Proceedings of the 6th International Conference on Civil Engineering for Sustainable Development (ICCESD 2022), 10~12 February 2022, KUET, Khulna, Bangladesh

DESIGN OF A TRAFFIC CONTROL SIGNALING SYSTEM AT BHANGA RASTAR MOR (T-INTERSECTION), FARIDPUR

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ABSTRACT

The traffic signal is a graphic indication of self-control traffic movement at intersections. The signal design currently has become a notable feature for major intersections. The increasing number of vehicles at Bhanga Rastar Mor (T-Intersection) has given rise to troubles such as collisions, road accidents, and bottlenecks. One way to solve such problems is by effectively controlling traffic signals at the intersection. The traffic signal is direct control of traffic maneuvers, which reduces accidents and empowers the road safety manipulators to use the area of the road efficiently. Traffic signal timing is a procedure that minimizes vehicle delays. The traffic volume study is performed to establish the number, maneuverability, and characterization of the vehicles at the intersection. This data is utilized to ascertain expected road flows. The manual count is conducted by us twenty-four hours a day for three consecutive days to collect traffic volume data. The signal design is based solely on the Webster formulations. The total duration of the signal is resolved in this method, which describes the total slightest delay that occurs in the signal.

Keywords: *T-Intersection, Saturation Flow, Traffic Volume, Automatic Traffic Control, Traffic Signal*

1. INTRODUCTION

Traffic engineering uses technical methods to keep people and products moving safely and efficiently. It fundamentally emphasizes the analysis and development of the mobile transport required for this behavior, such as highways, traffic signals, and signs (Surisetty & Sekhar, 2017). It is also described as an engineering process that manages roads' arranging and mathematical planning, adjoining lands, and traffic service. It is linked to the safe, serviceable, and economical transport of people and properties. Besides, it is a discipline of traffic and transport calculation, analysis of the fundamental laws affecting traffic movement, development, and implementation of this expertise to the planning profession. And traffic signal is a widely used traffic control system at intersections of urban highways (Reddy & Reddy, 2016). Urban road network performance primarily depends on the traffic signals capabilities. Traffic lights, otherwise termed traffic signals, indicator lights, stop lamps, are road intersection signaling systems, passerby intersections, and different areas to control clashing progressions of traffic (Adeleke, 2020). Traffic signals are an essential feature of equipment for traffic control. The establishment of traffic lights has a focal function in computing traffic perils at the intersection. An intersection is the road network's confrontation and congestion focal point (Dinta Dwi Agung Wijaya). Bhanga Rastar Mor (T-Intersection) is one of the most important Major District Road (MDR). We observed particularly this study area facing problems like road jams and other problems like congestions, roadside vehicles, and infrastructures as the number of road users increase quickly. Because of the aforementioned limitations, its appearance in research work has been expressed thus far. Congestions arising from movements of traffic in different directions is solved by time sharing of the principle. This design has advantages to develop traffic signal system including an orderly movement of traffic, increasing capacity of the intersection. This researrch main focus was to identify different types of vehicle the oderly traffic movent in Bhanga raster Mor T-Intersection. Also design the signal timings for vehicle movement at intersection. At last, at the study area, a traffic signal is required to enable efficient traffic control and faster traffic clearance from the intersection. Design & operate traffic systems to accomplish safe and effective development of people and goods. (Reddy & Reddy, 2016)

The detailed objectives of the research work are as follows:
• To categorize the orderly traffic movement
• To design and provide the signal timings at the "Bhanga Rastar Mor T-Intersection."
• To appraise the condition of the study road.

2. METHODOLOGY

The process of signal design requires a few essential steps: (Reddy & Reddy, 2016)

(1) Three-phase design
(2) Determining of amber and clearance time
(3) specified optimum cycle length
(4) Assigning of green time
(5) Estimates of the concept as mentioned in the above analysis.

- The main goal of the three-phase design is to split the overlapping movements at the intersection into distinct phases; therefore, there can be no differences between the movements at the phase. If there were no complications to distinguish all the movements, then an enormous number of phases would be required (Yang Li).

