PERFORMANCE AND DESIGN OF TWO INTERSECTIONS IN TRIPOLI CITY

Thesis

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STATEMENT OF AUTHENTIFICATION

Herewith I started that this thesis has never been published in other institution and there were no part of thesis has been directly form published sources except citing form listed bibliographies attached.

Semarang, April 2011

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DEDICATION

To all those who love me and those that I love.

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First my praise to Almighty Allah for giving me the power and will to complete this study and peace be upon his final Prophet and Messenger Mohamed, SAW.

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ABSTRACT

The increasing numbers of motor vehicles in Libya, all kinds from private cars, private transport, taxis and trucks and heavy equipment an indication of the severity of congestion on major roads between main and interior cities, there is continual congestion, traffic congestion is frequently a problem through weekdays between most of the intersections in the cities.

A methodology was proposed to reductions in delay and queuing traffic as well as improvement in mobility via a case study optimization using Indonesian Highway Capacity Manual IHCM to evaluating the performance of existing intersections and optimizes the Performance for each intersection by signal coordination.

Through the results of existing data the intersections show the low performance by high numbers in average intersection delay and average no. of stops. But this performance will be expected to perform better by changing the approach width and the new cycle time which was calculated using IHCM as shown the results, coordinate between them, it gives the full performance.

Keywords

Signalized intersections, IHCM, Traffic delay, Optimize the Performance, cycle length and signal coordination.

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CHAPTER I

INTRODUCTION

1.1 THE BACKGROUND OF THE STUDY

The increasing urban traffic congestion in major occidental cities and the reduction of urban space for the construction of new roads and roundabouts has lead traffic signal control to play a central role in nowadays urban traffic management (Hook 1995). Despite the growing research on the topic, the problem of urban intersections congestion remains an open issue: even in cities where advanced traffic management systems are in operation, sudden changes in traffic flow caused by accidents or congested conditions due to rush hours are commonly managed by manually operated timing plans (FHWA, 2008). In many situations of daily life, it addresses the problem of providing services to the requirements of random. Consider the simple case of drivers who arrive at a junction with traffic lights, if the arrival rate is heavy and the rate of supply is unable to cope, it is inevitable that increases in the queue. Delay occurred as a result. In fact, queuing and delays to traffic at intersections, especially at the traffic light is a common problem in dealing with urban traffic. In this perspective, it is necessary to apply appropriate management of traffic at intersections critical to minimize the effect of delays and queues for the global system of circulation (Chaudhary A. 2002).

The increasing numbers of motor vehicles in Libya, all kinds from private cars, private transport, taxis and trucks and heavy equipment an indication of the severity of congestion on major roads between main and interior cities, there is continual congestion, traffic congestion is frequently a problem through weekdays. Tripoli is growing very fast for the last ten years, both geographically and administratively, many of Tripoli streets and roads network started to suffer from various traffic problems. More and more policies and regulations are being developed at Tripoli level, particularly in the field of traffic and transport (Elmloshi & Ismail, 2010).

This study aims to demonstrate reductions in delay and queuing traffic as well as improvement in mobility via a case study optimization using the manual methods of Indonesian Highway Capacity Manual (IHCM,1997).

1.2 PROBLEM STATEMENT

This study will focus on two signalized intersections in Tripoli city, Figure 1.1, 1.2, show study area. These intersections experience congestion at the rush hours. It is frequently observed in a rapidly growing Tripoli city that traffic congestion and long queues at intersections occur during peak hours. Traffic congestion has become part of the daily routine of the city of Tripoli, and became the queues of cars that exceed in some cases, several kilometers long a familiar sight in those intersections and roads. This problem is mainly due to the poor setting signal timing and no coordination between the intersections, resulting in inefficient progressive traffic flows other problems.

Figure 1.1 Location of Tripoli city

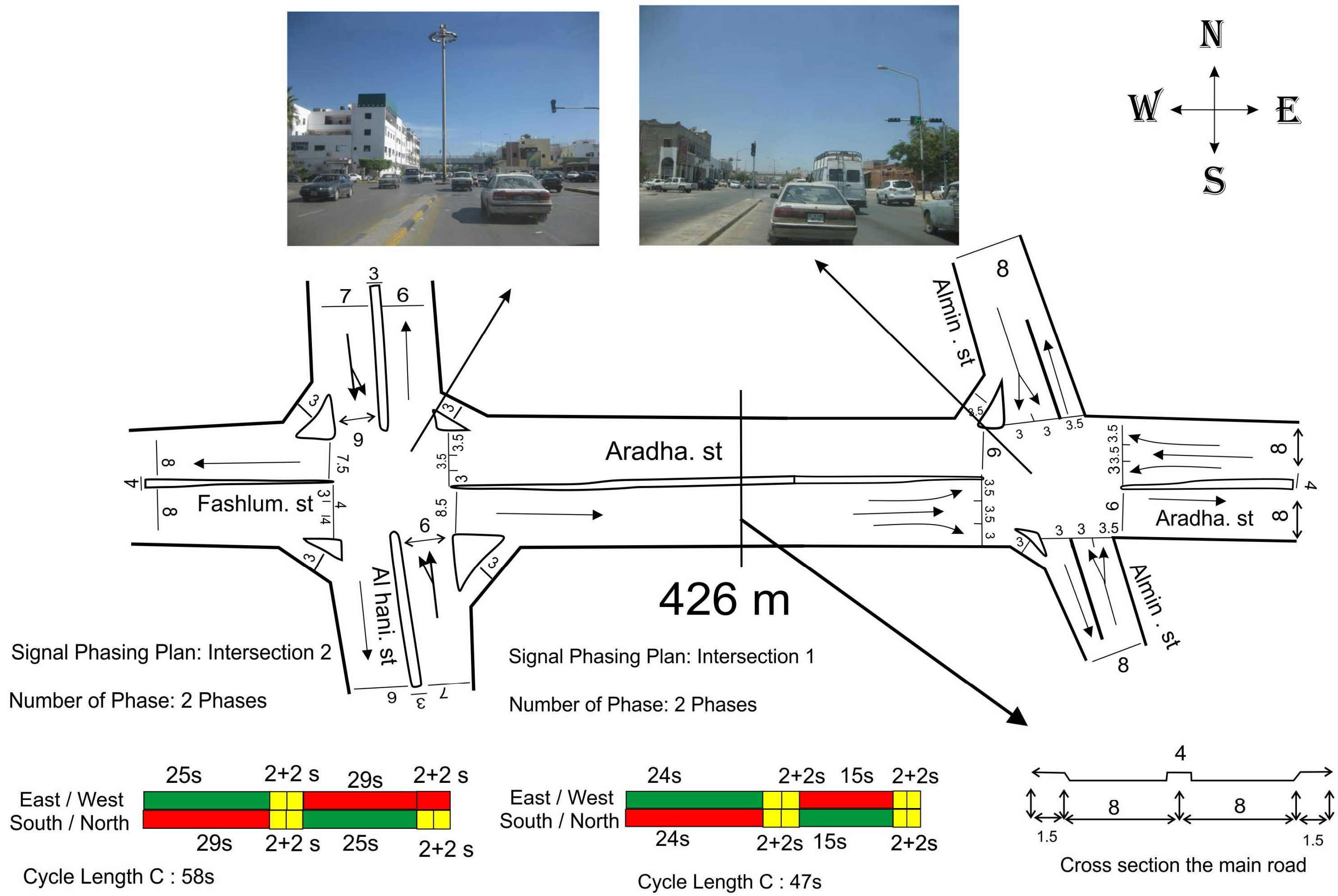


Figure 1.2 Study area in Tripoli

1.3 STUDY OBJECTIVES

The purpose of this study is to develop a framework for a sustainable transportation system and demonstrate the proposed framework with a case study. In order to accomplish the purpose, the objectives of this study are identified as follows:

1- Evaluating the performance of existing intersections.
2- Optimize the Performance for each intersection by signal coordination.

Hopefully that the results of this study will help Tripoli city officials bang to understand the reason for the delay at the intersection, and find solutions for the time interval, and try to make the mode of transport most important and save the people

1.4 SCOPE OF STUDY

This study focuses on the estimation of delays and queue lengths that result from the adoption of a signal control strategy at intersections, as well as on a sequence of intersections. Traffic delays and queues are principal performance measures of intersections. In the evaluation of the adequacy of cycle length, the obtained minimum delay being the foremost goal to the traffic engineers.

CHAPTER II

LITERATURE REVIEW

2.1 SIGNAL TIMING PARAMETER

The development of efficient signal timing plans for urban traffic networks has always been a challenging task for the traffic analyst. These networks can be quite complex in nature, serving a variety of vehicular and non-motorized users, and private as well as public transportation modes. Further, the performance of signal control strategies on such networks is quite difficult to predict due to the stochastic nature of traffic flows, as evident by day-today variations in traffic demand, vehicle composition and service times (Park. B. 2003) .

By extension, the production of signal control strategies that can effectively respond to such variations is also quite difficult to achieve. It is no coincidence, therefore, that signal timing methods are developed almost exclusively in macroscopic, deterministic traffic environments. For example, all the traditional optimization models for isolated, signalized intersections cited in (Click and Rouphail, 1999) fall in the category of macroscopic deterministic approaches.

Direct optimization in the context of this document refers to the use of a single, high-fidelity traffic model both for signal timing generation and for plan evaluation. Direct optimization provides a highly flexible environment for solving the signal timing optimization problem.

Coordinating two or more signals on a signalized arterial requires the determination of the following four signal-timing parameters to achieve the desired results or objectives:

1. Cycle length.
2. Green splits.
3. Phase sequence or order.
4. Offsets.

Providing or maintaining safe flow of traffic and pedestrian traffic at each signal in the system is very important. Engineers achieve this objective by selecting phase clearance times that satisfy minimum requirements based on operational needs and driver expectancy. In addition, engineers can coordinate signals to achieve one or more of the following objectives:

a) Minimizing delay.
b) Minimizing number of stops.
c) Maximizing progression efficiency.
d) Minimizing queue size at approaches.
e) Maximizing system throughput.

All of the above objectives may not apply under a given set of geometric and traffic conditions. Even if they do all apply, it may not be possible to fully achieve all objectives simultaneously. Delay to vehicles at a link, for instance, is a function of how much time vehicles spend traveling on the link and the time they spend stopped in queue at a signalized approach. Neither of these delays can be completely eliminated. Thus, engineers desire to minimize this delay. They can minimize time spent waiting during a red phase by using a smaller cycle length, which produces less red time and shorter cycle-by-cycle queues. However, since a smaller cycle length also produces smaller green time, the number of stops to vehicles may increase. In addition to using a smaller cycle length, engineers can minimize delay by timing the lights such that the bulk of vehicles arrive during green. In minimizing delay, priority is given to the most significant traffic stream (through or cross street) flowing from an upstream signal to the downstream signal.

Maximizing progression, on the other hand, gives priority to arterial through traffic. Thus, it minimizes stops and delay to through traffic at the expense of cross-street traffic, so it may not result in the lowest possible total delay. Signal timings providing maximum through progression are easily noticed and appreciated by drivers. The reason is that these drivers generally do not mind extra delay at minor approaches, but they do not like a situation where they have to stop many times while traveling through on the arterial. On the other hand, drivers cannot easily notice differences in delay.

Minimizing the size of a queue of vehicles becomes a necessity under many geometric and traffic scenarios, listed below:

1- A queue of vehicles in a turn bay starts to interfere with, or spills back into, the adjacent lane.
2- A queue in a through lane extends to, or beyond, the entrance to an adjacent turn bay.
3- A link queue reaches near, or spills back into, the upstream signal.

2.2 SIGNALIZED INTERSECTION

As the number of vehicles in use increases in all developing countries the most severe congestion is being experienced in urban areas where the number of junction severely restricts traffic flow. Urban Transport has many particular features in the form of journey to work peak hour, congestion, traffic restrain measures, public transport priorities ect. The usual solution to the problem of junction capacity has been either to make the area of the junction larger, or to adopt grade separation. The former is difficult to achieve in congested urban areas and the latter is extremely expensive. It is therefore important to investigate every possible means of increasing the capacity of single level junction so that delays are reduced.

Intersection is of the greatest importance in highway design because of their effect on the movements and safety of vehicular traffic flow. The actual place of intersection is determined by setting and design and the act of intersection by regulation and control of the traffic movement. Priority control of traffic at junction is one of the most widely used ways of resolving the conflict between merging and crossing vehicles. The universal adoption of the 'Give Way to traffic on the right' rule at roundabouts together with the use of 'Give Way' and 'Stop' control at junctions has considerably increased the number of occasions at which a driver has to merge or cross a major road traffic stream making use of gaps or lags in one or more conflicting stream.

Normally traffic signal is introduced for one or more of the following reasons:

1. To avoid blockage of an intersection by conflicting traffic stream, thus guaranteeing that a certain capacity can be maintain even during peak traffic conditions;
2. To facilitate the crossing of major road by the vehicles and/or pedestrian from a minor road;
3. To reduce the number of traffic accidents caused by collisions between vehicles in conflicting directions.

Signalization by means of three-colored light (green, amber, red) is applied to separate of conflicting traffic movement in time. Three basic mechanisms, which affect intersection operation and performance, should be well understood:

a) Discharge headways at signalized intersections, and their relationship to lost times and saturation flow rates.
b) Factor affecting left turn at signalized intersection.
c) Factor affecting right turn at signalized intersection.
d) Uses of demand volume.

The capacity of traffic signal controlled intersection is limited by the capacities of the individual approaches to the intersection. There are two types of factor, which affect the capacity of approach, roadway and environment factor and traffic and control factor.

The roadway and environmental factor that control the capacity of an approach are the physical layout of the approach, in particular its width, the radii along which left or right turning vehicle have to travel, and the gradient of the approach and its exit from the intersection. The capacity of an approach is measured independently of traffic and control factors and is expressed as the saturation flow. Saturation flow is defined as the maximum flow, expressed as equivalent passenger cars that can cross the stop line of the approach when there is a continuous green signal indication and a continuous queue of vehicles on the approach.

