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Design of Traffic Intersection

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Abstract: ***Transportation contributes to the economic, industrial, social and cultural development of any country. Traffic congestion is a major problem due to the unexpected growth of private vehicles in a country. The intersection is the most important part in any highway, Because the traffic congestion is due to this. An intersection is defined as the general area where two or more highways join or cross, within which are included the roadway and roadside facilities for traffic movements in that area. In this project, an intersection at Tirupur was taken for analysis. All the necessary traffic parameters of the intersection was collected and analyzed. The intersection is designed as per IRC standards ensuring safe and efficient movement of vehicles at intersection***

Keywords: Transportation, Traffic congestion, intersection, IRC standards, Highways

I. INTRODUCTION

An intersection is a location where two or more roads meet. The cars can turn in this location in many directions to go to their intended destinations. Its major job is to direct moving cars in the right direction. Any highway's traffic crossroads are difficult to navigate. This is due to the desire of vehicles travelling in opposite directions to share a place simultaneously. The same place is also sought after by pedestrians for crossing. At a junction, drivers must make a split-second decision while taking into account their path, the intersection's design, the speed and direction of other cars, etc. A slight lapse in judgement can result in catastrophic accidents. Also, depending on the type, geometry, and type of control, it creates latency. Traffic flow in general is dependent on the intersections performance. The road's capacity is also impacted. Hence, the analysis of crossings is crucial for traffic engineers, especially in metropolitan scenarios, from both an accident and a capacity standpoint.

II. OBJECTIVE OF THE STUDY

The objectives of this study are,

1) To select a congested intersection in an urban area.
2) To collect appropriate data for the intersection by using volume countsurvey.
3) To analyze the collected data.
4) To describe several fundamental aspects of intersection design includingmanaging multimodal conflicts, sight distance, layout etc.
5) To provide general principles, considerations and design guidelines for keyintersection components.
6) To suggest suitable measures for intersection to control the flow of vehicles.

III. CODE BOOK REFERENCE

INTRODUCTION

The literature review presented below is aimed to gather knowledge about design of traffic intersection and details of necessary design elements.

IV. IRC GUIDELINES

IRC 64: 1990 “Guidelines for Capacity of Road in Rural Areas”. It gives the guidelines for selecting a PCU value for different vehicles. The result of the presence of slow-moving vehicles in the traffic stream is that it affects the free flow of traffic.

IRC 65: 1976 “Recommended Practice for Traffic Rotaries”. It gives the guidelines for selecting a rotary type of intersection. Because of the limitation, rotaries are not suitable for every location.

IRC SP-41(1994): “Guidelines for the design of At-grade intersections in Rural and Urban areas” and also used for PCU values.

These guidelines are intended to assist those who are required to design or improve at-grade intersections in rural and urban areas. It takes into account the mixed and heterogeneous traffic conditions prevailing in India.

