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Regulating the Traffic Flow to 60th Road Khartoum, Sudan using the Green Wave System

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ABSTRACT : Sixtieth road is one of the main roads in Khartoum state –Capital of Sudan, and it's the widest road in the Khartoum state, the length of this road equal (6,880.0) meters, and it has seven traffic lanes with two Medians, and it has ten surface intersections. Overlooking this road is the most famous high-end residential neighborhood in the state of Khartoum, and the volume of traffic on this road is relatively large. Sixty road extends from the intersection of Al-Manshiya Bridge in the north to the intersection of Madani road in the south, and due to the large number of surface intersections of this road, it was necessary to coordinate the traffic signals on it, in order to facilitate movement on this road without frequent stops.In this study, the information required to coordinate the light signals with the green wave system, which is the distance between successive intersections and the number of lanes at each intersection, was collected. Traffic volume was also measured at all intersections. The study found a design of the light signals for all intersections in the green wave system, with a length of 135 seconds.

KEYWORDS: *Sixtieth road, green wave system, intersections, traffic signals*

I. INTRODUCTION

The most commonly-used linking system works with a cycle time common to all intersections and the signals are so timed that the `go' periods are staggered in relation to each other according to the road speed to give a 'progression' of green periods along the road in both directions [1 - 6]. Thus road speed should be considered "reasonable" by drivers; if speeding is common before linking, and then a measured speed will be too high for safe operation. In this case, a desired speed should be used to ensure that the platoon conforms to the legal limit [7 - 10]. The timings of the signals in a simple progressive system can be prepared with the aid of a tune-distance diagram, examples of which are shown in Figures 1 and 2.