- To illustrate the numerous step design options, find a triple-legged intersection with left and right turns. Turn left is dismissed.

Webster's Method: (Surisetty & Sekhar, 2017)

It is a critical approach to determining the optimum signal cycle time, Co corresponding to the minimum delay to all the vehicles on the approach roads of the intersection. [Surisetty & Sekhar, 2017]

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

Where,
L= Total lost time per cycle sec, $L = 2n+R$
n = is the number of phases.
R= all-red time or red-amber time
$Y= y1+y2+y3$
$y1= q1/s1,\ y2= q2/s2\ \&\ y3= q3/s3$
$G1= y1/Y\ (Co-L),\ G2= y2/Y\ (Co-L)\ \&\ G3= y3/Y\ (Co-L)$

The fieldwork consists of evaluating the following set of values near the intersection on each approach road:

- The normal flow "q" on each approach during the design hour.
- The saturation flow, S per unit time

Normal flow values are calculated during the design hours or during peak time from field studies undertaken. From diligent field studies, the saturation flow of vehicles is determined precisely by observing the number of vehicles in the compact flow stream during the green phases and the respective intervals. Essentially, the methodology is followed when there are more sign stages. (Surisetty & Sekhar, 2017)

2.1 Study Area

Bhanga Rastar Mor is located at Goalchamot, Faridpur, and is one of the busiest T-Intersections in the town of Faridpur. The DMS coordinate is 23°36'22.03" N 89°50'26.30" E. Since it has a cross-section, these three roads are connected by merges and divergences. And traffic would not be flowing in an orderly way. There is a risk for traffic delays and injuries occurring on connection. Therefore, there is a very strong need for traffic control & orderly movement. This requires a signalized cross-section.

While this is a cross-section of three roads, a traffic signal of three phases is expected. (Reddy & Reddy, 2016)

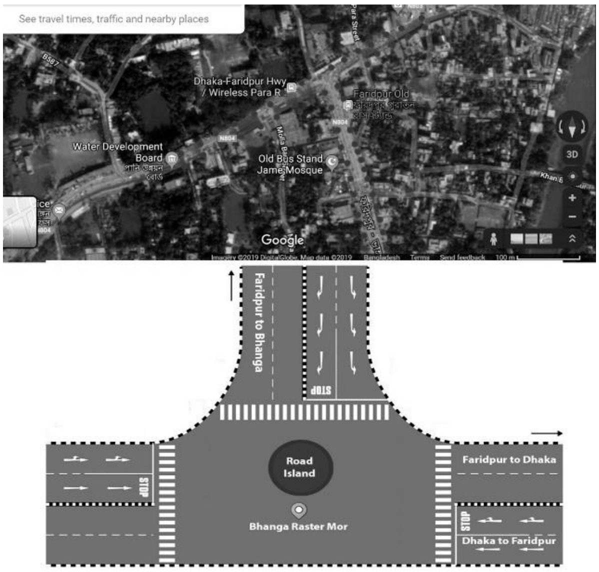

Figure 1: Study area & 2D view of "Bhanga Raster Mor"

2.2 Study Of Traffic Volume:

One of the basic measurements of traffic on the road system is the volume of traffic using the road at a given interval of time when traffic is composed of various vehicle types; it is the standard procedure to transform the flow into equal P.C.U. by using some equivalence factor. The flow is expressed as a P.C.U. (Government of the People's Republic of Bangladesh, 2001). We chose the manual method of counting.

3. RESULTS AND DISCUSSIONS

In this research work cycle time and signal timing classify in three stages. Threre are morning session, afternoon session and evening session. This results contains saturation flow, green time, cycle time ang signal timing in every session. And finally show thr real scenario at Bhanga raster Mor T-Intersection.

