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PERFORMANCE ANALYSIS OF ROUNDABOUTS IN KAKINADA

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Abstract:- With hike in road traffic due to globalization, it has become a necessity to develop a transportation network which could handle the present as well as the future traffic efficiently. To do so, proper designing and analysis of various infrastructures is to be done. One such infrastructure induced in road network to increase the efficiency of intersections by reducing the delay is roundabouts. So, an attempt has been made to determine performance of roundabouts based on capacity. It was observed that the geometrics of the roundabout played a crucial role in addressing the roundabout capacity. Thus, with this aspect as foundation, I have done a project report on performance analysis of roundabouts in Kakinada for heterogeneity in Indian traffic. For this, data from various roundabouts with varying geometry and flow properties were selected for including affect due to variations. In all, geometric elements were observed to have significant impact on capacity. Traffic inflow and circulating flow is considered as other parameter for giving the relation between them. The Suggestions are given to increase the capacity as per IRC: 65-1976. Approximate cost of project is also given by considering the NHA and IRC.

Index Terms— Infrastructures, Globalization Roundabouts, Traffic inflow

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I. INTRODUCTION

Rotary intersections or roundabouts are special form of at-grade intersections laid out for the movement of traffic in one direction around a central traffic island. Essentially all the major conflicts at an intersection namely the collision between through and right-turn movements are converted into milder conflicts namely merging and diverging. The vehicles entering the rotary are gently forced to move in a clockwise direction in orderly fashion. They then weave out of the rotary to the desired direction.

The key advantages of a rotary intersection are listed below:

1) Traffic flow is regulated to only one direction of movement, thus eliminating severe conflicts between crossing movements.

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2) All the vehicles entering the rotary are gently forced to reduce the speed and continue to move at slower speed. Thus, none of the vehicles need to be stopped, unlike in a signalized intersection.
3) Because of lower speed of negotiation and elimination of severe conflicts, accidents and their severity are much less in rotaries.
4) Rotaries are self governing and do not need practically any control by police or traffic signals.
5) They are ideally suited for moderate traffic, especially with irregular geometry, or intersections with more than three or four approaches.

Although rotaries offer some distinct advantages, there are few specific limitations for rotaries which are listed below.

1. All the vehicles are forced to slow down and negotiate the intersection. Therefore, the cumulative delay will be much higher than channelized intersection.
2. Even when there is relatively low traffic, the vehicles are forced to reduce their speed.
3. Rotaries require large area of relatively flat land making them costly at urban areas.
4. The vehicles do not usually stop at a rotary. They accelerate and exit the rotary at relatively high speed. Therefore, they are not suitable when there are high pedestrian movements. Traffic rotaries reduce the complexity of crossing traffic by forcing them into weaving operations. The shape and size of the rotary are determined by the traffic volume and shape of turning movements.

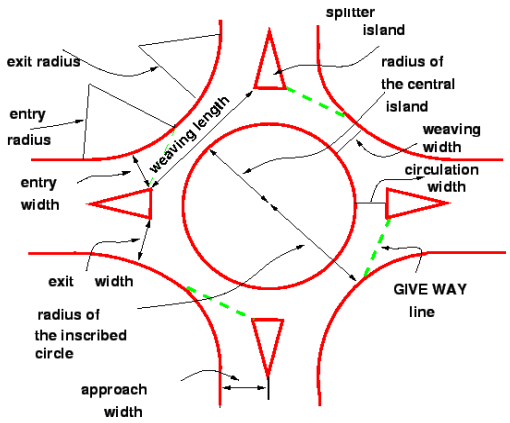

Fig 1: Design elements of a rotary

II. METHODOLOGY

Capacity assessment of a rotary is done by analyzing the section having the greatest proportion of weaving traffic and entry and flare length consideration. The analysis is done by using the formula given by TRL.

In this three important roundabouts of Kakinada city were selected.

1. Atchampeta round about
2. Sarpavaram roundabout
3. Zillah perished roundabout

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All geometric details were measured at site during off-peak traffic.