V. METHODOLOGY

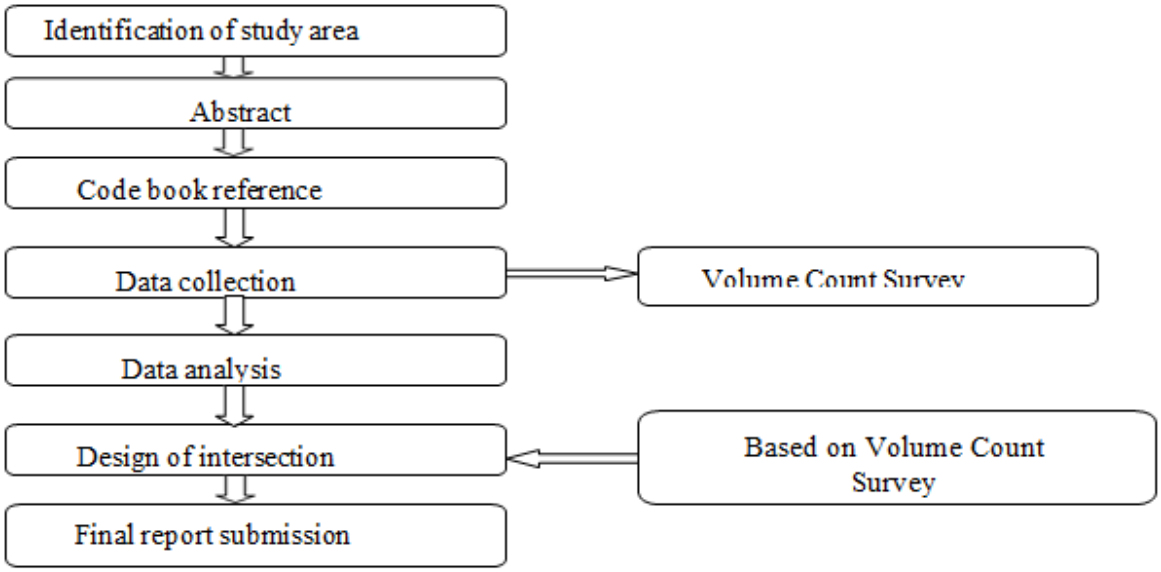

Fig 3.1 Methodology Chart

A. Study Area

An intersection in Pushpa theatre, Tirupur City was chosen as a study area for this study .It is a four-way skewed intersection type junction since the roads intersect at an angle less than 75 degree. The traffic flow is heavy in this area & mainly composed of buses & two wheelers because of presence of railway station and also schools, Colleges that are located nearby. In order to minimize traffic congestion, traffic delay & reduce risk of accident in that area it was planned to design the intersection and regulate the traffic flow in an orderly way. The satellite image of the intersection was shown in Fig 3.2.

Fig 3.2 Satellite Image of Pushpa Theatre Intersection

B. Data Collection

Types of data collection

Video graphic surveying

Traffic volumes can be counted by viewing videotapes recorded in a camera collection at the site. A digital clock in the video image can prove useful in noting time intervals. Video recording was done on 03/08/2016 Wednesday from Morning 8.00 AM to Evening 6.00 PM. The traffic count was done manually by looking at the videos for every 15 minutes from start to end of the video

graphic data collected. This counted data was used for PCU value findings and peak hour calculation based on which the capacity of the intersection was calculated. Fig 4.1 and Fig 4.2 shows the image of the Pushpa theatre junction taken from video graphic surveying.

Fig 4.1 Video graphic Surveying

C. Counting Procedure

The movement of vehicles in the intersection was counted for every 15 minutes interval from the recorded video. The flow of vehicles in each directions are noted separately. The counted vehicles are classified as per IRC SP41:1994. The flow of vehicles in different directions counted from the video graphic survey was given in the Annexure I.

D. Data Analysis

Volume Count Analysis

The volume count analysis was carried out as below.

VI. PASSENGER CAR UNIT

Table 5.1 PCU Values for Different Vehicles

TYPES OF VEHICLE	PCU VALUE
TWO WHEELER	0.5
BICYCLE	0.5
CAR\AUTO\JEEP\TAXI	1
LCV	1.5
BUS	3
HCV	4.5
BULLOCK CART	8
EARTH MOVERS	8

VII. PROCEDURE FOR CALCULATING PCU VALUES

A. Peak Hour

Maximum PCU values obtained in the one hour is called peak hour. The PCU values for each one hour from morning 8.00 a.m. to evening 6.00 p.m. were calculated. The maximum PCU value was obtained as 7794 PCU/hour at morning for 10.15 A.M to 11.15 A.M. Therefore this hour was considered as the peak hour of the study. The peak hour graph is shown in Fig 5.1.

B. Peak Hour Procedure

Peak hour was calculated by splitting the time 8.00 a.m. to 6.00 p.m. into one hour duration in every 15 minutes (For e.g., 8.00 to 9.00, 8.15 to 9.15). The PCU values for every splitted hour was calculated by summing up all the 15 minutes PCU values in that hour (i.e., PCU values of 8.15 to 8.30 + 8.30 to 8.45 + 8.45 to 9.00 + 9.00 to 9.15).

Finally, the peak hour as 10.15 a.m. to 11.15 a.m. was arrived.The Total PCU values per hour for individual roads is shown in Fig 5.2 and their percentage of vehicle composition is shown in Fig 5.3.