2.3 INDONESIA HIGHWAY CAPACITY MANUAL

Indonesia Highway Capacity Manual is program to determination of signal timing, capacity and traffic performance (delay, queue length and proportion of stopped vehicle) for signalized intersection in urban and semi-urban areas. The traffic facilities capacity and traffic performance is primarily a function of geometric conditions and traffic demand. By means of the signal, however the planner can distribute capacity to different approaches through the green time allocated to each approach. In order to calculate capacity and traffic performance it is therefore necessary to first determine the signal phasing and timing, which is most appropriate for the studied condition.

The methodology for analysis of signalized intersections described below is based on the following main principles.

2.3.1 Geometry

The calculations are done separately for each approach. One intersection arm can consist of more than one approach, i.e. be divided in two or more sub-approaches. This is the case if the right turning and/or left turning movements received green signal in different phases (s) than the straight thought traffic, or if they are physically divided by traffic island in the approach. For each approach or sub-approach the effective width (We) is determined with consideration to the lay out of the entry and the exit and distribution of turning movements.

2.3.2 Traffic flow

The calculation is performed on an hourly basis for one or more periods, e.g. based on peak hour design flow for morning, noon and afternoon traffic conditions. The traffic flow for each movement (left turning, straight through and right turning are converted from vehicles per hour to passenger car units (pcu) per hour using the following passenger car equivalent (pce) for protected and for opposed approach types.

Table 2.1 Passenger Car Equivalent

Vehicle Type	**pce for approach type**	
	Protected	**Opposed**
Light vehicle (LV)	1.0	1.0
Heavy vehicle (HV)	1.3	1.3
Motorcycle (MC)	0.2	0.4

2.3.3 Basic model

The amounts of traffic that can pass through a signal controlled intersection from a given approach depends on the green time available to the traffic and on the maximum flow of vehicles pass the stop line during the green period. When the signal changes to green vehicles take some second to start and accelerate to normal speed. After a few second the queue discharges at constant rate called saturation flow (S).

The saturation flow is the flow, which would be obtained if there was a continuous queue of vehicles and they were passed at green time, or the saturation flow is the maximum departure rate, which can be achieved when there is a queue. The saturation flow is generally expressed in vehicles per hour green time. Figure 2.1 could be seen that the average rate of flow is lower during few seconds because vehicles are accelerating to normal running speed.

The capacity (C) of an approach to a signalized intersection can be expressed as follows:

$$C = S \times g/c$$

Where:

C = Capacity (pcu/h)

S = Saturation flow, i.e. mean discharged rate from a queue in the approach during green signal (pcu/hg = pcu per hour of green)

g = Displayed Green Time

c = Cycle time, i.e. duration of a complete sequence of signal changes (i.e. between two consecutive starts of green in the phase).

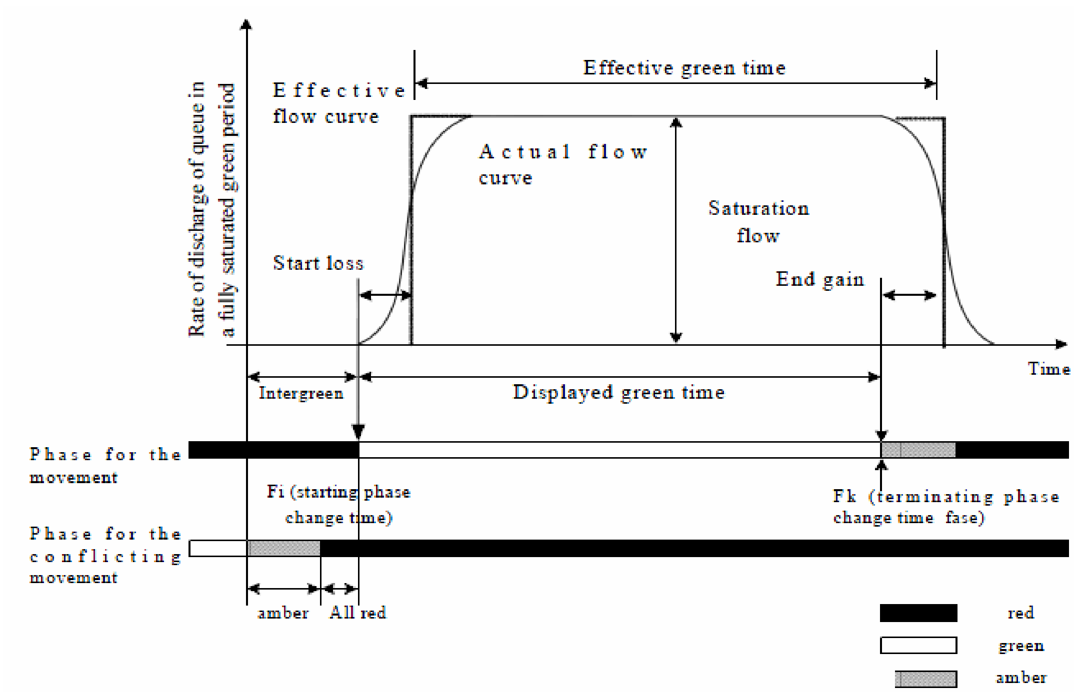


Figure 2.1 Basic model for saturation flow

The saturation flow (S) can be expressed as a product between a base saturation flow (So) for a set of standard conditions, and adjustment factors (F) for deviation of the actual conditions from a set of pre-determined (ideal) conditions.

S = So x F1 x F2 x F3 x F4 x ……………x Fn

Where:

S = Saturation flow.

So = Base saturation flow.

F = Adjustment factors.

For protected approaches P **(**protected discharge**)** the base saturation flows So is determined as a function of the effective approach width (We):

So = 600 x We pcu/hg, (see Figure 2.2)

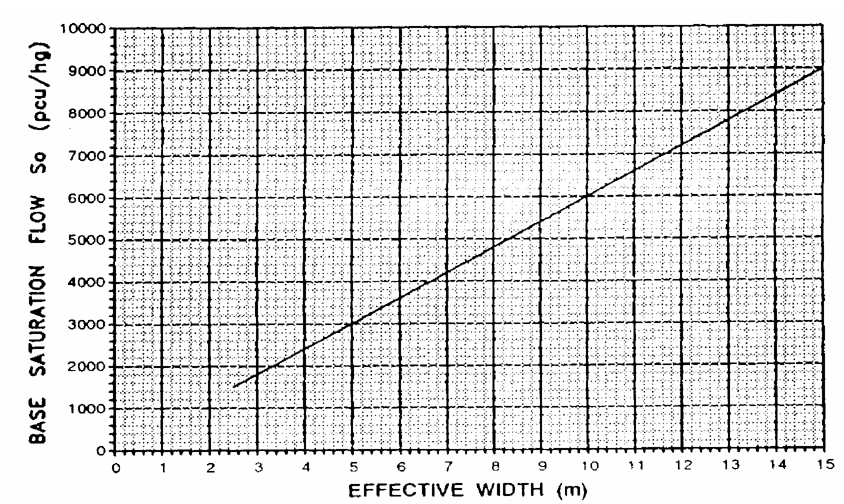


Figure 2.2 Base saturation flow for approach type P

For approach type 0 (opposed discharge), S_o is determined from Figure 2:3 (for approaches without separate left-turning lanes), and from Figure 2:4 (for approaches with separate left-turning lane) as a function of W_e Q_{LT} and Q_{LTO}.

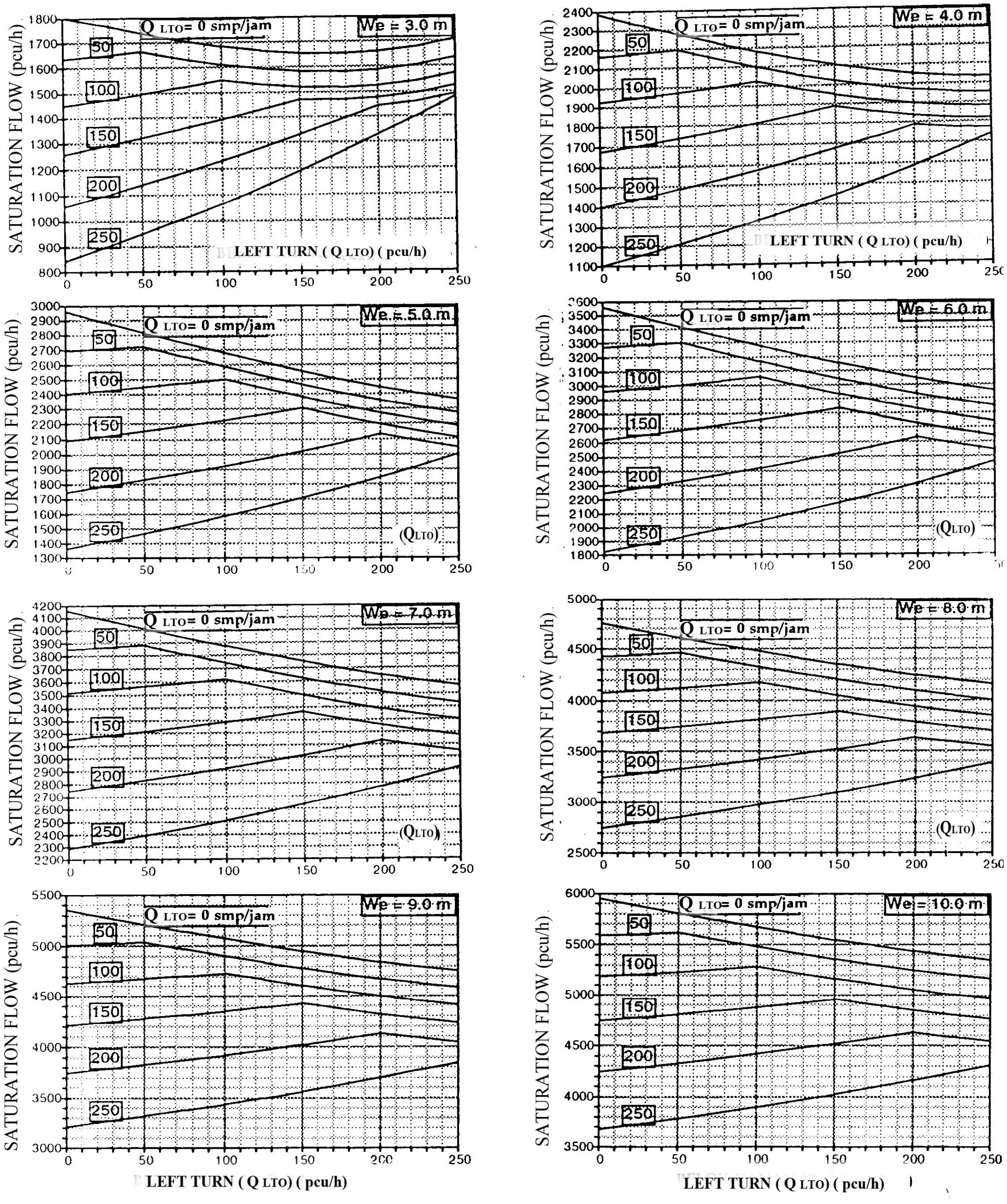


Figure 2:3 S_o for approaches type O without separate Left-turning lane

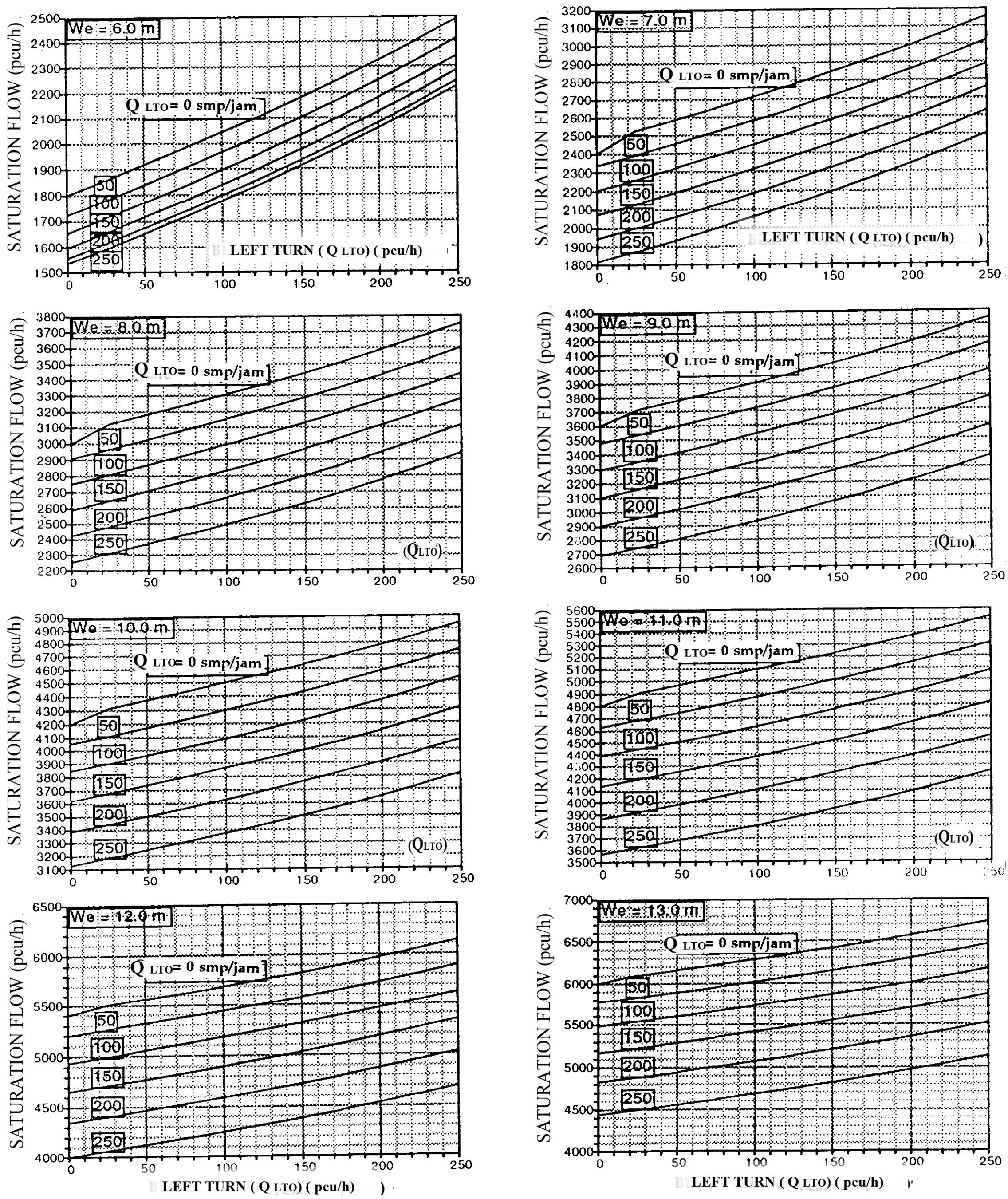


Figure 2:4 S_o for approach type O with separate Left-turning lane.