- Flare length , entry and exit radius are arriving from AutoCAD.
- Traffic flow at these roundabouts was determined manually in peak period.
- Based on TRL the capacity is calculated.
- Relation between capacity and geometric details is established.
- The efficient roundabout is given as final conclusion based on entry flow and circulating flow capacity.
- The capacity of roundabout is increased by providing the sufficient geometric details are also given.

III. STUDY AREA AND DATA COLLECTION

A. Atchampeta roundabout: The following are the geometric details of Atchampeta roundabout shown in Table 1 and Fig 2 indicates Atchampeta roundabout located in Kakinada

Table 1: Atchampeta roundabout geometric details

S.NO	Geometric Detail	Value (m)
1	Island circle radius	7.25
2	Inscribed circle radius	22.25
3	Weaving width	14.5
4	Weaving length	33
5	Circulation width	15
6	Approach width	10
7	Entry width	13
8	Exit width	13
9	Splitter width at entry	1.2
10	Splitter width at exit	1.2
11	Flare length	7.8
12	Entry radius	7.55
13	Exit radius	7.55

Fig 2: Atchampeta round about

B. Sarpavaram roundabout: The following are the geometric details of Sarpavaram roundabout shown in Table2 and Fig 3 indicates Sarpavaram roundabout located in Kakinada

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Fig 3: Sarpavaram roundabout

Table 2: Sarpavaram roundabout geometric details

S.NO	Geometric Detail	Value (m)
1	Island circle radius	3.25
2	Inscribed circle radius	16.75
3	Weaving width	13.5
4	Weaving length	25
5	Circulation width	13.5
6	Approach width	7.25
7	Entry width	8
8	Exit width	8
9	Splitter width at entry	0.5
10	Splitter width at exit	0.5
11	Flare length	6.1
12	Entry radius	16.5
13	Exit radius	16.5

C. Zillah perished (ZP) roundabout: The following are the geometric details of Zillah perished (ZP) roundabout shown in Table 3 and Fig 4 indicates Zillah perished (ZP) roundabout located in Kakinada

Table 3: Zillah perished (ZP) roundabout Geometric details

S.NO	Geometric Detail	Value (m)
1	Island circle radius	7
2	Inscribed circle radius	26.5
3	Weaving width	19
4	Weaving length	33
5	Circulation width	19.5
6	Approach width	12.5
7	Entry width	16.8
8	Exit width	16.8
9	Splitter width at entry	1.2
10	Splitter width at exit	1.2
11	Flare length	8.4
12	Entry radius	6.85
13	Exit radius	6.85

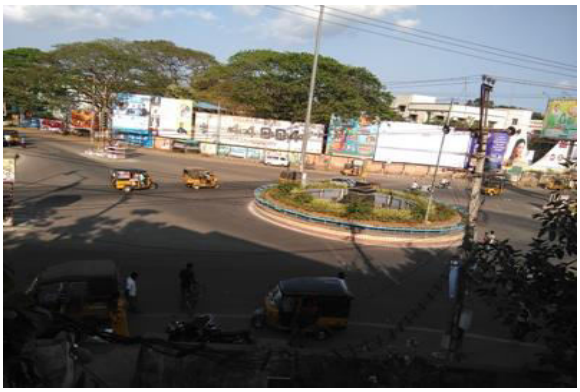

Fig 4: Zillah perished (ZP) roundabout

IV. RESULTS

A. Atchampeta traffic details

The following are the traffic details of Atchampeta located in Kakinada

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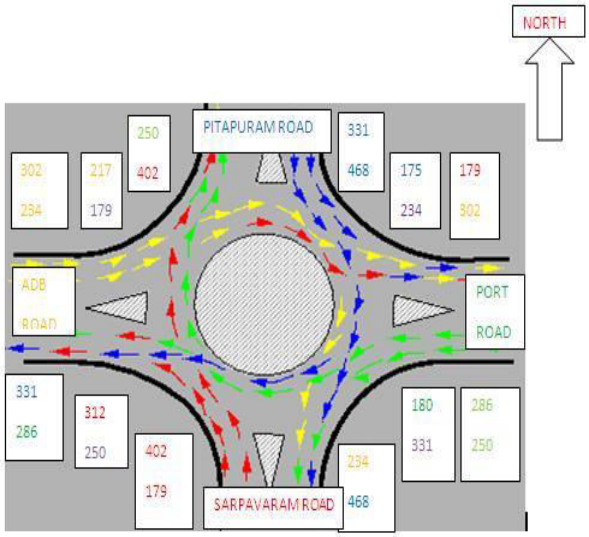