TIME	RAILWAYROAD	FLY OVER	COLLEGEROAD	PERUMANALLURROAD
8.00-8.15am	42	205.5	109.5	925
8.15-8.30am	36	268	125	919.5
8.30-8.45am	38.5	350.5	137	832.5
8.45-9.00am	37	466.5	118	915.5
9.00-9.15am	28.5	543	146	908.5
9.15-9.30am	24	790.5	135	871
9.30-9.45am	36	639.5	173	832.5
9.45-10.00am	43.5	619	166.5	889.58
10.00-10.15am	46.5	696	152	817
10.15-10.30am	40.5	782.5	195	791.5
10.30-10.45am	33.5	869	167	803.5
10.45-11.00am	34	887.5	215.5	807.5
11.00-11.15am	22.5	874.5	237.5	929
11.15-11.30am	26	797.5	219.5	748
11.30-11.45am	22	710.5	206	766
11.45am12.00pm	18	726.5	196	805.5
12.00-12.15pm	524	549	264.5	875
12.15-12.30pm	31.5	691	184	811
12.30-12.45pm	28	649.5	205	788
12.45-1.00pm	24	656	152.5	748.5
1.00-1.15pm	26.5	587.5	161	722.5
1.15-1.30pm	28.5	664.5	154	646
1.30-1.45pm	26.5	744.5	180.5	756
1.45-2.00pm	22.5	707	197.5	838
2.00-2.15pm	24	651.5	199	719
2.15-2.30pm	31.5	709.5	225.5	709.5
2.30-2.45pm	34.5	727.5	168.5	837
2.45-3.00pm	22	810.5	217	759
3.00-3.15pm	25	803	177	761.5
3.15-3.30pm	27.5	844.5	156	727
3.30-3.45pm	24	845.5	163	735
3.45-4.00pm	23	697	227.5	845.5
4.00-4.15pm	19.5	749.5	212	811
4.15-4.30pm	21	686.5	192.5	859.5
4.30-4.45pm	36	783.5	157.5	853
4.45-5.00pm	35.5	785.5	190	794
5.00-5.15pm	38	725.5	159.5	784

5.15-5.30pm	32	778	190.5	851
5.30-5.45pm	41.5	843	189	817.5
5.45-6.00pm	46	773.5	241.5	795.5

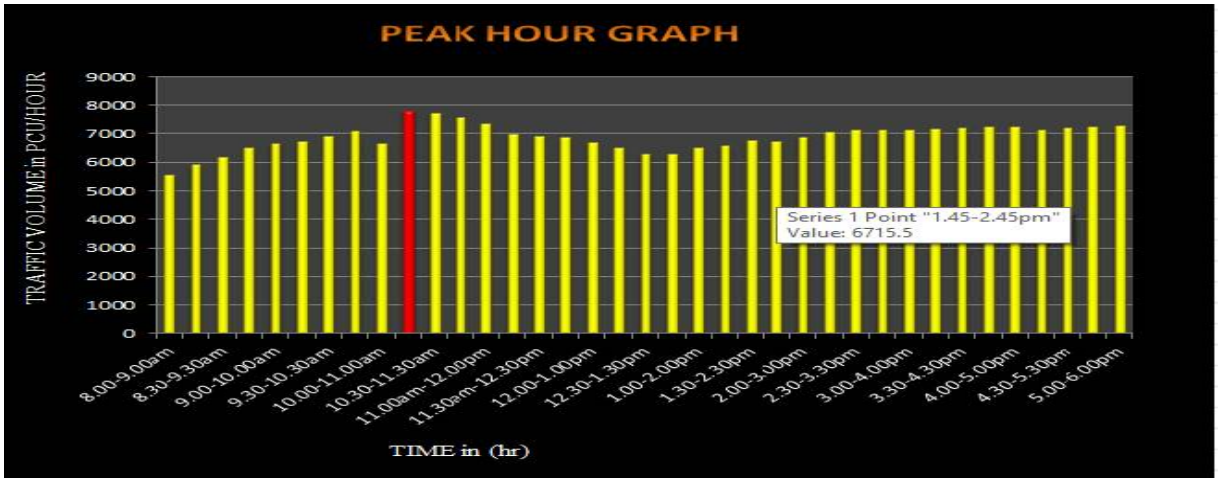

Fig 5.1 Peak Hour Graph

Note

The Table 5.2 shows 15 Minutes PCU values for individual roads. FLYOVER road reaches the maximum PCU values among the four roads. This show that the amount of traffic conflicts mainly occurs at this critical point only.

