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Modification of Existing Signal Cycles by Incorporating Approach Road Width Loss in Saturation Flow Formula Using Webster's Method

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Abstract: ***The Saturation Flow is that the flow which might be obtained if there was a nonstop queue of vehicles and that they got a one hundred per cent inexperienced time. it's typically expressed as P.C.U per hour of inexperienced time. Saturation flow depends on the layout of the intersection (especially the dimension of the approach road), the amount of right turning vehicles and product carrying (commercial) vehicles, the presence of lay vehicle on the road and different factors.The road dimension of approach is assumed to be constant for a minimum of the length of the approach road that is outlined because the length of road which can accommodate the queue which may simply submit to the intersection throughout a totally saturated inexperienced amount.In reference to the saturation flow formula for the amendment in approach road dimension, observations were command at 3 signalized intersections of bhubaneswar town, they are, Master canteen junction, Rasulgarh Junction, and Vani-vihar Junction.In this study, the approach road dimension loss thanks to vehicles lay close to the Signal intersections at busy and major bhubaneswar square measures are thought of and this loss is updated within the approach road dimension price to be employed in the Saturation flow formula and consequently the empiricism of the Saturation flow formula is updated to suit the bhubaneswar space Signal intersection styles.***

Keywords: Saturation Flow Approach road dimension, Intersections, Approach road dimension loss

I. INTRODUCTION

As the road traffic will increase, additional and additional traffic signals ar put in at the intersections. Since it's been calculable that queuing at traffic signals accounts for about100 million vehicle- hours every year it's clearly of the utmost importance to line the timings properly therefore on minimize the delay. capability of signal-controlled intersections may be a vital subject and is of goodly concern, not solely at style stage, however conjointly once creating economic assessments of various forms of intersections and valuable of enhancements at signal-controlled junctions.

Saturation flow formula S = 525w is that the ordinarily employed in Asian country for any breadth of road at signalized intersection [1]. In correction with the saturation flow formula for the modification in approach road breadth, observations were command at 3 signalized intersections of bhubaneswar town, they are, Master canteen junction, Rasulgarh Junction, and Vani-vihar Junction. These signalized intersections have the breadth of approach roads varied from nine to twelve meters.

The observations ar worn out the height hours of the day i.e. within the morning, noon, and evening peak times to urge the values of determined saturation flows for every approach road. The signal style is straightforward and is completely supported formulas arranged down by Webster, during this methodology, the overall cycle time of the signal is set that forms total least delay occurring at signal.

A. Traffic Engineering Studies

The traffic engineering studies ar disbursed for assortment of traffic volume information are known as as Traffic Surveys. Traffic engineering studies ar disbursed to research the traffic characteristics and wont to act geometric options and control measures for the safe and economical traffic movement. The analysis of results of the studies conducted is additionally helpful for assessing the necessity of planned road project with justifications.

The different traffic surveys typically disbursed ar

1) Traffic Volume Studies
2) Spot Speed Studies
3) Speed and Delay Studies

4) Origin and Destination Studies
5) Parking Studies Accident Studies

The type of survey adopted for the project is "Traffic Volume Study" and also the below describes concerning a similar.

B. Traffic Volume Studies

Traffic volume may be a live of amount of traffic flow and is expressed because the variety of vehicles that go through a given cross line of the road throughout unit time. because the roadway breadth might vary the amount is mostly expressed because the variety of vehicles per hour or per day, per lane.Different category of vehicles makes use of a similar route notably in developing countries like India; therefore the traffic streams accommodates 'mixed traffic flow'. The vehicles of traffic stream is also classified into totally different vehicle categories.

They consist of:

1) Fast Paced Vehicles Like
a) Rider cars
b) Busses
c) Trucks or significant business Vehicles (HCV)
d) lightweight business Vehicles (LCV)
e) automobile rickshaws
f) 2 wheelers

2) Slow Moving Vehicles or Animal Drawn Vehicles: In order to specific the overall traffic flows on a road per unit time. It becomes necessary to convert the flow of various categories of vehicles into one customary vehicle sort, like the 'Passenger Car'. so the equivalency issue, known as "Passenger automotive Unit (PCU)". and every one the vehicles ar expressed in terms of coach Units.

