Improvement of Traffic Operation in Congested Intersections for the CBD of Baghdad

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Abstract

The concept of capacity and level of service are central to the analysis of intersections, as they are for all types of facilities, however the two concepts are not as strongly correlated as they are for other facility types. It is critical to note at the outset, however that both capacity and level of service must be fully considered to evaluate the overall operation of the intersections. The objectives of the present study include the analysis, evaluation and improvement the operation of selected intersections in the CBD of Baghdad and to present a best proposal to enhance the performance at the required facility. Three congested intersections; Khullani, Wathba and Amin which are located at AL-Jomhoriya Street in the CBD of Baghdad are selected to achieve the objectives of the present study. The required traffic and geometrical data gathered manually and the (O – D) survey technique is used to estimate the distribution of traffic in different directions. SIDRA and TRAFFICQ programs are used for the requirements of traffic analysis process. It has concluded that the proposed improvement for the mentioned intersections is necessary to enhance the capacity and the operation at AL-Jomhoriya Street in CBD of Baghdad.

الخلاصة

إن مفهومَ الاستعيابية ومستوى الخدمةِ هو مفهوم رئيسي في تحليلِ التقاطعاتِ، كما هو الحال لكُلّ أنواع الخدمات، على أية حال فأن المفهومان ليسا مَرْبُوطان بقوة كما هو الحال لأنواع الخدمات الأخرى. ومن مُلاحَظة المحددات منذ البداية، فأنة . يجب درس كل من الاستيعابية ومستوى الخدمةِ لكي يتم تقييم التشغيل الكلي للتقاطعاتِ. تَتضمّنُ أهدافُ الدراسةِ الحاليةِ التحليلِ وتقييمِ وتحسينِ تشغيلِ التقاطعاتِ المختارةِ في مركز بغداد ولتَقديم أفضل اقتراح لتَحسين الأداءِ في الخدمة المطلوبةِ. لقد تم اختيار ثلاثة تقاطعاتِ مُزدَحَمةِ؛الخلاني,الوثبة, الأمين والتي تقع في شارع الجمهورية في مركز بغداد لإنْجاز أهدافِ الدراسة الحالة. وتم جمع معلومات عن طلب المرورُ والبياناتُ الهندسية يدوياً وتم استخدام تقنية (O-D) تقنية مسح تُستَعملُ لتَخمين توزيع المرور في الاتجاهات المختلفة. وقد تم استخدام برنامجي SIDRA وTRAFFICQ لمتطلباتِ عمليةِ تحليلِ المرور. وتم الاستنتاج بأنّ التطوير المُقتَرَحَ للتقاطعاتِ المَذْكُورةِ ضرورية لتَحسين الاستيعابية وعملية التشغيل في شارع الجمهورية في مركز بغداد CBD.

1.Introduction

The underlying objective of level of service analysis is to quantify a roadway's performance with regard to specified traffic volumes (i.e., its ability to efficiently handle a specified volume of traffic). This performance can be measured in terms of travel delay (as the roadway becomes increasingly congested) as well as other factors. The comparative performance of various roadway segments (which is determined from an analysis of traffic) is important because it can be used as a basis to allocate scarce roadway construction and improvement funds (1, 2).

Capacity is simply defined as the highest traffic flow that a roadway is capable of supporting. For level of service analysis, a consistent and reasonably precise method of determining capacity must be developed within the definition. Because it can readily be shown that the capacity of a roadway section is a function of factors such as roadway type (e.g., freeway, multilane highway without full access control, or rural road), free-flow speed, number of lanes, and widths of lanes and shoulders (3,4). Al-Jomhorria street represents the major street in the central business district (CBD) of Baghdad city. The section between Al-Tahrer square and Amin intersection is the most congested part in CBD. Fig. 1 shows the studied area that, consist of four intersections. These intersections are:

1. Tahrer square
2. Khullani square
3. Wathba square
4. Amin intersection

Khullani square is the highest congested intersection in Baghdad, because it contains five arms in addition to high traffic volume. Khullani square is located closely to the following three bridges; (Rasheed, Jomhorria, and Ahrar bridge) and from previous traffic volume survey, the peak hour volume is 10000 veh/h. The link between Wathba square and Amin intersection has the same problem due to the concentration of commercial activities and high pedestrian volume which increase the conflict with the vehicle movement.

To improve the level of service in Jomhorria street, it is very necessary to solve the problem of congestion in Khullani square and the section between Wathba and Amin intersections .The present study proposes to establish an overpass along Jomhria street at the congested sections. Two programs were used in evaluating and analyzing the calculation at three intersections (Khullani, Wathba and Amin). These programs are:

- SIDRA program
- TRAFFICQ program

Manual count for traffic volume was used in this study and many other data were collected at three intersections manually.

2.Traffic volume and Peak Hour Factor (PHF)

The required traffic data were collected in 2005; manual traffic counts were used to collect data from 7:00 A.M to 7:00 P.M at the following three intersections:

- Khullani square
- Wathba square
- Amin intersection

Accordingly, the peak hour volume was specified to be adopted as a design hour volume. For Khullani and Wathba square, the peak hour volume is found to be between 10:00-11:00 A.M. and between 11:00-12:00 A.M. for Amin intersection. Fig. 2, 4, and 6 show the variation of traffic volume for the above mentioned intersections respectively. The details of the counts of the peak hour volume are illustrated in Fig. 3, 5 and 7. The PHF was calculated according to the following formula:

PHF= total volume in peak hour / max. Volume for 15 min. × 4

PHF Khullani sq. = 10141/10368 = 0.98

PHF Wathba sq. = 5921/6236 = 0.95

PHF Amin int. = 4941/5248 = 0.94

The distributions of traffic volume at peak hour at Khullani, Wathba, and Amin intersections are shown in Fig. 8, 9 and 10 respectively. These Figures show the turning movement at the stop line, geometric layout phasing sequence and cycle time.

Fig.(1): Satellite Image Studied Area.