Table 5.3 PCU/Hour Value for Individual Roads

TIME	COLLEGEROAD	FLYOVER	RAILWAYROAD	PERUMANALLURROAD
8.00-9.00am	499.5	1325.5	58	3667.5
8.15-9.15am	540	1665	52	3646
8.30-9.30am	551	1979.5	50	3611.5
8.45-9.45am	583	2276.5	65	3569.5
9.00-10.00am	636.5	2433	72	3525.5
9.15-10.15am	639.5	2584	75	3437
9.30-10.30am	702.5	2770	67	3365.5
9.45-10.45am	688.5	2997.5	71	3332.5
10.00-11.00am	744.5	3262	85	2556.5
10.15-11.15am	839	3469.5	108	3377.5
10.30-11.30am	856.5	3469.5	78	3324
10.45-11.45am	894.5	3306	71	3292.5
11.00am-12.00pm	870	3157	58	3259.5
11.15am-12.15pm	901	2833.5	43	3212.5
11.30am-12.30pm	863.5	2726	43	3271.5
11.45am-12.45pm	866.5	2653	57	3297.5
12.00-1.00pm	825	2585.5	45	3247.5
12.15-1.15pm	711.5	2636	66	3099
12.30-1.30pm	688.5	2602.5	59	2929
12.45-1.45pm	669	2690.5	47	2886
1.00-2.00pm	702	2762.5	55	2988.5
1.15-2.15pm	743	2804.5	46	2971

1.30-2.30pm	808.5	2848.5	54	3044.5
1.45-2.45pm	687.5	2841.5	71	3124.5
2.00-3.00pm	821	2947	64	3045.5
2.15-3.15pm	804	3095.5	54	3089
2.30-3.30pm	728.5	3234.5	45	3110.5
2.45-3.45pm	732	3354.5	41	3002.5
3.00-4.00pm	740.5	3242	44	3885
3.15-4.15pm	774.5	3189.5	52	3150.5
3.30-4.30pm	814	3032	61	3297
3.45-4.45pm	803.5	2969	58	3398
4.00-5.00pm	776	3053.5	63	3348.5
4.15-5.15pm	721.5	3018.5	67	3319.5
4.30-5.30pm	717.5	3111.5	63	3310
4.45-5.45pm	744	3164	63	3266.5
5.00-6.00pm	799.5	3148	68	3262

