Traffic Signal Design at Gandhi Circle

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***Abstract*: Installation of traffic control devices at required locations is always an important traffic control measure. This paper aimed at designing a traffic signal at Gandhi circle in the Davangere city. The selected intersection has been facing some noticeable traffic problems such as congestion, accidents, delay and discomfort to the passengers while travelling through this intersection. In view of providing the solution to the above stated problems, traffic signal has to be designed and installed. The traffic volume collected through classified volume count at the intersection and it is found that the traffic volume satisfies warrants that are stated by IRC to adopt a traffic signal at any location. The collected traffic volume data and geometric details of the intersection are analyzed to use as input for the signal design. This paper represents the Webster's and IRC method of signal design. The Normal and Saturation flows are determined. The cycle time obtained from Webster's method and IRC methods are 56 seconds and 60 seconds respectively and the same are represented in this paper. It is a usual practice to adopt IRC method for the Indian traffic conditions and this paper also recommends adopting the design obtained from the IRC method for the selected intersection.**

Keywords: Traffic Volume, Traffic signal, Normal flow, Saturation flow.

I. INTRODUCTION

To manage the traffic at urban intersection, signal is necessary to control and to avoid traffic congestion as it plays a very important role in channelization of traffic. Traffic signal is also called as traffic light, located at road intersections, pedestrian crossing to control conflicting flows of traffic. Traffic signal is an improvement element of traffic control devices. Traffic signal is installed at intersection to minimize the traffic hazards. Traffic signals are automated control device, which will give indications for the road users to stop and proceed alternately at junction by using traffic light signals that is red and green light as per the pre-determination time setting.

Traffic signal is installed based on careful analysis of the current traffic data and on sound engineering judgment. The volume of traffic moving towards the intersection and its crossing movements is one the major importance in the criteria for traffic signal control.

II. OBJECTIVES

- To recognize the various factors influencing the traffic congestion.
- To ameliorate the traffic flow by designing a traffic signal.
- To provide recommendations needed if any, to improve the traffic performance.

III. CASE STUDY OF DAVANGERE CITY

Davanagere is a city located in the center of Karnataka state. It is the 7th largest city in Karnataka covered by an area of 77 km2 with a population 435,125 as per census of 2011-2012. The population growth in Davanagere city during 2001 to 2011 is about 19.61%.

The registered vehicular population as per RTO office till 2012 in Davanagere taluk is 145,726. This increased vehicular population result in traffic congestion on the streets of Davangere.

Gandhi circle is a junction located in the Davangere city which is intersected by the PB road and Ashoka Road. The circle is mainly connected by 4 roads in that towards North-east direction there is Ashoka Road.In south-east direction it is PB road then towards North-west it is connected to PB road.In south-west direction it is Ashoka Road connected to Jayadeva circle. PB road is a four-lane two-way road and a median is located in between each road. Ashoka road towards south-west direction it is one-way traffic of two-lane road. Then in North-east direction it is two-way traffic of two-lane road.

Fig. 1: Satellite Image of Gandhi Circle

IV. METHODOLOGY

For our study, in order to design the traffic signal at Gandhi circle by using Webster's method and IRC method, we have conducted studies on traffic flow.

Traffic volume is expressed.as the number of vehicles that move across selected transverse line of a particular road during unit time. In developing countries like India same road is used by various kinds of vehicles hence, the traffic flow is categorized as 'Mixed traffic flow'. The total traffic flow consisting of different classes of vehicles on a road is expressed as a single standard unit which is called as PUC.

Therefore the given traffic flow of different classes of vehicles can be converted to PCU/hr. For that, each class of vehicle is multiplied with an equivalency, called PCU and the total traffic of all vehicles is represented in terms of PCU/hr for that particular road.

The traffic volume count was taken for 3 days at the intersection on 22nd, 23rd, 24th April that is Friday, Saturday and Sunday. This data is used to design the traffic signal using Webster's method and IRC method.

V. DATA COLLECTION & RESULT ANALYSIS

The study of traffic volume at the selected intersection is conducted for 3 days by counting the different class of vehicles and the total number of vehicles is represented in terms of PCU/hr as given in Table 1.

