ANALYSIS OF INTERSECTION IN DERNA CITY (CASE STUDY: INTERSECTION OF REPULIC STREET AND REAL ESTATE STREET)

Thesis

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Of Civil Engineering Diponegoro University

BY

Abdussalam .A. A. Elkarshofi

Student Number: 21010111409019

Post Graduate Program in Civil Engineering

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RATIFICATION

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Arranged by :

Abdussalam .A. A. Elkarshofi
21010111409019

Maintained in front of the team of examiners on:

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This Thesis had been approved as one of the requirements

For the degree of Master in Civil Engineering

Team of Examiners

1.	Ir. EPF. Eko Yulipriyono, MS	:	Supervisor	…………………………
2.	Dr . Ir . Ismiyati . MS	:	Co-Supervisor	…………………………
3.	Ir . Wahyudi Kushardjoko . MT	:	Member 1	………………………….
4.	Kami Hari Basuki, ST. MT	:	Member 2	………………………….

Semarang, May 2013

DIPONEGORO UNIVERSITY

Faculty of Engineering

Civil Engineering Master Program

Dr. Ir. Bambang Riyanto, DEA

NIP. 19530326 198703 1 001

ABSTRACT

Rapid growth and development of Derna City in terms of population and the number of comers drive the pressure on transportation system. The appearing problem of traffic is traffic density and long lasting jam. Traffic jam is one of important things needed to solve especially on unsignalised intersection in a busy city like Derna City at peak hour and it is needed to observe if the systems have been suitable with the standard or not.

This study is aimed to reveal the solution in order to minimize traffic density as well as mobility repair by maximizing study of case using method guide from Indonesian Highway Capacity Manual (IHCM, 1997).

Location intersection in this study are located in Derna City, Libya considering Republic Street is one of pivotal cities in the city having crowded traffic especially at peak hour. The city is also one of areas with the most rapid population growth in Libya. In this case, intersection on Republic Street and Real Estate street are chosen to be the objects of study because of their traffic density.

The result and value show suitable saturation level on unsignalised intersection and the value is consistent with the standard used , but the safety on traffic is still low. Thus, the saturation level needs to be tested after five years to see if the standard is still suitable or not. From the result of analysis, it is obviously seen that the saturation level value is high. That is why it is necessary to plan intersection with signalised intersection and by considering the value of saturation degree is consistent and suitable with the standard used. As the conclusion, it is suggested to perform intersection with signalised intersection in the next.

Keywords

Unisignalised intersection, Signalised intersection, Degree of saturation, IHCM 1997 **.**

Abstraksi

Pertumbuhan dan kemajuan yang pesat Kota Derna dalam hal populasi dan jumlah pendatang memacu meningkatnya tekanan di bidang system transportasi. Masalah lalu lintas yang muncul adalah peningkatan kepadatan lalu lintas dan bertambah lamanya kemacetan. Kemacetan lalu lintas adalah salah satu hal yang dipandang perlu untuk dipikirkan terutama di persimpangan tanpa lampu lalu lintas di kota yang sibuk seperti kota Derna di jam-jam ramai dan perlu dipelajari apakah system-sistemnya sudah memenuhi standar atau belum.

Pembahasan ini bertujuan untuk menemukan solusi dalam rangka mengurangi kepadatan lalu lintas sebagaimana halnya perbaikan mobilitas melalui optimalisasi studi kasus dengan menggunakan metode panduan Indonesian Highway Capacity Manual (IHCM, 1997)

Lokasi persimpangan dalam pembahasan ini terletak di kota Derna, Libya, mengingat Republic Street adalah salah satu kawasan Kota terpenting di Derna yang memiliki lalu lintas padat, terutama pada jam-jam sibuk. Kota tersebut juga salah satu kawasan yang memiliki p ertumbuhan populasi tercepat di Libya. Dalam hal ini, terpilihlah persimpangan di Republik Street dan jalan Real Estat dengan tingkat kepadatan lalu lintas yang tinggi.

Hasil analisis data menunjukkan tingkat kejenuhan yang sesuai pada persimpangan tanpa lampu lalu lintas dan nilai-nilai ini konsisten dengan standar yang dipakai. Namun di sisi keselamatan tidak bagus. Dengan demikian perlu diuji kembali tingkat kejenuhan di 5 tahun mendatang dan melihat apakah standarnya masih sesuai atau tidak. Dari hasil analisis, terlihat bahwa nilai kejenuhan tinggi sehingga dirasa perlu merencanakan persimpangan-persimpangan dengan lampu lalu lintas. dan dilihat dari nilai derajat kejenuhannya cocok dan konsisten dengan standar yang dipakai. Jadi, disarankan untuk menggunakan persimpangan berlampu lalu lintas di masa mendatang.

Kata kunci

Persimpangan tak bertanda , persimpangan bertanda , tingkat kejenuhan , IHCM 1997.

DECLARATION AUTHENTICITY

To all those who love me and those that I love

ACKNOWLEDGEMENT

In the Name of Allah, the Beneficent, the Merciful. May His blessing be upon Prophet Muhammad, peace be upon him. Alhamdulillah, all praise to Allah, with His Blessing for giving me the power and will to complete this study

I would like to convey sincere gratitude to my advisors **Ir. Epf.Eko Yulipriyono MS** and **Dr. Ir. Ismiyati**, **MS** the Main Supervisor for their invaluable advice, guidance, constant support and encouragement. Their enthusiasm and commitment to this research project is deeply appreciated and undoubtedly invaluable.

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I gratefully thank all the staff of Department of Civil Engineering, Diponegoro University.

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Abdussalam. A. A. Elkarshofi

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CHAPTER 1
INTRODUCTION

1.1 Background

Due to the continued growth and rapid development in Libya and especially the city of Derna coastal away from the capital Tripoli, with distance about 1,300 kilometers in the east, and in 2012 reached a population could be about 250 Thousand people, a peninsula surrounded the Mediterranean Sea by a space about 4 kilometers, featuring a city landscape marine The hills and bays, This is what makes Mediterranean Mermaid attract tourists coming from all over the world, and causes rapid development of the population and the large number of tourists generating pressure growth on the transport system and the traffic pressure appears in form of longer period of congestion and traffic jams, especially in the peak hours, as well as the degree of safety and a few big loss on the road networks .

Intersections are the main reason for the congestion and traffic bottlenecks , There are different types of them such as unsignalised , signalised , roundabout intersection , But here is the analysis of the ability to use two types of intersections unsignalised otherwise we need to try with signalised intersection and see if this standard is appropriate or not .

This study is aimed to demonstrate reduction on traffic density as well as improvement in mobility via a case study optimization using the manual methods of Indonesian Highway Capacity Manual (IHCM, 1997).