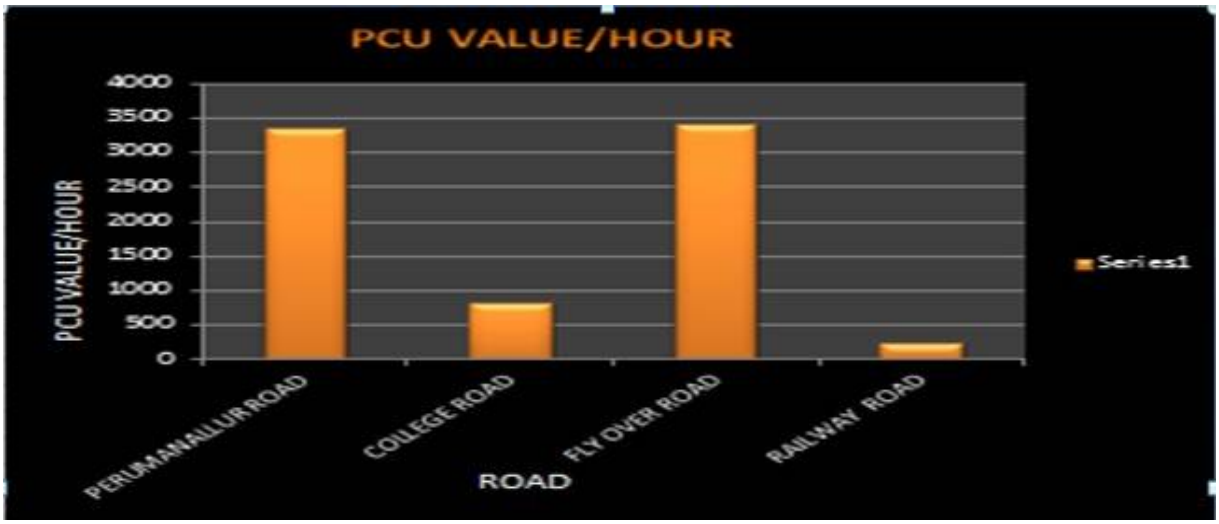

Fig 5.2 PCU Value for Peak Hour of Individual Road

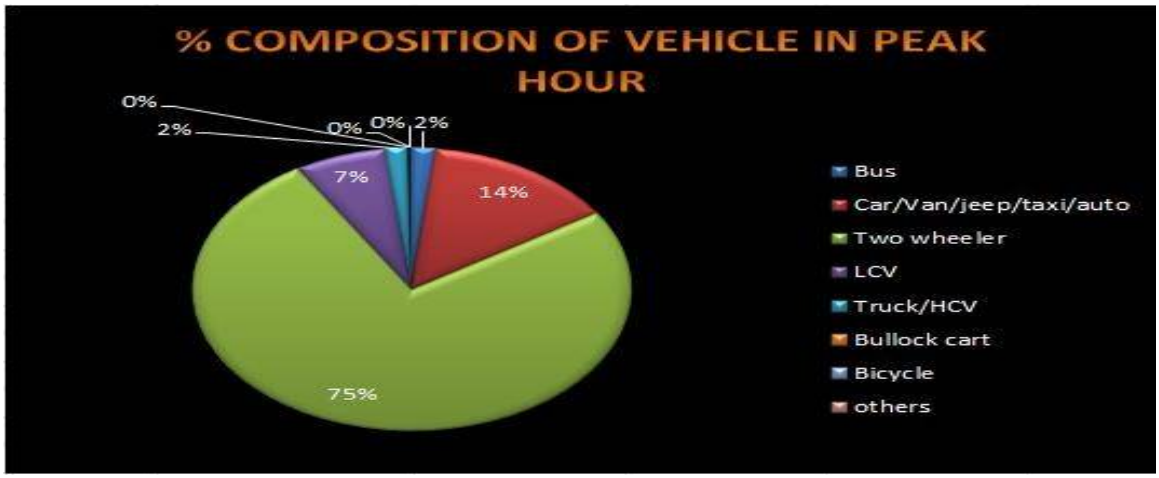

Fig 5.3 Vehicle Composition for Peak Hour

C. Design Of Rotaries

Introduction

Rotary intersections or roundabouts are special form of at-grade intersectionslaid 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 namelymerging 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 tothe desired direction. Fig 6.1 shows the existing layout of the Pushpa theatre intersection at Tirupur.

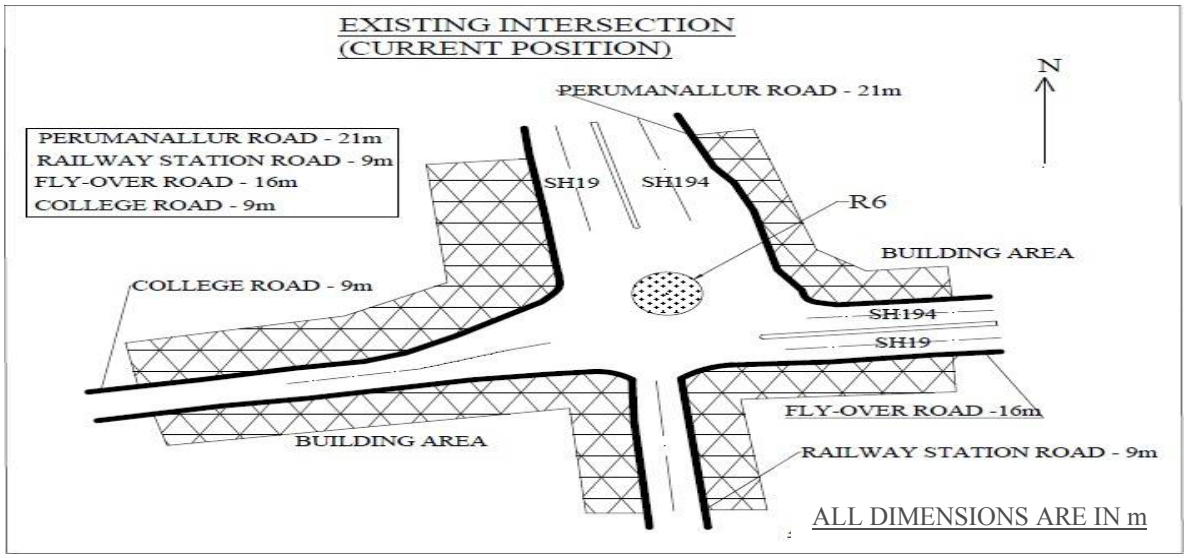

Fig 6.1 Pushpa Theatre Intersection

D. Design Elements

The design elements for rotary are Design speed, Radius at Entry, Exit and Central Island, Weaving Length, Width of Carriageway, Width of Rotary Carriageway, Entry Angle and Exit Angle, Super-elevation, Camber, Other Miscellaneous Factor, Slope, Stopping Sight Distance.

The elements of the rotary are shown in Fig 6.2.