2.3.4 Adjustment Factors

Determine the following correction actors for the base saturation flow value for both approach type P and O as follows:

The city size adjustment factors F_{CS} .is determined from Table 2.2 as a function of the city size.

Table 2.2 City size adjustment factors F_{CS}

City population (M. inhabitants)	City size correction factor F_{CS}
>3.0	1.05
1.0-3.0	1.00
0.5-1.0	0.94
0.1- 0.5	0.88
<0.1	0.82

The Side friction adjustment factor F_{SF} is determined from Table 2.3 as a function of Road environment type and Side friction. If the side friction is not known, it can be assumed to be high in order not to overestimate capacity.

Table 2.3 Adjustment factor. for Road environment type and Side friction

Road environment	Side friction	Phase type	Ratio of unmotorised vehicles					
			0.00	0.05	0.10	0.15	0.20	0.25
Commercial (COM)	High	Opposed	0.93	0.88	0.84	0.79	0.74	0.70
	.	Protected	0.93	0.91	0.88	0.87	0.85	0.81
	Medium	Opposed	0.94	0.89	0.85	0.80	0.75	0.71
	.	Protected	0.94	0.92	0.89	0.88	0.86	0.82
	Low	Opposed	0.95	0.90	0.86	0.81	0.76	0.72
		Protected	0.95	0.93	0.90	0.89	0.87	0.83
Residential (RES)	High	Opposed	0.96	0.91	0.86	0.81	0.78	0.72
	.	Protected	0.96	0.94	0.92	0.89	0.86	0.84
	Medium	Opposed	0.97	0.92	0.87	0.82	0.79	0.73
	.	Protected	0.97	0.95	0.93	0.90	0.87	0.85
	Low	Opposed	0.98	0.93	0.88	0.83	0.80	0.74
		Protected	0.98	0.96	0.94	0.91	0.88	0.86
Restricted access (RA)	High/Medium /Low	Opposed	1.00	0.95	0.90	0.85	0.80	0.75
		Protected	1.00	0.98	0.95	0.93	0.90	0.88

The Gradient adjustment factor F_G is determined from Figure 2.5 as a function of the gradient (GRAD).

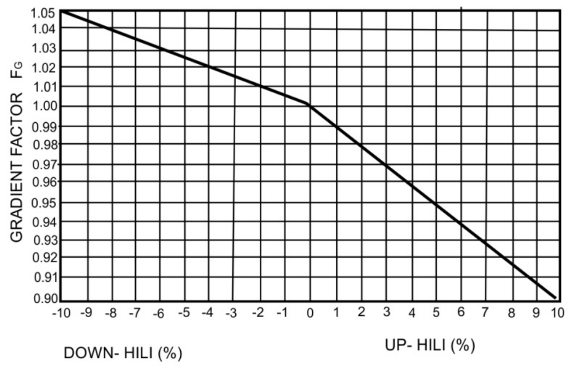


Figure 2.5 Adjustment factors for gradient F_G

The Parking correction factor F_P is determined from Figure 2.6 as a function of the distance from the stop-line to the first parked vehicle and the approach width W_A . This factor can also be applied for cases with restricted length of Right turning lanes.

F_P can also be calculated from the. Following formula, which includes the effect of the length of the green time :

$$F_P = [L_p/3 - (W_A - 2) \times (L_p/3 - g)/W_A]/g$$

Where

L_p = Distance between stop-line and first parked vehicle (m) (or length of short lane).

W_A = Width of the approach (m).

g = Green time in the approach (sec).

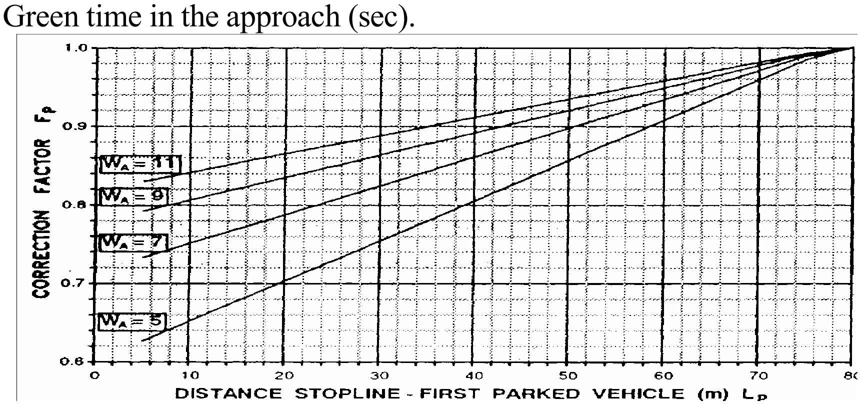
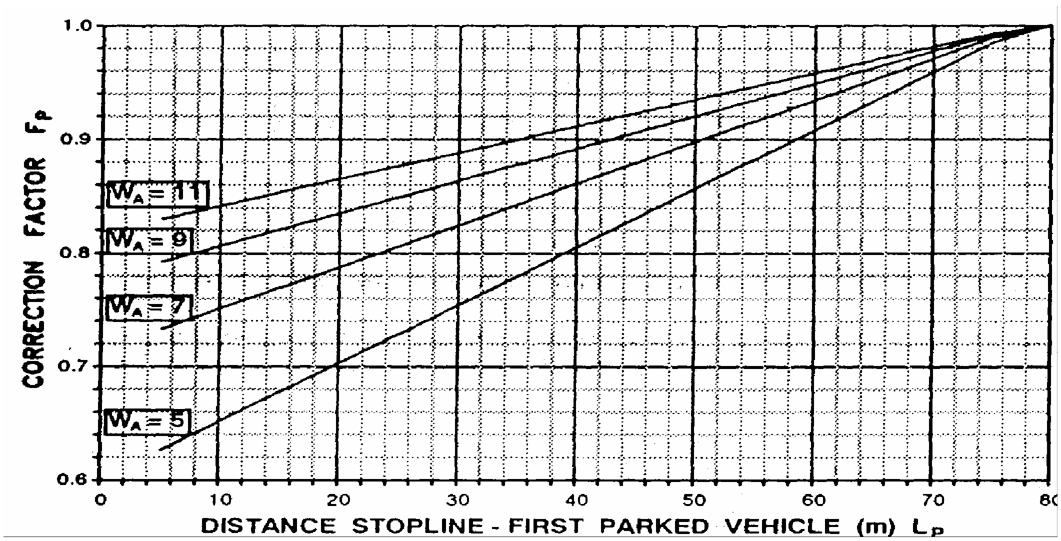


Figure 2.6 Adjustment factors for effect of parking and short left-turn lanes F_p

Determine the following correction factors for the base saturation flow value <u>only</u> for approach type P as follows:

The Left Turn correction factor F_{LT} is determined as a function of ratio of Left turning vehicles P_{LT}.



Only for Approach type P; No median; Two-way street: Calculate $F_{LT} = 1.0 + P_{LT} \times 0.26$, or obtain the value from Figure 2.7 below

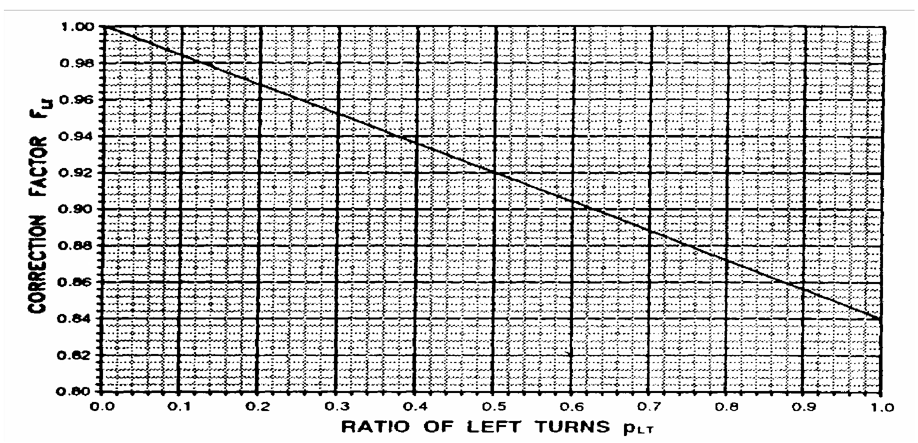


Figure 2.7 Correction factor for Left turns F_{LT}. (only applicable for approach type P, two-way streets)

2.3.5 Signal Timing and Cycle Time

The signal timing for fixed-time control conditions is determined based on the Webster (1966) method for minimization of overall vehicle delay in the intersection. First the cycle time (c) is determined, and after that the length of green (g) in each phase (i).

$$c = (1,5 \times LTI + 5) / (1- \sum FR_{crit})$$

where:

c = Signal cycle time (sec)

LTI = Lost time per cycle (sec)

FR = Flow divided by saturation flow (Q/S)

FRcrit = The highest value of FR in all approaches being discharge in a signal phase

ΣFRcrit = Intersection flow ratio = sum of FRcrit for all phases in the cycle

If the cycle time is shorter than this value there is a serious risk for over saturation of the intersection. Too long cycle time result in increased average delay to the traffic. If **ΣFRcrit** is close to or greater than 1, the intersection is oversaturated and the formula will result in very high or negative cycle time values.

2.3.6 Green Time

$$g = (c - LTI) \times FR_{crit} / \sum (FR_{crit})$$

where:

g = Displayed green time in phase I (sec)

The performance of a signalized intersection is generally much more sensitive to errors in the green time distribution than to a too long cycle time. Even small deviation from the green ratio (g/c) determined from equation of Cycle Time and Green Time above result in high increase of the average delay in the intersection.

2.3.7 Capacity and degree of saturation

The approach capacity (C) is obtained by multiplication of the saturation flow with the green ratio (g/c) for each approach;

The degree of saturation (DS) is obtained as:

$DS = Q/C = (Q \times c) / (S \times g)$

f. Traffic performance

Different measures of traffic performance can be determined based on the traffic flow (Q), degree of saturation (DS) and signal timing (c and g) as described below:

2.3.8 Queue Length

The average number of queuing puck at the beginning of green NQ is calculated as the number of pcu remain from the previous green phase NQ_1 plus the number of pcu that arrive during the red phase (NQ_2):

$$NQ = NQ_1 + NQ_2$$

With

$$NQ_1 = 0.25 \times C \times ((DS-1) + \sqrt{((DS-1)^2 + ((8x(DS-0.5))/C)}$$

If DS > 0.5, otherwise NQ 1 = 0

$$NQ_2 = c \times \frac{1-GR}{1-GRxDS} \times \frac{Q}{3600}$$

Where:

NQ_1 = number of pcu that remain from the previous green phase

NQ_2 = number of pcu that arrive during the red phase

DS = degree of saturation

GR = green ratio = g/c

c = cycle time

C = capacity (pcu/h) = saturation flow times the green ratio (S x GR)

Q = traffic flow in the approach (pcu/h)

For design purposes the manual includes provision for adjustment of this average value to a desired level of probability for overloading.

The resulting queue length QL is obtained by multiplication of NQ with the average area occupied per pcu (20 sqm) and division with the entry width.

$$QL = \frac{(NQmax \times 20)}{Wentry}$$

2.3.9 Stop Rate

The stop rate (NS), i.e. the average number of stop per vehicle (including multiple stop in a queue) before passing the intersection, is calculated as

$$NS = 0.9 \times \frac{NQ}{Q \times c} \times 3600$$

where: c is the cycle time (sec) and Q the traffic flow (pcu/h) in the studied approach.

2.3.10 Proportion of stopped vehicles

The proportion of stopped vehicles p_{sv}, i.e. the ratio of ratio of vehicles that have to stop because of the red signal before the intersection, is calculated as

p_{sv} = min (NS,1)

where: NS is the stop rate in the approach.

2.3.11 Delay

Delay D at an intersection can occur for two reasons:

a. Traffic Delay (DT) due to traffic intersection with other movement in the junction

b. Geometric Delay (DG) due to deceleration and acceleration when making a turn in the intersection and/or when being stopped by the red light.

The average delay for an approach j is calculated as:

Dj = DTj + DGj

Where:

Dj = Mean delay for approach j (sec/pcu)

DTj = Mean traffic delay for approach j (sec/pcu)

DGj = Mean geometric delay for approach j (sec/pcu)

The average traffic delay for an approach j can be determined from the following formula (based on Akcelik, 1988).

$$DT = c \times \frac{0.5 \times (1-GR)^2}{(1-GR \times DS)} + \frac{NQ_1 \times 3600}{C}$$

where:

DTj = Mean traffic delay for approach j (sec/pcu)

GR = Green ratio (g/c)

DS = Degree of Saturation

c = Cycle time

C = Capacity (pcu/h)

NQ_1 = Number of pcu that remain from the previous green phase

The average geometric delay for an approach j can be estimated as follow:

$DGj = (1 - p_{sv}) \times p_t \times 6 + (p_{sv} \times 4)$

Where:

DGj = Mean geometric delay for approach j (sec/pcu)

psv = Proportion of stopped vehicle in the approach

pt = Proportion of turning vehicle in the approach

2.4 SIGNAL COORDINATION

For signals that are closely spaced, it is necessary to coordinate the green time so that vehicles may move efficiently through the set of signals. In some cases, two signals are so closely spaced that they should be considered to be one signal. In other cases, the signals are so far apart that they may be considered independently. Vehicles released from a signal often maintain their grouping for well over 335m.