PNE=(231+397+139+232) / (231+397+139+232+118+181) =0.77

PSE=(181+397+220+192) / (181+397+220+192+137+231) = 0.73

PNW=(192+305+232+181) / (192+305+232+181+167+139) = 0.75

PSW=(231+220+305+139) / (231+220+305+139+238+192) = 0.680

Hence, p=0.77

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

Weaving width= w=14.5m

Average width of road at entry and exit=e=13m

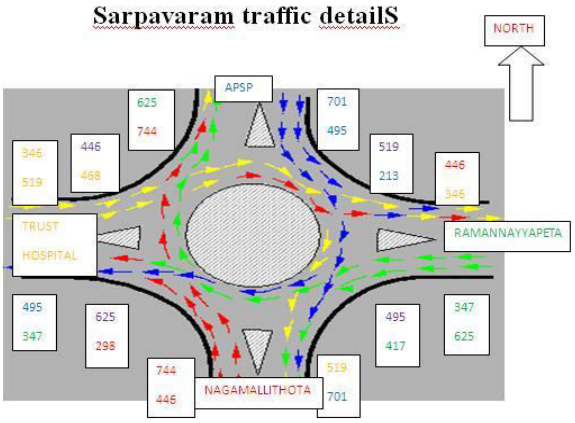
Length of weaving=l=33m

Q_w= 280x14.5 (1+13/14.5) (1-0.77/3)/ (1+14.5/33)

Q_w=3964.13PCU//hr

B. Sarpavaram traffic details

The following are the traffic details of Sarpavaram located in Kakinada



PNE=(494+351+309+241) / (494+351+309+241+150+603) =0.65

PSE=(241+432+603+494) / (241+432+603+494+289+351) = 0.73

PNW=(432+513+241+603) / (432+513+241+603+320+309) = 0.74

PSW=(351+241+513+309) / (351+241+513+309+207+432) = 0.69

Hence, p=0.74

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

Weaving width= w=13.5M

Average width of road at entry and exit=e=8M

Length of weaving=l=25M

Q_w= 280x13.5 (1+8/13.5) (1-0.74/3)/ (1+13.5/25)

Q_w=2927.045PCU/hr

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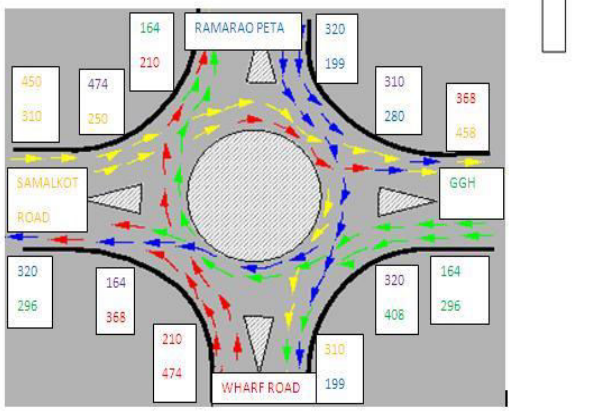
C. Zillah perished traffic details

The following are the traffic details of Zillah perished (ZP) located in Kakinada



