

TRAFFIC VOLUME STUDY AND DESIGN OF ROUNDABOUT AT PATHANAMTHITTA

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Abstract – A roundabout is a special type of at-grade intersection. Introducing a roundabout at Stadium junction, Pathanamthitta will eliminate direct conflict at the junction. Moreover, a roundabout avoids frequent stopping and starting of vehicles, which is a major disadvantage of the existing traffic signal system for the design of roundabout traffic volume data are needed. Traffic volume study is conducted at the junction for a period of 7 days. Roundabout is preferred when right turning traffic is more. The design of roundabout is done as per the guidelines of IRC 65:2017.

Here a traffic light signal system is existing, but it causes frequent stopping and starting of vehicles. To avoid the frequent stopping and starting of vehicles a continuous flow system should be introduced. The roundabout designed at this junction.

Key Words: Roundabout, At-grade intersection, traffic volume study, signal system, weaving traffic

1. INTRODUCTION

An efficient transportation system is the backbone of a country's economy. Therefore the regulation of traffic is essential for the smooth and safe movement of vehicles. Due to rapid urbanization, traffic is increasing day by day, which leads to traffic congestion at the intersection. Poor performance of the signalized intersection ultimately leads to environment pollution.

Pathanamthitta district is located at southern part of Kerala, with a latitude 9.28068° and 76.86967° E longitude and has an area of 2642 km². Many pilgrim centres including the famous Hindu pilgrimage Sabarimala is situated in Pathanamthitta district and is known as the 'Pilgrim capital of Kerala'.

Introducing a roundabout at stadium junction helps to reduce the traffic congestion, permits free flow ,allow uniform speed and reduce conflict points. At a four legged intersection, a self-regulating roundabout reduces the number of conflict points from 32 to 8. Traffic congestion at a conventional traffic signal system causes frequent starting and stopping of vehicles, idling and crawling causes loss of fuel and increase in emissions. This can be eliminated by the introduction of a roundabout.

2. STUDY AREA

The study area is Stadium junction Pathanamthitta with a latitude 9.26°N and longitude 76.78° E. The junction is an intersection of four roads; Pathanamthitta–Pandalam road , ring road, Thiruvalla-Kozhencherry road, post office road.

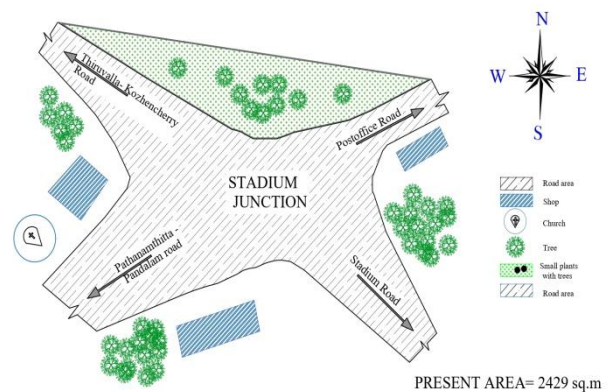


Fig -1: Present location sketch

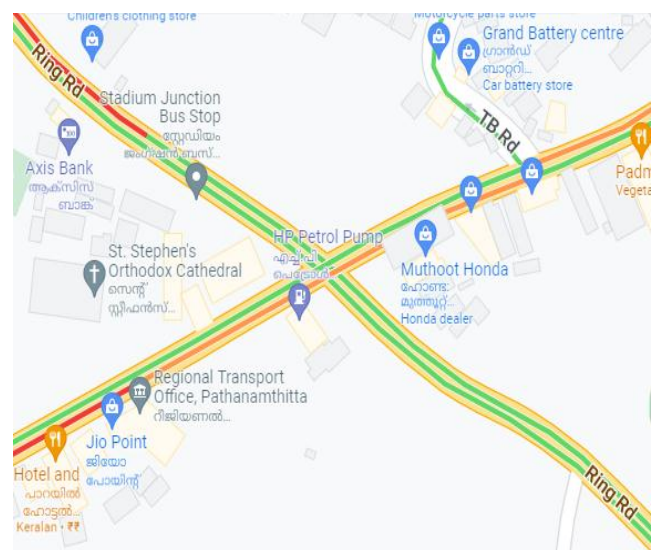


Fig -2 : Map of Stadium junction, Pathanamthitta, Kerala, India (Google Map)