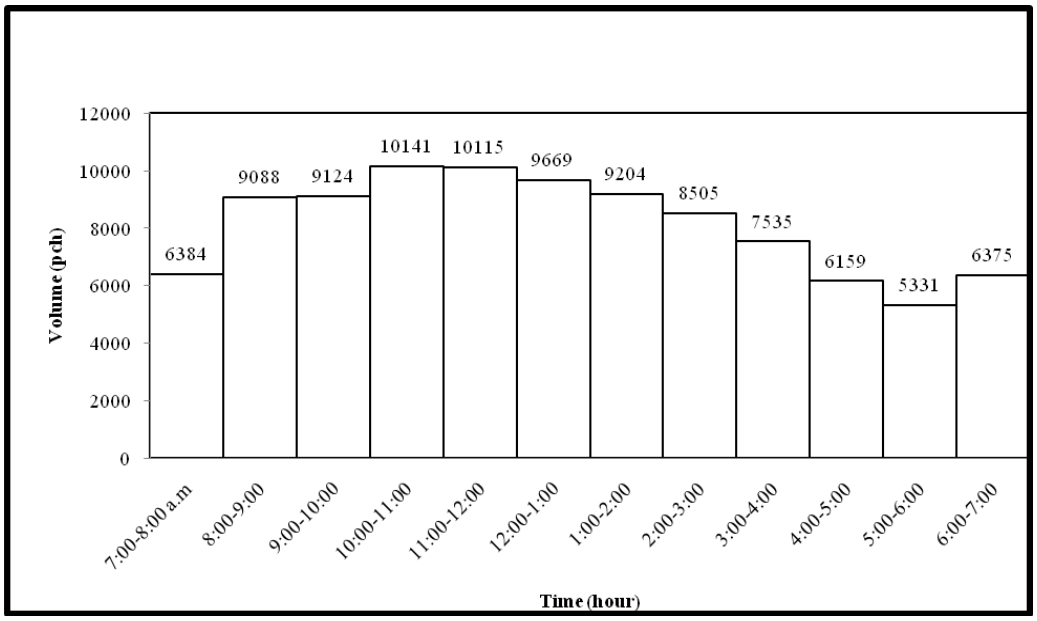


Fig.(2) Traffic volume in Khullani Square from 7:00 A.M. to 7:00 P.M.

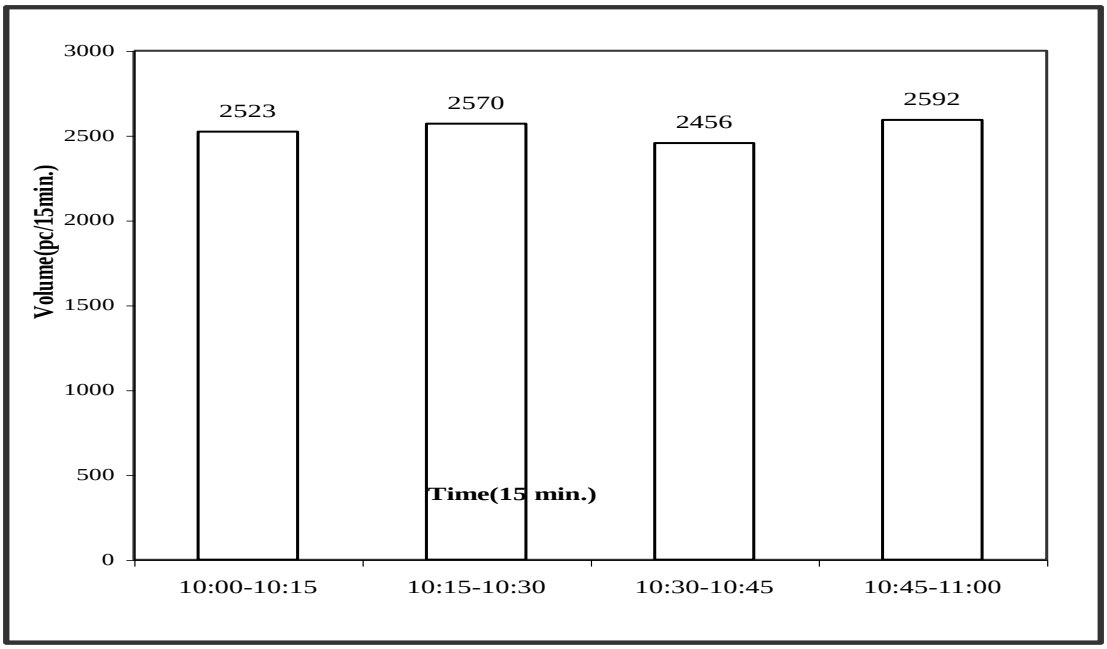


Fig. 3 – Variation of traffic volume in Khullani Square at peak hour

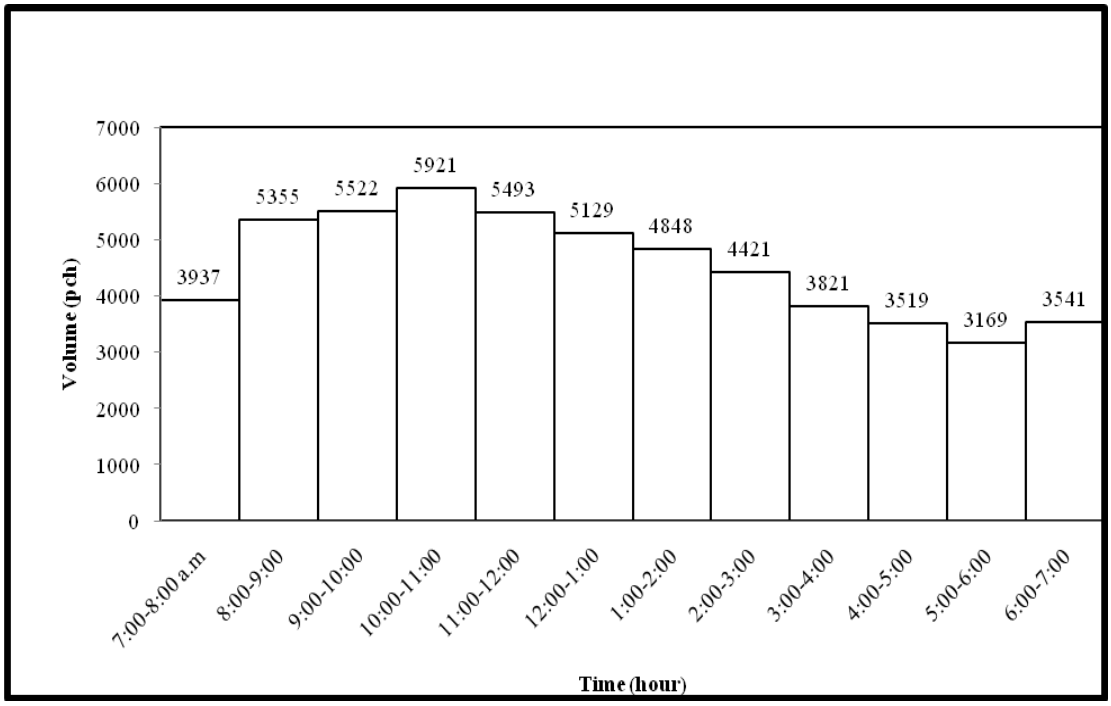


Fig. 4 – Traffic volume in Wathba Square from 7:00 a.m.to 7:00 p.m.