Calculation of cycle length (Reddy & Reddy, 2016)

Hourly Variations of Traffic in Morning Peak Hours at Bhanga Rastar Mor T-Intersection :

Table 1: Saturation flow values in the morning session

Name of the Intersection	Conflict	Maximum no. of Vehicles in PCU		
		Morning Session		
		1st Hour	2nd Hour	3rd Hour
Bhanga Rastar Mor	Faridpur to Bhanga	1827	1079	1638
	Dhaka to Faridpur	2233	1728	1513
	Faridpur to Dhaka	2164	1533	1392

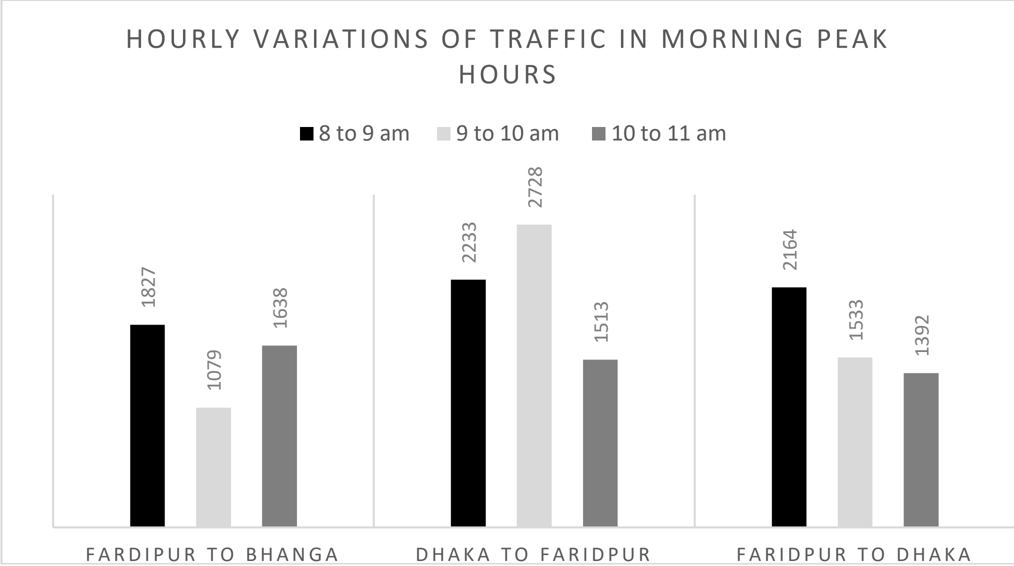

Figure 2: Hourly variations of traffic in morning peak hours

3.1 Calculation of Cycle length for Morning Session:

Table 2: Normal flow values in morning peak hours

Normal Flow		
q_1	=	327
q_2	=	584
q_3	=	537

Table 3: Saturation flow values in morning peak hours and calculation of Y

Saturation Flow		
s_1	=	1827
s_2	=	2233
s_3	=	2164

y_1	=	q_1/s_1	= .18
y_2	=	q_2/s_2	= .26
y_3	=	q_3/s_3	= .25
Y	= $y_1 + y_2 + y_3$		= .69

The cycle length according to Webster equation is determined using the formula, C_o= 1.5L+5/1-Y
Where, L=2n+R =18
Here,
n= 3
R= 12
Therefore, C_o= 10

Table 4: Calculation of green time for the morning session

Calculation of Green Time			
Formula			
$y_1(C_o\text{-}L)/Y$	Phase - 1	G_1 =	22 sec
$y_2(C_o\text{-}L)/Y$	Phase - 2	G_2 =	32 sec
$y_3(C_o\text{-}L)/Y$	Phase - 3	G_3 =	31 sec

Considering all, Pedestrian time = 12 seconds, Amber time = 2 seconds for each phase = 6 seconds for three phases. Here,
Amber Time = 6 seconds
Pedestrian time = 12 seconds
Total Cycle Time = 103 seconds

Table 5: Total cycle time and traffic signal timing for the morning session

	Phase 1		**Total Cycle Time**
22	2	79	103 seconds
Green Time	Amber Time	Red Time	
	Phase 2		103 seconds
32	2	69	
Green Time	Amber Time	Red Time	
	Phase 3		103 seconds
31	2	70	
Green Time	Amber Time	Red Time	

3.2 Calculation of Cycle length for Afternoon Session:

Hourly Variations of Traffic in Afternoon Peak Hours at Bhanga Rastar Mor T-Intersection :