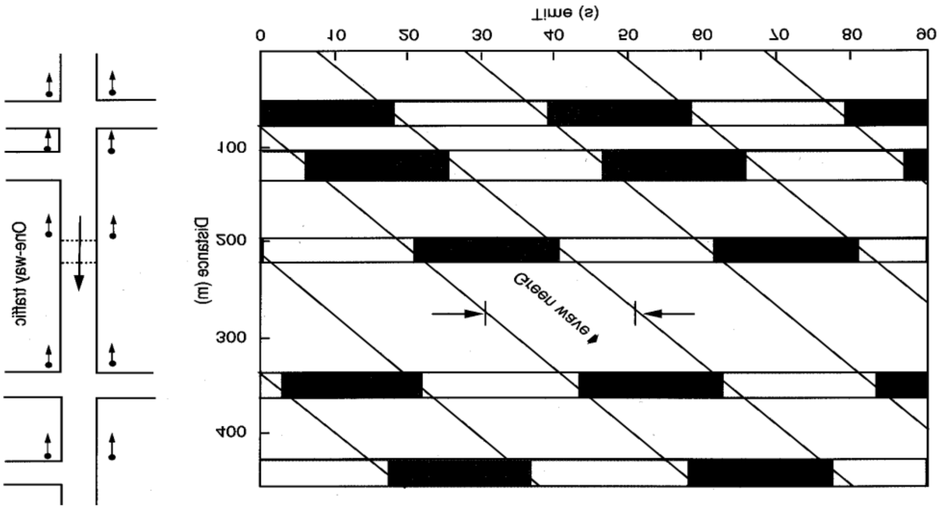

Figure 1 Co-ordinated signals for one-way traffic

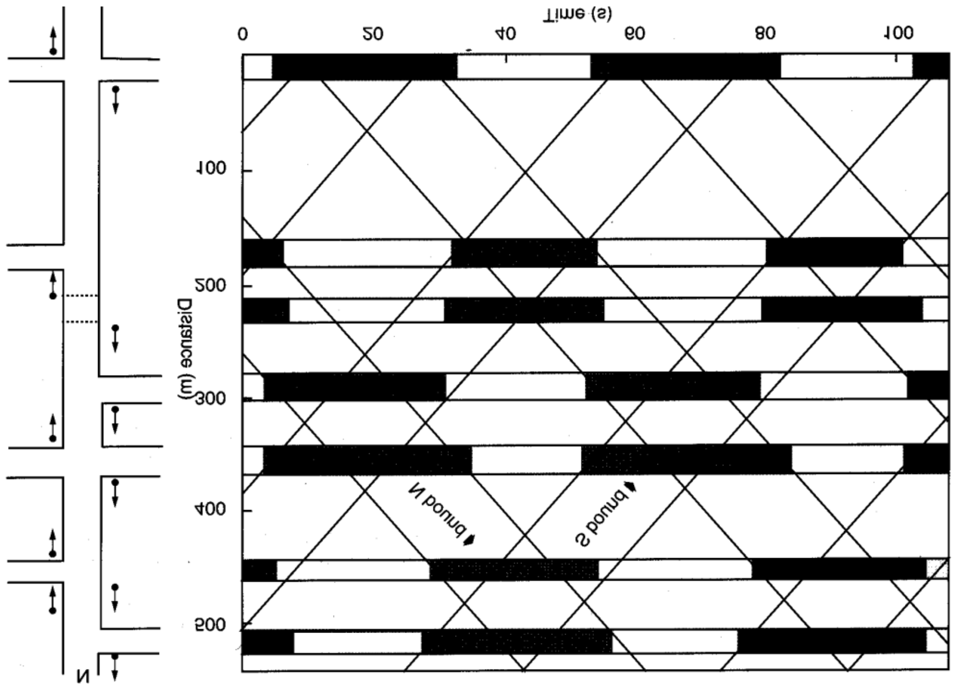

Figure 2 Co-ordinated signals for two-way traffic

On these diagrams, distances between junctions along the route are plotted along the abscissa (y axis) and the travel times are plotted along the ordinate (x-axis). The slopes of diagonal lines represent the chosen speed of progression and green stages of successive junctions are offset in time. Normally the problem is one of determining, by trial and error, the optimum through-band speed and width for a fixed cycle time. For one-way roads, the green bands follow each other in sequence. The driver, having passed one intersection, will then receive right of way at the others.

When the flow of traffic is two-directional and where the intersections are not equally spaced, the situation is more complex and it may be necessary to come to a compromise on progression between the two directions. It may also be necessary to take into account other requirements such as demands from cross- road traffic. In heavy city center traffic a design `speed' of about (40km/h) usually gives good results. For suburban traffic, where traffic is lighter and signals are about 300m apart, a design velocity of about (60km/ h) can be used as a first estimate, provided this does not conflict with local speed restrictions. On two-way roads, good coordination can usually be obtained by using a common cycle time equivalent to twice the average travel time between junctions [11 - 13].

II. LITERATURE SURVEY

60^{th} road is one of the main roads in the Khartoum state - Sudan; this road is considered the widest road in the state, the length of this road is 6,880.0 meters, the width of 7 traffic lanes, without the central medians, it has ten superficial intersections. It is located on this road, the most famous high-end residential neighborhood in the Khartoum state; traffic volume on this road is relatively large. 60^{th} road extends from the intersection of Al-Mansheya Bridge in the north direction to the intersection of Madani road in the south direction (Figure.3).