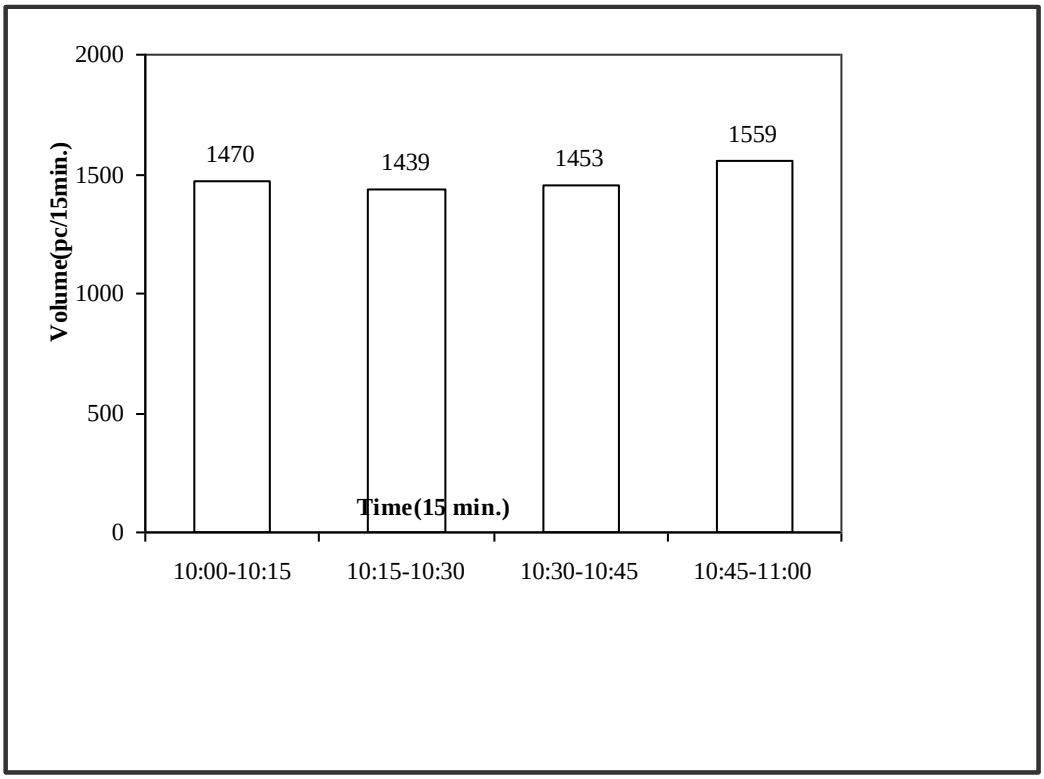


Fig. 5 – Variation of traffic volume in Wathba Square at peak hour

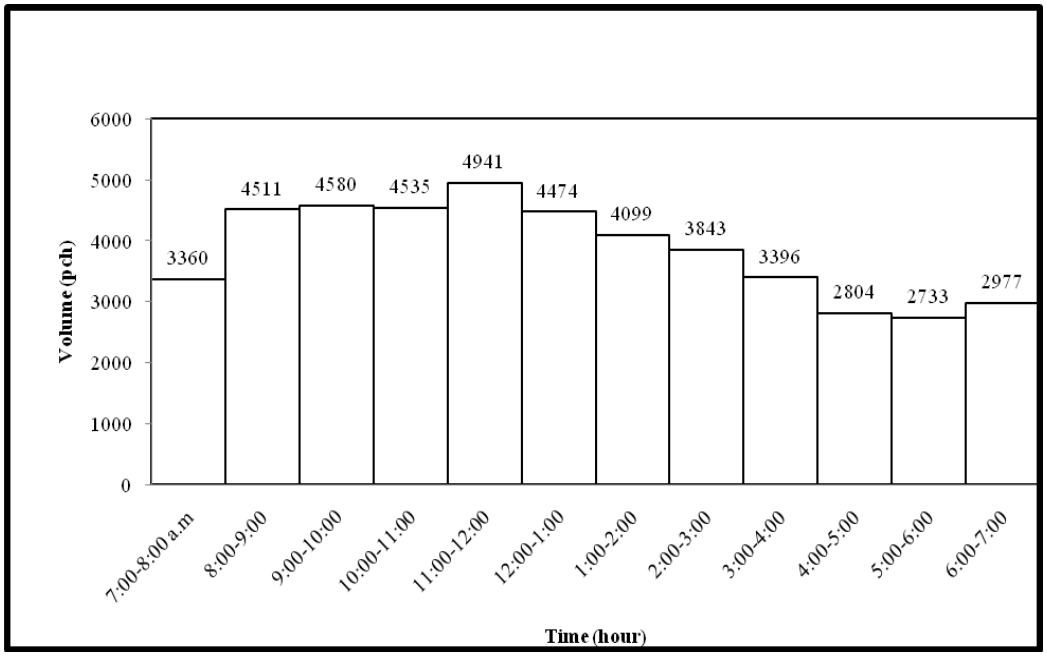


Fig. 6 – Traffic volume in Amin intersection from 7:00 a.m. to 7:00 p.m.