C. Basic ideas IN Traffic Engineering

One forms of Volume measure

Volume count varies significantly with time. Hence, many forms of measure of volume ar ordinarily adopted to average these variations. These measurements ar delineate below:

1) Average Annual Daily Traffic (AADT)

This is given by the overall variety of vehicles passing through a part in an exceedingly year divided by three hundred and sixty five days this will be used for the subsequent purposes:

a) Measure this demand for service by the road or road
b) Developing the key or blood vessel street
c) Evaluating this traffic flow with reference to the road system
d) Locating aras wherever new facilities or enhancements to existing facilities are required

2) Average Daily Traffic (ADT): It is the common 24-hour traffic volume at a given location surely amount of your time less however than a year. it should be measured for 6 months, a season, a month, a week, or as very little as a pair of days. AN ADT may be a valid variety solely the amount over that it absolutely was measured.
3) Average Weekday Traffic (AWT)season.
4) Average Annual Weekday Traffic (AAWT)

This is outlined because the average 24-hour traffic volume occurring on weekdays over a full year.

D. Variation Of Volume Counts And Peak Hour Factors

Variation in volume counts can be further sub-divide into daily, weekly and seasonal variation. For studying the daily variation, the flow in each hour has been expressed as percentage of daily flow. Weekdays, Sundays, and Saturdays usually show different patterns. That's why comparing day with day is much more useful.

Peak Hour Volume is very important factor in the design of roads and control of traffic, and is usually 2 to 2.5 times the average hourly volume. Apart from this there is one additional feature of this variation: 2 dominant peaks (morning and evening peak). Especially in urban areas, these mainly include work trips and are not dependent on weather and other travel conditions.

Similar to daily variation, weekly variation gives volumes expressed as a percentage of total flow for the week. Weekdays flows are approximately constant but the weekend flows vary a lot depending upon the season, weather and socio-economic factors. Seasonal variation is the most consistent of all variation patterns and represents the economic and social condition of the area served.

Table – 1.1: PCU values recommended by the IRC for different types of vehicles on roads in rural areas.

Sl. No	Vehicle class	Equivalency factors
Fast moving vehicles		
1.	Motor cycles and scooter	0.5
2.	Passenger car, pick-up van, and auto rickshaw	1.0
3.	Agricultural tractor an light commercial vehicles	1.5
4.	Single unit truck and bus	3.0
5.	Truck-trailer and agricultural tractor- trailer	4.5
Slow moving vehicles		
6.	Pedal cycle	0.5
7.	Cycle rickshaw	2.0
8.	Hand cart	3.0
9.	Horse drawn vehicles	4.0
10 (a).	Bullock cart- small	6.0
(b).	Bullock cart	8.0

Table – 1.2: PCU values recommended by the IRC for different types of vehicles on roadsin urban areas.

Sl.No	Vehicle class	Equivalency Factors Percentage Composition of Vehicle Type in Traffic Stream	
Fast moving vehicles		5%	10% and above
1.	Two wheelers- motor cycle, scooter, etc.	0.5	0.75
2.	Passenger car, pick-up van	1.0	1.0
3.	Auto rickshaw	1.2	2.0
4.	Light commercial vehicle	1.4	2.0
5.	Truck or bus	2.2	3.7
6.	Agricultural Tractor- trailer	4.0	5.0
Slow moving vehicles			
7.	Pedal cycle	0.4	0.5
8.	Cycle rickshaw	1.5	2.0
9.	Tonga (horse drawn vehicle)	1.5	2.0
10.	Hand Cart	2.0	3.0

E. Objectives of Traffic

Signals At intersections wherever there area unit an oversized range of crossing and right turning vehicles, there's an opening of many accidents as there can't be orderly movements. the issues of conflicts at the intersection gains additional significance because the traffic volume will increase. In such a state of affairs the sooner observe has been to manage the traffic with the assistance of traffic police UN agency stops the vehicles on one in every of the roads or else and permits the traffic stream of the opposite road to cross or take right flip. therefore the crossing streams of traffic flow area unit separated by 'time- segregation'. In larger cities, an oversized range of police personnel area unit needed at the same time to manage the traffic throughout peak hours at the most of the junctions with serious traffic flow. so traffic signals area unit created use of to perform this operate of control at road intersections.

II. LITERATURE REVIEW

Analysis of Saturation Flow at Signalized Intersection in Urban Area: Surat (2016)
Mr. Sharukh. M. Marfani Mr.H.K.Dave
The authors through their works found that the saturation flow obtained through field studies is higher than the saturation flow obtained by generalized formula S = 525 * W of IRC Sp-41 they also found that with increasing proportion of two wheeler, saturation flow per meter width also tends to increase due to heterogeneity and filling of gaps by two wheelers, while increase in proportion of cars the saturation flow tend to decrease to more homogeneity.