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1.2 PROBLEM STATEMENT

This study will focus on unsignalised intersection in Derna city as shown in, Figure 1.1, 1.2 ,1.3,1.4 This intersection experience congestion at the rush hours. It is frequently observed in a rapidly growing Derna 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 Derna , 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 intersection is unsignalised and no road marking .

Figure 1.1 Location of Derna City (Resource: googlearth)

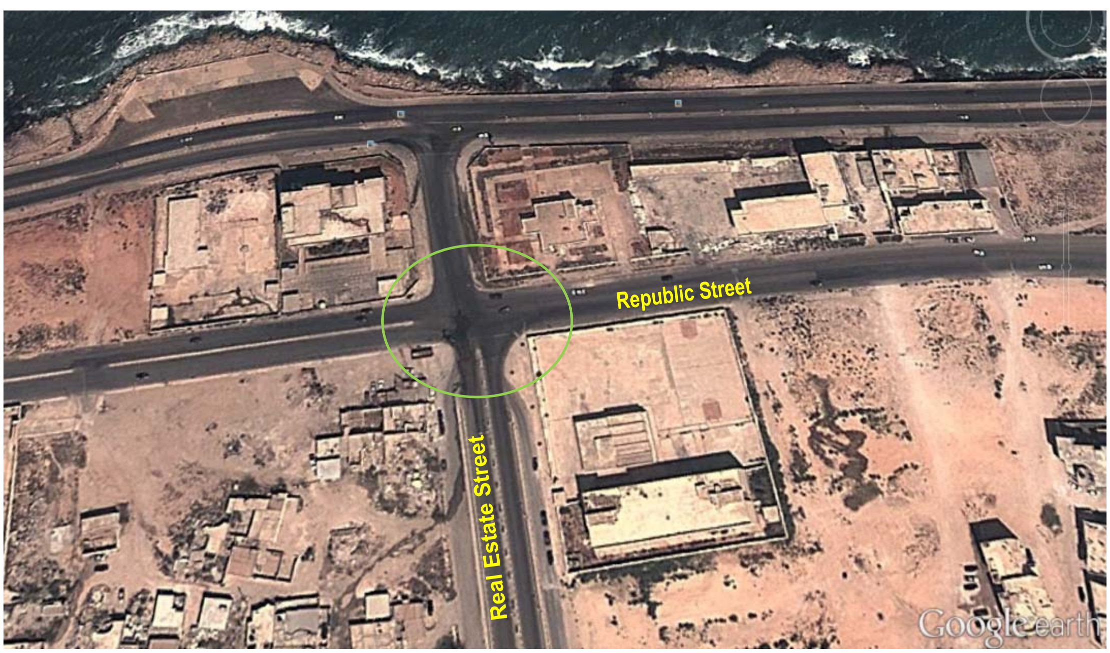


Figure 1.2 Study Area in Derna City (Resource: googlearth)

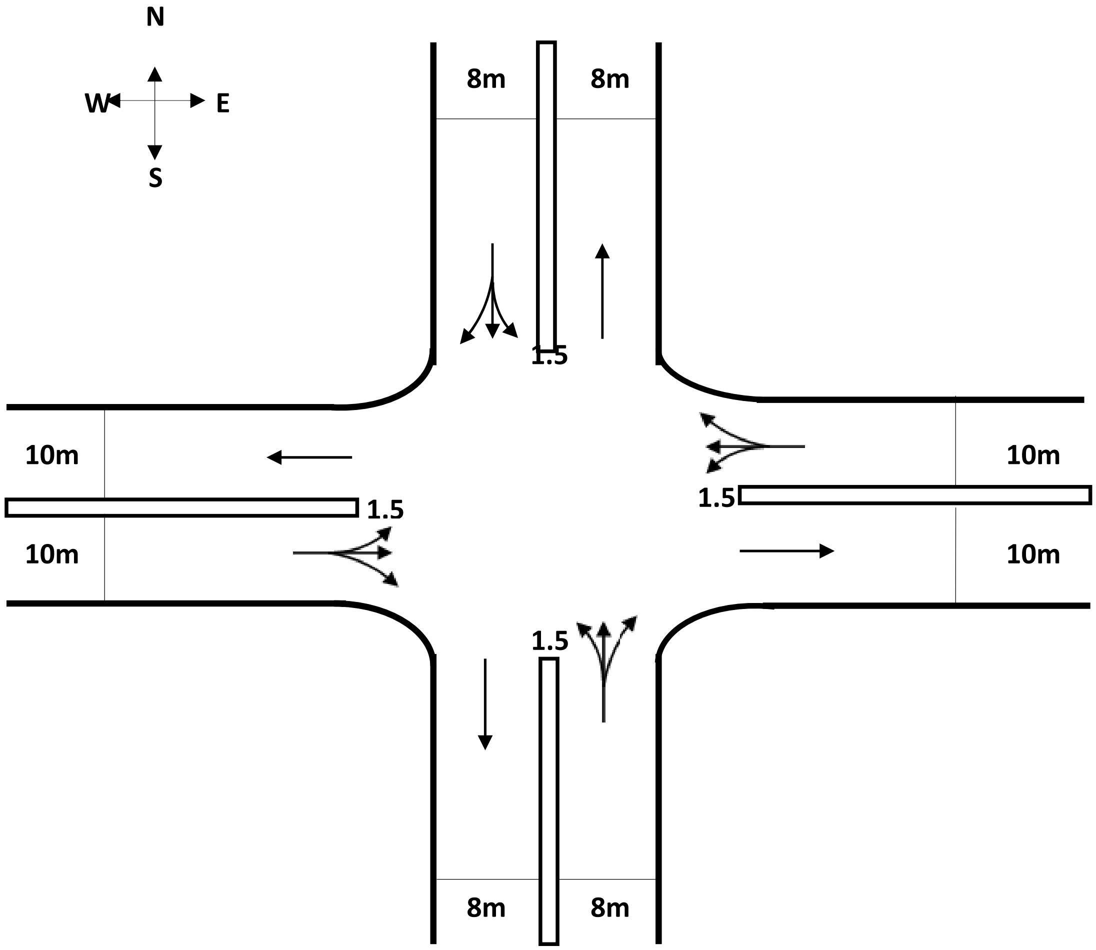


Figure 1.3 Geometry Of unsignalised
Intersection in Derna City (Sketch)

Figure 1.4 photograph of unsignalised intersection in Derna city

(Resource: Camera photograph)

1.3 STUDY OBJECTIVES

The purpose of this study is to give the right solution for some traffic problems at major intersection in the city of Derna and develop a framework for the proper transportation system and the achievement of the following objectives:

1) To analysis the performance of the intersection.
2) To achieve a solution to avoid the problem of the increasing volume of traffic and traffic accidents.