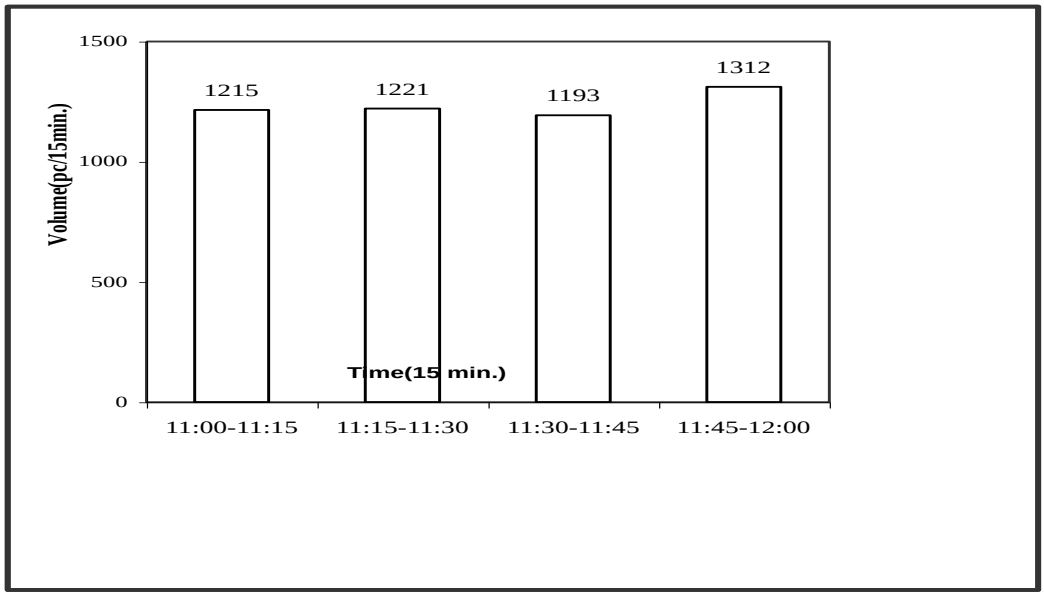
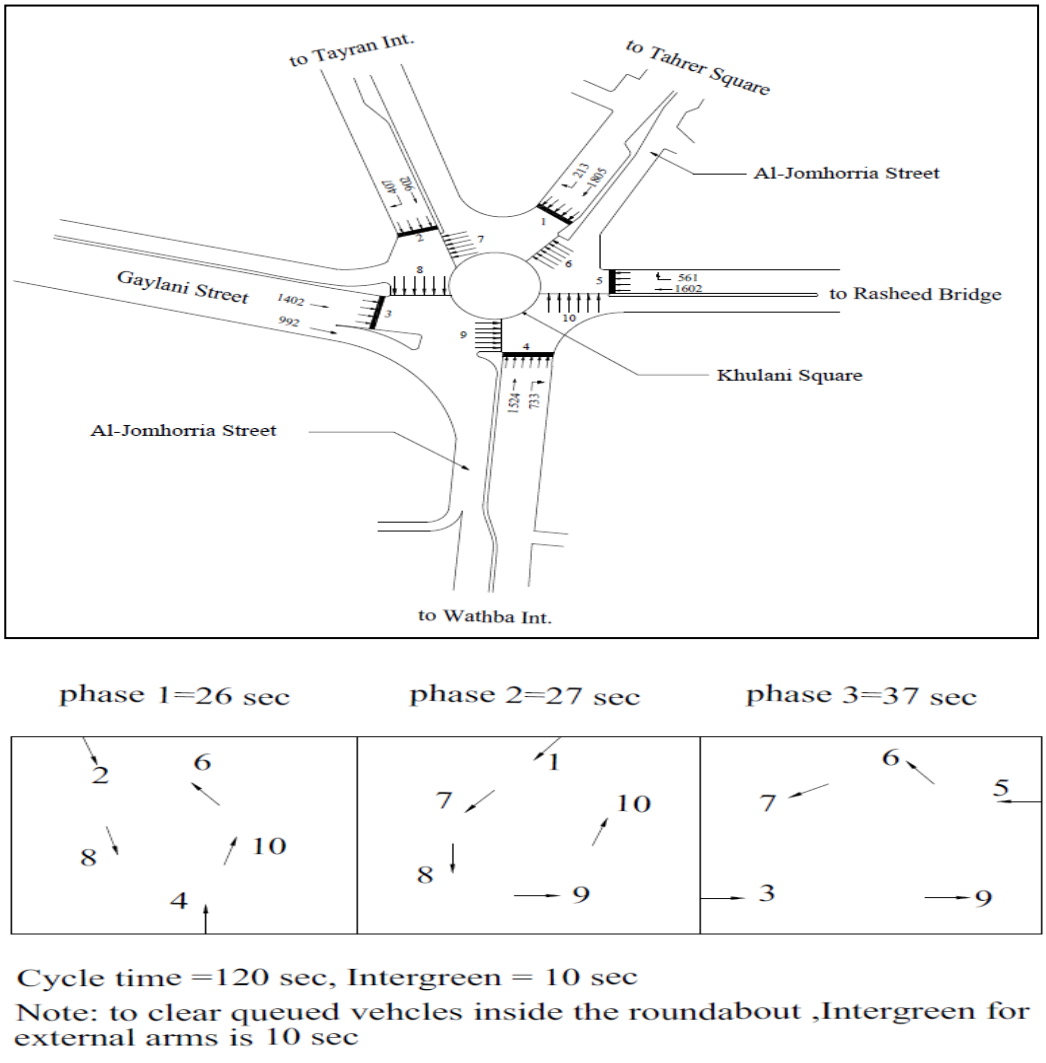


Fig. 7 – Variation of traffic volume in Amin intersection at peak hour



Fig(8)- Geometric layout, phasing sequences, cycle time and traffic volume for Khullani Sq. at peak hour.