Saturation Flow Model for Signalized Intersection under Mixed Traffic Condition (2018)
Satish Chandra l
The authors in the present study came up with a model of estimating saturation flow based on the composition of through traffic and percentage of right turning traffic in the approach. In this regard data from thirteen signalized intersections of four different cities where considered the validation showed that field observed saturation flow values were pretty much similar with the model estimated values. However, maximum difference was 8-10% which is in an acceptable limit. Therefore, I can be recommended that saturation flow measurement of an intersection approach can be successfully used for saturation flow measurement at intersection locations under mixed traffic conditions.

Case Study on Telugu Thalli Flyover bhubaneswar (2018) *[4]*
K. Srinivas, B. Brahmaiah, et. al
Presented a case study of bhubaneswar flyover i.e. TELUGU THALLI flyover, they calculated the traffic volumes on the flyover and roads below it by conducting traffic studies and estimate the traffic movement directions at various intersections and produce a traffic flow map of the roads. With the help of obtained data they suggest certain diversions to the flyover at specific junctions which have dynamic traffic movement. traffic movement directions at various intersections and produce a traffic flow map of the roads. With the help of obtained data they suggest certain diversions to the flyover at specific junctions which have dynamic traffic movement.
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Modification of saturation flow formula by width of road approach (2011)
Budi Hartanto Susiloa , Yanto Solihinb
The authors proposed that the formula of saturation flow s=600*We is still in use for narrow and medium width of approach(3m to 8m)for wide approach (9m to 12m)is better used s=500*We+400 at least for Bandung city. To convince the formula is valid it has to be tried at other cities, other countries.

III. METHODOLOGY

The entire project work is predicated on analyzing the known analysis drawback, by conducting traffic volume studies. The traffic volume knowledge consisting of the traffic volume count is denote in knowledge sheets. For the traffic samples obtained for the count is reborn into PCU/hr. From this calculated PCU/hr values the saturation flow and signal timings square measure calculated. victimisation the quantity count the breadth loss of the lane and therefore the saturation flow and signal timings for the corrected approach widths is calculated.

1) *Design Principles For Traffic Signals:* Traffic signals square measure one in every of the foremost emotive and versatile active management of traffic and is wide employed in many cities worldwide. The conflicts arising from movement of traffic in several directions is self-addressed by sharing principle. the benefits of traffic light embrace Associate in Nursing orderly movement of traffic, Associate in Nursing enhanced capability of the intersection and need solely straightforward geometric style.
2) *Types Of Traffic Signals Available*

There are essentially two types of signals in general use:
Fixed-Time
Vehicle Actuated signals

3) *Fixed – Time Signal*

With fixed-time signals the inexperienced periods, and thus the cycle times, ar planned and of mounted length. The controllers ar straightforward and comparatively in high-ticket however they're essentially in versatile and need careful setting. they're most helpful in joined systems. They can be equipped with time switches to change the settings at sure periods of the day, to hide completely different traffic conditions.

IV. OBSERVATIONS AND CALCULATIONS

Step 1 – Identification of Traffic Flow Volumes

Traffic flow volumes are identified, including turning movements. The traffic volume surveys are performed at the proposed intersections and the resulting data obtained is further converted into PCU/hr values from vehicles /hr.The following are the tables which show the observed traffic volume at the proposed intersections along with the PCU/hr conversion.

Step – 2 – Calculation of Pedestrian Crossing time (sec)

