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Simulation of Rotary Intersection at K. R. Hospital Junction

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Abstract — In today's scenario, cities are facing a lot of traffic problems due to increase in rate of vehicles. This has resulted in many adverse effects like pollution, delay in reaching destination, accidents and traffic congestion. Increased rate of vehicles requires more space for movement. The rotary intersection is the most vital component of urban roadway network. Hence, there is a need for capacity evaluation of rotary intersection for easy movement of vehicles which reduces accidents and improves the traffic management. The present research work is focused on calculation of PCU values, peak hour PCU capacity evaluation and redesign of rotary intersection as per IRC: 65 – 1976 and simulation of rotary intersection using vissim software. After simulation and redesign of the rotary intersection, the capacity of the rotary circle was increased from 3111 to 4081 PCU. Further, the vehicles should follow the lane traffic rules.

Keywords—Rotary intersection; PCU; Capacity evaluation; Vissim software;

I INTRODUCTION

In urban areas of India, mixed type of traffic persists and obviously, the road space has to be shared by all types of vehicles such as light motorized vehicles, heavy motorized vehicles and non-motorized vehicles [1]. Rapid urbanization of Indian cities has resulted in large volume of traffic during the peak hours. This large traffic volume is the prime cause of traffic congestion at urban road network, mainly at the intersections. Traffic congestion in urban area is a serious problem and is increasing day by day with the increase in population and economic status of urbanities. The traffic congestion not only raises the vehicle operating cost and travel time of trip makers, leads to poor performance of the intersection [2]. The performance of intersections is a key issue to address the congestion problem. Despite of investments made on the road infrastructure, users face problems like accidents, congestion and delay to reach destination. Due to congestion, pollution increases and it causes harmful effects on human health, who are residing in adjacent areas [3].

Mysore is located at the base of the Chamundi Hills with a latitude and longitude 12°18'25" N and 76°38'58" E respectively and spreads across an area of 128.42 km2.

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According to the provisional results of the 2011 National census of India, Mysore is the third most populous city in the state of Karnataka, with a population of 8 87 446. Mysore is popularly known as palace city and famous for festive celebration of Dasara. During Dasara festival, the city attracts lakhs of tourists. The total number of vehicles registered in 2012 was 6.1 lakh and exponentially increased to 15.7 lakh in 2018. The vehicle growth rate in Mysore city is about 8 to 9% p.a.Vissim is a microscopic multi modal traffic flow simulation software. The scope of application ranges from various issues of traffic engineering, public transportation, urban planning to 3d visualization for illustrative purpose and communication to the general public. In vissim software, traffic of vehicles cycles, pedestrians and rickshaws can be simulated [4].Coming to the kernel of present research study, Visvesvaraya circle, commonly renowned as "K. R. Hospital circle", was constructed during Wadiyar dynasty. This circle connects four important roads at right angles in four directions viz., Sayyaji Rao road, Irwin road, Bamboo bazaar road and railway station road. During pre -independence period, the Circle was designed keeping in view the traffic flow of those days. However, in present scenario, with exponential increase in vehicular traffic and mixed type of flow, congestion and unnecessary traffic jam leading to accidents are occurring at this spot. Hence, in this case study, an attempt is being made to scientifically design a rotary intersection at Visvesvaraya circle (K R Hospital circle).

II RESEARCH METHODOLOGY

A. Study Area

The Kernel of this case study is Visvesvaraya circle (popularly known as "K R Hospital circle") with starting and ending point having latitude and longitude 12° 18' 52.1532" N, 76° 39' 4.1472" E and 12° 18' 51.7752" N, 76° 39' 5.6736" E respectively and the same is indicated in Figure 1.1 and Plate 1.2. Mysore city has a radial and grid pattern road network with arterial roads originating from the city center. The study area has fair geometry (level gradient on all the approaches) and least interference to traffic by pedestrians, bus stops and parking lot etc. Average driving behavior was assumed and the condition of vehicles was assumed to be moderate.