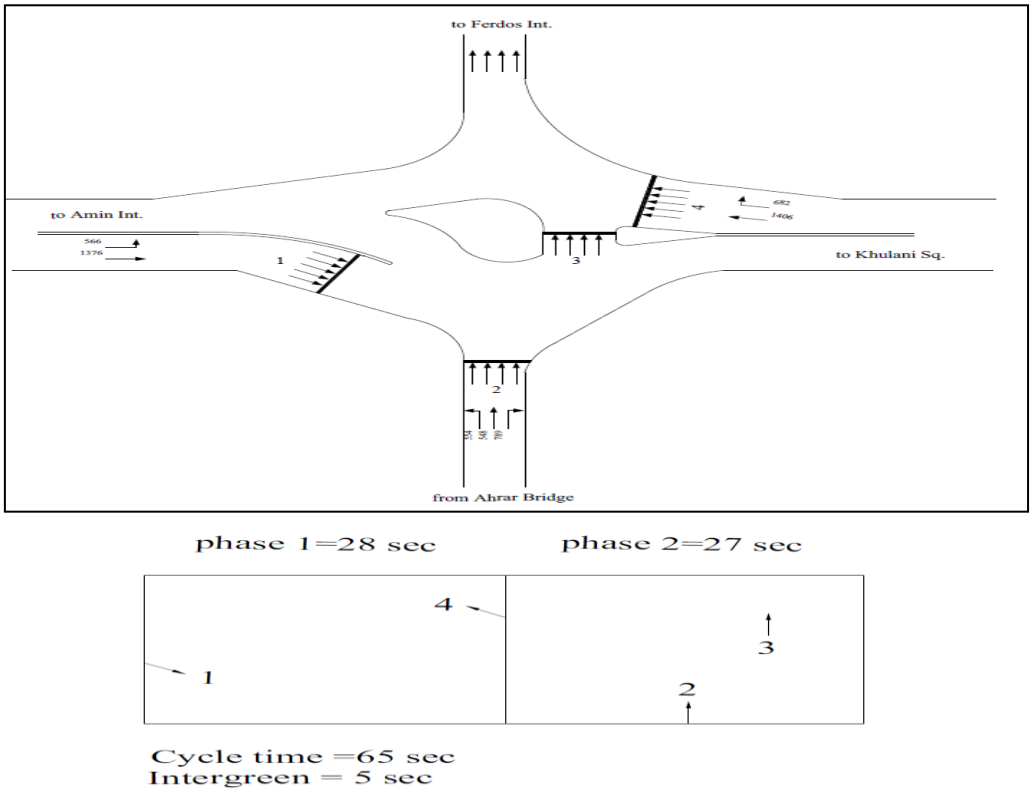


Fig (9) - Geometric layout, phasing sequences, cycle time and traffic volume for Wathba Sq. at peak hour.

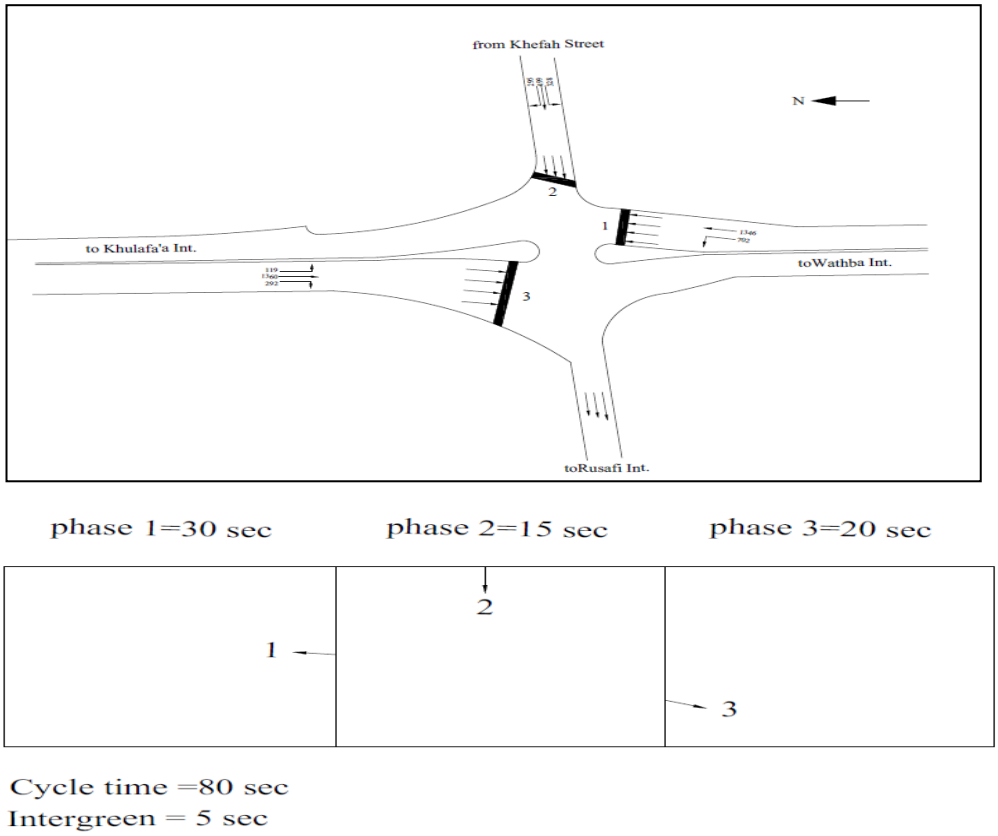


Fig (10)- Geometric layout, phasing sequences, cycle time and traffic volume for Amin Int. at peak hour.

3. Origin - Destination survey in Khullani square

Because Khullani square is a large Roundabout with five arms, it is very difficult to calculate the distribution of vehicles (left and through movement) from any approach to another. This distribution is very important for the applications of SIDRA and TRAFFICQ programs. To forecast the number of vehicles those will be served by the proposed overpass along Al-Jomhorria Street, stickers' method was used to estimate the distribution of vehicles (origin-destination) for all approaches. The results of the O-D matrix are very important in the analysis of this study especially for the applications of TRAFFICQ program. Table 1 shows the total distribution of vehicles from any approach to another at this intersection. The external zone numbers and queuing points according to TRAFFICQ requirements are shown in Fig. 11.

Table 1- Origin-Destination volume for all approaches in Khullani square in pcu

From / to	Tahrer sq.	Tayaran sq.	Gayllani str.	Wathba sq.	Rasheed br.
Tahrer sq.	141*	213	466	745	453
Tayaran sq.	143	25*	407	326	408
Gayllani str.	290	169	79*	992	864
Wathba sq.	938	211	268	107*	733
Rasheed br.	561	450	747	320	85*

- in TRAFFICQ program, the flow from any approach to the same approach was added to the left turning movement at a stop line because this program can't accept any flow from any zone to the same zone(5).