3. OBJECTIVES

- To conduct traffic volume study at the junction
- To determine the hourly volume of traffic in terms of equivalent passenger car units
- To determine the vehicular composition of the stream
- To design a roundabout as per IRC guidelines

4. SCOPE

- Reduction in traffic congestion at Stadium junction
- Reduction of travel time to reach the destination
- Reduction in environmental pollution and fuel consumption
- Reduction in number of accidents occurring at the junction due to direct conflict.

5. METHODOLOGY

5.1. Traffic volume study

Traffic volume survey is conducted at Stadium junction. To know about the present volume of traffic at the junction. Traffic volume study was conducted for a continuous period of 7 days. Vehicles are classified as per IRC 106:1990 as two wheelers, Auto-rickshaw, Car, light commercial vehicle (LCV), Bus and truck. The number of left turning, right turning and straight moving vehicles at each road at the intersection are counted in order to design the roundabout.

Since the traffic is heterogeneous the number of vehicles are converted to a standard unit called passenger car unit (PCU). The varies PCU factors are shown in the following table.

Table -1: PCU factors

| Vehicle type | Equivalent PCU factor |
|--------------------------|-----------------------|
| Two wheelers | 0.5 |
| Passenger car | 1.0 |
| Auto-rickshaw | 1.2 |
| Light commercial vehicle | 1.4 |
| Truck | 2.2 |
| Bus | 2.2 |

The following table shows the average traffic volume data of 7 days of four roads.

Table -2 Traffic volume count of Pathanamthitta-Pandalam road

| TIME | CAR /JEEP | 2 WHEELER | 3 WHEELER | BUS | LCV | TRUCK | PCU/hr |
|-------------|-----------|-----------|-----------|-----|-----|-------|--------|
| 6:00-7:00 | 339 | 539 | 109 | 34 | 37 | 34 | 1211 |
| 7:00-8:00 | 370 | 601 | 126 | 35 | 40 | 31 | 1023 |
| 8:00-9:00 | 604 | 846 | 205 | 34 | 39 | 29 | 1467 |
| 9:00-10:00 | 606 | 858 | 222 | 34 | 39 | 32 | 1502 |
| 10:00-11:00 | 625 | 846 | 244 | 36 | 42 | 37 | 1561 |
| 11:00-12:00 | 466 | 705 | 157 | 36 | 47 | 36 | 1232 |
| 12:00-1:00 | 473 | 728 | 166 | 33 | 39 | 37 | 1245 |
| 1:00-2:00 | 353 | 673 | 168 | 33 | 44 | 30 | 1092 |
| 2:00-3:00 | 544 | 757 | 180 | 32 | 44 | 35 | 1348 |
| 3:00-4:00 | 650 | 843 | 204 | 33 | 48 | 35 | 1534 |
| 4:00-5:00 | 658 | 896 | 215 | 37 | 52 | 40 | 1607 |
| 5:00-6:00 | 666 | 938 | 214 | 34 | 41 | 36 | 1604 |

