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Comparison of Signal Re-Design for G. Palya and Jakkur Junction by IRC and Webster's Method

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***Abstract*: Rapid growth of vehicles has resulted in traffic congestion at the intersection where there is absence of certain assets like traffic signals, timings, shortage of lanes etc. About 16 people die and 58 are injured every hour in India due to road accidents. The worst accident hotspots are near flyovers and junctions without signals. According to manual count with 15 minutes interval could be used to obtain the traffic volume data. The collected data is converted into PCU units. IRC and Webster's method is a rational approach for signal design. The design is simple and is totally based on formulae's laid down by IRC and Webster. In this method, the total cycle of the signal timing is determined which forms a total least delay occurring at signal. Traffic volume studies are to be made to determine the number, movement and classification of vehicles at the given location. The design of traffic signal is done according to Indian Road Congress and Webster's method of signal design by adopting maximum passenger car unit (P.C.U) in the intersection of each direction. In present study traffic studies will be carried out at the "G.palya and Jakkur traffic signal" in order to re-design traffic signal timings according to present vehicular count and suitable precautions are to be given. After re-designing the signal timings by using IRC and Webster's method, adopt highest total cycle length among two methods.**

***Keywords*: IRC, Traffic Signal, Webster.**

1. Introduction

At intersection where there are a large number of crossing & right turn traffic, there is possibilities of several accidents as there cannot be orderly movements. Traffic signals are control devices which could alternatively direct the traffic to stop &proceed at intersections using red & green traffic light signals automatically. The design of traffic signal is done according to the Indian Road Congress & Webster method of signal design by adopting maximum Passenger Car Unit (P.C.U) in the intersection of each direction. In present study traffic studies will be carried out at the "G.palya and Jakkur traffic signal" order to re-design traffic signal timings according to present vehicular volume count and suitable precautions are to besuggested. IRC (Indian Road Congress) has classified the roads in the India in the following categories: 1. Expressways. 2. National Highways. 3. State Highways. 4. Major District Roads. 5. Other District Roads. 6. Village Roads.

Expressways – These are the highest class of roads in the Indian road network. They are six or eight-lane controlled-access highways where entrance and exit is controlled by the use of slip roads.

National Highways – National Highways are the major arterial roads spanning in the length and breadth of the country and connects the Capital to the various state capitals of the country or with the neighboring countries. They also connect the famous tourism places of the country. National Highways are numbered and written as NH-1, NH-2 etc. They have the highest design specifications. Example: NH-1Delhi-Ambala-Amritsar.

State Highways – State Highways are the roads connect the state capital to other states and to the district headquarters in the state. They have design specifications similar to those of the National Highways because they carry enough traffic.

Major District Roads - These roads connect the district headquarters to the main town centers in the district and to the headquarters of the other districts also. They have lower design specifications as compared to the NH and SH.

Other District Roads - These roads connect the rural areas town centers to the major district roads of higher importance. They provide the facilities for the transportation of the raw materials or the goods mainly of agricultural products from the rural towns to the higher markets and vice-versa.

Village Roads - These roads connect the rural villages with one another and to the nearest higher level road or to the nearest town centre. They have lower design specifications and many of them are not even medaled.

The objectives of our project are: To identify the traffic conflicts in major and minor streams (roads) in a particular intersection/junction.

- To estimate the basic traffic stream parameters (parameters may include density and flow of traffic) for the selected road.
- To estimate the condition of study road.
- To better categorize and orderly traffic movement.
- To re-design and provide the signal timings at "Goruguntepalya and Jakkur" junction.

Passenger Car Unit - It is a metric used in transportation

engineering, to assess traffic flow rate on a highway. A Passenger Car Unit is a measure of that a mode of transport has on traffic variables (such as speed, density) compared to a single standard passenger car. This is also known as Passenger Car Equivalent (PCE). One car is considered as a single unit, cycle, motorcycle is considered as 0.2 car unit. Bus, truck causes a lot of inconvenience because of its large size and is considered equivalent to 3 cars or 3 PCU.

