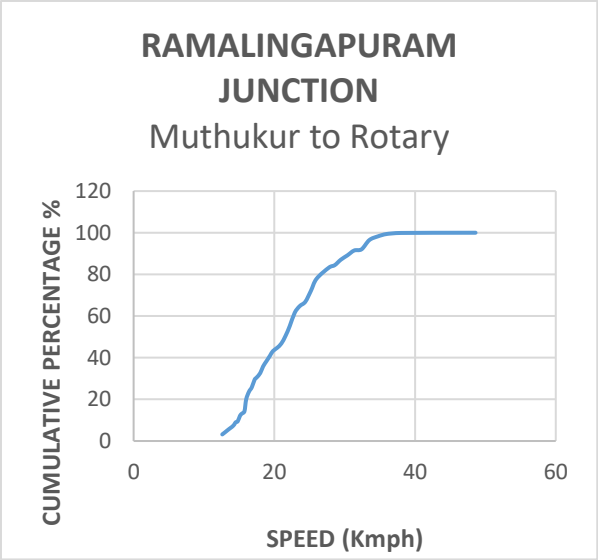
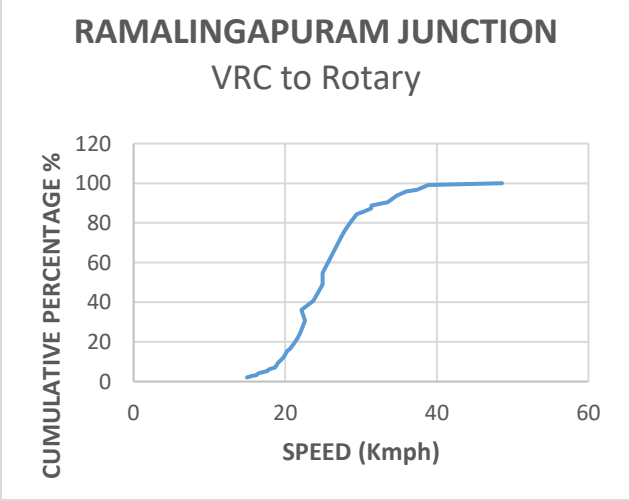
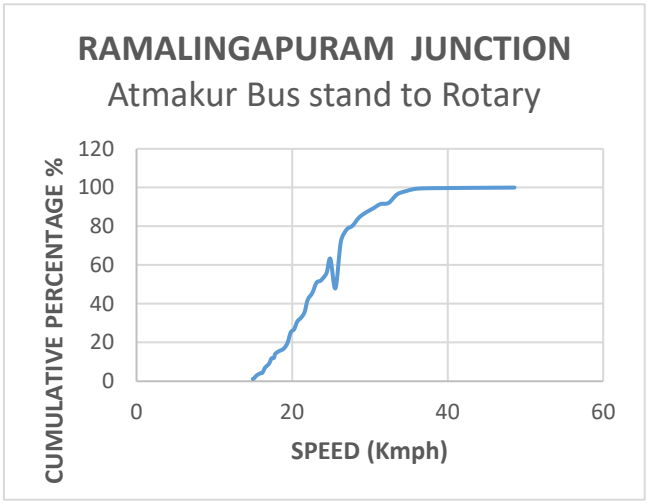


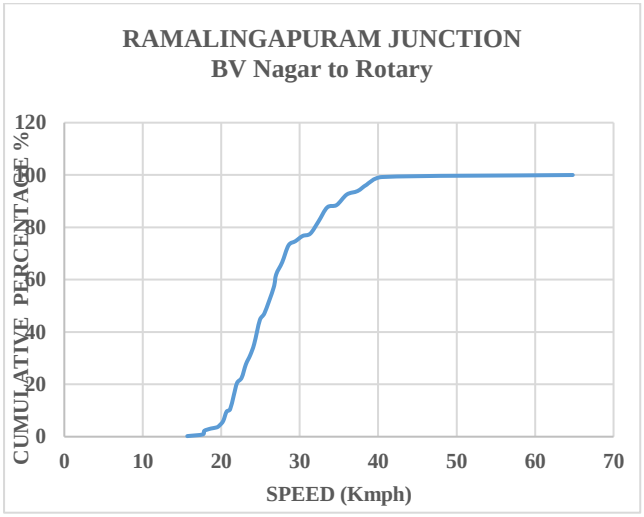
Fig 4.1 Cumulative Speed Distribution Curve