2.4.1 Factors affecting coordination

There are four major areas of consideration for signal coordination:

a) Benefits
b) Purpose of signal system
c) Factors lessening benefits
d) Exceptions to the coordinated scheme

The most complex signal plans require that all signals have the same cycle length. Figure 2.8 illustrates path (trajectory) that a vehicle takes as time passes. At $t=t_1$, the first signal turns green. After some lag, the vehicle starts and moves down the street. It reaches the second signal at some time $t=t_2$. Depending on the indication of that signal, it either continues or stops. The difference between the two green initiation times is referred to as the signal offset, or simply as the offset. In general, the offset is defined as the difference between green initiation times, measured in terms of the downstream green initiation relative to the upstream green initiation.

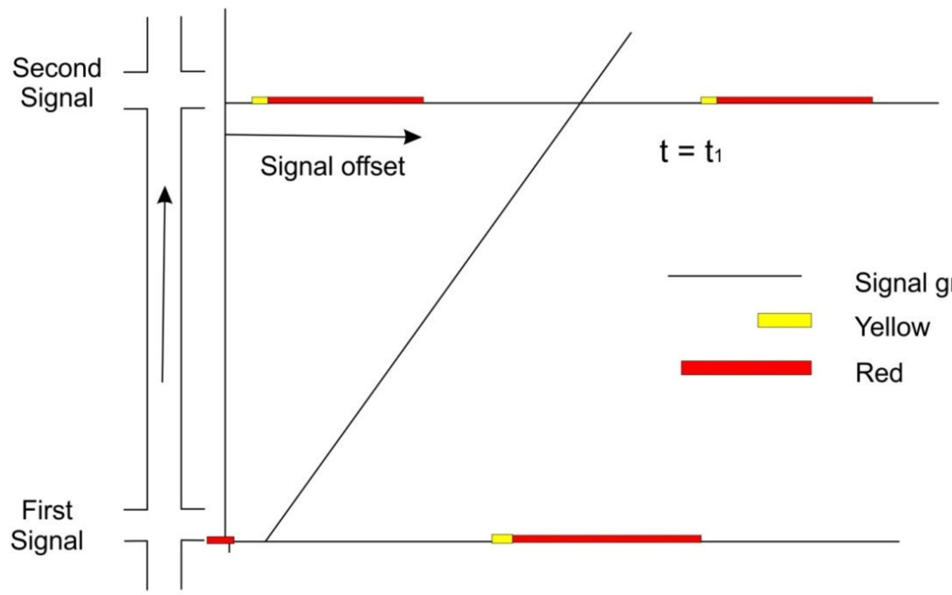


Figure 2.8 Vehicle trajectory

a) Benefits

It is common to consider the benefit of a coordination plan in terms of a ``cost″ *or* ``penalty″ function; a weighted combination of stops and delay, and other terms as given here: Cost = A x (total stops) + B x (total delay) + (other terms)

The object is to make this disbenefit as small as possible. The weights A and B are coefficients to be specified by the engineer or analyst. The values of A and B may be selected so as to reflect the estimated economic cost of each stop and delay. The amounts by which various timing plans reduce the cost, can then be used in a cost-benefit analysis to evaluate alternative plans. The conservation of energy and the preservation of the environment have grown in importance over the years. Given that the vehicles must travel, fuel conservation and minimum air pollution are achieved by keeping vehicles moving as smoothly as possible at efficient speeds. This can be achieved by a good signal-coordination timing plan. Other benefits of signal coordination include maintenance of a preferred speed, possibility of sending vehicles through successive intersections in moving platoons and avoiding stoppage of large number of vehicles.

b) Purpose of the signal system

The physical layout of the street system and the major traffic flows determine the purpose of the signal system. It is necessary to consider the type of system, whether one-way arterial, two-way arterial, one-way, two-way, or mixed network. the capacities in both directions on some streets, the movements to be progressed, determination of preferential paths.

c) Factors lessening benefits

Among the factors limiting benefits of signal coordination are the following:

- inadequate roadway capacity
- existence of substantial side frictions, including parking, loading, double parking, and multiple driveways
- wide variability in traffic speeds
- very short signal spacing
- heavy turn volumes, either into or out of the street

d) Exceptions of the coordinated scheme

All signals cannot be easily coordinated. When an intersection creating problems lies directly in the way of the plan that has to be designed for signal coordination, then two separate systems, one on each side of this troublesome intersection, can be considered. A critical intersection is one that cannot handle the volumes delivered to it at any cycle length.

2.4.2 The time-space diagram and ideal offsets

The time-space diagram is simply the plot of signal indications as a function of time for two or more signals. The diagram is scaled with respect to distance, so that one may easily plot vehicle positions as a position of time. Figure. 2.9 is a time-space diagram for four intersections.

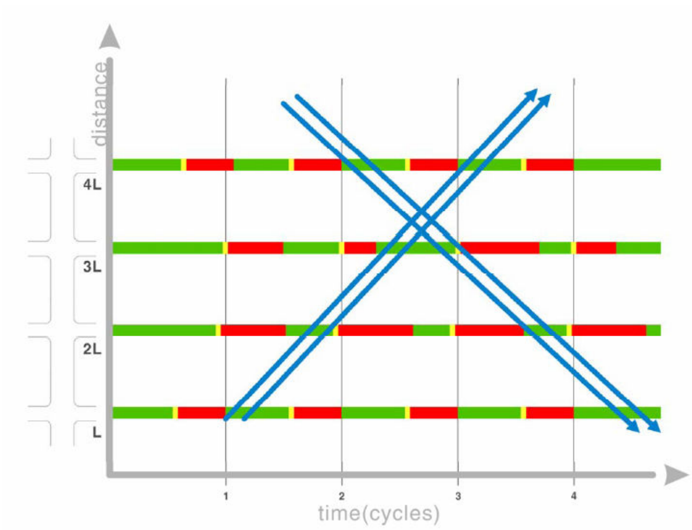


Figure 2.9 Time-Space Diagram for four intersections

2.4.3 The special problem of Progression on two-way streets

Figure 2.10 shows the trajectory of a southbound vehicle on this arterial.

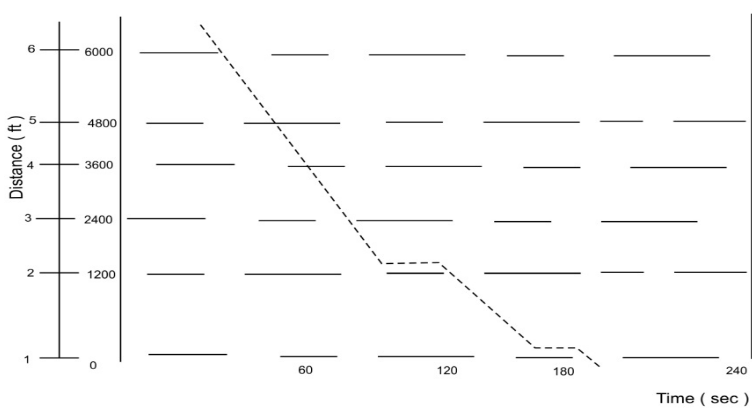
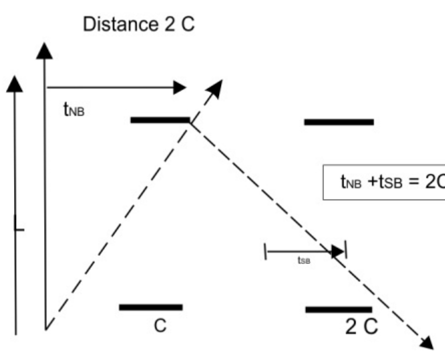


Figure 2.10 Moving southbound on a two-way arterial

If any offset were changed in Figure 2.10 to accommodate the southbound vehicle(s), then the northbound vehicle or platoon would suffer. The fact that offsets are interrelated presents one of the most fundamental problems of signal optimization. The inspection of a typical cycle (as in Figure. 2.11) yields the conclusion that the offsets in two directions add to one cycle length. For longer lengths (as in Figure. 2.12) the offsets might add to two cycle lengths. When queue clearances are taken into account, the offsets might add to zero lengths.



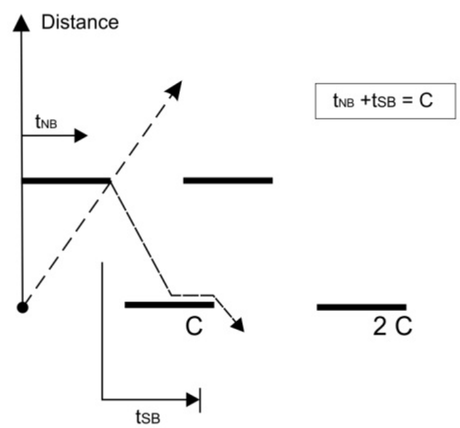


Figure 2.11 Offsets add to one cycle length   Figure 2.12 Offsets add to two cycle length

The general expression for the two offsets in a link on a two-way street can be written as:

$$t_{NB,\,i} + t_{SB,\,i} = nC$$

Where the offsets are actual offsets, n is an integer and C is the cycle length. Any actual offset can be expressed as the desired ``*ideal*'' offset, plus an ``*error*'' or ``*discrepancy*'' term:

$$t_{actual}(j,i) = t_{ideal}(j,i) + e(j,i)$$

where

t = offset

e = error or discrepancy

j = represents the direction

i = represents the link.

2.4.4 The bandwidth concept and maximum bandwidth

The bandwidth concept is very popular in traffic engineering practice, because:

1. The windows of green (through which platoons of vehicles can move) are easy visual images for both working professionals and public presentations
2. Good solutions can often be obtained manually, by trial and error.

a) Bandwidth and efficiency of a progression

The efficiency of a bandwidth (measured in seconds) is defined as the ratio of the bandwidth to the cycle length, expressed as a percentage:

$$\text{Efficiency} = \frac{bandwidth}{cycle\ length} \times 100\%$$

An efficiency of 40% to 50% is considered good. The bandwidth is limited by the minimum green in the direction of interest.

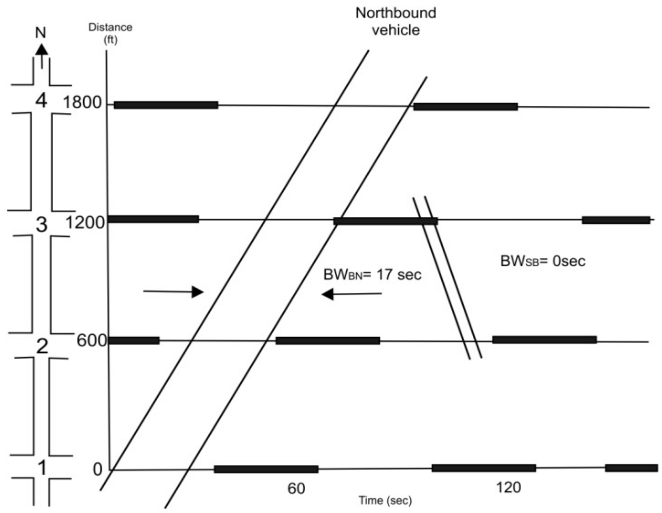


Figure 2.13 Bandwidths on a time space diagram

Figure 2.13 illustrates the bandwidths for one signal-timing plan. The northbound efficiency can be estimated as (17/60)100%=28.4%. There is no bandwidth through the south-bound. The system is badly in need of retiming at least on the basis of the bandwidth objective. In terms of vehicles that can be put through this system without stopping, note that the northbound bandwidth can carry 17/2.0=8.5 vehicles per lane per cycle in a nonstop path through the defined system. The northbound direction can handle

$$\frac{8.5veh}{\text{cycle}} \times \frac{\text{cycle}}{60sec} \times \frac{3600sec}{hr} = 510\text{vph per lane}$$

Very efficiently if they are organized into 8-vehicle platoons when they arrive at this system. If the per lane demand volume is less than 510vphpl and if the flows are so organized, the system will operate well in the northbound direction, even though better timing plans might be obtained. The computation can be formalized into an equation as follows:

Nonstop volume = $\frac{3600\,(BW)(L)}{(h)(C)}$ vph

Where:

BW = measured or computed bandwidth, sec,

L= number of through lanes in indicated direction

h = headway in moving platoon, sec/veh,and

C =cycle length.

b) Finding bandwidths: A trial-and-error approach and a case study

The engineer usually wishes to design for maximum bandwidth in one direction, subject to some relation between the bandwidths in the two directions. There are both trial-and-error and somewhat elaborate manual techniques for establishing maximum bandwidths. Refer to Fig. 2.14, which shows four signals and decent progressions in both the directions. For purpose of illustration, assume it is given that a signal with 50:50 split may be located midway between Intersections 2 and 3. The possible effect as it appears in Fig. 2.15, is that there is no way to include this signal without destroying one or the other through band, or cutting both in half. The offsets must be moved around until a more satisfactory timing plan develops. A change in cycle length may even be required. The changes in offset may be explored by:

a) Copying the time-space diagram of Figure 2.15,
b) Cutting the copy horizontally into strips, one strip per intersection.
c) Placing a guideline over the strips, so as to indicate the speed of the platoon(s) by the slope of the guideline.
d) Sliding the strips relative to each other, until some improved offset pattern is identified.