Table -3 Traffic volume count of Post Office Road

| TIME | CAR /JEEP | 2 WHEELER | 3 WHEELER | BUS | LCV | TRUCK | PCU/hr |
|-------------|-----------|-----------|-----------|-----|-----|-------|--------|
| 6:00-7:00 | 249 | 301 | 108 | 21 | 23 | 26 | 710 |
| 7:00-8:00 | 289 | 457 | 109 | 24 | 20 | 26 | 787 |
| 8:00-9:00 | 337 | 435 | 120 | 24 | 20 | 26 | 830 |
| 9:00-10:00 | 365 | 576 | 145 | 32 | 20 | 28 | 987 |
| 10:00-11:00 | 384 | 604 | 162 | 28 | 21 | 23 | 1022 |
| 11:00-12:00 | 321 | 512 | 131 | 29 | 22 | 25 | 884 |
| 12:00-1:00 | 251 | 516 | 130 | 28 | 21 | 32 | 827 |
| 1:00-2:00 | 343 | 493 | 134 | 27 | 19 | 28 | 898 |
| 2:00-3:00 | 352 | 546 | 126 | 31 | 18 | 25 | 925 |
| 3:00-4:00 | 361 | 548 | 143 | 29 | 20 | 29 | 963 |
| 4:00-5:00 | 368 | 595 | 160 | 27 | 23 | 24 | 1002 |
| 5:00-6:00 | 366 | 540 | 155 | 29 | 22 | 24 | 970 |

Table -4 Traffic volume count of Thiruvalla-Kozhencherry road

| TIME | CAR /JEEP | 2 WHEELER | 3 WHEELER | BUS | LCV | TRUCK | PCU/hr |
|-------------|-----------|-----------|-----------|-----|-----|-------|--------|
| 6:00-7:00 | 373 | 373 | 89 | 19 | 21 | 22 | 686 |
| 7:00-8:00 | 304 | 416 | 99 | 21 | 23 | 27 | 769 |
| 8:00-9:00 | 332 | 453 | 122 | 25 | 24 | 24 | 847 |
| 9:00-10:00 | 333 | 483 | 127 | 26 | 25 | 26 | 877 |
| 10:00-11:00 | 318 | 462 | 129 | 27 | 20 | 23 | 842 |
| 11:00-12:00 | 310 | 441 | 107 | 23 | 23 | 25 | 797 |
| 12:00-1:00 | 301 | 431 | 107 | 27 | 20 | 25 | 788 |
| 1:00-2:00 | 318 | 420 | 111 | 27 | 26 | 27 | 817 |
| 2:00-3:00 | 315 | 459 | 124 | 26 | 22 | 25 | 837 |
| 3:00-4:00 | 337 | 482 | 125 | 32 | 23 | 29 | 895 |
| 4:00-5:00 | 360 | 496 | 125 | 31 | 20 | 24 | 907 |
| 5:00-6:00 | 360 | 511 | 137 | 33 | 22 | 26 | 941 |