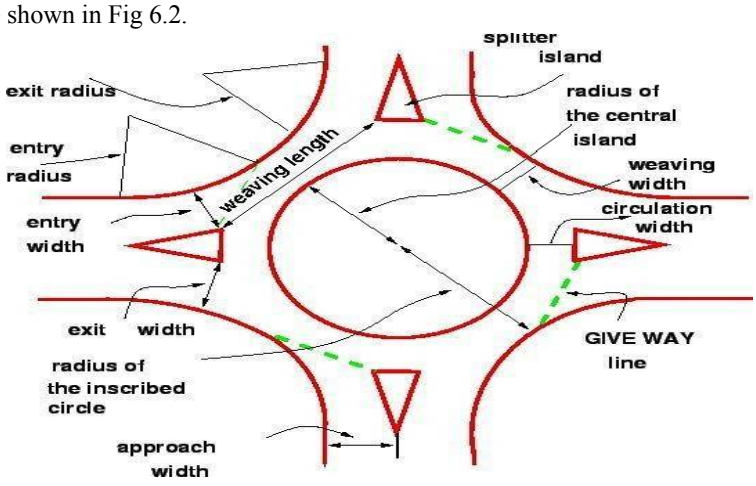

Fig 6.2 Design Elements of a Rotary

E. Result Analysis Design Details Of An Intersection

The design elements include design speed, radius at entry, exit and Central Island, weaving length and width, entry and exit widths. In addition the capacity ofthe rotary can also be determined by using some empirical formula. Some important design elements in Perumanallur Road, College Road, Railway station road, Fly-over Road are shown in the following Tables(Table 7.1 to Table 7.4)

Table 7.1 Perumanallur Road

Design Elements	Perumanallur Road	College Road	Intersection Road	Railway Station Road
Entry width	15m	10m	13m	10m
Exit width	20m	10m	15m	11m
Weaving length	40m	42m	30m	41m
Weaving width	31m	22m	24m	24m
Circular width	20m	17m	22m	16m

VIII. AREA OF AN INTERSECTION

Area of existing intersection = 2043.40 m^2
Extended area of intersection = 3029.80 m^2
Total area of modified intersection = 5073.20 m^2

IX. CALCULATION OF INTERSECTION CAPACITY

The capacity calculation of the intersection is shown in Table 7.5.

Table 7.5 Calculation of Intersection Capacity

	College road	Perumanallur road	Fly-overroad	Railway station road
Entry width, e_1(m)	10	15	15	10
Non-weavingwidth,e_2 (m)	17	21	22	16
Weaving width,W (m)	22	31	24	24
Weaving length,L (m)	42	40	30	41
Proportion of weaving traffic, p	0.94	0.40	0.92	0.40
E	13.5	18	18.5	13
Capacity ofRotary, Q_p (PCU/hour)	4479.21	6698.87	4583.70	5663.47