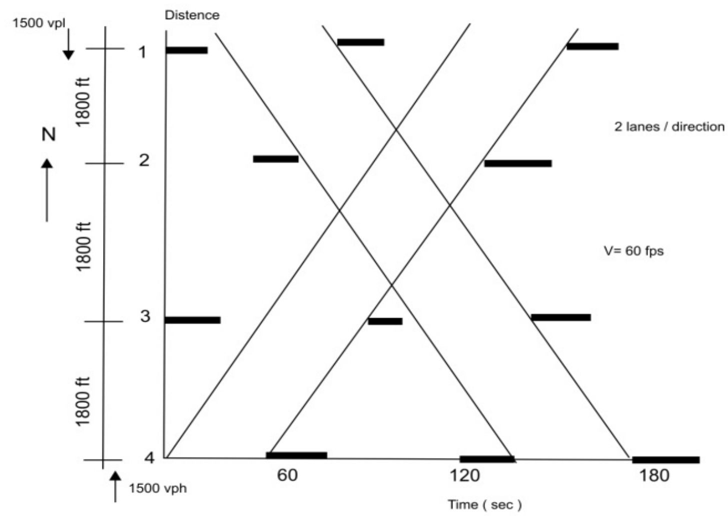


Figure 2.14, Case study four intersections with good progressions

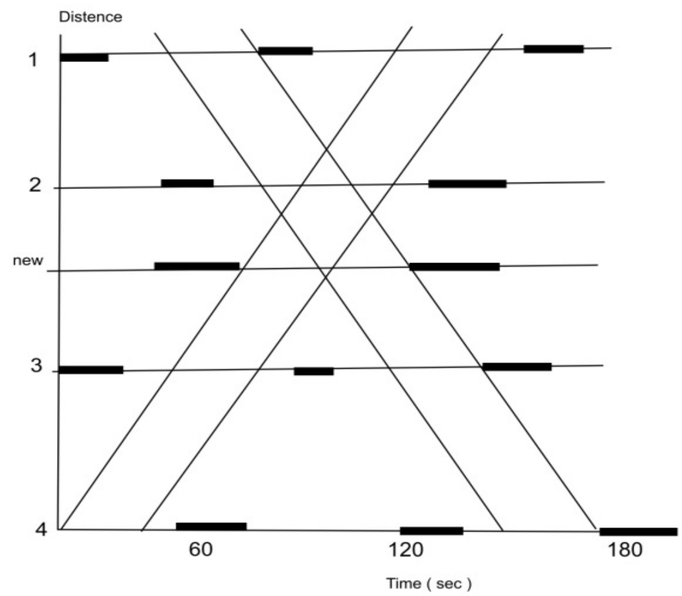


Figure 2.15, Effect of inserting a new signal into system

There is no need to produce new strips for each cycle length considered: all times can be made relative to an arbitrary cycle length `C". The only change necessary is to change the slope(s) of the guidelines representing the vehicle speeds. The northbound vehicle takes3600/60 = 60sec to travel from intersection 4 to intersection 2. If the cycle length C = 120sec the vehicle would have arrived at intersection 2 at C/2, or one half of the cycle length. To obtain a good solution through trial-and-error attempt, the following should be kept in consideration:

1. If the green initiation at Intersection 1 comes earlier, the southbound platoon is released sooner and gets stopped or disrupted at intersection 2.
2. Likewise, intersection 2 cannot be northbound without harming the southbound.
3. Nor can intersection 3 help the southbound without harming the northbound.

2.5 PREVIOUS STUDIES

1- TAMIN. E. 2003, The Evaluation Of Traffic Performance At Several Signalized Intersections Using 1997 Indonesian Highway Capacity Manual.

Most of the intersections in Bandung were controlled by the Area Traffic Control System (ATCS) to solve the congestion problem. The computer in Central Control is connected with loop detector to record the traffic flows. The objective of the research is to evaluate the performance of several intersections using the 1997 IHCM. In this research, the phases, cycle times, green times, amber and red lights for several intersections will be compared to those obtained by ATCS. The performance of several many intersections will be expected to perform better, so the traffic jam such as delay and queuing could be reduced.

Conclusion**,** almost all of the intersections have low performance due to high traffic flows and the geometric of intersection is not enough to accommodate the flows. The cycle times calculated using IHCM are different than those used by the ATCS. This is due to all the intersections are under controlled and coordinated by the ATCS.

2- Huapu Lu, Qixin Shi, Iwasaki, Masato 2002, a Study on Traffic Characteristics at Signalized Intersections in Beijing and Tokyo.

In this study, the traffic flow characteristics of the typical signalized intersections located at Beijing and Tokyo are observed and analyzed. Then, saturation flow rates and delays of the

intersections in both cities are compared and the factors affected to the saturation flow rates are discussed. Finally, some countermeasures for enhancing the capacities of the intersection are proposed including channelization of the traffic flow in the intersection, drawing the traffic marking and line in the intersection, strengthen traffic safety education, improving traffic control method, regulation of pedestrians and bicycle flows at the signalized intersection and improving the safety facility and capacity at the signalized intersections and so on.
Conclusion, Through the comparative analysis on saturation traffic flow of intersections between Beijing and Tokyo, we can find out the reason to low saturation traffic flow in Beijing ,

which can be reduced to six : disturbance by non-automobiles, by walkers, quality of vehicles, not enough channelization, driving psychology and traffic behavior characteristic.
In the light of these, we can adopt the following countermeasures to enhance the capacity of intersections.

3- MUNAWAR. A**.** 2006, Queues And Delays At Signalized Intersections, Indonesian Experience.

To predict queues and delays at signalized intersections in Indonesia, the 1997 Indonesian Highway Capacity Manual (IHCM) has been widely used. However, the queue length at signalized intersection predicted by IHCM was usually over value. The aim of this research is, therefore, to improve the IHCM formula to calculate the queue length at signalized intersection. Traffic surveys have been carried out at various signalized intersections in some Indonesian cities. The measured queues have been compared to the IHCM predicted queues. IHCM formula has been calibrated by trial and error method in such a way that there was no significant different between the predicted and the measured queues.

Conclusions, the queue length predicted by 1997 IHCM is higher than the actual one, especially in medium cities, because the entry width in medium cities is usually less than the normal standard, but the capacity is still high. The motorcycles need usually less space than the space predicted by 1997 IHCM, when the number of motorcycles is very high. In this case, it is, therefore, recommended to reduce the passenger car equivalent for motorcycle from 0.20 to 0.15 .

CHAPTER III

METHODOLOGY

3.1 STUDY OUTLINE

Figure 3.1 presents the flow chart of an overview of the study. The objective of this research is to improve transportation planning level techniques for the assessment of the traffic signal coordination system on congestion. Specifically, This study aimed to analyze traffic flow system in study area location to get green that optimized signal timing in that network. Study scope cover survey implementation traffic such as volume calculation saturated flow road and rate have been classified in peak hour.

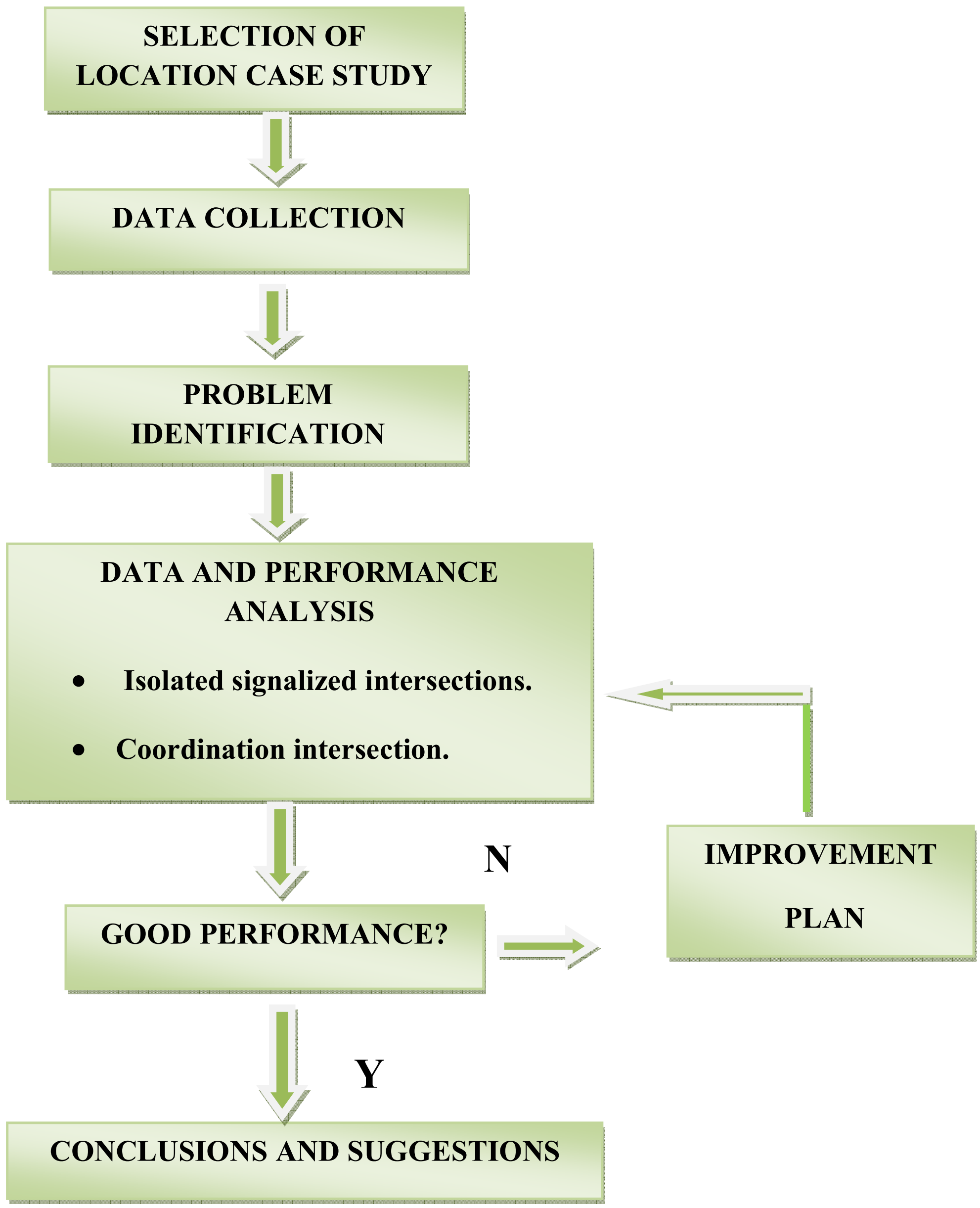


Figure 3.1 Flow chart of this study

3.2 SELECTION OF LOCATION CASE STUDY

The location and intersections of this study is located at the capital city of Libya, Tripoli. Consider Aradah Road region is one of the most important urban areas in Tripoli is busy traffic areas, especially in peak hours, one of the more developed regions the population in Libya. Select Two intersections in Aradah Road and with more traffic congestion and have found that intersections need to optimize on the timing of traffic signals and coordination of traffic signals, particularly some of the convergent and give sufficient time to time the length of the session and the division of the optimum time for the session.

3.3 DATA COLLECTION

The survey will be conduct in two congested signalised intersections in Tripoli during the peak hour. The purpose of the survey is to obtain the information on road geometric, traffic flows, signal phasing, intergreen time and lost time.

3.3.1 Data Collection Equipment

Field data collections will carry out at selected site using three types of equipment which are digital camera, digital stop watches, manual counters and trumeter. The method of traffic data collection is manual data sheet. The trumeter is used to measure distance between the intersections that function as a marker for distance the passage of vehicles.

3.3.2 Data collection time

The times for data collection during one hour morning peak, off peak hours, and afternoon peak. Data were collected during weekday's periods in the evening at peak and off peak hours. Field research was at one day starting in early 27 December 2010 Monday.

3.3.3 Method of data collection

Data for example volume of traffic flow and road geometric conditions when the signal is of primary data obtained by field observation method of direct field measurements and traffic counting on manual data sheet.

a) Method of counting traffic survey

Traffic Volume, Measuring traffic volume simply involves counting the number of vehicles that pass by during a set period of time. Volume is measured in each directions and the number of passenger vehicles should be counted separately from the number of heavy vehicle, Each team should use four manual counters. The first group member should count passenger vehicles going in one direction, the second group member should count passenger vehicles going in the opposite direction and the third group member should count trucks going in both directions (e.g., hold one counter in each hand). Perform two 15 minute counts (e.g., start the count and continue for 15 minutes).

b) Data required

data needed to carry out this research include:

1 - Map of study area and the distribution zone

2 - Data geometric condition of roads and intersections

Some of the assumptions and constraints that are used as the basis for collecting data and crossing the road geometric conditions among others:

I) Data-gathering is done by direct measurement in the field.

II) Measurement of geometrical parameters of roads and intersections in accordance with the understanding of each parameter according

III) If there are no markers that separate the lanes from one another, determination of lane width, taking into account aspects of decency, giving priorities to major movements and does not reduce the overall width of the path of motion.

3- Data on the phase settings for the traffic lighted intersection is obtained by direct measurement of the duration of phase traffic light.

3.4 PROBLEM IDENTIFICATION

Problems at an intersection are identified through a survey at congested signalised intersections, field investigations, and preliminary operational and safety analysis. To determine whether a problem exists, this information needs to be evaluated against defined goals or standards. A problem statement can be defined after a review of the established operational and safety criteria against the known characteristics of an intersection. In some cases, additional data may need to be collected to confirm that a problem exists.

3.5 DATA AND PERFORMANCE ANALYSIS

Calculations in this study to evaluate the performance of signal intersections are using the rules set by IHCM 1997. The existing data consists of geometric, traffic flow, side friction condition, the phase, green time. The result of calculation consists of capacity, degree of saturation, average no. of stops, mean average intersection delay and Almost all of the intersections show the low performance. Figure 3.2 below is a flow chart of procedures for calculating the performance analysis.