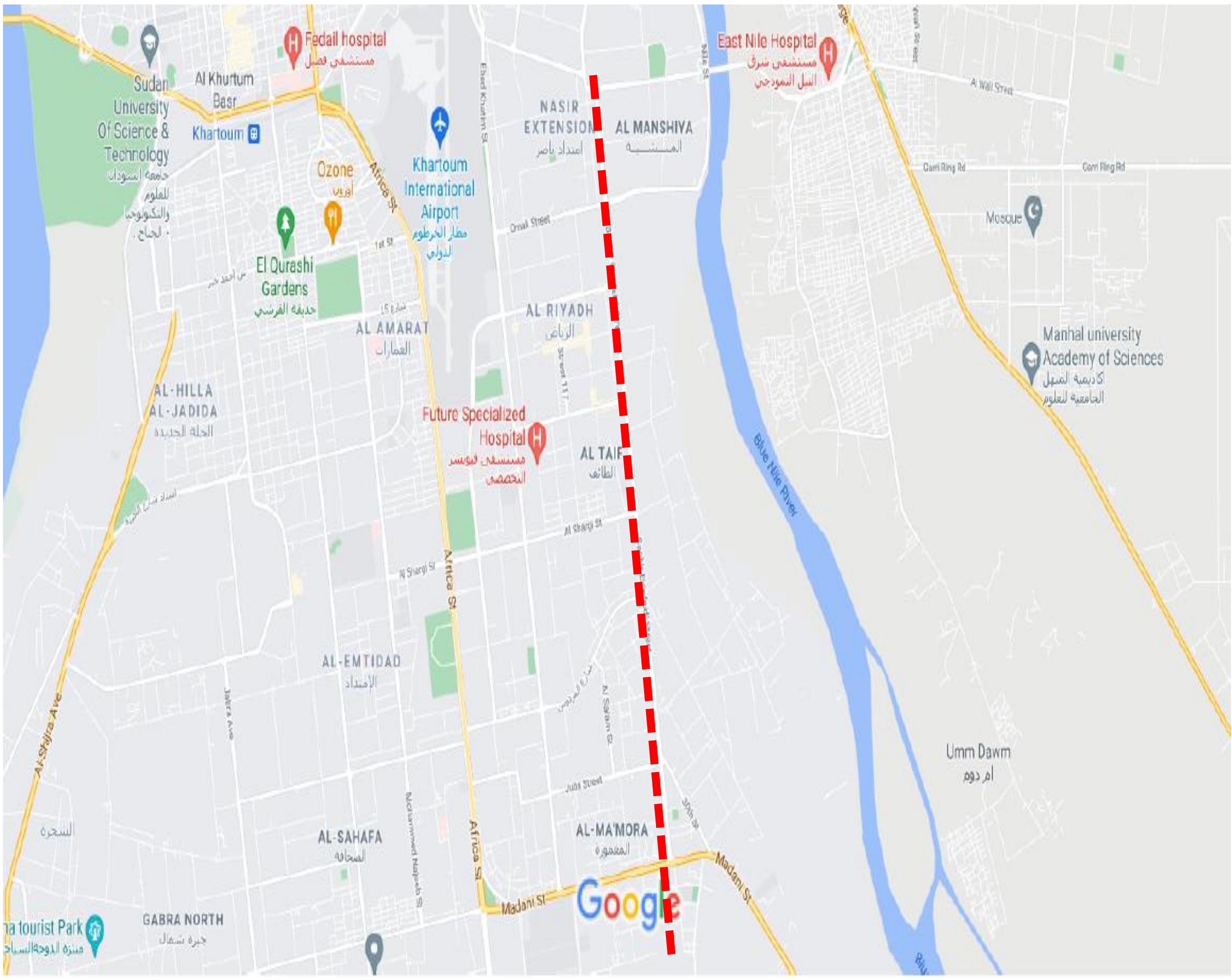

Figure 3 Screen shot of 60th road Gate from Google map

The field information was collected and results are shown in Table 1 and Figure 4.

***Table.1** The number, names and shapes of intersections on the 60th road.

No	Intersection Name	Shape
1	Mansheya Bridge	T Section
2	Alsafarat	+ Section
3	Omak	+ Section
4	Almashtl	T Section
5	Mukah	T Section
6	Abdullah AlTayeb	T Section
7	Alshargi	+ Section
8	Alblabil	T Section
9	juba	+ Section
10	Madni road	T Section

1.Mansheya Bridge Intersection

2.Alsafarat Intersection

3.Omak Intersection

4.Almashtl Intersection

5. Mukah Intersection

6.Abdullah AlTayeb Intrsection

7. Alshargi Intersection

8. Alblabil Intersection

9. juba Intersection

10. Madni road Intersection

Figure 4 Screen shot of shapes of intersections on the 60th road Gate from Google map

III. METHODOLOGY

*Calculate the total length of the road and the distance between successive intersections (Table 2).