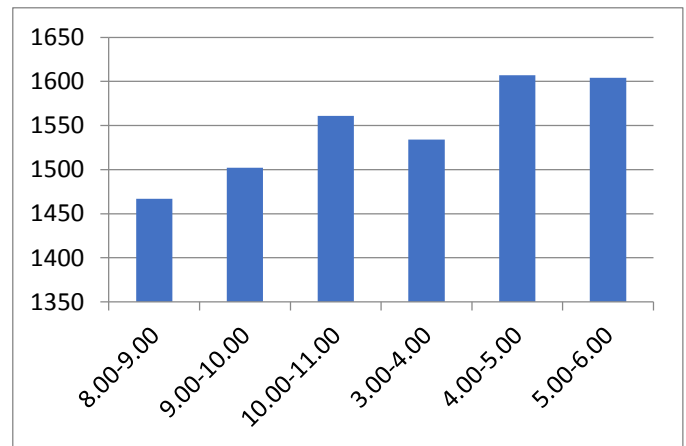


Chart -1: Pathanamthitta-Pandalam road

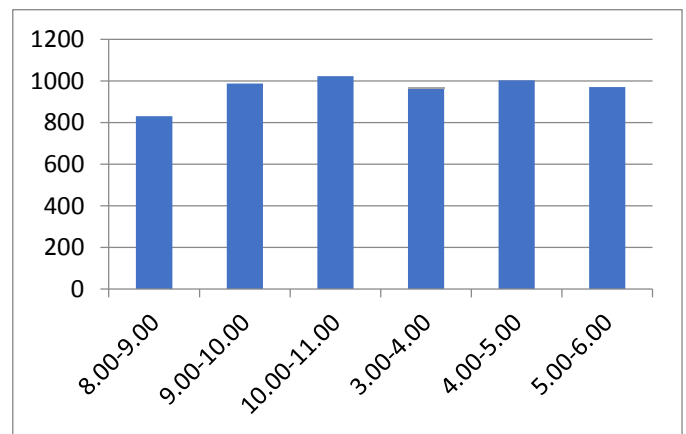


Chart -2: Post office road

Table -5 Traffic volume of Stadium-Ring road

| TIME | CAR /JEEP | 2 WHEELER | 3 WHEELER | BUS | LCV | TRUCK | PCU/hr |
|-------------|-----------|-----------|-----------|-----|-----|-------|--------|
| 6:00-7:00 | 204 | 335 | 102 | 31 | 28 | 24 | 655 |
| 7:00-8:00 | 306 | 427 | 127 | 21 | 22 | 22 | 790 |
| 8:00-9:00 | 374 | 581 | 127 | 29 | 42 | 42 | 1035 |
| 9:00-10:00 | 404 | 652 | 139 | 28 | 49 | 49 | 1122 |
| 10:00-11:00 | 431 | 698 | 168 | 32 | 43 | 43 | 1207 |
| 11:00-12:00 | 329 | 508 | 130 | 28 | 35 | 35 | 934 |
| 12:00-1:00 | 307 | 498 | 124 | 29 | 30 | 30 | 868 |
| 1:00-2:00 | 306 | 458 | 122 | 30 | 29 | 29 | 863 |
| 2:00-3:00 | 377 | 516 | 133 | 34 | 31 | 31 | 981 |
| 3:00-4:00 | 433 | 600 | 123 | 30 | 33 | 33 | 1083 |
| 4:00-5:00 | 425 | 677 | 135 | 34 | 55 | 55 | 1181 |
| 5:00-6:00 | 494 | 630 | 143 | 89 | 44 | 34 | 1313 |