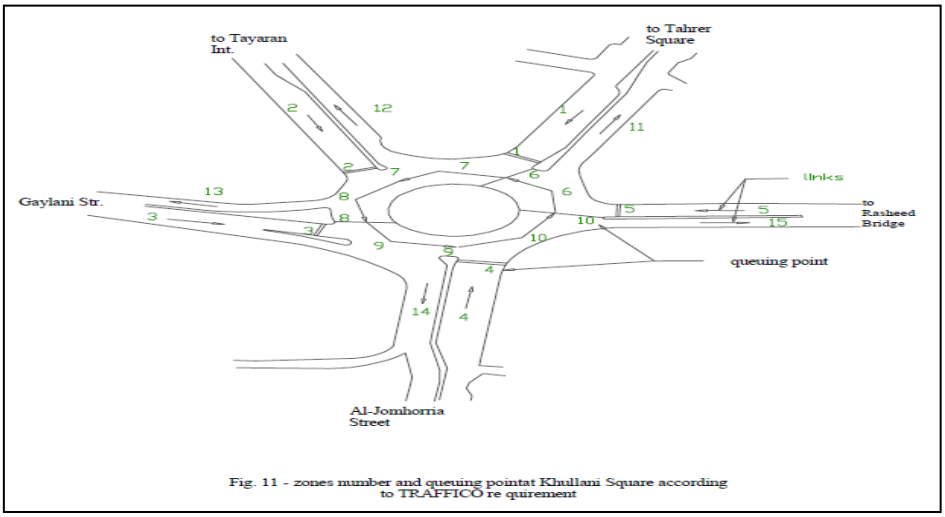


Fig. 11 - zones number and queuing pointat Khullani Square according to TRAFFICQ re quirement

Fig 11- Zone Number and Queuing Point at Khullani Square According at TRAFFICQ Requirements

4. Saturation flow

Saturation flow is the main considered parameter in the present study that used in calculations for this study, thus existing saturation flow was calculated at a stop line according to an Australian traffic volume account method (2). Results were used in SIDRA and TRAFFICQ programs to evaluate the level of service LOS for the existing and proposal geometric. Table 2 present the results of the existing calculations for saturation flow in the considered intersections:

Table 2 – Existing saturation flow at the stop line

Intersection	Saturation flow (pc/h)		
	Left turning	Through move.	Right turning
Khullani sq.	1500	1600-1650	1500
Wathba sq.	1500	1600-1650	1500
Amin int.	1500	1600-1650	1500

5. Analysis and Calculations

SIDRA and TRAFFICQ programs were applied in this study for the requirements of evaluating and analyzing the three signalized intersections,. SIDRA program was used in Khullani, Wathba, and Amin intersections while TRAFFICQ program was used in Khullani square only because this program is sensitive and gives accurate results for coordinated links, which are existed at Khullani square. SIDRA program was used in Khullani Square for its good results for external links.

5.1- Khullani square

This square consists of five arms controlled by traffic signal. The layout and phasing are shown in Fig. 8. Peak hour in Khullani square was found to be between 10:00 A.M. and 11:00 A.M. As previously mentioned, the total number of vehicles during the peak hour was 10000 veh/h. By using SIDRA program, the following parameters were calculated;

- Degree of saturation
- Average delay
- Practical spare capacity
- Level of service (LOS)

For the existing condition, the results are shown in Table 3. From these results it was found that the practical spare capacity in Khullani square has a negative value, of (-18%). This negative value means that Khullani square was operating in over-saturated level.

Table 3- Existing degree of saturation, average delay, and LOS in Khullani square

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From Tahrer sq.	1.08	239.8	F
From Tayaran sq.	0.89	67.4	E
From Gayllani sq.	0.68	35.2	D
From Wathba sq.	1.09	225.5	F
From Rasheed Br.	1.06	188.2	F
Average value		117.0	F

To improve the level of service in Khullani square, it is proposed to construct an overpass along Al-Jomhorria Street which has the highest volume while the other direction along Rasheed Bridge there is no enough distance because this bridge is located closely to Khullani square. This overpass must serve the approach of Tahrer square - wathba square in two direction and also connect Tahrer square with Gaylani Street in one direction to reduce the number of vehicles which used the ground level as shown in Fig. 12. By this type of overpass we can improve the level of service in Khullani square to be accepted.

This proposal needs to redesign khullani square to provide enough island width for the requirements to execute the columns for the proposed overpass and to get an accepted level of service at the ground level. This design was evaluating by SIDRA program to check the LOS for external approaches. It was found that the results for new geometric and overpass proposal gave a practical spare capacity equal to 18%. Table 4 shows summary results of SIDRA program.

Table 4- Degree of saturation, average delay, and LOS in Khullani square(applying overpass construction proposal)

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From Tahrer sq.	0.74	46.5	D
From Tayaran sq.	0.76	40.6	D
From Gayllani sq.	0.52	23.2	C
From Wathba sq.	0.75	39.8	D
From Rasheed Br.	0.75	28.3	C
Average value		28.2	C

SIDRA program give inaccurate results for links inside the Roundabout because this program is not sensitive for coordination which exists in the phasing of Khullani square.

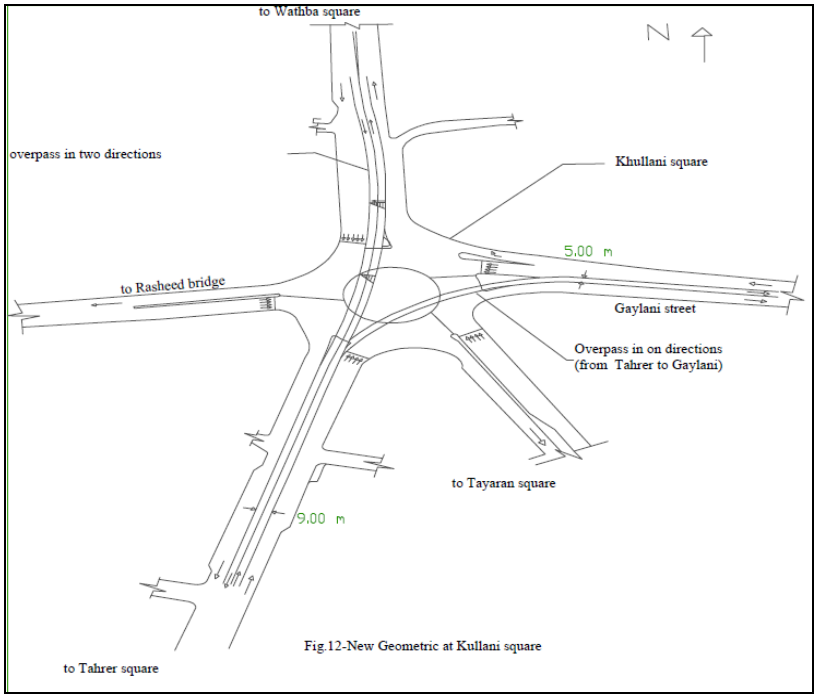


Fig 12 .New Proposed Geometric Design at Kullani Square

TRAFFICQ program was used to test the level of congestion for links inside the Roundabout to check whether the queue length of vehicles is more than the length of link. To run TRAFFICQ program, a new layout was prepared according to requirements of this program. Fig. 11 shows all queuing points and links in Khullani square. Links numbered 6, 7, 8, 9, and 10 represent links inside the Roundabout which are needed to be checked. TRAFFICQ program results for links inside the Roundabout for existing condition are shown in Table 4.