Table 1: Total Vehicular Volume of 3 days at intersection in PCU/hr

Route	Day 1	Day2	Day3	Peak PCU/hr
KSRTC to Oneway	127	130	127	130
KSRTC to Railway	782	773	775	782
Railway to Oneway	121	122	122	122
Railway to KSRTC	860	757	753	860
KSRTC to Ashoka	85	86	86	86
Railway to Ashoka	103	102	102	103
Ashoka to Oneway	97	95	95	97
Ashoka to KSRTC	77	78	78	78
Ashoka to Railway	71	71	71	71

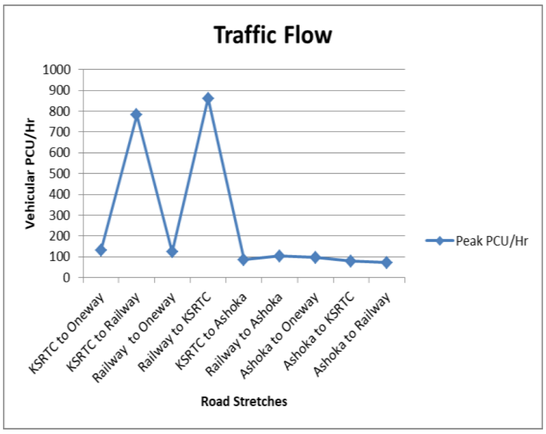

Fig. 2: Traffic Flow in PCU/hr

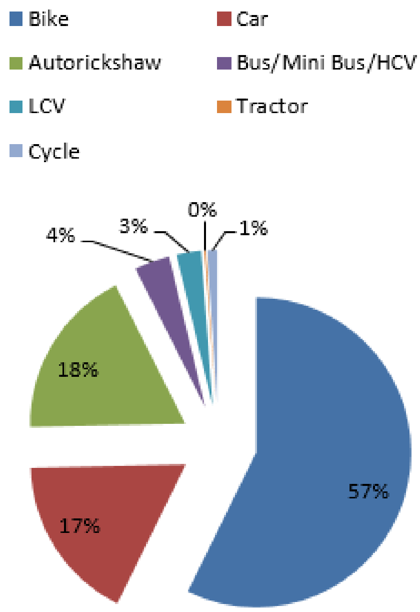

Fig. 3: Traffic Composition

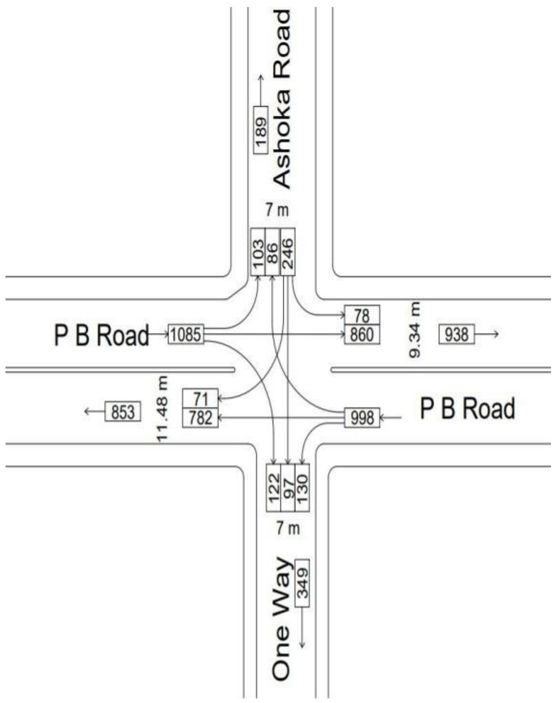

Fig. 4: Traffic flow diagram at intersection

The normal flow value q_1 is determined by taking the sum of vehicles in PCU/hr which is approaching towards the other roads of the intersection from KSRTC road and q_2 is determined by taking the sum of vehicles in PCU/hr which is approaching towards the other roads of the intersection from Railway station. The normal flow value q_3 is determined by taking the sum of vehicles in PCU/hr which is approaching towards the other roads of the intersection from Ashoka road

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q_1 = 998 PCU/hr q_2 = 1085 PCU/hr

q_3 = 246 PCU/hr

Let S be the saturation flow

The S_1 value is calculated by multiplying the 160 PCU/0.3 meter road breadth to the total width of KSRTC road and S_2 is determined by multiplying the 160 PCU/0.3 meter road width to the total width of Railway Station road. The saturation flow S_3 is determined by multiplying the 160 PCU/0.3 meter road width to the total width of Ashoka road

S_1 = 6118 PCU/hr S_2 = 4978 PCU/hr

S_3 = 1865 PCU/hr

On the basis of selected values of normal flow y_1, y_2, y_3 are calculated on the approach roads.

$y_1 = q_1/S_1$ $y_2 = q_2/S_2$

$y_3 = q_3/S_3$

$y_1 = 998/6118 = 0.163$

$y_2 = 1085/4978 = 0.217$

$y_3 = 246/1865 = 0.131$

$Y = (y_1+y_2+y_3) = 0.512$

WEBSTER'S METHOD

In this method, design of traffic signal is an systematic proposal to decide the C_o value corresponding to least total delay of vehicles on the roads meeting at the selected junction.

Let C_o be the optimum signal cycle time

Road 1 = KSRTC to Railway Station

Road 2= Railway Station to KSRTC

Road 3 = Ashoka Road

The C_o value is governed by the general physical features or the geometric data of the roads which are meeting the junction and the traffic flow moving towards intersection from all the approach roads during the design period.