A. Design Details Of Rotary

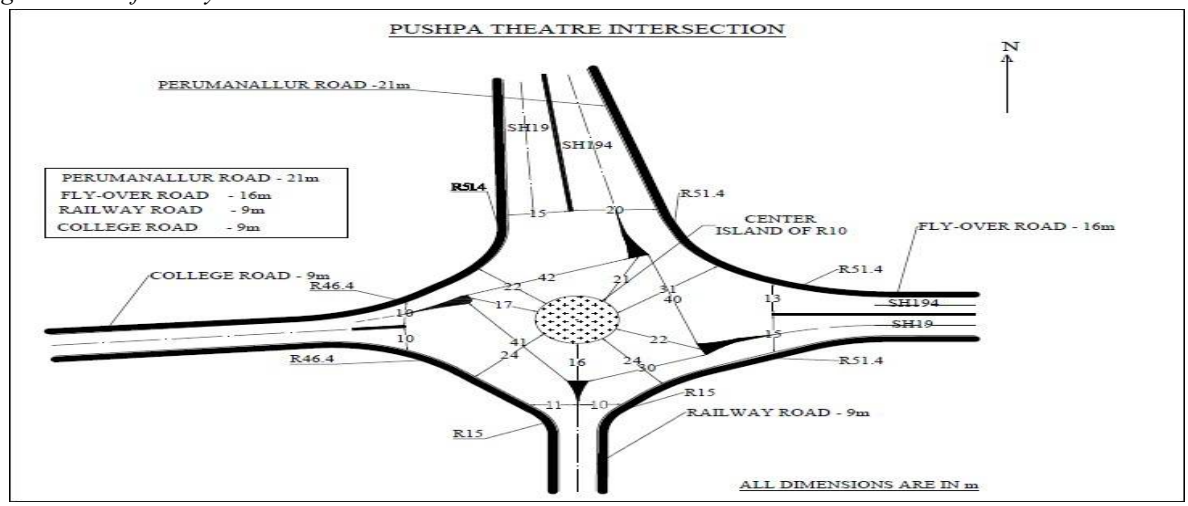

Fig 7.1 Design of Pushpa Theatre Intersection

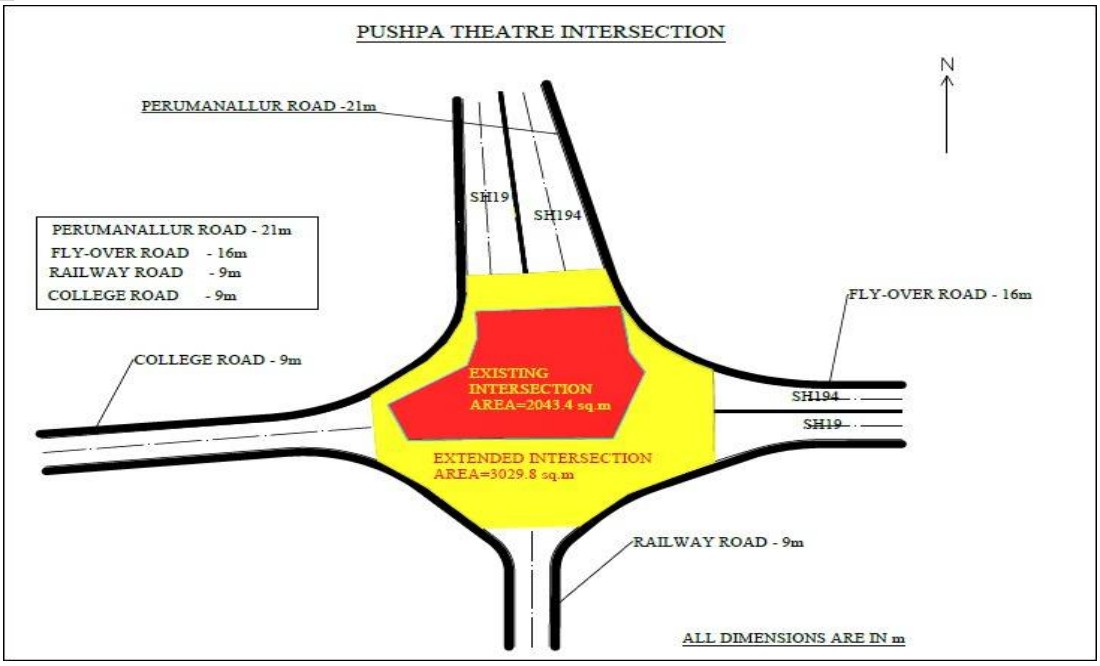

Fig 7.2 Area of Pushpa Theatre Intersection

B. Design Of Traffic Signal

Phase assumption for each signal is given in Appendix I

Design of the study corridor is given below,

1) Design for Signal Calculation of saturation

Table 8.1 Signal Design

	PHASE 1			PHASE2			PHASE3			PHASE4		
FROM	W			N			E			S		
TO	N	E	S	W	S	E	N	W	S	W	N	E
Given flow PCU/hr	213	601	25	250	46	3081.6	3076.5	337	56	13	49	46
Correction for Left turn	53.25					770.38				3.25		
Correction for Right turn			18.75	87.5			2307.38					34.5
Total	266.25	601	43.75	337.5	46	3851.88	5383.88	337	56	16.25	49	80.5
Design hourflow(q) PCU/hour	911			4235.58			5776.88			145.75		
Saturation(s)	1763.5			1726.25			1729.22			4725		
Y	0.52			2.45			3.34			0.03		
Y	6.34											

From the Table 8.1, the flow is saturated. Since the signal is not adopted forthis intersection. So the fly-over is the best option for this intersection.

X. CONCLUSION

A. Recommendations

The following recommendations are suggested from this study to improve traffic movements and safety at the intersections. The recommendations are,

Providing traffic islands as given in the Fig 7.1, will help in orderly movement of vehicles at the intersection.

The flow from Perumanallur to the Fly-over during peak hour was . The busstop is located at the intersection leg of Perumanallur to Fly-over roads. As per IRC 70:1977, the bus stops must be located minimum 75m away fromthe intersection area. So this bus stop must be shifted to near by convenient place to ensure free flow of vehicles.

The rotary intersection can efficiently function up to the capacity of 5000 PCU/hour during the peak hour. Since the peak hour flow for this intersection is 7794 PCU/hour, a traffic signal along with rotary was planned. But the signal cannot be designed since the flow is saturated in Fly-over and Perumanallur.