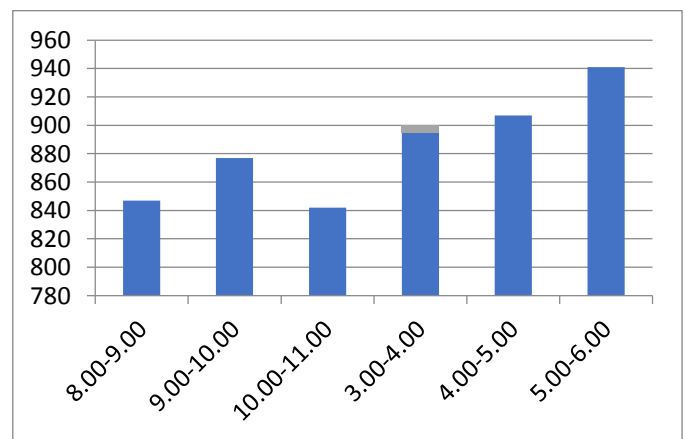


Chart - 3:Thiruvalla-Kozhencherry road

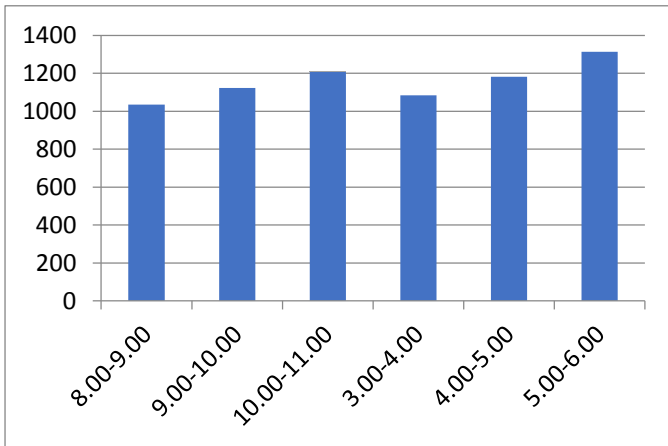


Chart -4: Ring road

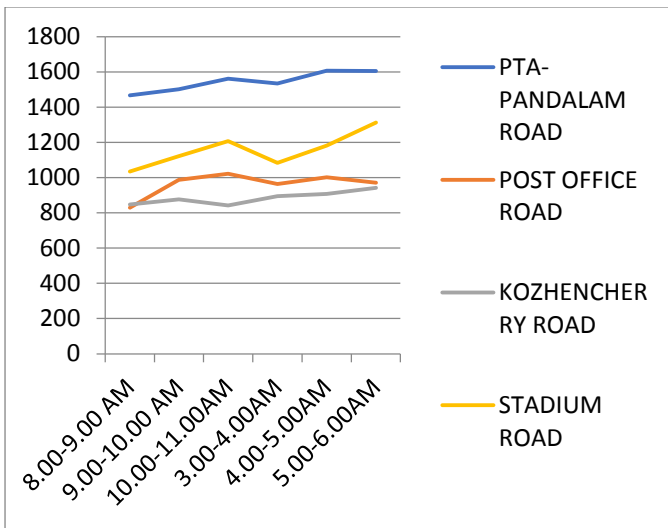


Chart -5: Traffic volume data

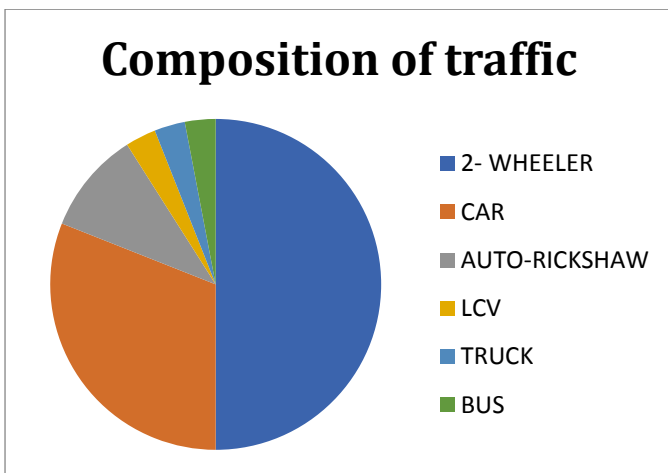


Chart -6: Vehicular composition of traffic

5.2. Traffic volume data for roundabout design

The number of right turning, left turning and straight moving traffic is shown in the below table.

Table -2: PCU VALUE

| Right turning(PCU/hr) | Straight (PCU/hr) | Left turning (PCU/hr) |
|-----------------------|-------------------|-----------------------|
| 115 | 272 | 194 |
| 480 | 154 | 313 |
| 282 | 267 | 104 |
| 387 | 150 | 478 |