Year	Total vehicle Registered
2012	611429
2013	668658
2014	734536
2015	798580
2016	884437
2017	963237
2018	1577119

Figure 1.1: Map of Visvesvaraya Circle

Plate 1.2: Arial View of Study Area

B. Inventory Survey, Preliminary Observations and Vehicle Volume Data

Field survey was conducted at the selected locations using high resolution video camera mounted on high-rise building at vantage location. Movement review was completed at the study crossing points. As a major aspect of this, turning movement study was done by photographic technique and the same is represented in Plate 1.3. On week days, in the wake of increase in vehicles, adequate numbers of activity enumerators were posted to get the grouped vehicle tally of left turning, straight going and right turning movements. Further, information of crest hours was collected by video recording procedure. The mobile camera was placed on terrace of Government Ayurveda Hospital to capture the turning movement of vehicles in all the four directions at the intersection and shown in Plate 1.4. The video tapes were later played on computer screen to sort out the vehicles moving inwards and outwards at the intersection and then converted to the common factor known as Passenger Car Unit (PCU).
The traffic data was collected on all days of the week at different time intervals during summer. To calculate the rotary traffic capacity, the peak hour traffic data from morning to evening was taken.

Plate 1.3: Turning Movement of Vehicles

Plate 1.4: Data Collection through Videography

C. Road Survey, Redesign and Simulation of Rotary Intersection

The geometrics of rotary intersection was analyzed based on survey measurements. The existing rotary intersection was modified as per IRC: 65 – 1976. Vissim software was used to simulate the existing and modified rotary intersection considering the parameters of rotary intersection.

D. Vehicle Volume Data

The volume of vehicles registered from 2012 to 2018 were collected from two Regional Transport Offices located in East and West of Mysore respectively and is represented in Table 1.

Table 1: Vehicle Registered at RTO from 2012 to 2018
(Source: RTO, Mysore)

III RESULTS AND DISCUSSIONS

A. Average volume count data

It was observed that the traffic was highly heterogeneous in nature with poor adherence of lane discipline, though the traffic police were deployed. The composition of traffic consisted of a large number of motorized two wheelers, auto rickshaws, cars and good number of city buses. The analysis of the PCU towards and outwards the circle was calculated and the average values are represented from Figure 2.1 through Figure 2.4.

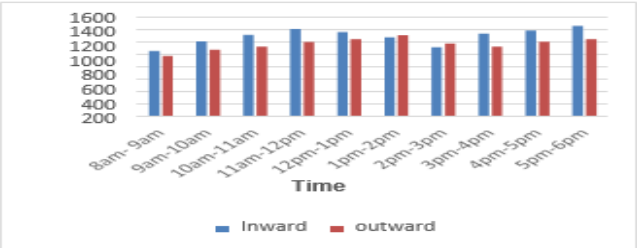

Figure 2.1: Peak hour PCU values for Railway station road

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Referring to Figure 2.1, it can be observed that on Railway Station road, the peak hour was between 5 – 6 pm with 1467 PCU in inward direction and between 1 – 2 pm with 1318 PCU in outward direction. The distance between Visveswarya circle and Railway station is 850 m

It can be seen from Figure 2.2, on Bamboo Bazaar road, the PCU value was high during 12 - 1pm in both inward and outward direction i.e., 1116 PCU and 1074 PCU respectively, and this can be attributed to the sub arterial roads on the stretch, Mission Hospital, Poly clinics, Pharmacies, Pathology laboratories and Private bus stand. The Bamboo bazaar road ends up connecting Mysore-Bangalore at Bannimantapa ground and is 3.3 Km long.