I hope that this study will help the government in the city of Derna understand the problems of congestion and accidents and the development of operational plans to solve the problems of the people.

CHAPTER II
LITERATURE REVIEW

2.1 Traffic Signal

Transportation systems are an integral part of a modern day society designed to provide efficient and economical movement between the component parts of the system and offer maximum possible mobility to all elements of our society. A competitive, growing economy requires a transportation system that can move people, goods, and services quickly and effectively. Road transportation is a critical link between all the other modes of transportation and proper functioning of road transportation, both by itself and as a part of a larger interconnected system, ensures a better performance of the transportation system as a whole.

Signalised intersections, as a critical element of an urban road transportation system, regulate the flow of vehicles through urban areas. Traffic flows through signalised intersections are filtered by the signal system (stopping of vehicles during red time) causing vehicular delays. Vehicular delay at signalised intersections increases the total travel time through an urban road network, resulting in a reduction in the speed, reliability, and cost-effectiveness of the transportation system. Increase in delay results in the degradation of the environment through increases in air and sound pollution. Thus, delay can be perceived as an obstacle that has a detrimental effect on the economy. It has been the traffic engineers. endeavor to quantify delay and optimize the signal system to perform at a minimum delay.

The traffic signal is one of the most common facilities being operated by traffic engineers to control traffic in an orderly manner. Traffic signal control settings optimization (a.k.a., traffic signal timing optimization) has been recognized as one of the most cost-effective methods for improving accessibility and mobility at signalised arterials and networks. Thus, traffic engineers always wanted to achieve better operation of traffic signal control, while researchers focused on the development of efficient methods for traffic signal control settings optimization and Coordinating two or more signals on a signalised 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.

There are two ways to design a intersections (IHCM1997) as follows:

1. UNSIGNALISED INTERSECTION.
2. SIGNALISED INTERSECTION.

   Note (all the figure and table in this chapter from Indonesian Highway Capacity Manual IHCM,1997).

2.2 UNSIGNALISED INTERSECTION

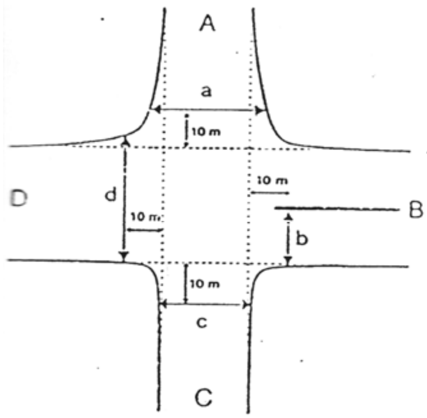
Unsignalised intersection is a common type of intersection used to control traffic movement. They play an important role in determining overall capacity of road networks. A poorly operating unsignalised intersection may affect adjacent signalized intersection. Therefore, it is important to make sure that the intersection is designed appropriately to prevent either under or over designing of the facility. Analysis procedure with respect to Libyan road condition is needed to design the unsignalised intersection so the capacity is always greater than traffic demand.

The evaluation of capacity at unsignalised intersection is practically measured using the gap acceptance approach and the empirical regression approach. In this study, the gap acceptance approach is used for unsignalised intersection procedure. The critical gap and the follow-up time are two major parameters needed for various gap acceptance capacity models , the following performance measures can be estimated for given conditions regarding geometry, environment and traffic with the method outlined :

1. capacity
2. degree of saturation
3. delay
4. queue probability

2.2.1 GEOMETRY

Area for entering vehicles in an intersection arm. Major road approaches are denoted B and D, minor A and C in a clockwise order. Classification of major road median type depending on possibility to use the median to pass the major road in two steps. Code for number of intersection arms and number of lanes on minor and major road in the intersection. Number of lanes defined from the acreage road approach width, see Figure 1.3 .



Average road approach width, W_{AC}, W_{BD} (m)	No. of lanes. (total for both directions)
$W_{BD} = (b + d/2)/2$ < 5.5	2
$W_{AC} = (a/2 + c/2)/2$ ≥ 5.5	4

Figure 2.1 Determination of number of lanes

(Resource: IHCM 1997)

2.2.2 Traffic safety considerations

The traffic accident rate for four-arm unsignalised intersections has been estimated as 0.60 accidents/million incoming vehicles as compared to 0.43 for signalized intersections and 0.30 for roundabouts.

EFFECT OF INTERSECTION LAYOUT

- Three-arm intersections with T-shape have approximately 40% lower accident rates than four-arm intersections.
- Y-intersections have 15-50% higher accident rates than T-intersections.

EFFECT OF GEOMETRIC DESIGN

- A median on the major road reduces the accident rate somewhat.

EFFECT OF INTERSECTION CONTROL

- Yield sign control reduces the accident rate with 60% as compared to priority from the left (uncontrolled)
- Stop sign control reduces the accident rates a further 40% as compared o Yield sign control.
- Traffic signal control reduces the accident rate with 20-50% as compared to uncontrolled operation.

Table 2.1 K-factor default values

Road environment	k-factor-City size	
	> 1 M	≤ 1 M
Roads in commercial areas and arterial roads	0.07 – 0.08	0.08-0.10
Roads in residential areas	0.08-0.09	0.09-0.12

(Resource: IHCM 1997)

Table 2.2 Default values for traffic composition (observe that the unmotorised vehicles are not included in the traffic flow)

City size M inhabitants	Traffic composition motorized vehicles %			Ratio of unmotorised vehicles P_{UM}
	Light veh. LV	Heavy veh. HV	Motorcycles MC	
> 3 M	60	4.5	35.5	0.01
1 – 3 M	55.5	3.5	41	0.05
0.5 – 1 M	40	3.0	57	0.14
0.1 – 0.5 M	63	2.5	34.5	0.05
< 0.1 M	63	2.5	34.5	0.05

(Resource: IHCM 1997)

Table 2.3 General traffic default values

Factor	Default
Minor road flow ratio P_{MI}	0.25
Left turning ratio P_{LT}	0.15
Right turning ratio P_{RT}	0.15
Pcu-factor, F_{pcu}	0.85

(Resource: IHCM 1997)

2.2.3 Environmental considerations

No empirical Indonesian data regarding vehicle, emission were available at the time of production of this manual. Vehicle exhaust and/or noise emissions are generally increased by frequent acceleration and deceleration maneuvers, as well as by time spent idling. From this point of view unsignalised intersections with their lower average delay than signalized intersections at similar total flow are favorable. For cases with intersections between a major road with higher traffic than the minor road however, yield-or stop sign control on the minor road (if enforced), should considerably reduce the need for major roads vehicles to stop or slow down, which would be more favorable from an environmental point of view than unsignalised intersections without such control.

a. City size class CS

Table 2.4 City size classes

City size CS	No. of inhabitants (M)
Very small	< 0.1
Small	0.1 – 0.5
Medium	0.5 – 1.0
Large	1.0 – 3.0
Very large	> 3.0

(Resource: IHCM 1997)

b. Road environment type RE

The road environment is classified in classes describing land use and accessibility of the roads from surrounding activities.