Step – 3 – Calculation of minimum Green time

Step – 4 – Calculation of Revised Green Time

Step – 5 – Check for Revised Green Time

C Date: 20/09/2019

Location: Vani-vihar Junction

Day: Friday

Weather: Sunny

Direction: East

Phase: 3

Table 4.4: Field Data Sheet For Traffic Census

Time		Cars				Buses				Three Wheelers				Two Wheelers				Total
From	To	L	S	R	T	L	S	R	T	L	S	R	T	L	S	R	T	PCU
08:00	08:30	11	57	5	73	9	0	0	9	16	30	15	61	12	24	30	66	209
08:30	09:00	19	39	8	58	14	0	0	14	26	33	18	77	18	45	53	116	188
09:00	09:30	16	53	6	78	8	0	0	8	18	42	19	79	13	58	24	95	260
09:30	10:00	16	56	4	76	14	0	0	14	25	36	13	74	11	70	35	116	280
12:00	12:30	26	71	6	93	9	0	0	9	42	59	14	115	59	84	42	185	402
12:30	13:00	7	70	6	102	9	0	0	9	16	35	18	69	87	22	22	131	311
13:00	13:30	13	27	7	47	14	0	0	14	11	51	21	83	28	65	44	137	281
13:30	14:00	24	20	8	52	10	0	0	10	18	43	17	78	51	49	23	123	263
16:00	16:30	18	15	5	38	9	0	0	9	40	38	19	97	34	16	33	83	227
16:30	17:00	8	34	10	52	10	0	0	10	15	20	18	53	19	70	40	129	244
17:00	17:30	16	36	15	67	12	0	0	12	19	27	25	71	34	44	45	123	273
17:30	18:00	17	48	7	72	20	0	0	20	33	13	38	84	38	77	37	152	328
19:00	19:00	18	40	4	62	4	0	0	4	44	18	14	76	41	64	26	131	273
19:30	20:00	29	28	16	73	8	0	0	8	26	58	15	99	75	68	21	164	344
20:00	20:30	16	37	6	59	17	0	0	17	10	39	16	65	66	42	18	126	267

Peak Hour Factor (PHF) = peak hourly volume (2 x peak 30 min volume) = (402+280)/ (2 x 402) = 0.85 PCU/hr of peak traffic volume = (peak hour traffic)/PHF = (402+280)/ 0.85 = **802.35 PCU/hr**

A. Data Obtained from Traffic Volume Studies

- Width of road 1, 2, 3, and 4 = 9 m (two lanes each of 4.5 m)
  - Approach road volume of road 1 = 1513 PCU/hr
  - Approach road volume of road 2 = 2021 PCU/hr
  - Approach road volume of road 3 = 803 PCU/hr
  - Approach road volume of road 4 = 540 PCU/hr
  - Pedestrian walking speed = 1.2 m/sec
  - Design traffic on road 1 = 1513/2
    = 756.5 PCU/hr
  - Design traffic on road 1 = 2021/2
    = 1011 PCU/hr
  - Design traffic on road 1 = 803/2
    = 402 PCU/hr
  - Design traffic on road 2 = 540/2
    = 270 PCU/hr

Step 2: Pedestrian Crossing Time

(The pedestrian green time is equal to initial walk time of 7.0 sec plus walking speed of 1.2 m/sec) [as per clause 2.2.4 (i)]

Step 3: Minimum Green Time for Traffic

- Minimum green time on road 1 $G_1 = \frac{15*1011}{756.5}$ = 24.54seconds = 20 sec
- Minimum green time on road 2 G_2 = 15 sec
- Minimum green time on road 1 $G_3 = \frac{15*402}{270}$ = 22. 3 sec = 23 sec
- Minimum green time on road 2 G_4 = 15 sec

Step 4: Revised Green Time or Traffic Signals

Adding 2 seconds each towards clearance amber and 2.0 seconds inter-green period for each phase, total cycle time required forRoad 1and 2= (2+15+2) + (2+20+2), Road 3 and 4 = (2+17+2) + (2+23+2)

= 43 sec = 48 sec

Signal time may be conveniently taken in the multiples of 5 sec and so the cycle time is = 50 sec

The extra time of 50 – 48 = 2 sec per cycle may be approximated to the green times of road 3 and 4, as 1 sec and 1 sec respectively.Therefore adopt G_1 = 25 sec

G_2 = 15 sec

G_3 = 23+1 = 24 sec

G_4 = 15+1 = 16 sec

Step 5: Check for Clearing the Vehicles Arrived During the Green Phase

Vehicle arrivals per lane per cycle on Road 1 = 1011/55 = sec

Minimum green time required per cycle to clear vehicles on road 1 = 6 + (22.7 - 1.0)2 = 49.5 sec Vehicle arrivals per lane per cycle on Road 2 =756.5 /55 = 13.75 secMinimum green time required per cycle to clear vehicles on road 1 = 6 + (13.75 - 1.0)2 = 31.5 sec

so

Step 6: Check for Optimum Signal Cycle by Webster's Method

Lost time per cycle = (amber time + inter green time + lost time for the initial delay of first vehicle) for 4 phases = (2+2+4) x 4 = 32 sec. Saturation flow on road 1 = 3858 PCU/hr