Table 6: Saturation flow values in the afternoon session

Name of the Intersection	**Conflict**	**Maximum no. of Vehicles in PCU**		
		Afternoon Session		
		1st Hour	2nd Hour	3rd Hour
Bhanga Rastar Mor	Faridpur to Bhanga	2313	2044	1093
	Dhaka to Faridpur	2421	2025	1590
	Faridpur to Dhaka	2418	2312	1494

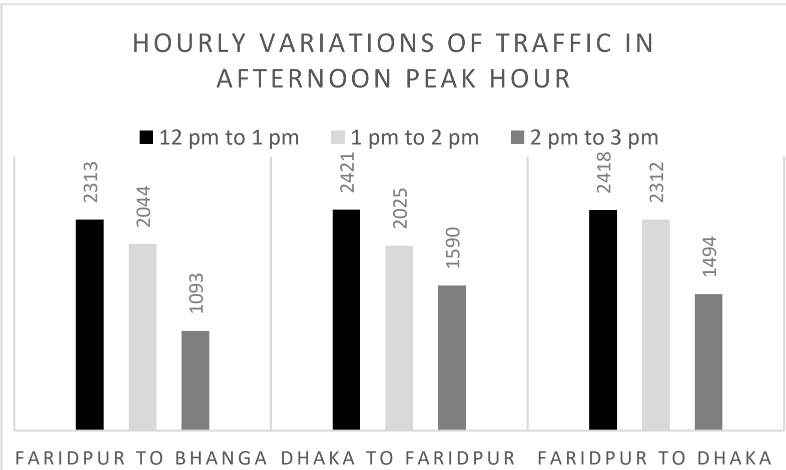

Figure 3: Hourly variations of traffic in afternoon peak hours

3.3 Calculation of Cycle length for Afternoon Session:

Table 7: Normal flow values in afternoon peak hours

Normal Flow
q_1 = 671

q_2	= 557
q_3	= 653

Table 8: Saturation flow values in afternoon peak hours and calculation of Y

Saturation Flow		
s_1	=	2313
s_2	=	2421
s_3	=	2418

y_1	=	q_1/s_1	= .29
y_2	=	q_2/s_2	= .23
y_3	=	q_3/s_3	= .27
Y	= $y_1 + y_2 + y_3$		= .79

The cycle length according to Webster equation is determined using the formula, C_o= 1.5L+5/1-Y
Where, L=2n+R =18
Here,
n= 3
R= 12
Therefore, C_o= 152

Table 9: Calculation of green time for the afternoon session

Calculation of Green Time			
Formula			
$y_1(C_o\text{-}L)/Y$	Phase - 1	G_1 =	49 sec
$y_2(C_o\text{-}L)/Y$	Phase - 2	G_2 =	39 sec
$y_3(C_o\text{-}L)/Y$	Phase - 3	G_3 =	46 sec

Considering all, Pedestrian time = 12 seconds, Amber time = 2 seconds for each phase = 6 seconds for three phases. Here,
Amber Time = 6 seconds
Pedestrian time = 12 seconds
Total Cycle Time = 152 seconds

Table 10: Total cycle time and traffic signal timing for the afternoon session

	Phase 1		**Total Cycle Time**
49	2	101	152 seconds
Green Time	Amber Time	Red Time	
	Phase 2		152 seconds
39	2	111	
Green Time	Amber Time	Red Time	
	Phase 3		152 seconds
46	2	104	
Green Time	Amber Time	Red Time	

3.4 Calculation of Cycle length for Evening Session:

Hourly Variations of Traffic in Evening Peak Hours at Bhanga Rastar Mor T-Intersection :

Table 11: Saturation flow values in the evening session

Name of the Intersection	Conflict	Maximum no. of Vehicles in PCU Evening Session		
		1st Hour	2nd Hour	3rd Hour
Bhanga Rastar Mor	Faridpur to Bhanga	2230	1822	1320
	Dhaka to Faridpur	2176	1578	1165
	Faridpur to Dhaka	2114	1576	929