Table 2.5 Road environment types

Commercial	Commercial land use (e.g. shops, restaurants, offices) with direct roadside access for pedestrians and vehicles
Residential	Residential land use with direct road side access for pedestrians and vehicles.
Restricted access	No or limited direct roadside access (e.g due to the existence of physical barriers, frontage streets etc).

(Resource: IHCM 1997)

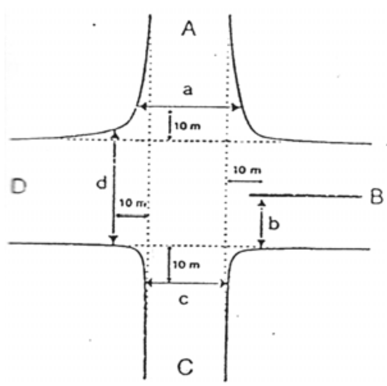
c. Side friction class SF

Side friction describes the impact of road side activities in the intersection area on the traffic discharge, e.g. pedestrians walking on or crossing the carriageway, urban transportation and buses are stopping to pick up or let off passengers, vehicles entering and leaving premises and parking lots outside the carriageway. Side friction is defined qualitatively from traffic engineering judgment as High, Medium or Low.

2.2.4 Approach width and intersection type

a) Average road approach widths W_{AC3} W_{BD} and Average intersection approach width W_1

$$W_{AC} = (W_A + W_C)/2 \qquad W_{BD} = (W_B + W_D)/2$$



Average intersection approach width, W_1 :

$W_1 = (a/2 + b + c/2 + d/2)\ 4$

If A is only exit :

$W_1 = (b + c/2 + d/2)/3$

Road entry widths:

$W_{AC} = (a/2 + c/2)/2$ $W_{BD} = (b + d/2)/2$

b) Intersection type

Intersection type defines number of intersection arms and number of lanes on minor and major road in the intersection by a three digit code. The number of arms is the number of arms with either entering or exiting traffic.

2.2.5 Base capacity value C_0

Table 2.6 Intersection type base capacity C_0 (pcu/h)

Intersection type IT	Base capacity C_0 (pcu/h)
322	2700
342	2900
324 or 344	3200
422	2900
4242 or 444	3400

(Resource: IHCM 1997)

2.2.6 Approach width adjustment factor F_w

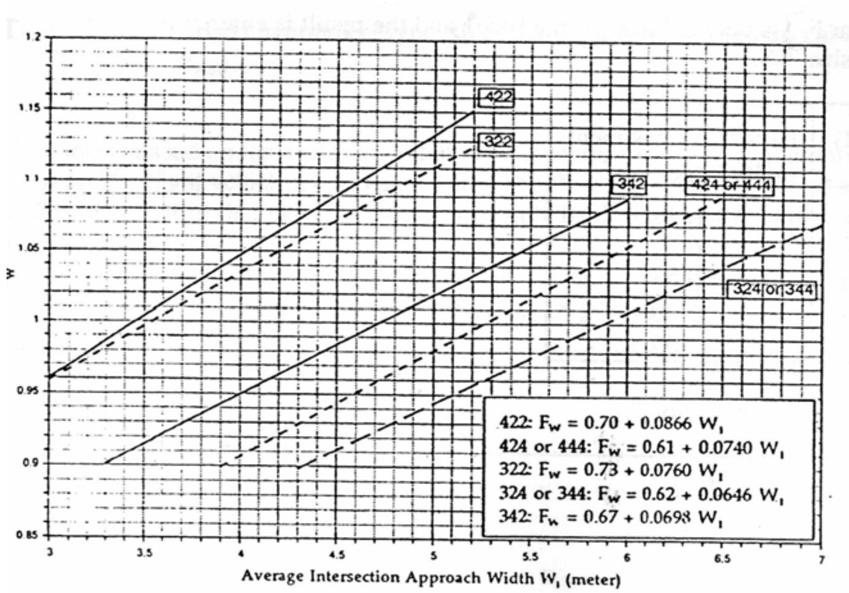


Figure 2.2 Approach width adjustment factor F_W

(Resource: IHCM 1997)

2.2.7 Major road median adjustment factor FM

Traffic engineering judgment is needed to decide the median factor. The median is wide if a standard light vehicle can shelter in the median area without disturbing the discharge of traffic on the major road.

Table 2.7 Major road median adjustment factor F_M

Description	Type M	Median adjustment factor, F_M
No major road median	None	1.00
Major road median exists, width < 3m	Narrow	1.05
Major road median exists, width $\geq$ 3m	Wide	1.20

(Resource: IHCM 1997)

2.2.8 City size adjustment factor F_{CS}

Table 2.8 City size adjustment factor F_{CS}

City size CS	Inhabit. (M)	City size adjustment factors F_{CS}
Very small	< 0.1	0.82
Small	0.1 – 0.5	0.88
Medium	0.5 – 1.0	0.94
Large	1.0 – 3.0	1.00
Very large	> 3.0	1.05

(Resource: IHCM 1997)

2.2.9 Road environment type, side friction and unmo-torised vehicles adjustment factor F_{RSU}

Table 2.9 Road environment type, side friction and unmotorised vehicles adjustment factor F_{RSU}

Road environment type class RE	Side friction class SF	Ratio of unmotorised vehicles P_{UM}					
		0.00	0.05	0.10	0.15	0.20	≥ 0.25
Commercial	High	0.93	0.88	0.84	0.79	0.74	0.70
	Medium	0.94	0.89	0.85	0.80	0.75	0.70
	Low	0.95	0.90	0.86	0.81	0.76	0.71
Residential	High	0.96	0.91	0.86	0.82	0.77	0.72
	Medium	0.97	0.92	0.87	0.82	0.77	0.73
	Low	0.98	0.93	0.88	0.83	0.78	0.74
Restricted access	High/medium/ low	1.00	0.95	0.90	0.85	0.80	0.75

(Resource: IHCM 1997)

The table is based on the assumption that the impact on capacity of an unmotorised vehicle is the same as of a Light vehicle, i.e. pce_{UM} =1.0. The following equation can be applied if the user has evidence showing that $pce_{UM} \neq 1.0$, which might be the case if the unmotorised vehicles mainly are bicycles.