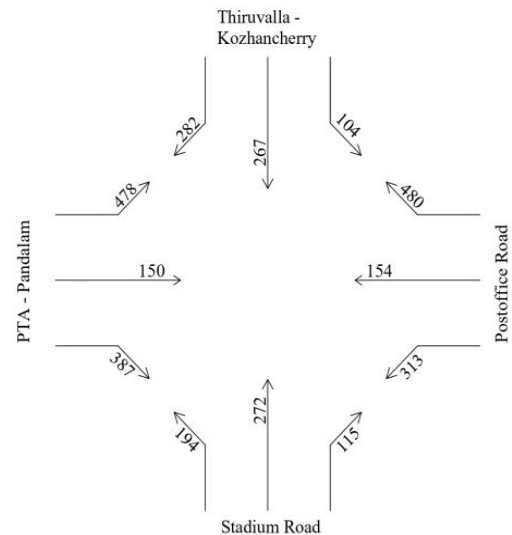


Fig -3: Traffic approach of the roundabout

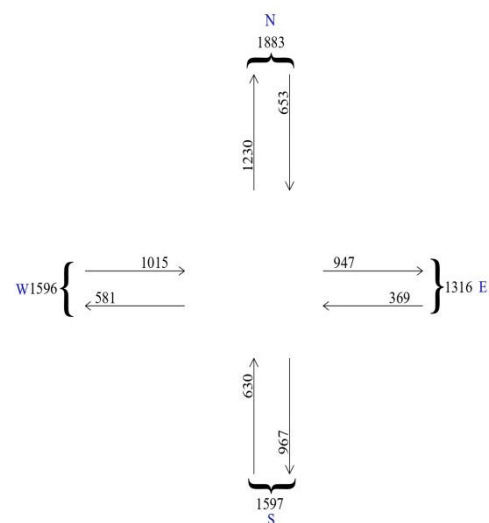


Fig -4: Traffic approach of roundabout

Total right turning traffic=115+480+282+387=1264 pcu/hr

Total left turning traffic= 194+313+104+478=1089pcu/hr

Total straight moving traffic= 272+154+267+150=843 pcu/hr

5.3 Passenger Car Unit for Roundabout

In the case of roundabouts, the PCU of a vehicle is the function of vehicular dimensions and speed only. But the PCU value in dynamic nature depends upon the size of roundabouts also.

6. DESIGN OF ROUNDABOUT

The design of roundabout is done as per guidelines of IRC 65:2017.

6.1. Design speed

As per IRC 65:2017 the design speed should not be more than 30 kmph around urban roundabouts. Hence we adopt a design speed of 30 kmph.

6.2. Inscribed circles and central island diameter

The inscribed circle diameter is the basic parameter used to define the size of a roundabout. It is the distance between outer edges of the circulatory path. The inscribed circle diameter for urban single lane roundabout as per IRC is in a range of 28-40m. The inscribed circle diameter adopted here is 40m.

The diameter of the central island for 40m inscribed circle diameter as per IRC is 24m. The basic function of the central island is to convert direct conflict points into angular conflict points.

6.3. Radius of entry and exit curve

The radius of entry curve should be between 20 to 40m for 2 lane road. Hence provide an entry curve of 20m. Exit radius should be greater than entry radius. Therefore, Radius of exit curve=40m.

6.4. Entry and Exit curve

Entry width is 6.5m for 20m radius entry curve, as per IRC 65:2017. The exit width of 40m radius exit curve is 6.5m.

6.5. Entry angle and Exit angle

As per IRC 65:2017, the entry angle is in a range of 20⁰-60⁰. Hence we provide as entry angle of 60⁰. The entry angle should be larger than exit angle.

Exit angle= 30⁰

6.6. Width of the circulatory carriageway

Circulatory carriageway is the clockwise path followed by the vehicles to move around the central island. For 40m inscribed circle diameter, width of carriageway=8m

6.7. Weaving length

Weaving length is the length at which weaving occurs. The weaving length of 30 kmph design speed is 30m as per IRC.

6.8. Camber

A camber of 0.5%-1% can be provided to drain the surface runoff away from central island. A camber of 0.5% adopted.