PNE=(237+147+123+343) / (237+147+123+343+208+230) =0.66

PSE=(159+355+230+147) / (159+355+230+147+237+275) = 0.64

PNW=(237+159+220+123) / (237+159+220+123+305+355) = 0.53

PSW=(355+220+230+343) / (355+220+230+343+187+123) = 0.79

Hence, p=0.79

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

Weaving width= w=19.5

Average width of road at entry and exit=e=16.8

Length of weaving=l=23m

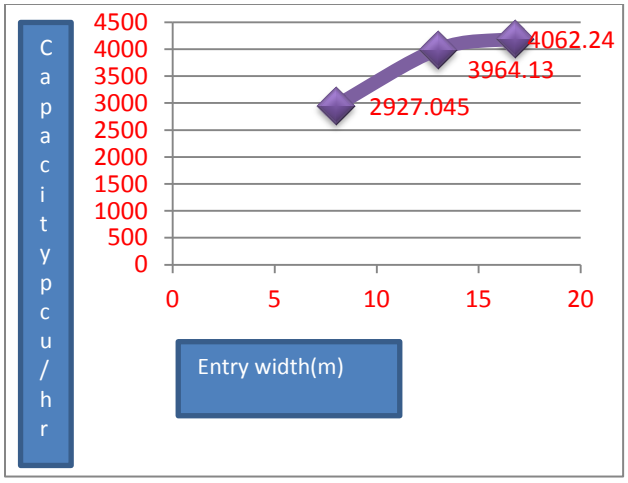
Q_w= 280x19.5(1+16.8/19.5) (1-0.79/3)/ (1+19.5/23)

Q_w=4062.24PCU/hr

Data extraction:

Detail	ZP	Atchampa	Sarpavaram
Entry width(m)	16.8	13	8
Flare length(m)	8.4	7.8	6.1
Capacity(pcu /hr)	4062.24	3964.13	2927.045
Inflow(PCU/hr)	2789	2555	4335
Circulatory flow(PCU/hr)	1814	1895	3569

Graph 1: Relation between capacity and entry width



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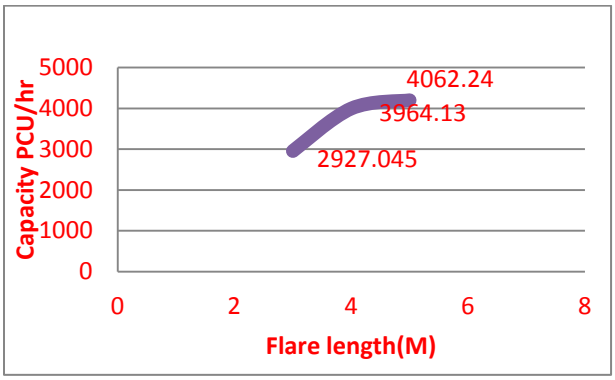
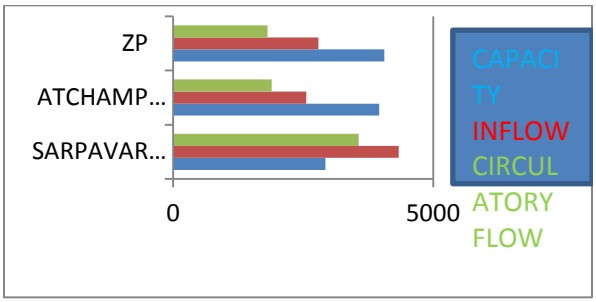
Graph 2: Relation between capacity and flare length



Based on the results, from the following graph 1 we can observed that the capacity of roundabout is increased with increase in entry width

Based on the results and from the graph 2 , we can observed that capacity of roundabout is increased with increase in flare length.

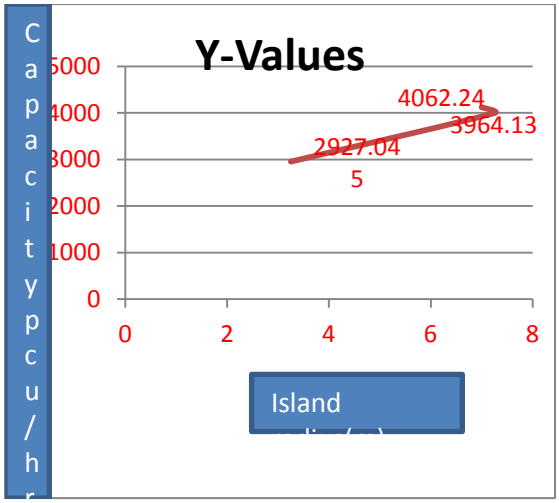
Graph 3: Relation between entry flow and circulating flow



Based on the above results and from graph 3 we can be observed that, the entry flow and circulating flow at sarpavaram roundabout is more than ZP and Atchampeta rounabouts.