85th Percentile speed = 27 Kmph



85th Percentile speed = 31 Km





85th Percentile speed = 33 Kmph

85th Percentile speed = 29 Kmph

4.1 REDESIGN OF RAMALINGAPURAM ROTARY INTERSECTION

- Assuming that shape of Rotary is Circular.
- As per IRC Design Speed For urban Area as 30Kmph.
- Assuming Radius at Entry Curve as suggested by IRC **15m** as speed 30Kmph.
- Radius of Exit curve = 2 x Radius of Entry
  = 2 x 15
  = 30 m
- Radius of the Central Island
  = 1.33 xRadius of Entry
  = 1.33 x 15
  = 19.95 m
  = **Say 20 m**

  As P (RS-M) = 0.613
- Assuming that Approach road Carriage Way Width =21m.
- So width of Carriage Way at Entry & Exit,
  i.e**. e1 = 15m** (As per IRC Table No.2)
- Width of Non Weaving Section
  i.e. **e2 = 15m** (As per IRC)
- So, The Width of Weaving Section

$$W = \frac{e1+e2}{2} + 3.5$$

$$W = \frac{15+15}{2} + 3.5$$

But limitations Width of Weaving Section is 6-18m So,

W = 18m

Length of Weaving Section (L),

L = 4 × Width of Weaving Section

= 4 × 18
=72

As Per IRC L > 30 as Design Speed is 30 Kmph

As $\frac{e}{w}$ is Within the Range of 0.4 to 1.00

so $\frac{e}{w} = \frac{15}{18}$ = 0.833

It is safe for Average entry width

So Theoretical Capacity of Rotary

$$\frac{280w\left(1+\frac{e}{w}\right)\left(1-\frac{p}{3}\right)}{\left(1+\frac{w}{2}\right)}$$

=

$$\frac{280\times18\left(1+\frac{15}{18}\right)\left(1-\frac{0.613}{3}\right)}{\left(1+\frac{18}{72}\right)}$$

=

= **6084.38 PCU/hr** (on Railway Station & High Road)

Sum of the total Traffic of Rotary in that Weaving Section is **5313.7 PCU/hr**

Now **Qa < Qp** the design is correct and safe.

Certain adjustments can be made

- Radius at exit = 22m
- Radius of central island - 20m

Even we can implement any one taken from below design

- By reducing weaving length 1-55m we get Qp = 4553 PCU/hr
- By keeping w=16m, 1-55m, we get Qp = 4507 PCU/hr.

The above two design satisfy all the conditions require for Qp.

∴ Theoretical Capacity of Rotary

(6084.38PCU/hr) > (5313.7 PCU/hr). Total Traffic in Weaving Section

∴ The Design is Safe

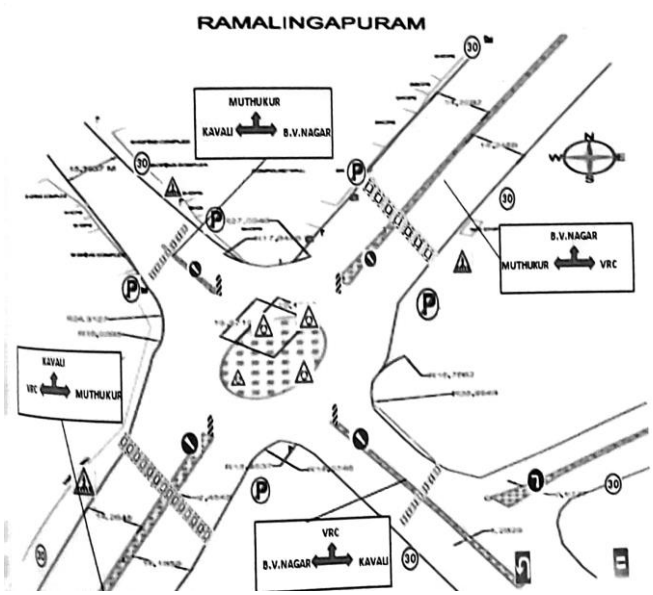


Fig 4.2 Informatory/Guide Signs

5.0 Conclusion

The following conclusions are drawn from the performance analysis and redesigns of rotary tersection in Nellore city is

- Spot speed maintained around **30 kmph** at RAMALINGAPURAM junction.
- Sign boards are not present at both the junctions. So proper installation of sign boards at the both the junction is must. The place where the sign boards are to be installed is shown in both junction plans.
- Road markings are not present at both the junctions. Proper road markings should be placed at both the junctions.
- Auto and 2-wheelers are more comparing to other class of vehicles.
- Vehicles are parking at the both junctions. No parking boards should be placed at the junctions.
- The rotary design at the RAMALINGAPURAM junction is not according to the
- IRC 65-1976. The practical capacity at this junction is very less compare to actual capacity. So redesign is must at the RAMALINGAPURAM junction.
- According to the IRC 65-1976 the RAMALINGAPURAM junction is redesigned. Traffic rules should be followed by the traffic vehicles strictly

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