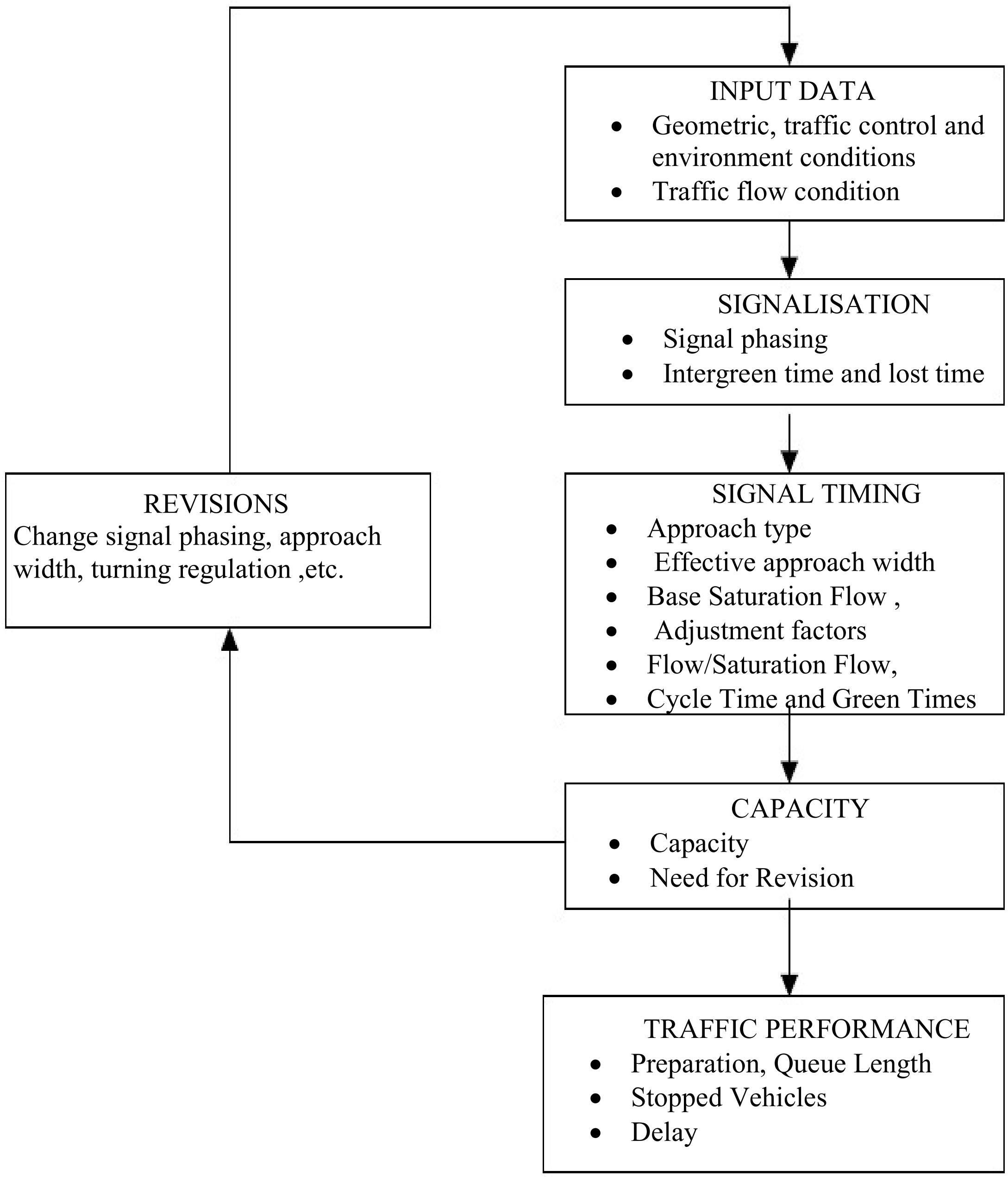


Figure 3.2 Flow chart of the performance analysis at signal intersections

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

The data for this study were obtained by directly taking on the field and by using Survey data from the really location. Here is the data that is needed to carry out this research include:

a)Map of study area and the intersections zone.

b) Data geometric condition of roads and intersections.

c) Data setting phase to the signalized intersections.

d)Data of traffic flow volume for the intersections.

4.1Data geometric condition of roads and intersections.

Data geometric condition of roads and intersections were obtained by direct measurement of the standard geometric parameters of road and intersection segments of roads and intersections affected by traffic expected.

Table 4.1:Geometry, traffic arrangements and environmental conditions for intersection 1

Code approach	South	North	East	West
City size	1,065,405 million			
Median Y/N	N	N	Y	Y
Turn right immediately Y/N	Y	Y	Y	Y
Type of road environment	RES	COM	COM	COM
Gradient %	0	0	0	0
Approach W_A (m)	6.5	6	10	7
Entry W_{Entry} (m)	8	8	8	8
RT on Red W_{RTOR} (m)	non	3.5	non	3
Exit W_{Exit} (m)	3	5.5	6	6

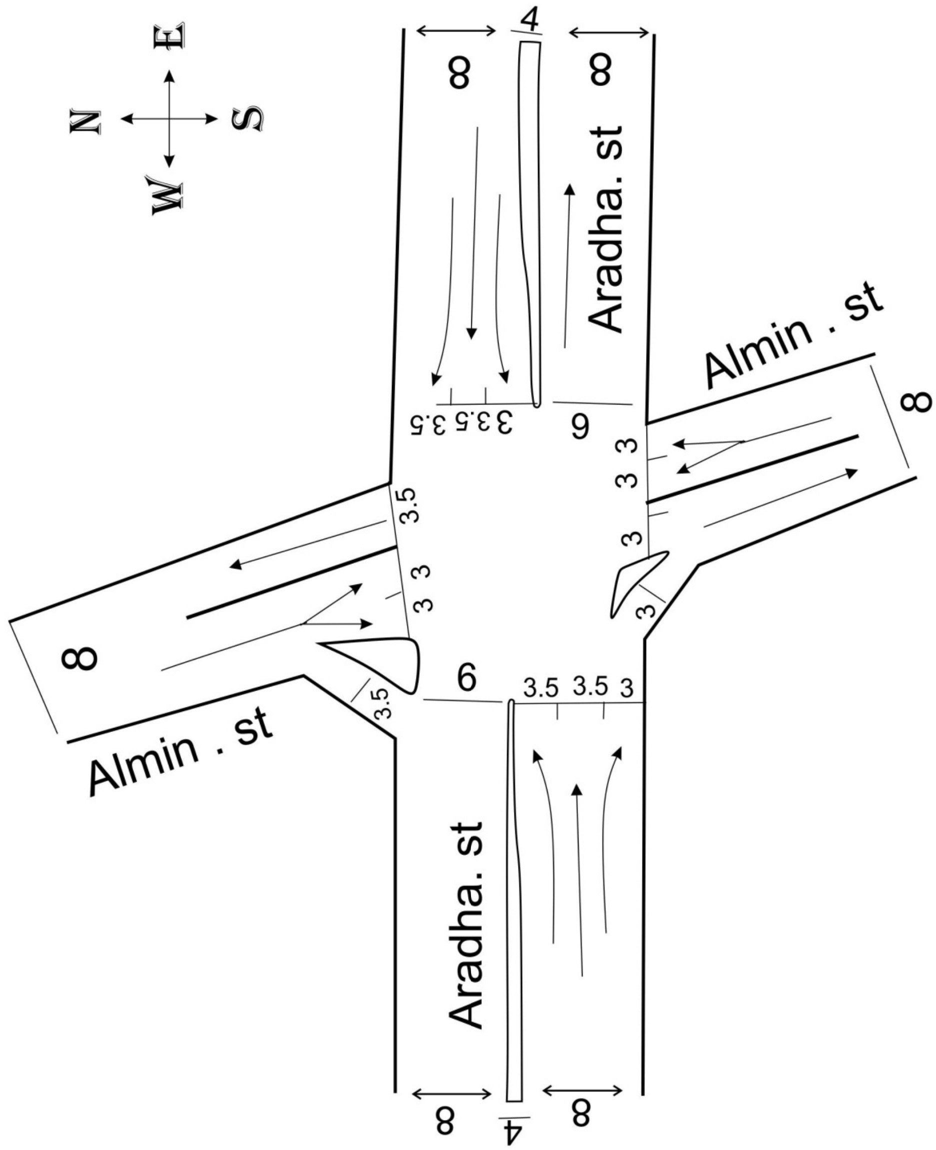


Figure 4.1 The existing Intersection 1

Table 4.2: Geometry, traffic arrangements and environmental conditions for intersection 2

Code approach	South	North	East	West
City size	1,065,405 million			
Median Y/N	Y	Y	Y	Y
Turn right immediately Y/N	Y	Y	Y	Y
Type of road environment	COM	COM	COM	COM
Gradient %	0	0	0	0
Approach W_A (m)	6	6	8	8
Entry W_{Entry} (m)	6	6	10	10
RT on Red W_{RTOR} (m)	3	3	3	3
Exit W_{Exit} (m)	7	7	7.5	7.5

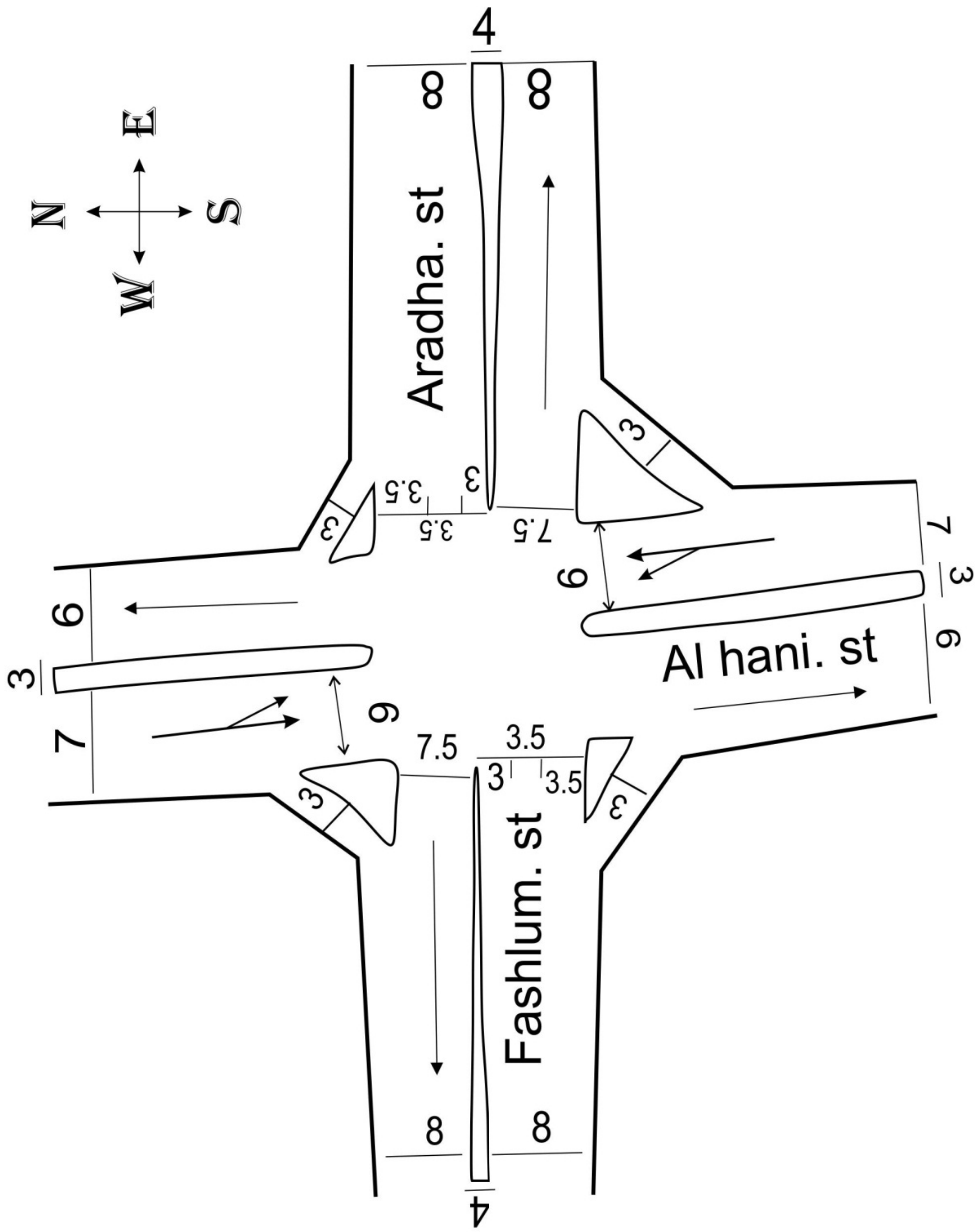


Figure 4.1 The existing Intersection 2

4.2Data setting phase to the signalized intersections.

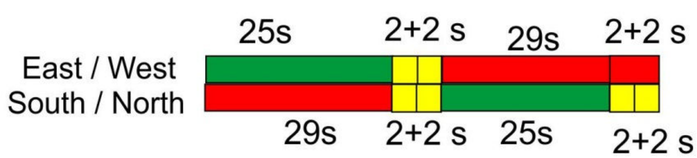
Data on the phase settings for the traffic signalized intersection is obtained by direct measurement of the phase duration of traffic lights at the existing intersections.

Table 4.3: Phase time, green, and cycle time for intersection 1

Code approach	Phase time		Total phase	Cycle time
	Green	Intergreen		
East	24	4	2 phase	47
West	24	4	2 phase	47
South	15	4	2 phase	47
North	15	4	2 phase	47

Table 4.4: Phase time, green, and cycle time for intersection 2

Code approach	Phase time		Total phase	Cycle time
	Green	Intergreen		
East	25	4	2 phase	58
West	25	4	2 phase	58
South	25	4	2 phase	58
North	25	4	2 phase	58



4.3 Data of volume traffic flow for the intersections.

Data volume of traffic crossing the road or obtained by surveying the traffic counting on roads and intersections.