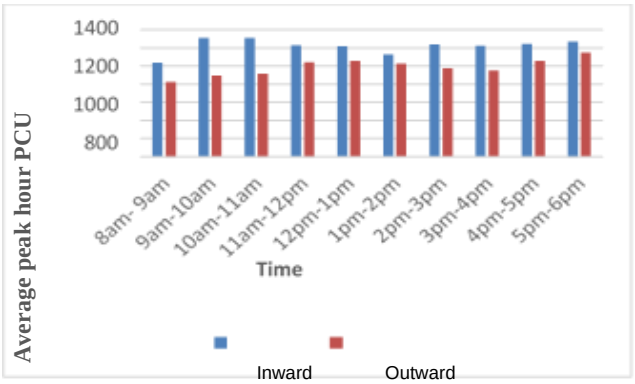

Figure 2.3: Peak hour PCU values for Irwin Road

In case of Irwin road, shown in Figure 2.3, the PCU value was observed to be high during 10 - 11am in inward direction with 1313 PCU. This is attributed to people travelling to workplace and 5 - 6pm in outward direction with 1147 PCU. This is due to people returning back from work, to and fro movement from Sub-urban bus stand, Gold & hardware shops located on Ashoka road. The distance between Visveswarya circle and sub urban bus stand is 1 km.

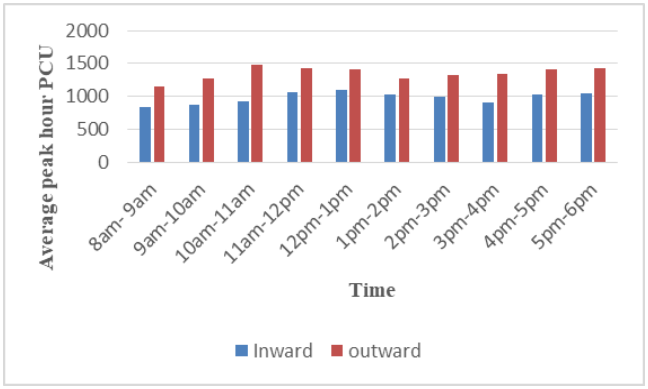

Figure 2.4: Peak hour PCU values for Sayyaji Rao Road

In Figure 2.4, it can be shown that on Sayyaji Rao road, the PCU value was high during 10 - 11a.m in inward direction with 1102 PCU and 12 - 1p.m in outward direction with 1474 PCU, it is due to movement of people towards commercial outlets, K. R. circle, City Market and Theatres. The distance between Visveswarya circle and K.R. circle is 700 m

B. Traffic Volume Data and Shape of Rotary Intersection

The traffic flow volume of the Rotary Intersection was 3748 PCU/h. As per IRC: 65 – 1976, a total volume of about 3000 vehicles per hour can be considered as upper limiting case and a volume of 500 vehicles per hour as lower limit [6]. If it exceeds the upper limiting value, signalized intersection is recommended. However, in this case study, installation of traffic signal is ruled out, due to the presence of hospitals and railway station, Furthermore, longer delay time has to be made which leads to stoppage of vehicles for longer duration, more traffic congestion, honking horns and air pollution. Nevertheless, the only scientific solution to increase the capacity of the rotary intersection is to provide rotary intersection which can handle more traffic volume. According to IRC: 65-1976, the shape of the rotary intersection should be convex towards the circle [7], but the existing rotary intersection has concave shape. The disadvantage is that when vehicle is moving from one road to another road, it moves in concave shape and hence working space is underutilized. The existing footpath width is 4.4 m. Hence, by reducing footpath space and encroaching the open space in front of Mysore Medical College and K R Hospital which is more than 100feet, one can increase the capacity of the roundabout. The traffic capacity of the proposed roundabout is 4081 PCU/h which is more than the capacity of the present vehicles as well as capacity of the existing roundabout.