Table 5- TRAFFICQ results for links inside the Roundabout at Khullani square for existing condition

Approach	Aver. Queue (meters/app.)	Travel time (sec/veh)
Link no. 6	18.3	15.7
Link no. 7	14.9	15.9
Link no. 8	17.4	28.4
Link no. 9	10.2	20.8
Link no. 10	8.5	12.3

For new design proposal in which Khullani square contain a fly over passing through the Roundabout, average queue length and travel time for links 6, 7, 8, 9 and 10 are shown in Table 6.

Table 6- TRAFFICQ results for links inside the Roundabout at Khullani square after overpass construction

Approach	Aver. queue (meters/app.)	Travel time (sec/veh)
Link no. 6	18.2	16.4
Link no. 7	12.1	16.7
Link no. 8	19.9	22.4
Link no. 9	10.5	20.8
Link no. 10	10.1	20.8

From Table 6, it seems that the results of queue length and travel time for new proposed design are accepted. In addition, SIDRA program gave a practical spare capacity of 18% with an accepted degree of saturation and LOS C.

5.2 – Wathba Square

This square consists of four arms with traffic light. One of these arms was operated in one direction. The layout and phasing are illustrated in Fig. 8. For Existing condition, SIDRA program gave a degree of saturation 0.84. The summary of results for the traffic analysis of this square is presented in Table 7. The practical spare capacity in Wathba square is 8%.

Table 7- Existing degree of saturation, average delay, and LOS in Wathba square

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From khullani sq.	0.79	22.9	C
From Amin int.	0.835	27.2	C
From Ahrar Bridge	0.81	17.7	B
Average value		19.9	C

To improve the LOS at Wathba square and reduce the congestion in the section between Wathba and Amin int., an overpass is proposed to be constructed along Al-Jomhorria Street. Figure 13 shows the new layout for the existing street and intersection for the same section. Results of degree of saturation and average delay for new proposed design are shown in Table 8, and the new practical spare capacity for Wathba square is found to be 35%.

Table 8- Degree of saturation, average delay, and LOS in Wathba square after overpass construction

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From khullani sq.	0.49	16.4	B
From Amin int.	0.64	17.6	B
From Ahrar Bridge	0.66	10.3	B
Average value		9.5*	B

* There is a filter right movement in which reduce the value of average delay

5.3 – Amin intersection

Layout and phasing for Amin intersection are obvious in Fig. 9. For existing condition, SIDRA program results show that the degree of saturation 0.88, which is too close to practical degree of saturation. The summary of results for this square are presented in Table 9 . The practical spare capacity is 1%.

Table 9- Existing degree of saturation, average delay, and LOS in Amin intersection

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From Wathba sq.	0.887	36.3	D
From Zubayda sq..	0.837	45	D
From Amin int.	0.882	47	D
Average value		37.9	D

The proposed overpass street along Al-Jomhorria street as shown Fig. 13 and 14 will serve the flow along Al-Jomhorria street directly, which will reduce the congestion in Wathba square and Amin intersection.

Results of degree of saturation and average delay for new proposed design for Amin intersection are shown in Table 10, while the new practical spare capacity is 33%.

Table 10- Degree of saturation, average delay, and LOS in Amin intersection after overpass construction

Approach	Degree of saturation	Average delay sec/veh	Level of service (LOS)
From Wathba sq.	0.67	20.3	C
From Zubayda sq..	0.68	26.5	C
From Amin int.	0.66	27.6	C
Average value		22.1*	C