The C_o value is given by the relation C_o = 1.5L+5/1-Y

Where
L = total time lost per cycle in sec = 2n+R
n = number of phases
R = red amber time

L = 2n + R = (2×3) +9 = 15 sec
C_o = 1.5L+5/1-Y
C_o = ((1.5×15) +5)/ (1-0.512)

C_o = 56.45 sec
$G_1 = y_1/Y$ (Co-L) = 0.163/0.512 (56.45-15) **G_1=13.18sec**
$G_2 = y_2/Y$ (C_o-L) = 0.217/0.512 (56.45-15)
G_2 = 17.60 sec
$G_3 = y_3/Y$ (C_o-L) = 0.131/0.512 (56.45-15)
G_3 = 10.65 sec

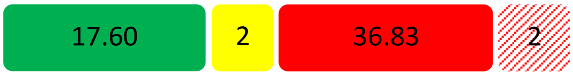
Provide red amber time = 9 sec and allocating amber time of 2 sec each.
Total cycle period = 13.18+17.60+10.65+9+6
Total cycle time = 56.43 sec

Table: 2 Calculated Signal timings using Webster's method

Road	Green	Amber	Red	Cycle Time
Road 1	13.18	2	41.25	56.43
Road 2	17.60	2	36.83	56.43
Road 3	10.65	2	43.78	56.43

Phase 1

Phase 2



Phase 3

IRC METHOD

- Width of Road 1 = 11.48 m
- Width of Road 3 =7.0 m
- Approach volume on

Road 1 = 998 PCU/ hr

Road 3 = 246 PCU/ hr

- Wandering speed of pedestrian=1.2 meter/sec
- Design traffic on

Road no.1 = 499 PCU/hr

Road no.2 = 246 PCU/hr

STEP 1: Walker time of crossing

Green time of Pedestrian for road no.1
= 11.48/1.2+7.0=16.56~17sec
Green time of Pedestrian for road no.2
= 7.0/1.2+7.0=12.83~13sec

STEP 2: Minimum Green period for traffic

Least green time for vehicle on road no.3,
Y_3 = 17 sec
Min green time for road no.1,
Y_1 = 17*(499/246) = 34.48 sec

STEP 3: Reviewed green phase for traffic signal

By taking 2 sec each towards clearance amber and 2 sec inter green time for every phase.

Required total cycle time = (2+17+2) + (2+34.48+2) = 59.5 sec

Total cycle time is set in multiples of 5 sec and it is equal to 60 sec.

The additional period of 60 – 59.5 = 0.5 sec/cycle is selected to the green time of roadway 1 and roadway 3 as 0.5 and 0 sec respectively.

Take G_1 = 34.5 + 0.5 = 35 sec
G_2 =17 + 0 = 17 sec

STEP 4: Vehicles checking for clearance arrived during the green phase

Arriving vehicles/lane/cycle on roadway 1 = 499/60 = 8.3 PCU/cycle

Least green period required per cycle to clear vehicles on road 1 = 6+ (8.3-0) 2 = 22.65 sec (less than 35sec)

Vehicle arrival/lane/cycle on road no.3 =246/60 = 4.1 PCU/ cycle

Minimal green time for vehicle to pass on road 3 = 6 + (4.1-0)2 = 14.2 sec (less than 17 sec)

STEP 5: Check for design cycle time

Lost time per cycle = (Amber time + inter green time + lost time for initial delay of 1st vehicle) for 2 phases = (2+2+4) *2 =16 sec

S_1 road width 5.74 m =525*5.74 = 3013.5 PCU/hr

S_3 3.5 meter of wide road =1890 PCU for 3.5 m road width + (40*3)/5 =1914 PCU/hr

Y_1 = 998/3013.5 = 0.331 and

Y_3 =246/1914 = 0.128

Y = 0.459

C_o = (1.5L+5)/ (1-Y)

C_o = ((1.5*16) +5)/ (1-0.459)

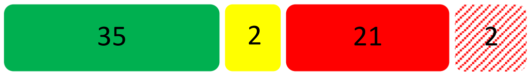
C_o = 53.65 sec

The above 60 seconds designed earlier is taken for design.

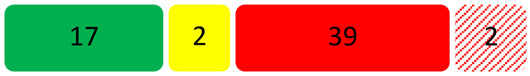
Table 3: Calculated Signal timings using IRC method

Road	Green	Amber	Red	Cycle Time
Road 1	35	2	(21+2)	60
Road 3	17	2	(39+2)	60

Phase 1



Phase 2



The next two-phase signal design is carried out by taking the normal flow and saturation flow values Railwa y station road and Ashoka Road respectively.