$$F_{RSU} \text{ (Actual } P_{UM}) = F_{RSU} (P_{UM}=0) \times (1-p_{UM} \times pce_{UM})$$

2.2.10 Left-Turning adjustment factor F_{LT}

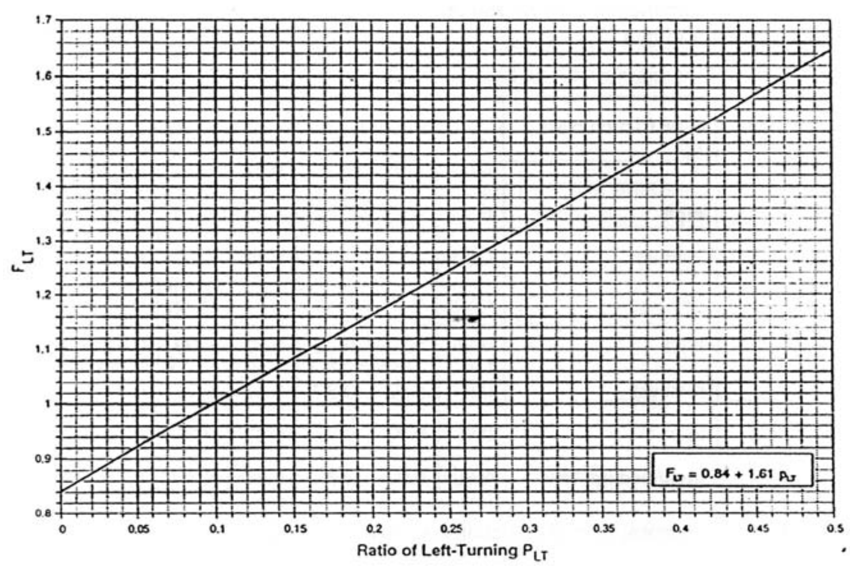


Figure 2.3 Left-turning adjustment factor F_{LT}

(Resource: IHCM 1997)

Here this study must take Right-turning adjustment factor from this figure Because drive role in Libya to disagree with in the direction of entry and exit with Code (IHCM 1997) .

2.2.11 Right-turning adjustment factor F_{RT}

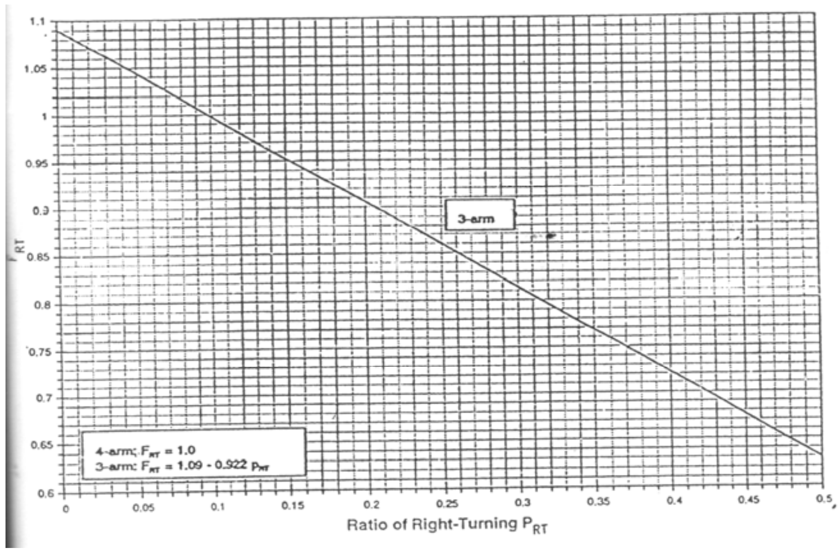
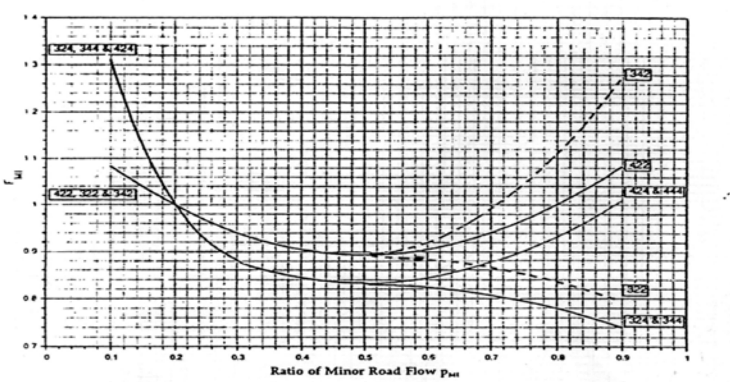


Figure 3.4 Right-turning adjustment factor F_{RT}

(Resource: IHCM 1997)

Here this study must take Left-turning adjustment factor from this figure Because drive role in Libya to disagree with in the direction of entry and exit with Code (IHCM 1997)

2.2.12 Minor road flow ratio adjustment factor F_{MI}



IT	F_{MI}	p_{MI}
422	$1.19 \times p_{MI}^2 - 1.19 \times p_{MI} + 1.19$	0.1 - 0.9
424	$16.6 \times p_{MI}^4 - 33.3 \times p_{MI}^3 + 25.3 \times p_{MI}^2 - 8.6 \times p_{MI} + 1.95$	0.1 - 0.3
444	$1.11 \times p_{MI}^2 - 1.11 \times p_{MI} + 1.11$	0.3 - 0.9
322	$1.19 \times p_{MI}^2 - 1.19 \times p_{MI} + 1.19$	0.1 - 0.5
	$-0.595 \times p_{MI}^2 + 0.595 \times p_{MI}^3 + 0.74$	0.5 - 0.9
342	$1.19 \times p_{MI}^2 - 1.19 \times p_{MI} + 1.19$	0.1 - 0.5
	$2.38 \times p_{MI}^2 - 2.38 \times p_{MI} + 1.49$	0.5 - 0.9
324	$16.6 \times p_{MI}^4 - 33.3 \times p_{MI}^3 + 25.3 \times p_{MI}^2 - 8.6 \times p_{MI} + 1.95$	0.1 - 0.3
344	$1.11 \times p_{MI}^2 - 1.11 \times p_{MI} + 1.11$	0.3 - 0.5
	$-0.555 \times p_{MI}^2 + 0.555 \times p_{MI} + 0.69$	0.5 - 0.9

Figure 2.5 Minor road flow adjustment factor F_{MI}

(Resource:IHCM 1997)

2.2.13 Actual capacity C

$$C = C_o \times F_w \times F_M \times F_{CS} \times F_{RSU} \times F_{LT} \times F_{RT} \times F_{MI}$$

2.2.14 Traffic performance

a. Degree of saturation DS

DS = Q_{TOT}/C

DS = degree of saturation

Where:

Q_{TOT} = Actual total flow (pcu/h)

C = Actual capacity

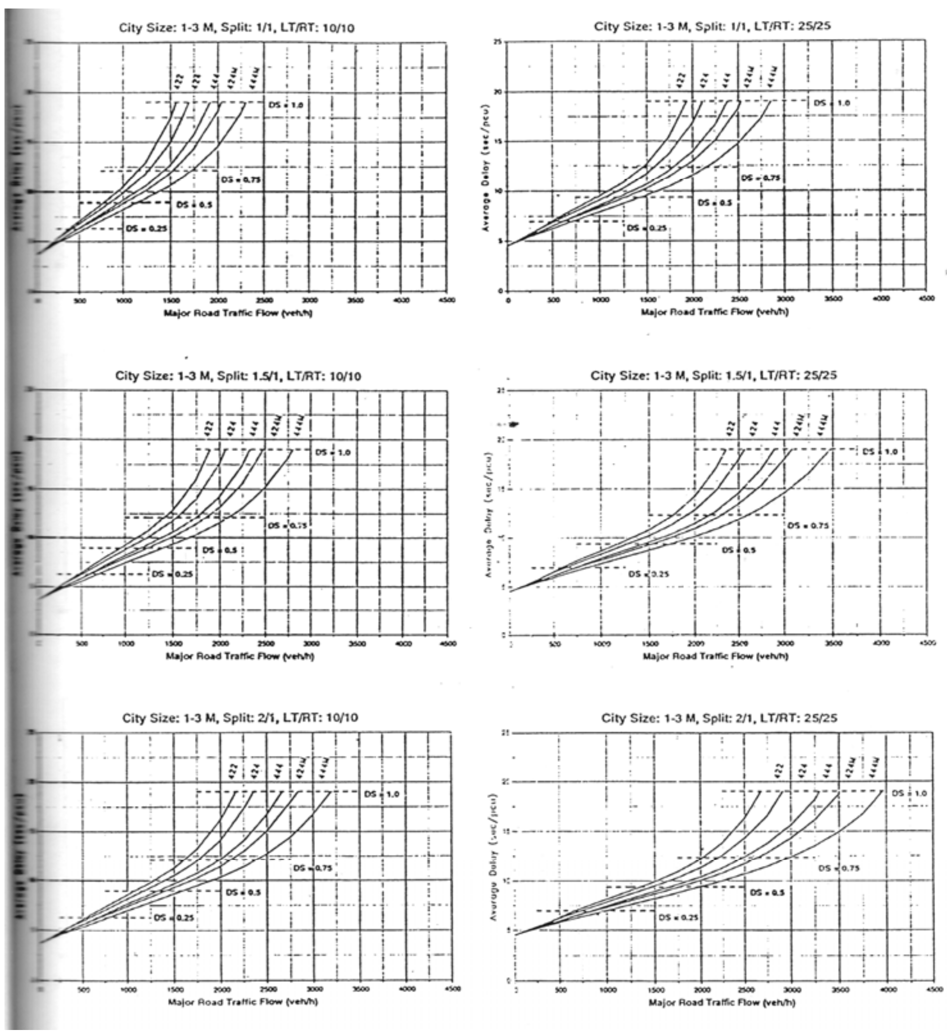


Figure 2.6 Traffic performance for four-arm unsignalised intersections.

(Resource: IHCM 1997)

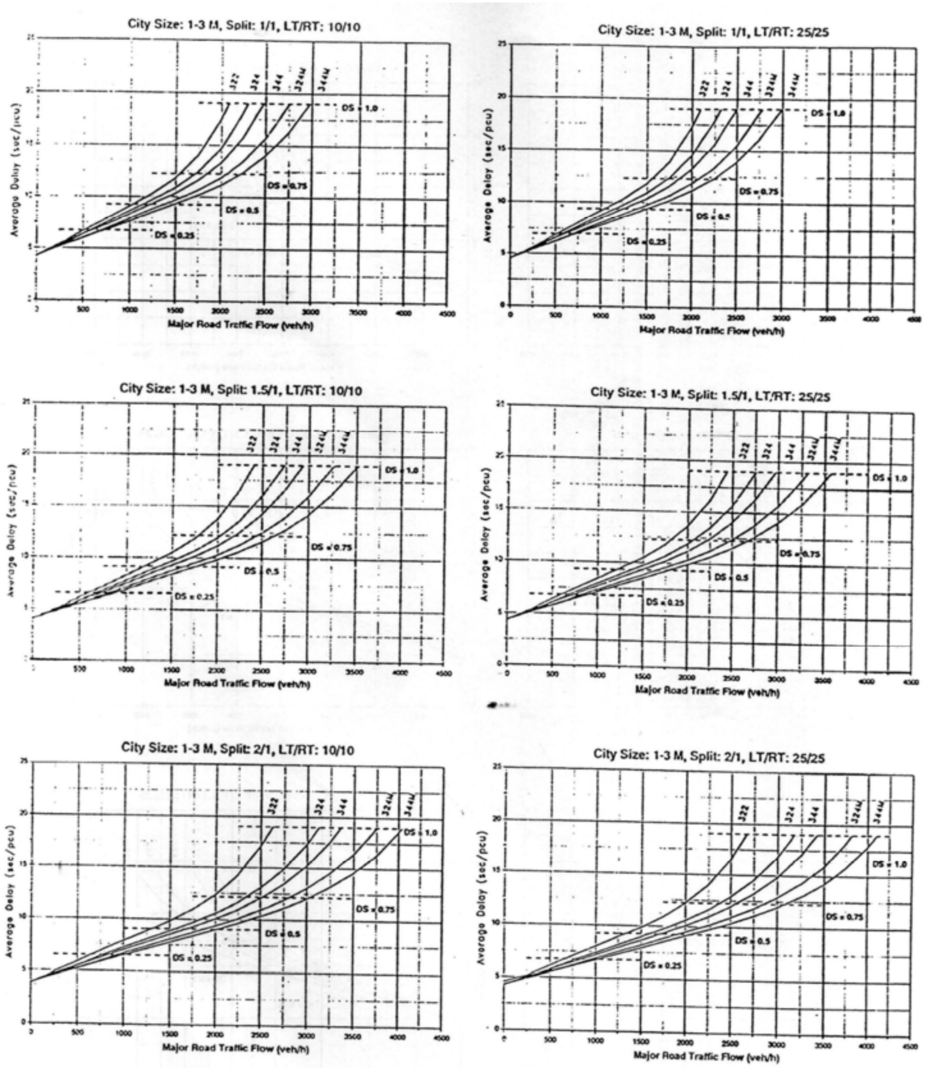


Figure 2.7 Traffic performance for four-arm unsignalised intersections.