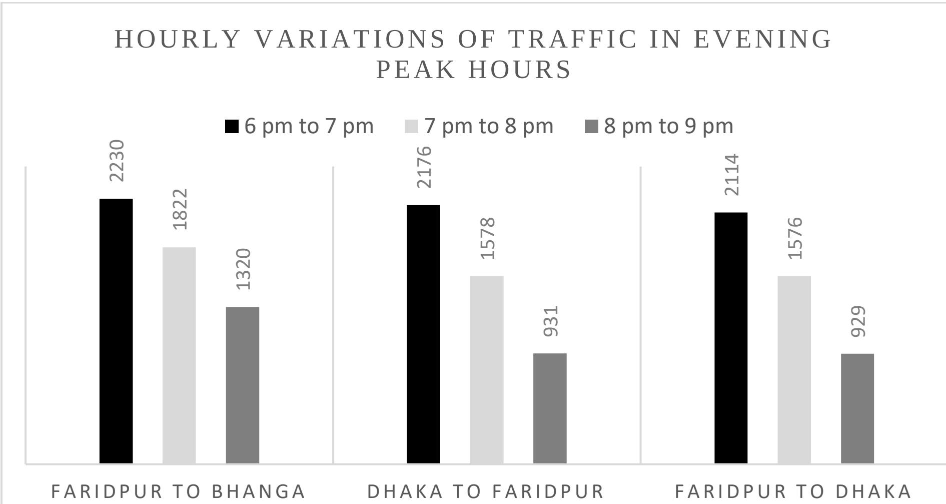

Figure 4: Hourly variations of traffic in evening peak hours

3.5 Calculation of Cycle length for Evening Session:

Table 12: Normal flow values in evening peak hours

Normal Flow
q_1 = 513
q_2 = 457
q_3 = 274

Table 13: Saturation flow values in evening peak hours and calculation of Y

Saturation Flow		
s_1	=	2230
s_2	=	2176
s_3	=	2114

y_1	=	q_1/s_1	= .23
y_2	=	q_2/s_2	= .21
y_3	=	q_3/s_3	= .13
Y	$= y_1 + y_2 + y_3$		= .57

The cycle length according to Webster equation is determined using the formula, C_o= 1.5L+5/1-Y
Where, L=2n+R =18
Here,
n= 3
R= 12
Therefore, C_o= 75

Table 14: Calculation of green time for the evening session

Calculation of Green Time			
Formula			
$y_1(C_o\text{-}L)/Y$	Phase - 1	G_1 =	23 sec
$y_2(C_o\text{-}L)/Y$	Phase - 2	G_2 =	21 sec
$y_3(C_o\text{-}L)/Y$	Phase - 3	G_3 =	13 sec

Considering all, Pedestrian time = 12 seconds, Amber time = 2 seconds for each phase = 6 seconds for three phases. Here,
Amber Time = 6 seconds
Pedestrian time = 12 seconds
Total Cycle Time = 152 seconds

Table 15: Total cycle time and traffic signal timing for the evening session

	Phase 1		**Total Cycle Time**
23	2	50	75 seconds
Green Time	Amber Time	Red Time	
	Phase 2		75 seconds
21	2	52	
Green Time	Amber Time	Red Time	
	Phase 3		75 seconds
14	2	59	
Green Time	Amber Time	Red Time	

4. CONCLUSIONS

The computation is carried out based on the PCU values collected from the traffic study; the signal interval for the morning session is 103 seconds, for the afternoon session is 152 seconds, and 75 seconds for the evening session. The incidents and crashes will be minimized by providing signals, given a secure movement of traffic at the intersection. If allowable, the intersection layout should be redesigned by including the number of approaching lanes or increasing the lane width to efficiently accommodate demand, converting intersections into roundabouts to increase capacity and ensure safety, or converting cross-sections into continuous flow intersections for improved execution. Implementation of road improvement at approaches to acquire general path widths with defined pavement markings to direct drivers and enhance direction field for effective utilization of the intersections. Traffic control authorities should take enforcement measures against motorists who decrease lane width by on-street parking at intersections to maximize saturation flow and demand for reserve storage spaces. Local government councils should ensure the involvement of traffic management and security agencies at junctions to reduce the rate of red-light running that causes incidents and obstructs free flow.

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