Saturation flow on road 2 = 2723 PCU/hr Saturation flow on road 3 = 3858 PCU/hr Saturation flow on road 4 = 2723 PCU/hr

- Maximum Y values: y1 = 0.25

y2 = 0.34
y3 = 0.18
y4 = 0.059
Therefore,

Y = y1+ y2 + y3 + yn
Y1 = 0.25 + 0.34 = 0.59 and Y2 = 0.18+0.059 = 0.24

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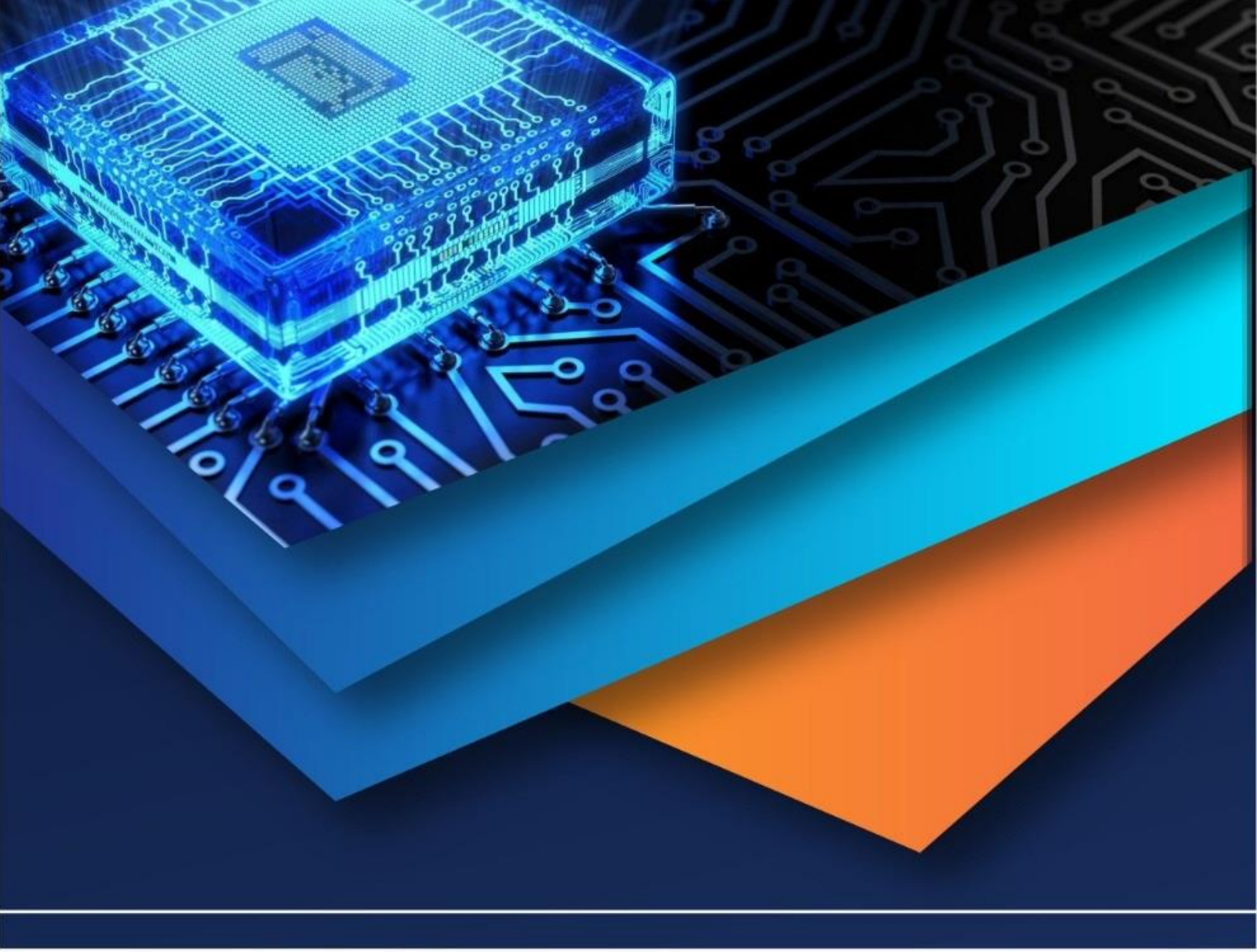

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