Table 1
The static PCU values and the vehicular classification

Vehicles	Composition Identification Number	Static PCU
Bicycle	1	0.2
Two wheelers	1	0.3
Cars	1	1
LCV	1	2.2
Auto	1	0.8
Bus	1	2.8
HCV	1	4

2. Methodology

- Need of the study
- Scope and objective of the
- study
- Study stretch and data
- collection
- Classified Traffic surveys
- volume count
- Road inventory
- Capacity evaluations
- Literature review
- Re-design of signal timings

The different phases involved in methodology shall be summarized as follows:

- Need of the study is to determine the capacity of different roads and compare to the standards.
- Scope and objects are explained in section 1
- Section 2 deals with literature review.

3. Data Collection

Study Area:

The study stretch was selected after conducting reconnaissance survey such that it satisfies following conditions.

a) Study stretch should be fairly straight.

b) Study stretch should be uniform in width.

Study stretch should not contain direct access from adjoining areas.

Traffic Survey:

The input data should be collected from the study stretch in order to generate base model. The study methodology begins with data collection of study site and extraction of collected data, the extracted data was used in the calculation on travel time, speed, flow and density.

The trend lines are developed using average speed flow and density, and the flow values are projected for the change in density values. Speed Flow and density relationships were established by using Green shields macroscopic stream model method. The field traffic flow data of the selected stretch should be collected from digital video camera for a total duration of one hour. The speeds of different categories of vehicles were measured by noting the time taken by the vehicles to traverse a trap length of 20 m. the free speed different classes of vehicles will be measured under free-flow conditions. The observed maximum, minimum and mean speeds of different vehicles types and corresponding standard deviations has to be calculated. Any vehicles moving on traffic stream has to maintain sufficient lateral clearances between the vehicles.

4. Signal Design Methods

METHOD 1 – IRC (Indian Road Congress)

Overview of IRC

The Indian Road Congress (IRC) is the Apex Body of Highway Engineers in the country. The IRC was set up in December, 1934 on the recommendations of the Indian Road Development Committee best known as Jayakar Committee set up by the Govt. of India with the objective of Road Development in India.

IRC Standard

Table 2
IRC Standard saturation flow per lanes in metres

Lanes in Meters	Saturation Flow
3.0	1890
4.0	2250
5.0	2990
3.0	1890
4.0	2250
>5.0	2990

5. Design Method as per IRC Guidelines

The pedestrian green time required for the major roads are calculated based on walking speed of 1.2m/sec and initial walk time of 7.0sec. These are the minimum green time required for the vehicular traffic on the minor and major roads respectively. 2. The cycle time is calculated after allowing amber time of 2.0sec each. The minimum green time required for clearing vehicles arriving during a cycle is determined for each lane of the approach road assuming that the first vehicle will take 6.0sec and the subsequent vehicles or the PCU of the queue will be cleared at a rate of 2.0sec. The minimum green time required for the vehicular traffic on any of the approaches is limited to 16sec. The optimum signal cycle time is calculated using Webster's formula. The saturation flow values may be assumed as 1850, 1890, 1950, 2250, 2550 and 2990PCU per hour for the approach roadway widths (kerb to median or centerline) of 3.0, 4.0, 4.5, 5.0 and 5.5m. For widths above 5.5m, the saturation flow may be assumed as 525 PCU per hour per meter width.4. The lost time is calculated from the amber time, inter-green time and the initial delay of 4.0secs for the first vehicle, on each

leg.5. The signal cycle time and the phases may be revised keeping in view the green time required for clearing the vehicles and the optimum cycle length determined it, steps 4 and 5 above.

Method 2 – Webster's

Overview of webster method

It is a method of traffic signal design is an analytical approach of determining the optimum signal cycle time, Co corresponding to minimum total delay to all the vehicles at the approach roads of the intersection.

Webster's design method:

1. It has been found from studies that the average delay and the overall delay to the vehicles at a signalized intersection very with the signal cycle length.
2. The average delay per vehicle is high when the cycle length is very less, as sizable proportion of vehicles may not get cleared during the first cycle and may spill over to subsequent cycles. As the signal cycle time is increased, the average delay per vehicle decreases up to a certain minimum value and thereafter the delay starts increasing, indicating that there is an "optimum signal cycle time" corresponding to least overall delay. 4. The optimum cycle time depends on the geometric details of the intersection and the volume of traffic approaching the intersection from all the approach roads during the design hour.5. The field work consists of determining the following two sets of values on each approach road near the intersection: The normal flow, q on each approach during the design hour and the 'saturation flow', S per unit time. The normal flow values, q1 and q2 on roads 1 and 2 are determined from field studies conducted during the design hour or the traffic during peak 15 – minute's period. 7. The saturation flow of vehicles is determined from careful field studies by noting the number of vehicles in the stream of compact flow during the green phases and the corresponding time intervals precisely. In the absence of data the approximate value of saturation flow is estimated assuming 160 PCU per 0.3 metre width of the approach