The implementation of traffic count survey conducted on Monday 27 December 2010 in morning the period of time between the hours of 7:30 am 8:30 am, afternoon in time period between 13:30 pm.14:30 pm, and evening while the time period between 16:30 pm 17:30 pm.

a) Survey data traffic flow at Intersection 1

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: East

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	RT	25	15	2	42
	ST	207	53	5	265
	LT	38	10	2	50
7:45 - 8:00	RT	15	0	7	22
	ST	223	62	4	289
	LT	45	28	1	74
8:00 - 8:15	RT	59	7	4	70
	ST	197	33	8	230
	LT	67	29	2	98
8:15 - 8:30	RT	46	18	6	70
	ST	164	47	7	218
	LT	55	10	3	68

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	RT	48	12	7	67
	ST	203	27	2	232
	LT	25	18	0	43
13:45 - 14:00	RT	45	11	3	59
	ST	196	41	4	241
	LT	18	9	0	27
14:00 - 14:15	RT	42	19	3	64
	ST	167	63	0	230
	LT	41	26	0	67
14:15 - 14:30	RT	33	28	4	65
	ST	138	47	6	191
	LT	76	18	4	98

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	RT	29	7	7	43
	ST	173	49	2	224
	LT	18	9	0	27
16:45 - 17:00	RT	21	18	3	42
	ST	168	12	1	181
	LT	26	18	2	46
17:00 - 17:15	RT	39	15	0	54
	ST	225	37	2	264
	LT	23	9	5	37
17:15 - 17:30	RT	48	14	2	64
	ST	145	37	6	188
	LT	49	35	1	85

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: West

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	43	37	2	82
	ST	155	41	4	200
	RTOR	20	13	0	33
7:45 - 8:00	LT	24	22	2	48
	ST	143	31	5	179
	RTOR	25	42	8	75
8:00 - 8:15	LT	65	13	2	80
	ST	173	17	7	197
	RTOR	43	23	0	66
8:15 - 8:30	LT	42	16	4	62
	ST	145	13	0	158
	RTOR	63	34	1	98

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	55	14	9	78
	ST	187	24	8	219
	RTOR	28	25	4	67
13:45 - 14:00	LT	36	22	6	64
	ST	202	33	3	238
	RTOR	36	18	4	58
14:00 - 14:15	LT	46	24	7	87
	ST	205	14	2	221
	RTOR	17	22	0	39
14:15 - 14:30	LT	62	34	3	99
	ST	165	54	6	219
	RTOR	25	16	7	48

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	43	28	0	71
	ST	139	45	2	186
	RTOR	36	49	6	91
16:45 - 17:00	LT	31	42	4	77
	ST	203	20	3	226
	RTOR	29	12	2	43
17:00 - 17:15	LT	68	47	2	117
	ST	176	38	1	215
	RTOR	23	16	0	39
17:15 - 17:30	LT	46	35	6	87
	ST	168	28	7	203
	RTOR	54	47	3	104

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: South

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	RT	34	15	2	51
	ST	76	26	3	105
	LT	63	18	5	86
7:45 - 8:00	RT	53	23	3	79
	ST	86	32	2	120
	LT	47	17	0	60
8:00 - 8:15	RT	24	11	1	36
	ST	56	32	8	96
	LT	12	23	2	37
8:15 - 8:30	RT	64	9	4	77
	ST	52	21	1	75
	LT	46	17	0	63

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	RT	31	7	0	38
	ST	120	14	3	137
	LT	12	22	2	34
13:45 - 14:00	RT	22	12	0	34
	ST	147	24	1	172
	LT	21	26	2	49
14:00 - 14:15	RT	19	11	4	34
	ST	132	13	9	154
	LT	12	22	7	41
14:15 - 14:30	RT	17	23	3	43
	ST	121	53	1	175
	LT	35	5	5	45

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	RT	37	12	6	55
	ST	157	44	1	202
	LT	15	18	4	37
16:45 - 17:00	RT	22	12	6	38
	ST	196	15	3	214
	LT	31	9	4	44
17:00 - 17:15	RT	26	13	4	43
	ST	123	19	1	143
	LT	26	23	3	52
17:15 - 17:30	RT	45	9	2	56
	ST	111	14	0	125
	LT	12	11	7	30

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: North

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	35	29	0	54
	ST	112	20	1	132
	RTOR	43	17	0	60
7:45 - 8:00	LT	9	17	2	28
	ST	109	8	0	117
	RTOR	34	18	0	52
8:00 - 8:15	LT	32	9	4	45
	ST	118	23	6	147
	RTOR	44	0	7	51
8:15 - 8:30	LT	23	9	0	32
	ST	97	21	7	125
	RTOR	19	3	5	27

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	17	24	0	41
	ST	135	21	2	158
	RTOR	36	12	3	51
13:45 - 14:00	LT	27	15	2	44
	ST	163	11	0	147
	RTOR	15	12	3	30
14:00 - 14:15	LT	45	24	3	72
	ST	112	32	4	148
	RTOR	26	15	5	46
14:15 - 14:30	LT	8	16	1	25
	ST	103	22	7	132
	RTOR	34	14	2	50

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	22	11	12	45
	ST	108	7	6	120
	RTOR	13	9	2	24
16:45 - 17:00	LT	18	9	0	27
	ST	97	21	3	121
	RTOR	21	12	1	34
17:00 - 17:15	LT	14	21	1	36
	ST	86	27	3	116
	RTOR	21	9	2	32
17:15 - 17:30	LT	14	9	1	24
	ST	77	24	6	107
	RTOR	15	13	2	30

b) Survey data traffic flow at Intersection 2

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey: 27 December 2010 (Normal Activity)

Direction: East

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	57	45	8	110
	ST	147	87	12	246
	RTOR	41	37	6	84
7:45 - 8:00	LT	78	58	3	139
	ST	203	65	17	285
	RTOR	92	45	8	145
8:00 - 8:15	LT	94	35	7	136
	ST	220	65	9	294
	RTOR	72	7	4	83
8:15 - 8:30	LT	63	16	9	88
	ST	178	89	5	272
	RTOR	74	23	7	104

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	46	41	9	96
	ST	187	87	14	288
	RTOR	58	28	7	93
13:45 - 14:00	LT	40	16	8	64
	ST	251	54	12	317
	RTOR	31	24	7	61
14:00 - 14:15	LT	69	7	4	80
	ST	217	84	12	313
	RTOR	84	35	8	127
14:15 - 14:30	LT	63	22	11	96
	ST	123	59	0	182
	RTOR	74	43	3	120

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	23	14	2	39
	ST	177	23	7	207
	RTOR	31	17	2	50
16:45 - 17:00	LT	44	18	1	63
	ST	167	11	3	181
	RTOR	23	45	0	68
17:00 - 17:15	LT	41	7	4	52
	ST	102	21	2	125
	RTOR	47	25	1	73
17:15 - 17:30	LT	35	23	7	65
	ST	193	17	5	215
	RTOR	43	11	0	54

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: West

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	27	12	7	46
	ST	212	76	3	291
	RTOR	55	23	7	85
7:45 - 8:00	LT	26	46	5	77
	ST	239	34	4	277
	RTOR	22	13	5	40
8:00 - 8:15	LT	54	11	9	74
	ST	205	34	0	239
	RTOR	16	18	3	37
8:15 - 8:30	LT	38	24	4	66
	ST	217	37	7	261
	RTOR	36	48	8	92

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	68	22	12	9
	ST	201	47	6	264
	RTOR	37	38	9	84
13:45 - 14:00	LT	39	12	4	55
	ST	233	47	0	280
	RTOR	44	22	8	74
14:00 - 14:15	LT	47	16	0	63
	ST	205	37	1	243
	RTOR	34	22	7	63
14:15 - 14:30	LT	43	11	44	98
	ST	198	45	8	271
	RTOR	28	53	6	87

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	23	18	4	45
	ST	177	49	3	229
	RTOR	65	67	2	134
16:45 - 17:00	LT	23	16	8	47
	ST	222	26	4	252
	RTOR	45	6	0	51
17:00 - 17:15	LT	34	18	2	52
	ST	178	63	8	249
	RTOR	33	25	3	61
17:15 - 17:30	LT	23	24	0	47
	ST	168	56	6	230
	RTOR	38	26	3	67

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: South

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	19	46	5	70
	ST	89	34	4	123
	RTOR	23	13	5	41
7:45 - 8:00	LT	24	11	2	37
	ST	67	26	0	93
	RTOR	29	11	2	42
8:00 - 8:15	LT	32	16	5	53
	ST	65	24	2	91
	RTOR	10	13	2	25
8:15 - 8:30	LT	25	7	3	32
	ST	58	13	0	71
	RTOR	24	7	2	33

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	46	32	0	78
	ST	179	66	4	249
	RTOR	34	18	2	54
13:45 - 14:00	LT	56	28	0	84
	ST	165	24	2	191
	RTOR	35	26	2	63
14:00 - 14:15	LT	64	16	4	84
	ST	138	16	0	154
	RTOR	34	43	7	84
14:15 - 14:30	LT	24	14	4	42
	ST	167	23	0	190
	RTOR	54	13	5	72

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	34	14	4	52
	ST	140	20	0	160
	RTOR	26	13	4	43
16:45 - 17:00	LT	18	15	3	36
	ST	132	31	1	164
	RTOR	32	18	0	50
17:00 - 17:15	LT	25	13	1	39
	ST	143	14	1	158
	RTOR	26	23	0	49
17:15 - 17:30	LT	34	16	5	55
	ST	109	17	0	126
	RTOR	23	12	3	38

Location: Tripoli city

Object of the survey: traffic flow

Date of the survey:27 December 2010 (Normal Activity)

Direction: North

Time	Direction	LV	HV	MC	Total
7:30 - 7:45	LT	33	24	5	62
	ST	163	26	0	189
	RTOR	30	14	4	48
7:45 - 8:00	LT	15	34	8	57
	ST	146	19	6	171
	RTOR	21	8	1	30
8:00 - 8:15	LT	45	21	4	70
	ST	121	52	7	180
	RTOR	32	13	4	49
8:15 - 8:30	LT	42	23	2	67
	ST	130	15	0	145
	RTOR	34	21	2	57

Time	Direction	LV	HV	MC	Total
13:30 - 13:45	LT	46	25	4	75
	ST	127	24	7	158
	RTOR	42	36	5	83
13:45 - 14:00	LT	23	44	3	70
	ST	138	23	0	161
	RTOR	41	14	4	59
14:00 - 14:15	LT	36	23	8	67
	ST	74	64	5	143
	RTOR	35	24	4	63
14:15 - 14:30	LT	36	36	2	74
	ST	103	45	7	155
	RTOR	25	63	1	89

Time	Direction	LV	HV	MC	Total
16:30 - 16:45	LT	44	12	0	56
	ST	137	23	0	160
	RTOR	24	9	1	34
16:45 - 17:00	LT	43	19	3	75
	ST	125	23	2	116
	RTOR	42	28	0	70
17:00 - 17:15	LT	32	23	1	55
	ST	121	15	4	140
	RTOR	32	17	7	56
17:15 - 17:30	LT	53	16	1	74
	ST	110	32	5	147
	RTOR	24	25	3	52

Table 4.5 Comparison between existing and design Result for isolated intersection 1

Data	Existing			Design		
Period	Morning	Afternoon	Evening	Morning	Afternoo n	Evening
No of phase	2			2		
Cycle (sec)	47	47	47	61	53	73
Integreen	4	4	4	4	4	4
Green (E, W)	24	24	24	27	23	32
Green (S, N)	15	15	15	26	22	35
AV.no of stop (sec/pcu)	2.3	2.4	5.1	0.3	0.3	0.3
AV.inter delay (sec/pcu)	155.5	151.2	417.5	21.4	16.6	23.6

Table 4.6 Comparison between existing and design Result for isolated intersection 2

Data	Existing			Design		
Period	Morning	Afternoon	Evening	Morning	Afternoo n	Evening
No of phase	2			2		
Cycle (sec)	58	58	58	54	80	50
Integreen	4	4	4	4	4	4
Green (E, W)	25	25	25	25	36	21
Green (S, N)	25	25	25	22	36	21
AV.no of stop (sec/pcu)	0.6	1.4	1.2	0.3	0.4	0.3
AV.inter delay (sec/pcu)	37.3	94.1	78.8	14.7	24.7	14.9