C. Details of Existing and modified Rotary Intersection

The details of existing and modified Rotary Intersection are represented in Table 2.5, Figure 2.6 and 2.7. Referring to the Table 2.5, it can be observed that capacity of Rotary was increased from 3111PCU/h to 4081 PCU/h and weaving length was increased from 10m to 36m.

i) Capacity of the Existing Rotary Intersection for P = 0.76

$$Q_P = \frac{280 \times 10 \times \left(1 + \frac{11.5}{10}\right)\left(1 - \frac{0.76}{3}\right)}{1 + \left(\frac{16}{36}\right)}$$

Q_P = 3111 PCU/h

From the above calculations, it is found that the present rotary intersection capacity is 3111 PUC/h.

ii) Capacity of the Redesign Rotary Intersection for P = 0.70

$$Q_P = \frac{280 \times 16 \times \left(1 + \frac{11.125}{16}\right)\left(1 - \frac{0.70}{3}\right)}{1 + \left(\frac{16}{36}\right)}$$

Q_P = 4081 PCU/h

From the above calculation, it is found that the modified rotary intersection capacity is 4081 PUC/h.

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Table 2.5: Details of Existing and modified Rotary Intersection

Parameter	Existing Rotary Intersection	Redesign of Rotary Intersection
Capacity of Rotary	3111PCU/h	4081PCU/h
Weaving length	10m	36m

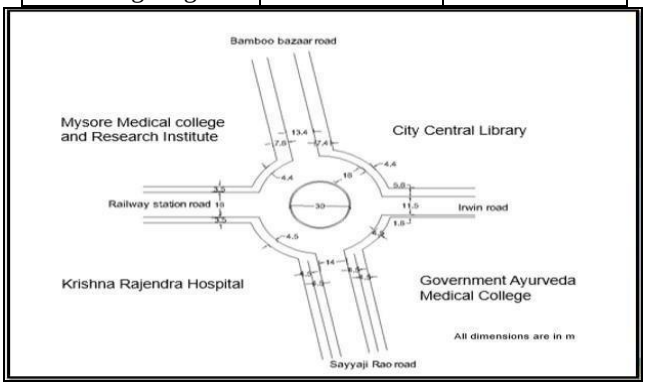

Figure 2.6: Existing Visvesvaraya Circle

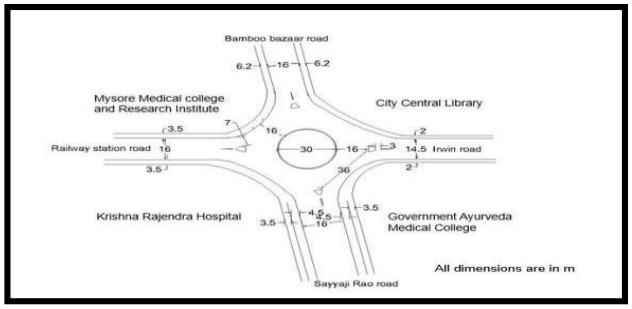

Figure 2.7: Inventory of modified Rotary Intersection.

D. Elements of Modified Rotary Intersection

As per IRC: 65-1976,

- •Design speed of Rotary: 30 kmph
- •Entry speed of Rotary : 20 kmph
- •Radius of entry curve should be between 10 - 25m for design speed of 30 kmph
- •Radius of exit curve: 22.5m
- •Weaving length: 36m
- •Weaving width: 16m
- •Rotary roadway of radius:31m

E. Travel Time to Cross the Intersection

Average time required by 2 wheelers: 28 sec

- • Average time required by LCV: 38 sec
- • Average time required by HCV: 58 sec
- • Average time required by all vehicles: 40 sec

The average time required by all vehicles to cross the intersection is 40 secs, which is between 35 to 45 secs which belongs to level of service D. This indicates that the city road is operating at high density levels, but stable flow still persists. Small increase in flow levels will result in significant operational difficulties on the city road.

F. Simulation of Rotary Intersection

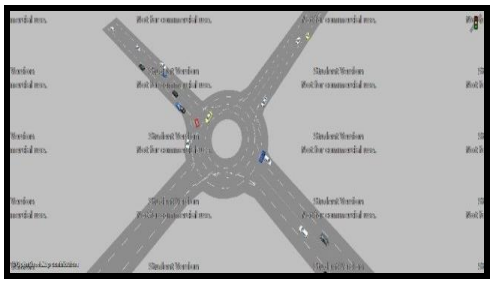

Figure 2.8: Simulated Existing Visvesvaraya Circle, Mysore

Figure 2.8 shows the existing condition of Rotary Intersection at K. R. hospital circle where the vehicle volume data and existing road links was given as input and then simulated in 2D using Vissim Software (Student Version). The existing capacity of the intersection was observed.

