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FIELD INVESTIGATION OF TRAFFIC SIGNAL DESIGN

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Abstract: Signaling equipment also including traffic lights are used to control traffic positioned at road intersections, pedestrian crossings, and other locations to control flows of traffic. Traffic lights alternate the right of way accorded to users by displaying lights of a standard color i.e. red, amber (yellow), and green. The green light allows traffic to proceed in the direction denoted. The amber light warns that the signal is about to change to red. The red signal prohibits any traffic from proceeding. Properly designed Traffic signal helps in minimizing waiting time of vehicles at intersection. Jaipur is among the few cities with automated traffic control system in the country. The report is analysis of automatic traffic signal at two intersections in Jaipur i.e. India Gate & Haldighati.

1: INTRODUCTION

General

Traffic signals are one of the most effective and versatile active traffic management systems available, and they are widely utilized in many cities across the world. The advantage of traffic signal includes an orderly movement of traffic, an increased capacity of the intersection and requires only simple geometric design. However, the disadvantages of the signalized intersection are large stopped delays, and complexity in the design and implementation. Although the overall delay may be lesser than a rotary for a high volume, a user may experience relatively high stopped delay.

Purpose of Study

The study of traffic volume at a particular location is necessary to fulfill the following purposes:

- Determine the total traffic entering and exit in the area.
- Design signal’s cycle times.
- Traffic management purpose.

Objectives

1. The aim of this project is to analyze the cycle length variation by the automated traffic signaling system.
2. Field analysis of the cycle length variation by automated traffic signaling system.
3. To analyze field for cycle length variation by Webster’s method.
4. To compare the data obtained using the above two methods & select the appropriate method for the site under consideration.

2: LITERATURE REVIEW

D. Leither et al. (2022), This paper comprehensively reviews the advancements in traffic signal performance evaluation, emphasizing the significance of such evaluations for transportation agencies combating congestion and adapting to changing traffic patterns through signal retiming. The paper outlines performance measures derived from both sources and evaluates various methodologies employed in research studies, detailing their advantages and disadvantages.

H. Wang et al. (2022), this study introduces a novel multi-input multi-output optimal bilinear signal control method for urban traffic networks. The approach utilizes a bilinear dynamic model approximation to capture the nonlinear dynamics of traffic networks, considering signal green time splits as control inputs and traffic delay changes as outputs for each intersection. The bilinear system model incorporates interactions among traffic delays and signal timing splits.

D. Babic et al. (2021), carried out study on Analysis of Market-Ready Traffic Sign Recognition Systems in Cars: A Test Field Study. The study investigates the variations in detection and readability accuracy among market-ready Traffic Sign Recognition Systems (TSRS), a component of Advanced Driver Assistance Systems (ADAS). Despite TSRS being available for over a decade, differences persist in the hardware, software, and sign recognition capabilities across various brands.

S. Nygardhs (2021), This study investigates the adaptive behaviors of cyclists towards countdown timers (CDTs) for green traffic lights in a real traffic setting. Conducted as a before-after study, the research reveals that cyclists adjusted their behavior by utilizing the information provided by the CDT, particularly in terms of speed adaptation and glance behavior.

Yue R. Yang et al. (2021), this research introduces an innovative signal retiming approach aimed at addressing limitations in current signal coordination practices, including managing coordination data, optimizing parameters, diagnosing errors, and assessing performance. The approach utilizes a time-space diagram (TSD) to display vehicle trajectories, enabling transportation engineers to diagnose potential issues with existing signal coordination plans and develop optimized alternatives.

3: METHOD OF TRAFFIC DATA COLLECTION

General

Traffic Data Collection of traffic volumes are basic requirements for planning of road development and management schemes. Traffic Data knowledge is essential in drawing up a rational transport policy for movement of passengers and goods by both government and the private sectors.

Selection of Sites

A specific location for counting site (permanent or temporary) must be determined on site. Where automatic counting system is to be used, the exact locations of loops should be decided while taking cognizance of the potential use of data collected.

Methods of Traffic Data Collection

It is essential to know the magnitude of traffic data required or to be collected, which will then determine its quality and type of vehicle classification to be adopted. Traffic counting falls in two main categories, namely; manual counts and automatic counts. There is no distinct difference between the two methods however the economic use or selection of an appropriate method of traffic counting is a function of the level of traffic flow and the required data quality.

Methodologies for Design

Traffic Signals are one of the more familiar types of intersection control. Using either a fixed or adaptive schedule, traffic signals allow certain parts of the intersection to move while forcing other parts to wait, delivering instructions to drivers through a set of colorful lights (generally, of the standard red-yellow (amber)-green format).