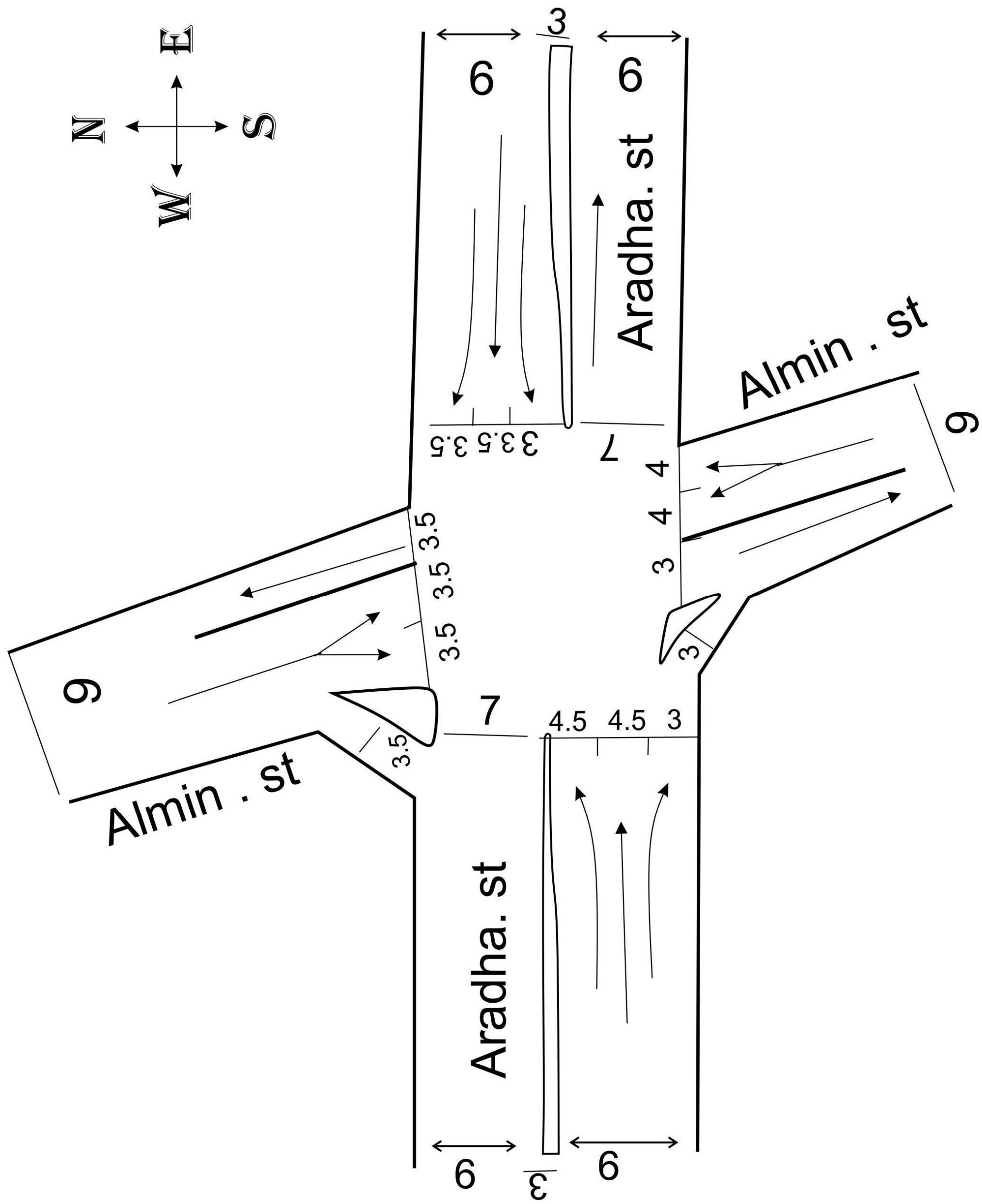


Figure 4.3 Intersection 1 after design

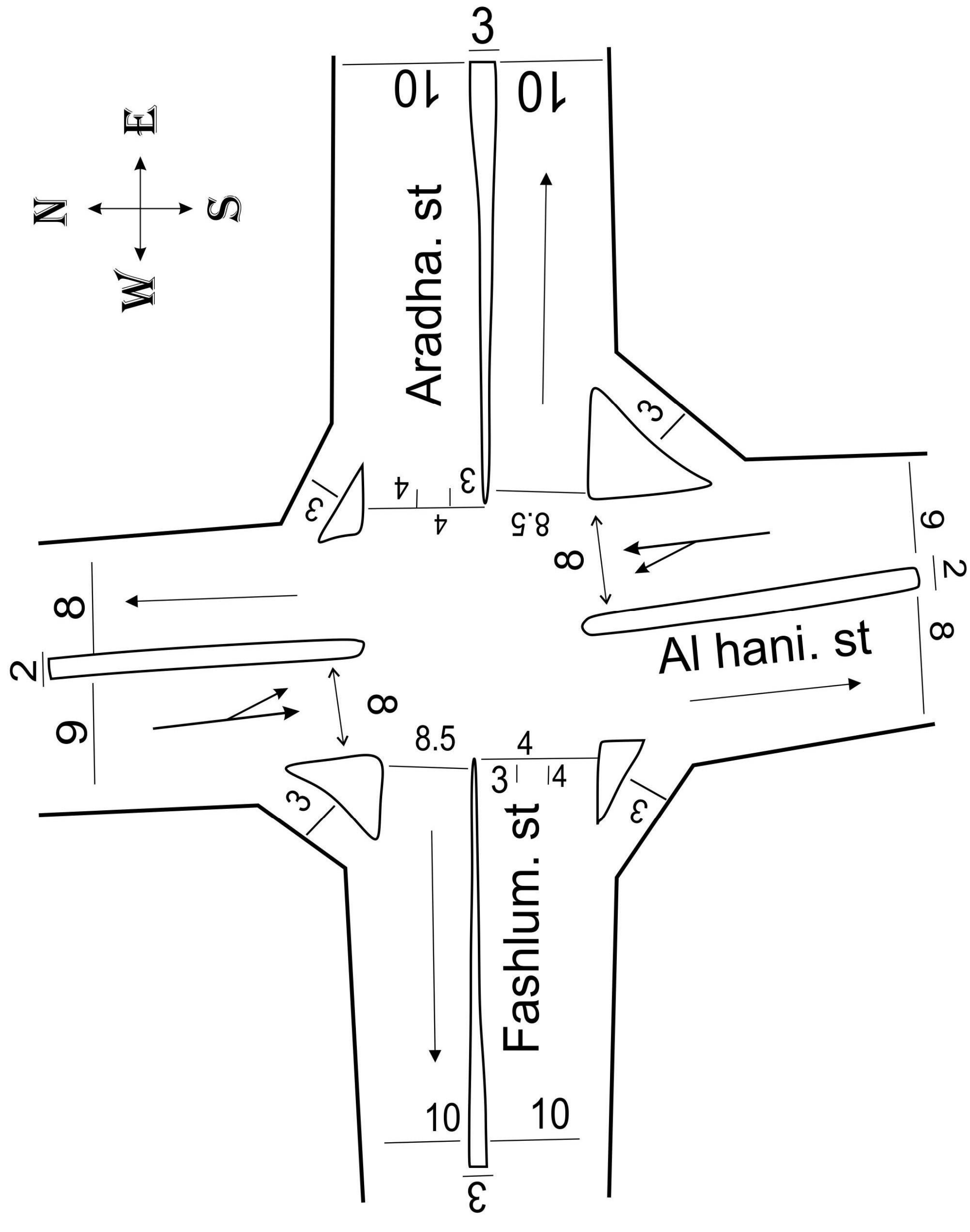


Figure 4.4 Intersection 2 after design

Table 4.7 Coordination Result.

Data	Intersection 1			Intersection 2		
Period	Morning	Afternoon	Evening	Morning	Afternoo n	Evening
No of phase	2			2		
Cycle (sec)	61	80	73	61	80	73
Integreen	4	4	4	4	4	4
Green (E, W)	27	36	35	31	40	40
Green (S, N)	26	36	30	22	32	25
AV.no of stop (sec/pcu)	0.3	0.3	0.17	0.3	0.46	0.4
AV.inter delay (sec/pcu)	18	18	9.8	14.6	25.8	24

4.4 Bandwidth and Efficiency of a Progression

t Ideal offset $= \frac{L}{V} = \frac{m}{m/sec} = \frac{426}{11.11} = 38$ sec

Where

t = ideal offset

L = block length (m)

V = vehicle speed (m/sec), v= 40 km = 40 × 1000 / 3600 = 11.11 m/sec

a) Morning

Cycle = 61 sec

Green time inter .1 = 27

Green time inter. 2 = 61 × 0.514 = 31 sec

Where 0.514 = phase ratio for design

Bandwidth = 27 sec

Efficiency $= \frac{bandwidth}{cycle\ length} \times 100\% = \frac{27}{61} \times 100\% = 44.2\ \%$

East/ West bound = $\frac{13.5\,veh}{cycle} \times \frac{cycle}{60\,sec} \times \frac{3600\,sec}{hr} = 810\ vph\ per\ lane$

Nonstop volume = $\frac{3600\,(BW)(L)}{(h)(C)}\ vph = \frac{3600 \times 27 \times 2}{2.0 \times 61}$ = 1593 vph

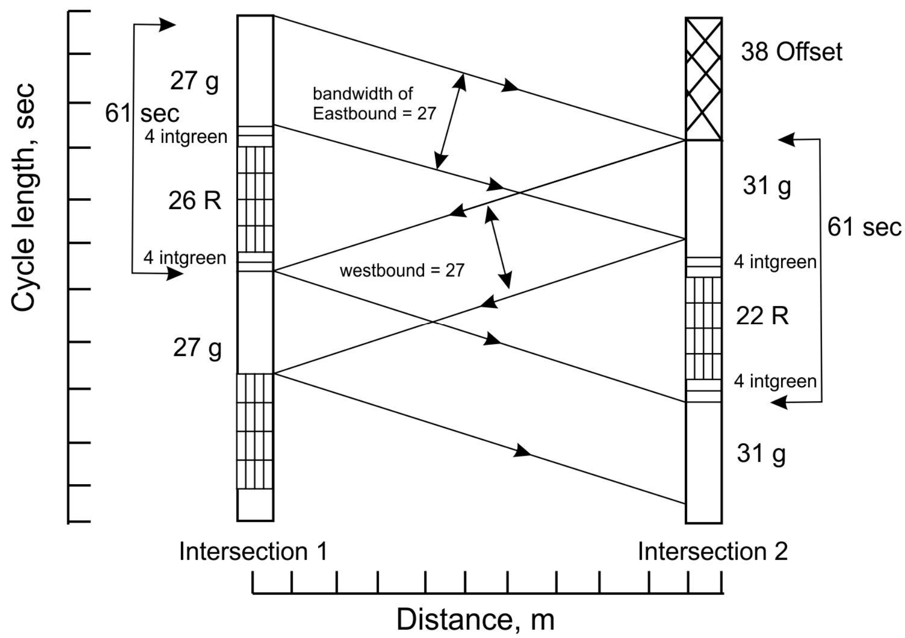


Figure 4.6 Offset on two-way arterial at morning

b) Afternoon

Cycle = 80 sec

Green time inter.1 = 36

Green time inter. 2 = 80 × 0.503 = 40 sec

Where 0.503 = phase ratio for design

Bandwidth = 36 sec

Efficiency = $\frac{bandwidth}{cycle\ length} \times 100\% = \frac{36}{80} \times 100\% = 45\ \%$

East / West bound = $\frac{18\,veh}{cycle} \times \frac{cycle}{60\,sec} \times \frac{3600\,sec}{hr} = 1080\ vph\ per\ lane$

Nonstop volume = $\frac{3600\,(BW)(L)}{(h)(C)}\ vph = \frac{3600 \times 36 \times 2}{2.0 \times 80}$ = 1620 vph

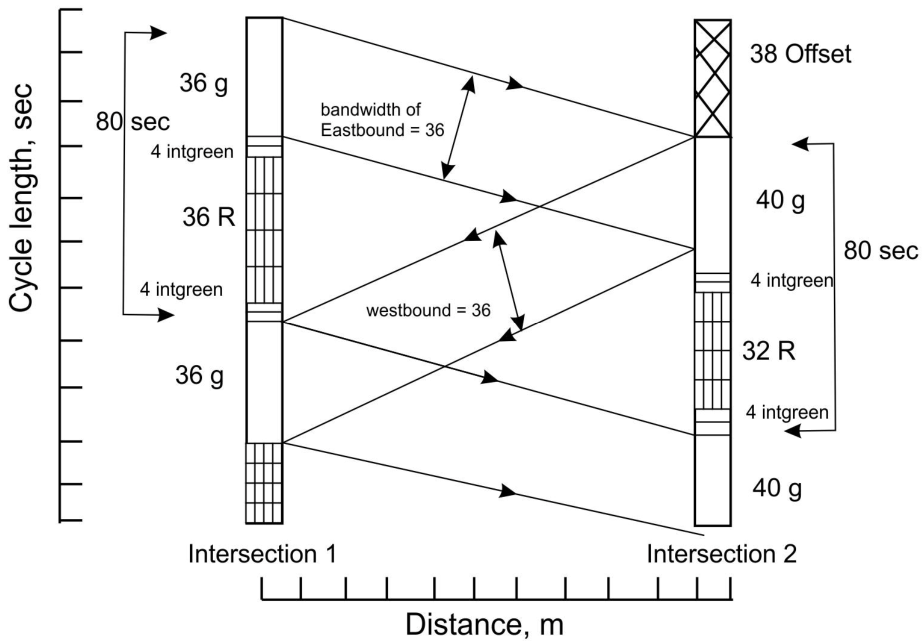


Figure 4.7 Offset on two-way arterial at afternoon

c) Evening

Cycle = 73 sec

Green time inter. 1 = 35

Green time inter. 2 = 73 $\times$ 0.547 = 40 sec

Where 0.547 = phase ratio for design

Bandwidth = 35 sec

Efficiency = $\frac{bandwidth}{cycle\ length} \times 100\% = \frac{35}{73} \times 100\%$ = 48 %

East/ West bound = $\frac{17.5\ veh}{cycle} \times \frac{cycle}{60\ sec} \times \frac{3600\ sec}{hr} = 1050\ vph\ per\ lane$

Nonstop volume = $\frac{3600\,(BW)(L)}{(h)(C)}\ vph = \frac{3600 \times 35 \times 2}{2.0 \times 73}$ = 1726 vph

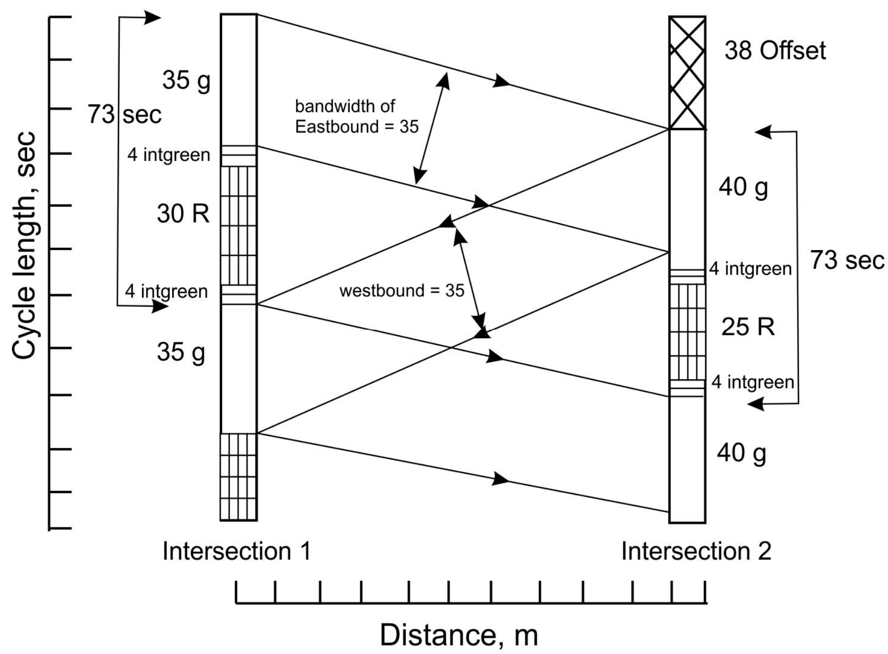


Figure 4.8 Offset on two-way arterial at evening

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5. 1 CONCLUSION

All of the data inserted and analyzed by using IHCM. The result of calculation consists of number of phase, cycle length, integreen, green time, average intersection delay and average no. of stops. The intersections show the low performance in existing data case by the highest numbers in average intersection delay and average no. of stops.

The performance of the intersections will be expected to perform better by changing the approach width and the cycle time which was calculated using IHCM for both intersections, so that the traffic jam such as delay and No of stops could be reduced. Almost all of the intersections give better performance if they are compared to the previous condition.

Trying to coordinate between them. To give the full performance, Can be seen low in some of average no. of stops and average intersection delay, and rising in others but we got good efficiency and nonstop volume, in coordination result.

5. 2. SUGGESTION AND RECOMMENDATION

1. Implementation of traffic management such as improved geometric (without widening the means) and movement arrangements need to be done because it will provide significant performance improvements at the intersection signalized intersection and intersection-existing

2. It is recommended the study area is extended to conclude for more intersections and network in order to observe the role of a coordination system for traffic performance on network to avoid the many problems such as congestion.

3. The last recommendation is change from private transportation to public transportation to get rid of congestion and blocking traffic on the roads**.**

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