Table.2 Length between the intersections

From	To	Length (m)
Mansheya Bridge	Alsafarat	490.0
Alsafarat	Omak	530.0
Omak	Almashtl	730.0
Almashtl	Mukah	400.0
Mukah	Abdullah AlTayeb	620.0
Abdullah AlTayeb	Alshargi	1,000.0
Alshargi	Alblabil	750.0
Alblabil	juba	1,470.0
juba	Madni road	890.0
Total Length (Km)		**6,880.0**

*Calculating the number and width of lanes on 60th road and the roads connected to it (Table 3).

Table.3 number and width of lanes on 60th road

No	Intersection Name	width of lanes (m)	
		60th St.	Roads
1	Mansheya Bridge	17.5	14.0
2	Alsafarat	17.5	07.0
3	Omak	24.5	14.0
4	Almashtl	24.5	14.0
5	Mukah	24.5	07.0
6	Abdullah AlTayeb	24.5	07.0
7	Alshargi	24.5	07.0
8	Alblabil	21.0	14.0
9	juba	21.0	14.0
10	Madni road	21.0	14.0

* Traffic survey's/count shown in Tables 4.A and 4.B

Table.4.A Normal flow, Saturation flow on 60th road

Tree Phase (T Section, six Intersections)*					
FROM	**N**		**W**	**S**	
TO	**S**	**W**	**N&S**	**N**	**W**
Q (Pcu/hr)	2574	332	257	362	351
S (Pcu/hr)	5400	1800	1800	1800	1800

*The maximum traffic volume was chosen from among the six intersections

Table.4.B Normal flow, Saturation flow on 60th road

Four Phase (+ Section, four Intersections)*												
FROM	**N**			**S**			**E**			**W**		
TO	**S**	**E**	**W**	**N**	**E**	**W**	**N**	**S**	**W**	**N**	**S**	**E**
Q (Pcu/hr)	224	450	347	420	153	210	152	256	233	284	241	243
S (Pcu/hr)	3600	1800	3600	1800	1800	1800	1800	1800	1800	1800	1800	1800

* The maximum traffic volume was chosen from among the four intersections

IV. CALCULATION OF CYCLE LENGTH

Three phase intersection

(Mansheya Bridge, Almashtl, Mukah, Abdullah AlTayeb, Alblabil and Madni road)

- C0 =(1.5L+5)/(1-Y)
- L = 2N+R
- G1 = (Y1/Y)(C0-L)
- G2 = (Y1/Y)(C0-L)
- G3 = (Y1/Y)(C0-L)

Where:

- ✓ C0 = Optimum cycle length (sec).
- ✓ L = Total lost time per cycle (sec).
- ✓ Y = Maximum value of the ratios (Q/S).
- ✓ N = Number of phases.
- ✓ R = All red time (sec).
- ✓ Q = Normal flow (Pcu/hr).
- ✓ S = Saturation flow (Pcu/hr).

4.2 Four phase intersection

(Alsafarat, Omak, Alshargi and juba)

INPUT DATA		
N=	4.0	Sec
R =	8.0	Sec
L =	16.0	Sec

	Phase.1, N		
FROM	N		
TO	S	E	W
Q (Pcu/hr)	224	450	347
S (Pcu/hr)	3600	1800	3600
y (q/s)	0.06	0.25	0.10
Y max		0.25	

	Phase.2, E		
FROM	E		
TO	N	S	W
Q (Pcu/hr)	152	256	233
S (Pcu/hr)	1800	1800	1800
y (q/s)	0.08	0.14	0.13
Y max		0.14	

	Phase.3, S		
FROM	S		
TO	N	E	W
Q (Pcu/hr)	420	153	210
S (Pcu/hr)	1800	1800	1800
y (q/s)	0.23	0.09	0.12
Y max		0.23	