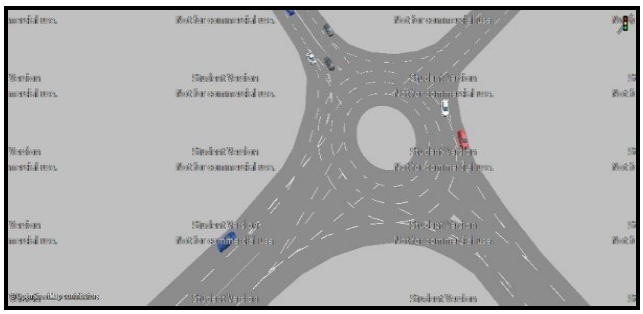

Figure 2.9: Simulated Redesigned Rotary Intersection

The modified values of Rotary Intersection at K. R. hospital circle was drawn and then simulated in 2D as per IRC: 65-1976, which is shown in Figure 2.9. Increase in capacity of the intersection was observed after simulation of existing Vehicle data.

III CONCLUSIONS

- •The data collected from RTO indicated that the number of vehicles has increased from 6.1 lakh (2012) to 15.7 lakh (2018) which is 2.6 times the existing flow
- •The present traffic at the existing circle was 3748 PCU/h, which exceeds the capacity of the rotary of 3111 PCU/h by 20.5%
- •After modification of the rotary intersection, the capacity was increased from 3111 to 4081 PCU/h which is 31% greater than existing capacity
- •The existing Rotary intersection confines to category D of Level of service (approaches unstable flow as per Highway Capacity Manual)
- •The vehicular movement increased after simulating the rotary intersection
- •In addition, awareness should be created amongst vehicle riders to follow lane traffic

REFERENCES

1. Parth M. Pande, Srinath Karli (2003), “Design of Rotary Intersection as an Alternative to Four ARM Signalized Intersection of Urban Area”, International Journal for Scientific Research & Development, Vol. 4 (3), pp 32 – 39.

2. Billy M. Williams, Asce, Lester A. Hoel (2008), "Modeling and Forecasting Vehicular Traffic Flow as a Seasonal ARIMA Process: Theoretical Basis and Empirical Results", Journal of Transportation Engineering, Vol. 2, pp 664 - 672.
3. Miteshkumar N Damor, Harshad C Prajapati (2010), "An Evaluation of Capacity of Roundabout: A Case Study of Aanjali Roundabout at Ahmedabad", International Journal of Emerging Technology and Advanced Engineering, Vol. 4(2), pp 149 – 151.
4. Binny Pandey, Kumkum Bhattacharya (2016), "Assessment of Heterogeneous Traffic at Roundabout using Vissim", International Journal of Advance Engineering and Research, Vol. 3 (2), pp 189-191.
5. Mira Patel (2010), "Solution for reduction of traffic congestion: a case study of thaltej rotary intersection", International Journal of Applied Engineering and Technology, Vol. 4 (1), pp.37 - 45.
6. Junaid Yaqoob, Er. Amir Lone (2012), "Design of Rotary at Janglatmandi Anantnag to reduce traffic congestion at the Intersection", International Journal of Advanced Research in Education & Technology (IJARET), Vol. 3(2), pp 241 – 244.
7. Veethika Gomasta, Mohit Malviya, Abhishek Singh, Saleem Akhtar (2012), "Design and Analysis of Intersections for Improved Traffic Flow at Bhopal-Case Studies of Jyoti Talkies Square and Vallabh Bhawan Roundabout", Vol. 5(6) pp 3522 – 3526.

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