6.9. Capacity of the roundabout

As per IRC 65-1976, the capacity of roundabout is given by,

$$Qp=280w(1+e/w)(1-p/3)/(1+w/l)$$

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

The crossing streams a, b, c, d can be calculated from the figure below,

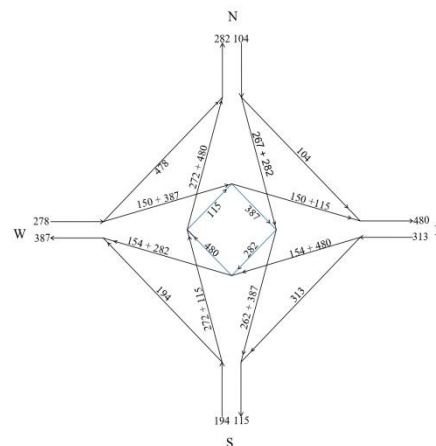


Fig- 5: traffic approach for capacity calculation

$$\begin{aligned} a &= 194 \\ b &= 387 \\ c &= 436 \\ d &= 480 \end{aligned}$$

$$\begin{aligned} Qp &= 280*8(1+6.5/8)(1-0.55/3)/(1+8/30) \\ &= 2617.63 \\ &= 2620 \text{ pcu/hr} \end{aligned}$$

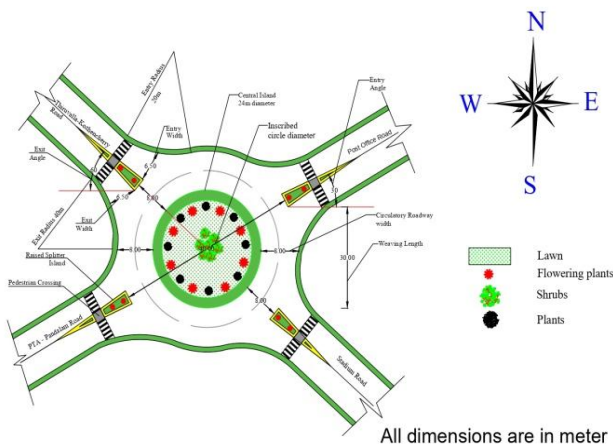


Fig-6: Proposed plan of roundabout

For the design of roundabout, the available carriageway width is not enough. Therefore area acquired for roundabout design is shown in the figure.

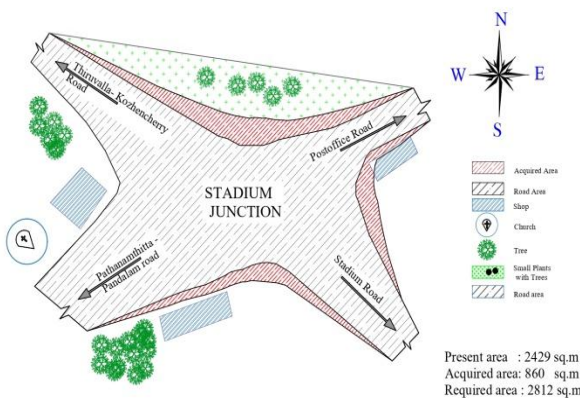


Fig-6: Plan showing the area needed for roundabout

7. ADVANTAGES OF ROUNDABOUT

The followings are the advantages of roundabout,

- The direct conflict point at a junction is reduced from 32 to 8.
- Potential right angle collision will be converted to angular collisions.
- Roundabouts promote a continuous flow of traffic.
- Due to continuous flow of traffic, it avoids frequent starting and stopping of vehicles, thereby reduce emissions.
- Splitter island refuse ensures the safety of pedestrians.

- Crossing can be compared to a signalized intersection.

8. CONCLUSIONS

From the traffic volume studies conducted at stadium junction Pathanamthitta it is seen that the right turning traffic is more at the junction. Hence roundabout can be adopted to control and guide the traffic flow at the intersection. The design of roundabout is done as per IRC 65:2017. The geometric design of roundabout depends on design speed.

The design capacity of roundabout is 2620 PCU/hr, which is greater than the present traffic volume 1883 PCU/hr.

The following measures can also be adopted to reduce the traffic congestion

- Developing byroads for reducing the traffic on major roads.
- Provide off-street parking facilities for vehicles.

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