(Resource: IHCM 1997)

2.2.15 Delays D

a. Intersection traffic delay DT

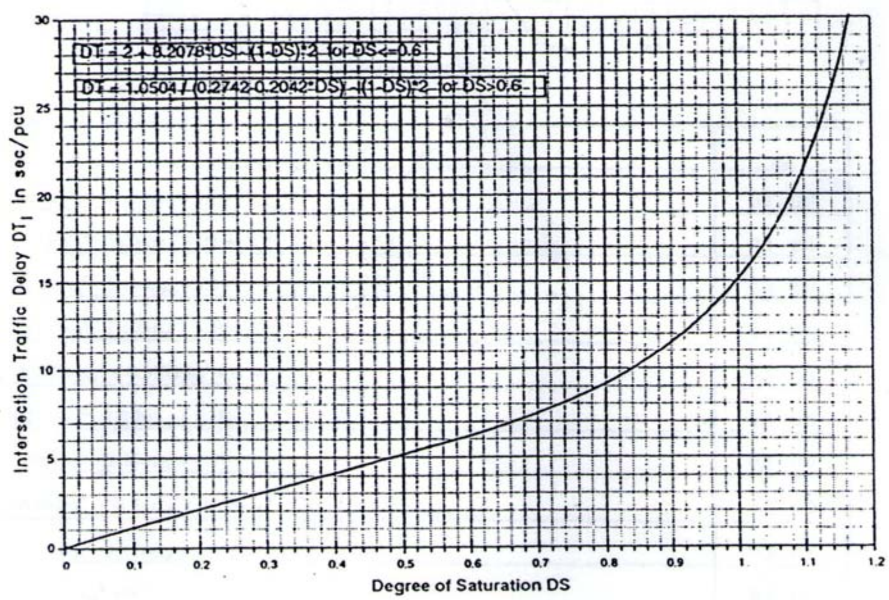


Figure 2.8 Intersection traffic delay versus DS = Q_{pcu}/C

(Resource: IHCM 1997)

b. Major road traffic delay DT_{MA}

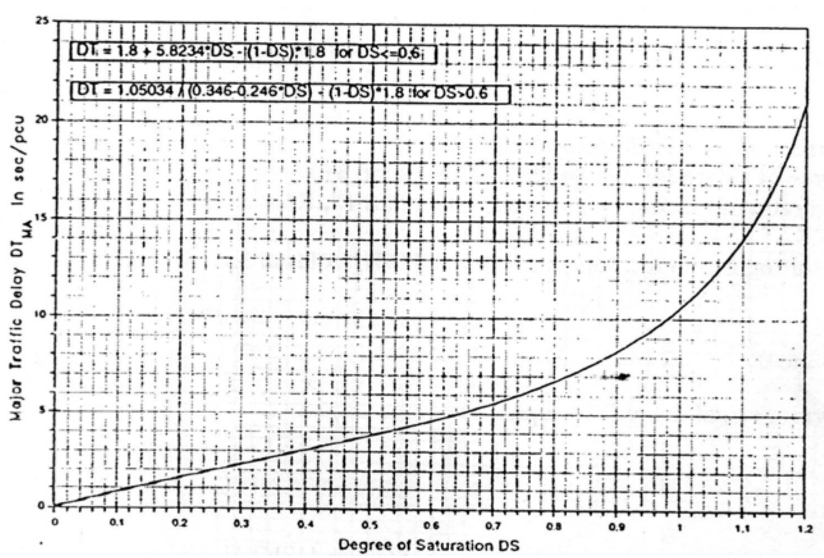


Figure 2.9 Major road traffic delay versus DS = Q_{pcu}/C

(Resource: IHCM 1997)

c. Determination of average traffic delay for the minor road DT_{M1}

The average delay for the minor road DT_{M1} (sec/pcu) is determined based on the average delay for the whole intersection and the average delay for the major road.

$$DT_{M1} = (Q_{TOT} \text{ x } DT_1 - Q_{MA} \text{ x } DT_{MA})/Q_{M1}$$

d. Intersection geometric delay DG

Intersection geometric delay DG is calculated from the following formulae:

For DS <1.0:

$DG = (1\text{-}DS)x\ (P_T x6 + (1\text{-}P_T)x3) + DSx4$

For DS $\geq$ 1.0: DG = 4

Where :

DG = Intersection geometric delay (sec/pcu)

DS = Degree of saturation

P_T = Total ratio of turning

e. Intersection delay D

Calculate average total delay D (sec/pcu) as:

D = DG + DT1

Where:

DG = Intersection geometric delay (sec/pcu)

DT_1 = Intersection traffic delay (sec/pcu)

2.2.16 Queue probability QP%

A range of queue probability QP% is estimated from the empirical relationship between queue probability QP% and degree of saturation DS

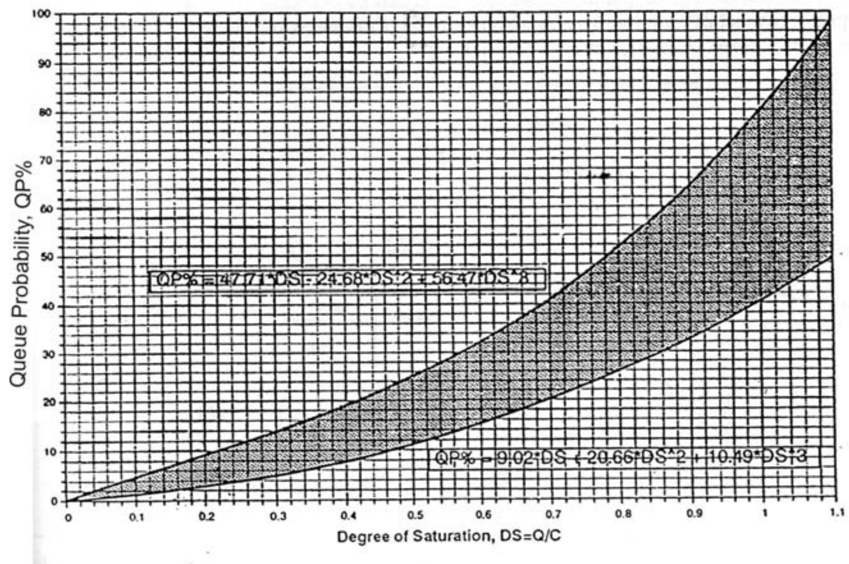


Figure 2.10 Range of queue probability QP% versus degree of saturation DS = Q_{TOT}/C

(Resource: IHCM 1997)

2.2.17 Evaluation of traffic performance

This Manual has been primarily designed to estimate consequences regarding capacity and traffic performance of a set given conditions regarding geometric design, traffic and environment. Since the outcome usually cannot be predicted beforehand, it is quite likely that it will be necessary to revise some of the conditions which are within the engineer's control, particularly geometric conditions, in order to get a desired traffic performance regarding capacity and delay.