	Phase.4, W		
FROM	W		
TO	N	S	E
Q (Pcu/hr)	284	241	243
S (Pcu/hr)	1800	1800	1800
y (q/s)	0.16	0.13	0.14
Y max		0.16	

Σ Ymax = 0.78

C0 =	134	Sec
Take C0	135	Sec
G.1 (N)=	38	Sec
G.2 (E)=	22	Sec
G.3 (S)=	35	Sec
G.4 (W)=	24	Sec

	Pase (1)	Phase (2)	Phase (3)	Phase (4)
	N	E	S	W
TG (sec)	38	22	35	24
T(G/Y) (sec)	2	2	2	2
T (R) (sec)	90	106	93	104
T(Y) (sec)	5	5	5	5

INPUT DATA		
N=	3.0	Sec
R =	6.0	Sec
L =	12.0	Sec

Phase.1		
From		N
To	S	W
Q (Pcu/hr)	2574	332
S (Pcu/hr)	5400	1800
y (q/s)	0.48	0.18
Y max		0.48

Phase.2	
From	W
To	N&S
Q (Pcu/hr)	257
S (Pcu/hr)	1800
y (q/s)	0.14
Y max	0.14

Phase.3		
From		S
To	N	W
Q (Pcu/hr)	362	351
S (Pcu/hr)	1800	1800
y (q/s)	0.20	0.20
Y max		0.20

Σ Ymax = 0.82

C0 =	128	Sec
Take C0 =	135	Sec
G.1=	71	Sec
G.2=	21	Sec
G.3=	30	Sec

	Pase (1)	Phase (2)	Phase (3)
	N	W	S
TG (sec)	71	21	30
T(G/Y) (sec)	2	2	2
T (R) (sec)	57	107	98
T(Y) (sec)	5	5	5

V. DISCUSSION OF RESULTS

The (T-section) intersections (6 intersections) were designed with a three-phase traffic light due to the presence of three arms, total cycle time = 130 seconds, while the (+ section) intersections (4 intersections) were designed with a four-phase traffic light because they consist of four arms, the total cycle time = 135 seconds, it was chosen that the total cycle time for all intersections equal to 135 seconds (Table 5).

Table.5 Cycle length for green wave

No	Intersection Name	Shape	Cycle length (from design) (Sec).	Cycle length (for green wave) (Sec).
1	Mansheya Bridge	T Section	130	135
2	Alsafarat	+ Section	135	135
3	Omak	+ Section	135	135
4	Almashtl	T Section	130	135
5	Mukah	T Section	130	135
6	Abdullah AlTayeb	T Section	130	135
7	Alshargi	+ Section	135	135
8	Alblabil	T Section	130	135
9	juba	+ Section	135	135
10	Madni road	T Section	130	135

According to the distance between the ten intersections (in meters) and considering that the average speed of walking on this road is (50Km/hr), the time of the green wave between the intersections was determined, which is as shown in Table 6.

Table.6 Time between intersections (sec)

From	To	Distance (m)	Speed (Km/hr)	Time between intersections (sec)
Mansheya Bridge	Alsafarat	490.0	50.0	35
Alsafarat	Omak	530.0	50.0	38
Omak	Almashtl	730.0	50.0	53
Almashtl	Mukah	400.0	50.0	29
Mukah	Abdullah AlTayeb	620.0	50.0	45
Abdullah AlTayeb	Alshargi	1000.0	50.0	72
Alshargi	Alblabil	750.0	50.0	54
Alblabil	juba	1470.0	50.0	106
juba	Madni road	890.0	50.0	64

VI. CONCLUSION

From the results of this study, the following conclusions have been drawn:

- The total length of 60th road is equal to 6,880.0 meters, and the number of its intersections is equal to ten surface intersections.
- The distance between intersections is unequal.
- The light signals are all working, but need to modify the geometric design to match the design of the green wave signal.
- There are four traffic signals that need maintenance and rehabilitation.
- Standardization of the traffic signal cycle time for similar intersections.
- Improving the geometric design at all intersections in 60th road in order for the green wave system to function properly.

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