Considering the rapid growth of traffic and to avoid right turn conflicts, a Fly-over is the best option to control the movement of vehicles to minimizedelay and improve the level of service of the intersection.

B. Conclusion

The rapid growth of vehicles has become a major detrimental to road safety. This leads to more congestion at the intersections and increase the risk of accidents. Many intersection in urban areas has become accidents prone and the delay at such intersections was quite high. In order to reduce the risk of accidents and enhance the orderly movement of vehicles, it is very much essential to design the intersections. In this project, an intersection in Tirupur city, which is heavily crowded with vehicles was redesigned and suitable measures are suggested.

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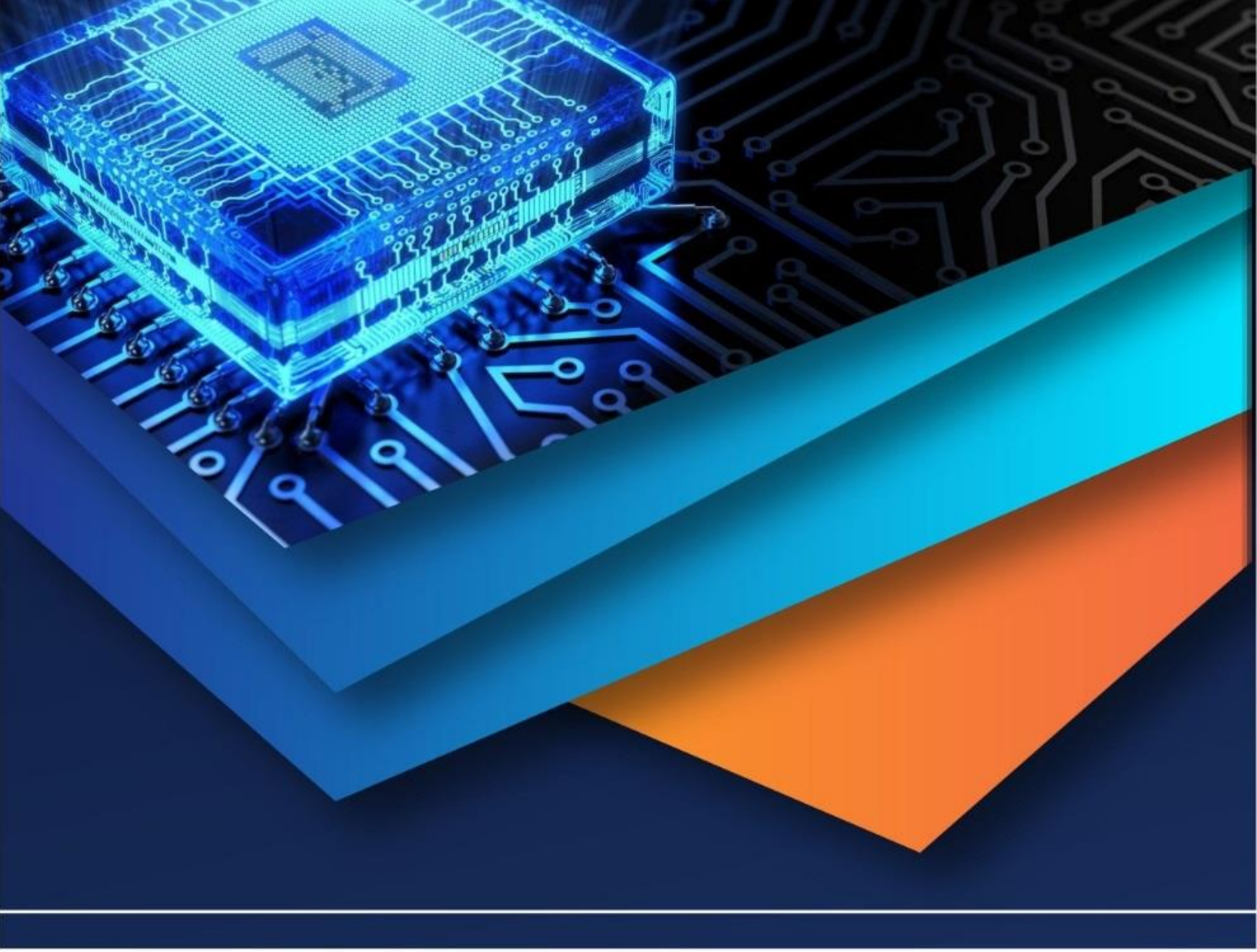

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