From the literature review and from guide lines of TRL the large entry width and Flare length roundabouts must have high capacity and entry flow and circulating flows.But in Kakinda Sarpavaram roundabout had more traffic in terms of entry and circulating flow due to busy areas located around it.Because of heavy traffic around this with insufficient geometric details the roundabout traffic faces delays and causes ques around the intersection in peak periods of traffic flow.The traffic growth is more in future period. For providing safety and comfort to road users it must requires redesign or expansion of the geometrics is necessary. For this I have checked many parameters for increasing the capacity of sarpavaram roundabout.They are

A. Island radius:



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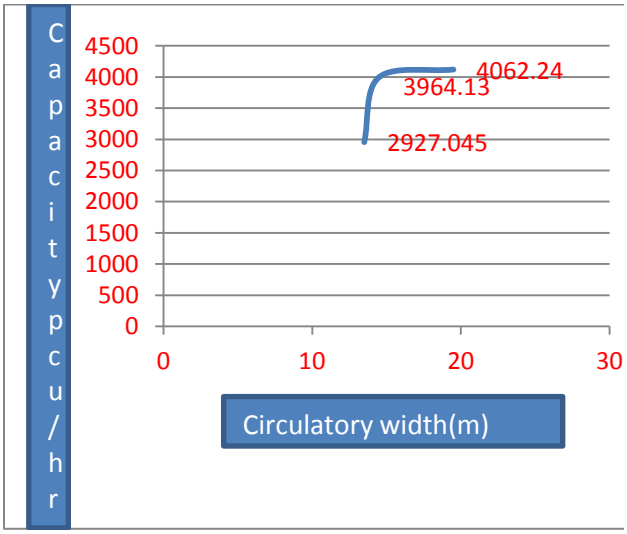
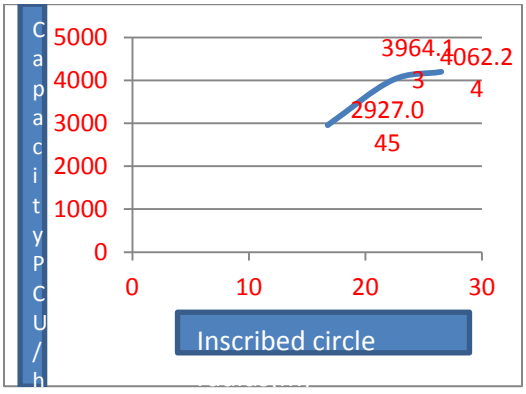
From the above data it is cleared that the increse in island diameter is not largely effect the capacity growth.

B. Circulatary width

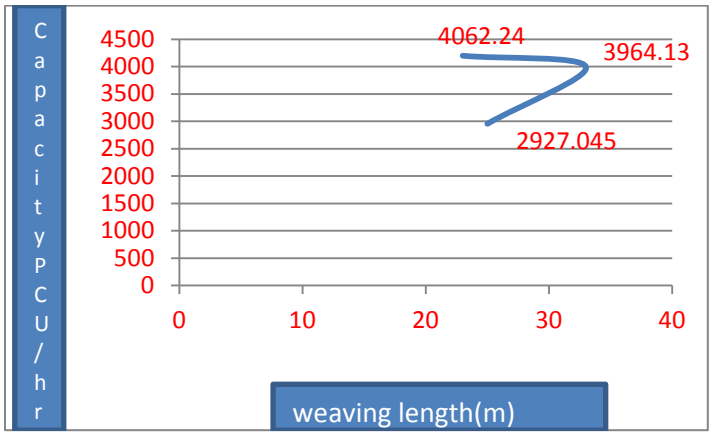


From this graph we can observe that , increase in circulatary width increases capacity.The increase in circulatary width increses the inscribed circle radius. Hence, Capacity is also increases with incresed inscribed circle radius.