- Width of the Road 2= 9.34 m
- Width of the Road 3= 7 m
- Approach volume on

Road 2 = 1085 PCU/ hr

Road 3 = 246 PCU/ hr

- Pedestrian walking speed = 1.2 meter/sec
- Design traffic on

Road 2 =543 PCU/hr

Road 3 =246 PCU/hr

STEP 1: Time required for the pedestrian to cross the road.
Pedestrian green period for
Roadway 3 = (9.34/1.2) + 7 = 15 sec
Roadway 2 = (7/1.2) + 7 = 13 sec

STEP 2: Least green time needed for traffic to cross the junction.

Road 3, G_3 = 15 sec
Road 2, G_2 = 15*(543/246) = 33 sec

STEP 3: Modified green period for traffic

2 seconds is added for clearance amber and inter green time period for all phase.

Total cycle time required = (2+15+2) + (2+33+2) = 56 sec

The above 56 seconds is approximately equal to 60 seconds in multiple of 5 sec.

The additional time of 60 – 56 = 4 seconds/cycle may is taken for the green time of road 2 and road 3 as 2 and 2 sec respectively.

Hence take $G_1 = 33 + 2 = 35$ sec and
$G_2 = 15+2=17$ sec

STEP 4: Examining the vehicle clearance in green phase

Vehicle arrival/lane/cycle on road 2 = (543/60)
= 9 PCU/cycle
Minimal green time needed/cycle to eliminate vehicles on road 2 = 6+ (9-2)*2 = 20 sec (less than 35 sec)

Vehicle arrival/ lane/ cycle on road 3 =246/60 = 4.1 PCU/cycle

Least green time for passing vehicle on road 3 = (6+ (4.1-2)*2) = 10.2 sec (less than 17 sec)

STEP 5: Check for C_o value

Time lost/cycle = 16 sec

S_2 road of width 4.67 m ~ 5 m = 2550*5 m = 12750 PCU/hr

S_3 road of width 3.5 m = 1890 PCU for 3.5 m + (40*3)/5= 1914 PCU/hr

$y_1 = 1085/12750$ $y_2 = 246/1914$

$y_1 = 0.08$ $y_2 = 0.12$

Y = 0.2

$C_o = 1.5L+5/ (1-Y)$

$C_o = ((1.5*16) +5)/ (1-0.2)$

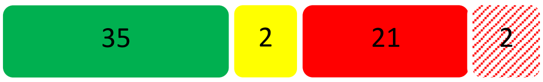
C_o = 36.2 sec

Hence 60 sec designed earlier is acceptable

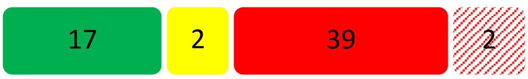
Table 4: Calculated Signal timings using IRC method

Road	Green	Amber	Red	Cycle Time
Road 2	35	2	(21+2)	60
Road 3	17	2	(39+2)	60

Phase 1



Phase 2



VI. CONCLUSION

Provision of traffic signal will reduce the number of conflicts and there will be a well-organized traffic flow at the selected intersection. The peak hours are identified as 9:00-11:00 in the morning and 5:00-7:00 in the evening. Traffic flow variation chart is shown for peak variation for 3 days. Although the traffic signal has been installed at the Gandhi Circle intersection but it is not in operating condition. The designed traffic signal cycle times are 56 seconds by Webster's method and 60 seconds by IRC method. The results obtained by both the methods are approximate. It is recommended to adopt IRC method for the selected intersection since this method is best suited for the Indian traffic conditions.

REFERENCES

[1] Vijesh P V: "Traffic Signal Design at Mundur Junction" International Journal of Innovative Research in Science, Engineering and Technology Volume 8, Issue 12, December-2019.
[2] Faisal Mehraj Wani: "Design of Traffic Signal at Kundalahalli Junction Bengaluru Karnataka" International Journal of Scientific and Engineering Research, Volume 9, Issue 6, June-2018.
[3] Adeke Paul: "Traffic Signal Design and Performance Assessment of 4-Leg Intersections Using Webster's Model: A Case of 'SRS' and 'B-Division' Intersection in Makurdi Town" International Research Journal OfEngineering and Technology Volume 5, Issue 5, May-2018.
[4] Lijin Rajeev: "Junction Improvement by Implementing Traffic Signal and Road Widening at Tirumala Thiruvananthapuram, Kerala" International Journal of Engineering Research and Technology, Volume 6Issue 6, 2018.
[5] Vaishali Parmar: "Traffic Signal and Junction Design: A Case Study of Rajkot City" International Journal for Research and Development in Technology, Volume 6, Issue 7, July-2017.
[6] Nithil: "Redesign of Traffic Signal by Webster's Method at Intersection in The City of Shimoga" International Journal for Research and Development in Technology, Volume 7, Issue 2, February-2017.