6. Details and Design of Study Stretch's

A. Overview of study stretch -1

Name of the road is NH-75; it is a National Highway passing through states of Karnataka, Andhra Pradesh and Tamilnadu. This National Highway was earlier known as NH-48 before rationalization of highway numbers in 2010. NH-75traverses all three geographical regions of Karnataka state namely Karavali, Malenadu and Bayaluseemae. The length of the road is 533Km, which starts at Bantwal in Karnataka and terminates at Katpadi, near Vellore. The method used to take volume count of vehicles in peak and off – peak hours is by manually.

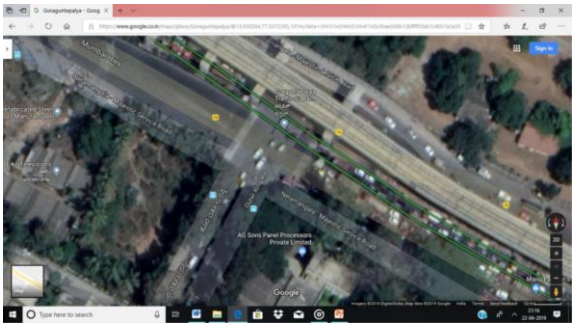

Fig. 1. Satellite image of Gorguntepalya traffic signal

Table 3
Details of the Study Stretch -1

Name of the road	NH 75
Geometry	Divided
Width of carriage way	3.5m per lane
District	Bengaluru, Urban
No. of lanes 2 (each road)	2 (each road)
Category of the road	National Highway

Re-Design of Study Stretch–1 (G. Palya Signal) using Webster's Method:

Step 2: Minimum green time for traffic.

Minimum green time for vehicles on road - 2, G2 = 16.375 seconds minimum green.

Table 4
Direction of roads in Study Stretch – 1

S. no.	**Direction of Road**	**Geometry**	
	From	**To**	
	Goruguntepalya	Hebbal	Divided
	3. Yeshwanthpura	Goruguntepalya	Divided
	4. Hebbal	Tumkur	Undivided

Lanes in Metres	**Saturation Flow**
3.0	1890
4.0	2250
5.0	2990
3.0	1890
4.0	2250
>5.0	2990

Overview of study stretch 2:

Name of the road is NH-43; it is a National Highway. It passes through Indian cities of Agra, Gwalior, Nagpur and Bangalore, Madurai. The method used to take volume count of vehicles in peak and off – peak hours is by video graphic.

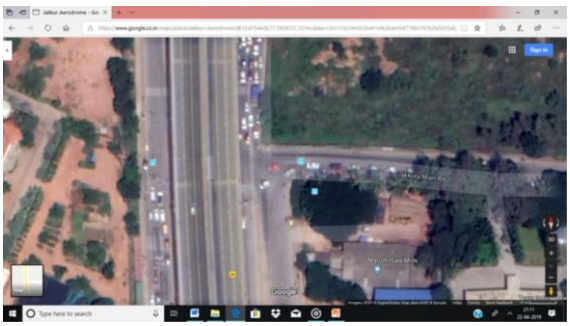

Fig. 2. Satellite image of Jakkur junction

Trap length:

It is the two defined points on the road way a known distance apart (short distance) usually less than 90m.

- Trap length we considered is 10m. Using this trap length method we have measured the speed, flow and density parameters of each vehicle by using Avidemux software and importing data to MS-excel. The purpose of considering this trap length is to find the speed of the vehicles.
- When we measure the traffic parameters over a short distance, we generally measure the spot speed.
- Spot speed studies are used to determine the speed distribution of a traffic stream at a specific location.
- In present scenario due to heavy traffic volume, the existing roads are insufficient to maintain design speed. With the help of spot speed studies we can manage the traffic volume by re-designing signal cycle time.

Avidemux:

It is a free and open source video editing program designed for video editing and video processing.