F.V. Webster's Method

In the 1950s, Webster conducted a series of experiments on pre timed isolated intersection operations. Two traffic signal timing strategies came from his study. One is signal phase splits. Webster demonstrated, both theoretically and experimentally, that pre timed signals should have their critical phases timed for the equal degrees of saturation for a given cycle length to minimize the delay.

The other is the minimum delay cycle length equation In developing the equation for the optimal minimum delay cycle length, it was assumed that the effective green times of the phases were in the ratio of their respective y values (Flow ratios)

$$C0 = \frac{1.5L+5}{1-Y}$$

Where C0 = the optimal minimum delay cycle length, in sec

L = total lost time within the cycle, in sec

Y= the sum of critical phase flow ratios

IRC Method

The I.R.C. has provided following guide line for design of traffic signal:

The pedestrian green timing for the major and minor road should be calculated on the basis of the walking speed of 1.2m/sec. and initial walking time of 7sec.These are the minimum green timing required for the vehicular traffic on the minor and major road respectively. The cycle time is calculated after allowing amber time of 20 seconds each.

The optimum signal cycle is calculated using Webster's formulae-

C_0 = 2n+R

Where,

C0 = the optimal minimum delay cycle length, in sec

L = total lost time within the cycle in sec

N = number of phase

R = red time

Y = the sum of critical phase flow ratio

Y = Y1+Y2

Trial Cycle Method

In this method the green, amber and the red time period are assumed asG1,G2 A1,A2 and R1,R2 for two road number 1 and 2 number of vehicles crossing lane number 1 and 2 per hour, then

$G_1 = \frac{2.5n_1C_1}{900}$ and $G_2 = \frac{2.5n_2C_2}{900}$

Figure Field data collection

4: ANALYSIS & DISCUSSION

There are three cyclical variations that are of particular interest:

- Hourly pattern: The way traffic flow characteristics varies throughout the day and night
- Daily Pattern: The day-to-day variation throughout the week.
- Monthly and yearly Pattern: The season-to-season variation throughout the year.

Data Entry

Data entry menu provides a means of entering collected traffic data from the collection forms received from the counting sites into a computerized system. The data entered in the system should be cleaned of errors before it is summarized and analyzed. Once the data has been summarized for each station, on regional or national basis, the system should not allow for the same data to be summarized again unless the condition or inventory of data entered has changed.

Data Analysis

The analysis of the summarized data uses conversion parameters set up by the user or administrator, and where parameters are not defined default system parameters could be used.

- Defined vehicle types and counting stations.
- Conversion of data in different formats into a common data format.
- Calculation of Traffic Growth Rates of traffic volumes.
- Production of forecasts based on historical data and growth rate.

5: RESULTS AND CALCULATIONS

Calculation of Normal Flow

The table presents a comprehensive analysis of traffic volume converted into Passenger Car Units (PCU) for two distinct locations: Haldighati and India Gate Jaipur, during three key time periods: morning, afternoon, and evening.

Table of PCU

Type pf Vehicle	**PCU Values (IRC SP 41)**
Car	1
Motor Cycle	0.5
Auto Rickshaw	1
Tempo	1
Truck	4.5
LCV	1.5
Bus	3

Result of India-Gate Intersection

The existing cycle length of the signal at India-Gate is 115 sec.

Table- Morning session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	170	49	30
2		48	25
3		32	15
4		23	30

Table- Afternoon session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	110	30	30
2		29	25
3		20	15
4		14	30

Table- Evening session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	113	32	30
2		31	25
3		19	15
4		14	30

Result of Haldighati Intersection

The existing cycle length of the signal at Haldighati is 140 sec.

Table- Morning session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	213	66	40
2		61	40
3		38	20
4		30	25

Table- Afternoon session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	182	56	40
2		53	40
3		31	20
4		24	25

Table- Evening session at India Gate

Phase No.	Optimum Cycle Time (sec)	Designed Green Time (sec)	Existing Green Time (sec)
1	189	59	40
2		57	40
3		30	20
4		25	25

6: CONCLUSION

In conclusion, the traffic signal analysis using the Webster method revealed significant disparities between the actual cycle times and the calculated optimum cycle times at the India-Gate and Haldighati intersections. Despite the total cycle times being 115 seconds and 140 seconds, respectively, our calculations demonstrated a need for longer cycle times of 170, 110, and 113 seconds at India-Gate, and 213, 182, and 189 seconds at Haldighati during morning, afternoon, and evening periods, respectively.

7: FUTURE SCOPE

The capital's roads can have a 'smart' signaling system that will measure traffic pressure on a stretch and change signals on it accordingly. Under this new system, the smart signals will have remote sensors which will communicate with nearby signals to control the traffic flow at a particular intersection.

Connecting Traffic Management System (Traffic signals and Traffic Command centers) with a GIS enabled digital road map of the city and using the power of analytics is a key to smooth traffic management.

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