C. Inscribed circle radius



D. Weaving length



Hence we observed that increase in weaving length is not greatly affecting the capacity but it mostly effecting how smoothly traffic is flowing. Based on these I have suggested that, increase of entry width, weaving width and weaving length increases the capacity of Sarpavaram roundabout

I provided,

Entry and exit width = 13m

Weaving width = 18m

Weaving length=40m

Hence, the capacity is increased to

$$Q_w = \frac{280w[1+\frac{e}{w}][1-\frac{P}{3}]}{1+\frac{w}{l}}$$

= 280*18(1+13/18)(1-0.79/3) / (1+18/40)

= 4450PCU/hr.

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Modified geometric details of sarpavaram rotary:

S.NO	Geometric Detail	Value (m)
1	Island circle radius	3.25
2	Inscribed circle radius	21.25
3	Weaving width	18
4	Weaving length	40
5	Circulation width	18
6	Approach width	7.25
7	Entry width	13
8	Exit width	13
9	Splitter width at entry	0.5
10	Splitter width at exit	0.5
11	Flare length	12.5
12	Entry radius	20
13	Exit radius	20

The area at intersection at present is = 881.41m
The area required for carrying the capacity is = 1418.625m^2
The area to be acquired at intersection is
(1418.625-881.41)=537.215m^2
=540m^2

- As per competent authority and add joint collector report given on village of sarpavaram in Kakinada rural mandal east Godavari district land value for category I is 48, 40,000 per acre.
- 1 acre = 4046.86 square meter
- 1 square meter = 0.000247105 acre
- Our area = 540*0.000247105 =0.1334367acres
- cost of land = 0.1334367*48,40,000 =6,45,833.628/-
- According to IRC approximate cost for 1km length of road is 2.5 crore per single lane.
- Therefore the cost of road construction is 0.023*2.5*10000000 = 5,75,000/-
- Total cost of construction is 645833.628+575000 = 12,20,833.628/-

Other alternative:

- The Sarpavaram roundabout performance is also effectively improved by reducing the entering traffic and by diverting to the surrounding arterial roads.
- The traffic coming from the Bhanugudi junction which has destination point to trust hospital road must be diverted from the point of **Ashram public school** to ROAD NUMBER 1 and then to VS RAJU COLONY.
- In the same manner whatever the traffic having destination point to Ramannayyapeta market road must be diverted from the point of **NAGAMALLITHOTA JUNCTION** to NFCL road and then to RTO office road.
- The traffic coming from the Pitapuram road which has the destination point to trust hospital road must be diverted from