The program has a clear toolbar on top with all the important buttons – Open, Save Video, and Load/Run Project.

Comparison of signal re-design for G. palya and Jakkur junction by IRC and Webster's method

Fig. 3. Entry point of the car is shown using Avidemux

Fig. 4. Exit point of the car is shown using Avidemux

Comparison of signal re-design for G. palya and Jakkur junction by IRC and Webster's method:

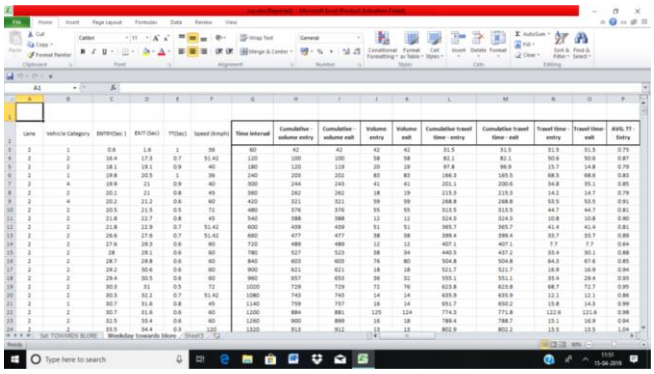

Fig. 5. Volume count data extraction in excel for plotting graphs

Re-Design of Study Stretch – 2 (Jakkur Junction) using IRC method:

IRC design

- Width of road 1 = 7m. (2-lanes).
- Width of road 2 = 7m. (With opposite direction).
- Approach volume on road 1 = 2843.8 PCU/hour.
- Approach volume on road 2 = 8035 PCU/hour.
- PCU/hour; pedestrian walking speed = 1.2m/sec.
- Design traffic on road 1 =
- = 1421.9 PCU/hour.
- Design traffic on road 2 = 803.5 PCU/hour.

Step 1: Pedestrian crossing time Pedestrian green time for road– 1

= 12.83 seconds. Pedestrian green time for road – 2

= 12.83 seconds.

Step 2: Minimum green time for traffic Minimum green time for vehicles on road - 2, G2 = 12.83 seconds

Minimum green time for road – 1, G1 = 12.83 = 22.70 seconds.

Step 3: Revised green time for traffic signal

Adding 2 seconds each towards clearance amber and 2 seconds. Inter – green period for each phase, total cycle time required = (2+12.83+2) + (2+22.70+2) = 43.53 seconds. Signal cycle time may be conveniently set in multiples of 4 seconds and so the cycle time = 45 seconds.

The extra time of 45-43.53 = 1.47 seconds per cycle may be apportioned to the green times of road -1 and road – 2, as 0.8 and 1 seconds respectively. Therefore, adopt G1 = 22.70+0.8 = 23.5 seconds. G2 = 12.83+10 = 13.83 seconds.

7. Conclusion

For the present scenario of the traffic, I.R.C is suitable to re-design the signal timing. Whereas, Webster's method of signal timings is not sufficient. By comparing the Webster's and IRC method, we can conclude that I.R.C signal

timing is suitable for that traffic condition. Based on the

calculations done on the PCU values obtained from the traffic survey the signal cycle length is “165sec”. By providing I.R.C timing there will be reduction in the conflicts and there will be free flow of traffic. For the present scenario of the traffic, I.R.C is suitable to redesign the signal timing. Whereas, Webster’s method of signal timings is not sufficient. By comparing the Webster’s and IRC method, we can conclude that I.R.C signal timing is suitable for that traffic condition. Based on the calculations done on the PCU values obtained from the traffic survey the signal cycle length is “304sec”. By providing I.R.C timing there will be reduction in the conflicts and there will be free flow of traffic. If R value is near by “1” in the graph for the field obtained data then the derived equation is fair. For an accurate results video-graphic survey was carried out in one junction and remaining manually calculation was carried out it was found that recorded data gives accurate results and can be stored as for future reference. In case determination of the PCU values in mixed traffic condition by Chandra’s method it was found out that values were matching to I.R.C method. Future scope: To clear the traffic conflicts in major and minor streams (roads) in a particular intersection/junction. The IRC method of signal timings will be implementing on particular junction to avoid major accidents. Identifying the conflicts roads to re-design of the signal timings for the betterment of free flow.

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