- There is a filter right movement in which, reduce the value of average delay

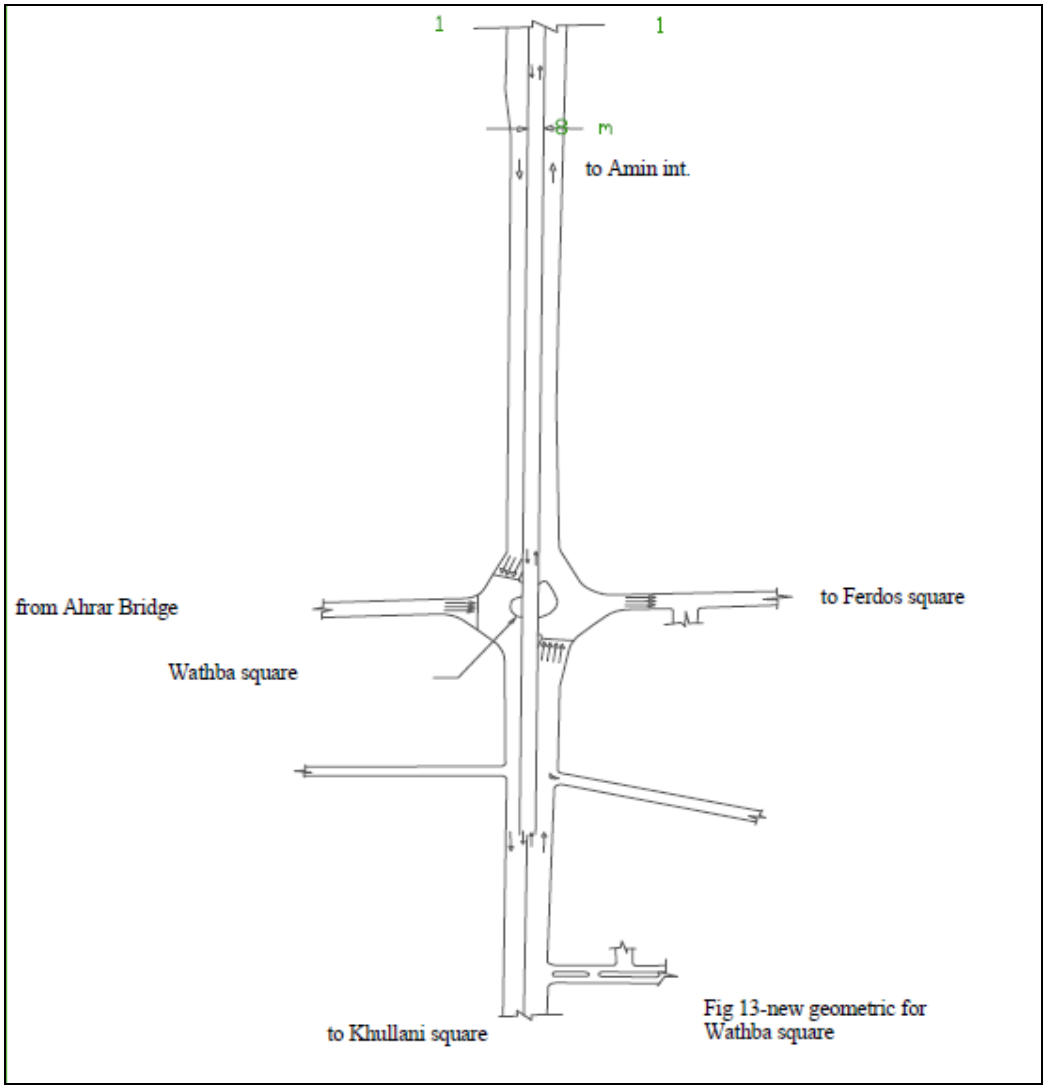


Fig. 13 New Proposed Geometric Design for Wathba Square

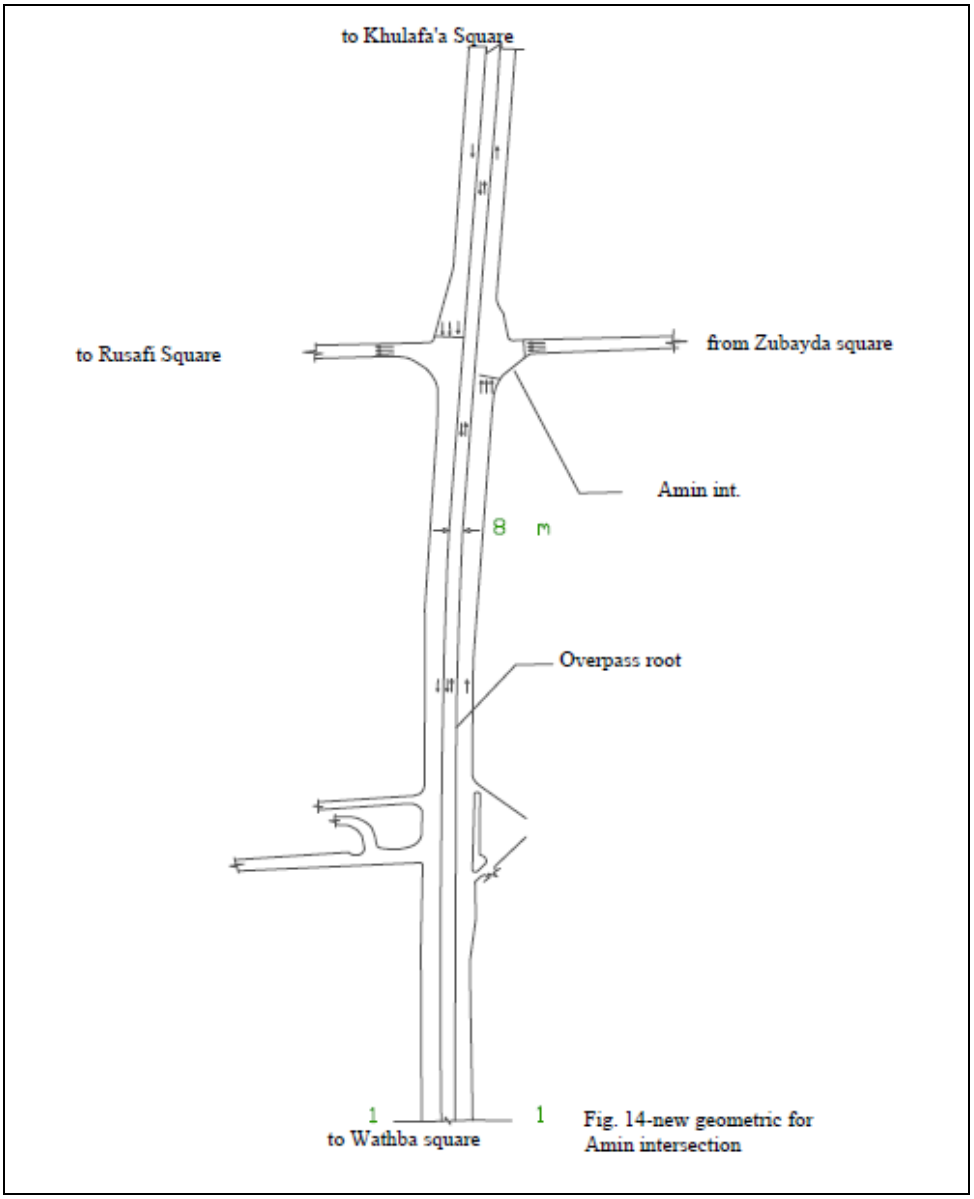
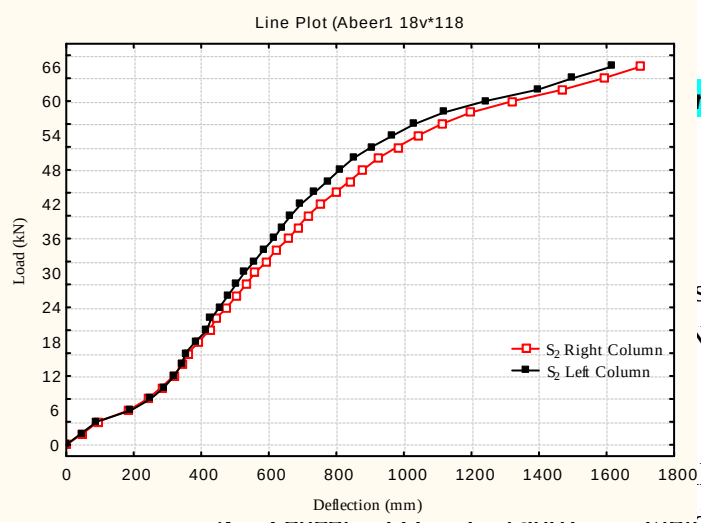


Fig. 14 New Proposed Geometric Design for Amin Intersection.

6.Conclusions

During the analysis of the study area, it was concluded that the proposed improvement for the mentioned intersections by establishing an overpass along AL- Jomhria street in CBD of Baghdad is necessary to enhance the capacity and the operation at the congested sections.



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