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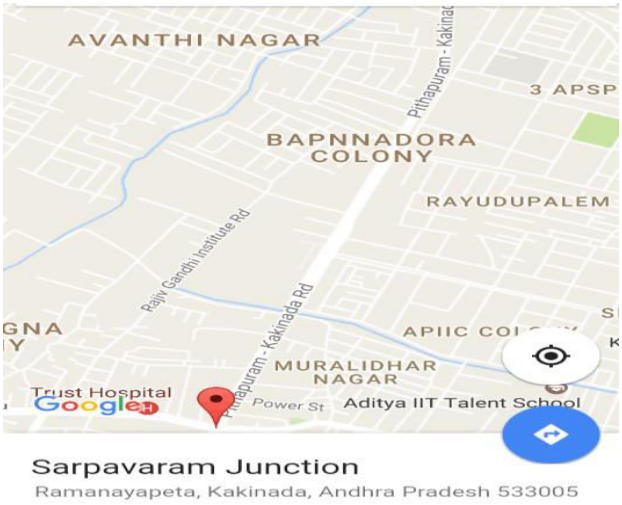
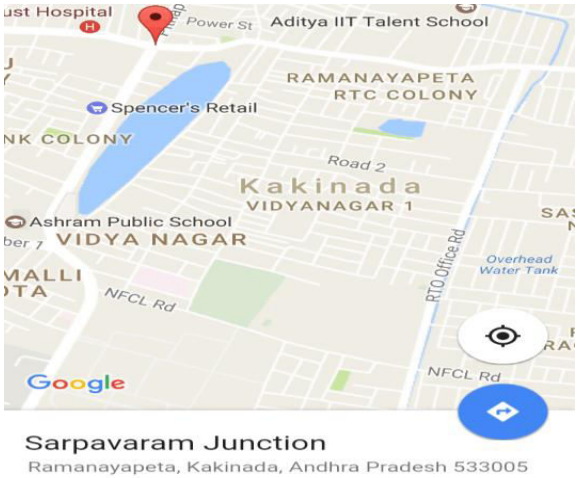
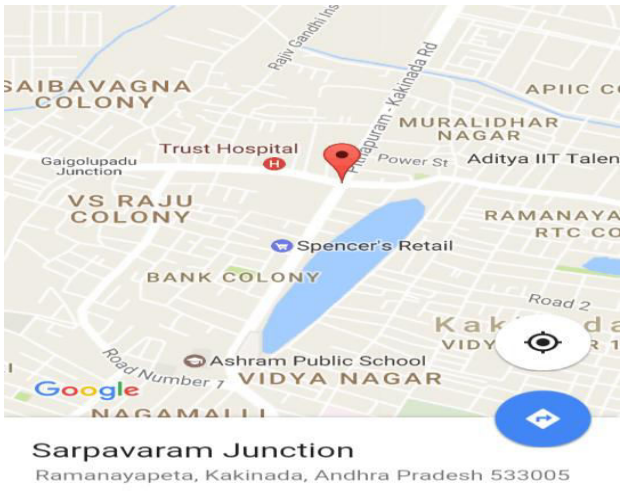
the point of **BAPNNADORA COLONY** to Rajiv Gandhi institute road.

- In the same manner whatever the traffic having destination point to Ramannayyapeta market road must be diverted from the point of **MURALIDHAR NAGAR** to RAMANNAYYAPETA FISH MARKET.







V. DISCUSSIONS

- From the all experiments it can be seen that the capacity of roundabout is mostly based on entry width flare length and circulatory width.
- As per geometric details point of view capacity of ZP roundabout is more than the other two (Atchampeta and Sarpavaram) roundabouts.
- As per traffic point of view traffic is

maximum in the form of entering and circulating flow at Sarpavarm roundabout.

- Because of signal system ZP roundabout satisfactorily maintains the emerging traffic with less delay.
- Atchampeta roundabout is maintaining traffic in well condition because of low traffic.
- Sarpavaram roundabout is having insuffient geometric details to carry traffic in safe manner.
- If we modify the geometrics then the Sarpavaram roundabout capacity is increasing and reduces the delay and ques formation.
- Thus the performance of Sarpavaram roundabout is effectively increasing.
- I provided entry width as 13m weaving width 18 m and weaving length as 40m for increasing the capacity of sarpavaram roundabout.
- The land acquired is 540 square meters.
- The cost of land isRs.6,45,833.628/-
- The cost of construction is Rs.5,75,000/-
- Total cost of construction is 645833.628+575000 = Rs.12,20,833.628/-
- And acquiring of land is difficult, so that I have suggested other alternative to divert the traffic from emerging roads to some arterial roads around the sarpavaram junction.
- The route map is also given.

VI. CONCLUSIONS

From this study we have the following conclusions

- . From the all experiments it can be seen that the capacity of roundabout is mostly based on entry width flare length and circulatory width.
- As per geometric details point of view capacity of ZP roundabout is more than the other two (Atchampeta and Sarpavaram) roundabouts.
- As per traffic point of view traffic is maximum in the form of entering and circulating flow at Sarpavarm roundabout.
- Because of signal system ZP roundabout satisfactorily maintains the emerging traffic with less delay.
- Atchampeta roundabout is maintaining traffic in well condition because of low traffic.
- Sarpavaram roundabout is having insuffient geometric details to carry traffic in safe manner.
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