The quickest way to evaluate the results is to look at the degree of saturation (DS) for the studied case, and to compare it with the annual traffic growth and the desired functional "life" of the intersection in question. If the obtained DS values are too high (> 0.75), the user might want to revise his assumptions regarding approach width etc and make a new set of calculations. This will then require a new set of forms with a new assigned case.

2.3 SIGNALISED INTERSECTION

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this results in some congestion. As demand approaches the capacity of a road (or of the intersections along the road), extreme traffic congestion sets in. When vehicles are fully stopped for periods of time, this is colloquially known as a traffic jam or traffic snarl-up.

Traffic congestion occurs when a volume of traffic or modal split generates demand for space greater than the available road capacity; this point is commonly termed saturation. There are a number of specific circumstances which cause or aggravate congestion; most of them reduce the capacity of a road at a given point or over a certain length, or increase the number of vehicles required for a given volume of people or goods. About half of U.S. traffic congestion is recurring, and is attributed to sheer weight of traffic; most of the rest is attributed to traffic incidents, road work and weather events.[2]

Traffic research still cannot fully predict under which conditions a "traffic jam" (as opposed to heavy, but smoothly flowing traffic) may suddenly occur. It has been found that individual incidents (such as accidents or even a single car braking heavily in a previously smooth flow) may cause ripple effects (a cascading failure) which then spread out and create a sustained traffic jam when, otherwise, normal flow might have continued for some time longer

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.

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

2.4 GENERAL PRINCIPLES

2.4.1 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.

2.4.2 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 2.10 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

(Resource: IHCM 1997)

Q = Qlv + Qhv + Pce hv + Qmc + Pce mc

2.4.3 Basic model

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

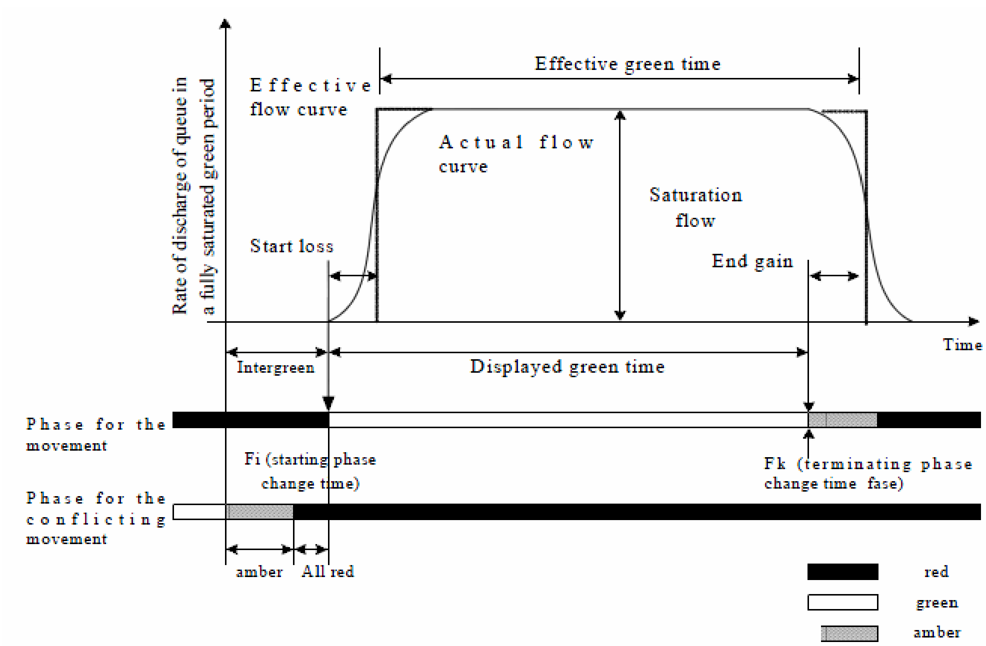


Figure 2.11 Basic model for saturation flow

(Resource: IHCM 1997)

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 2.12)

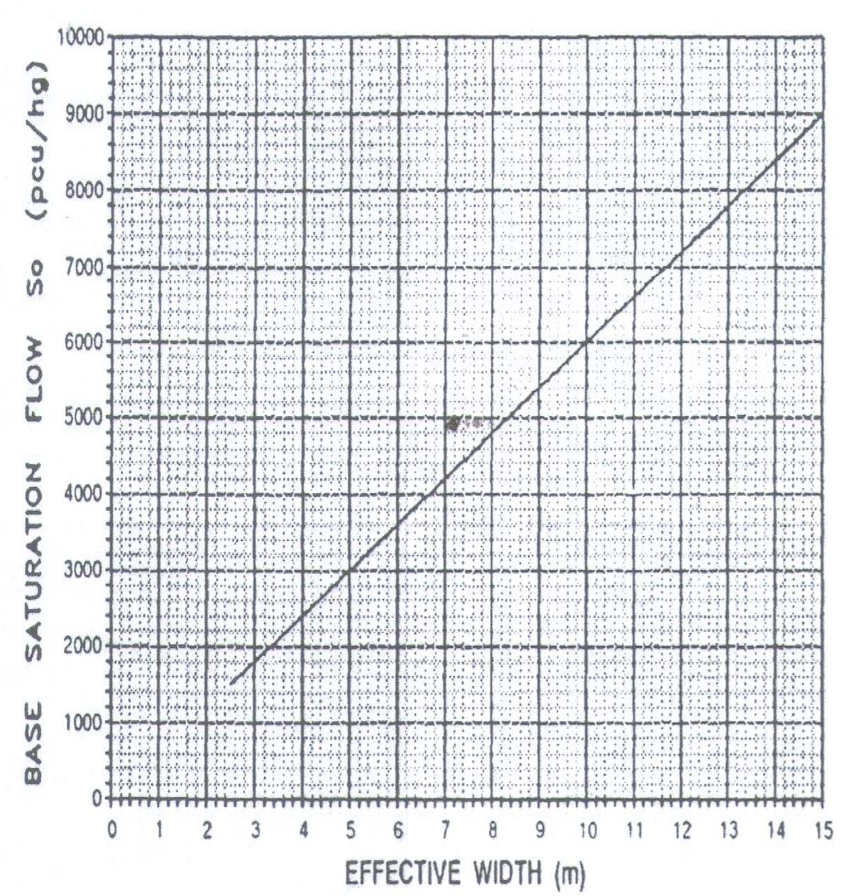


Figure 2.12 Base Saturation flow for approach type P

(Resource: IHCM 1997)

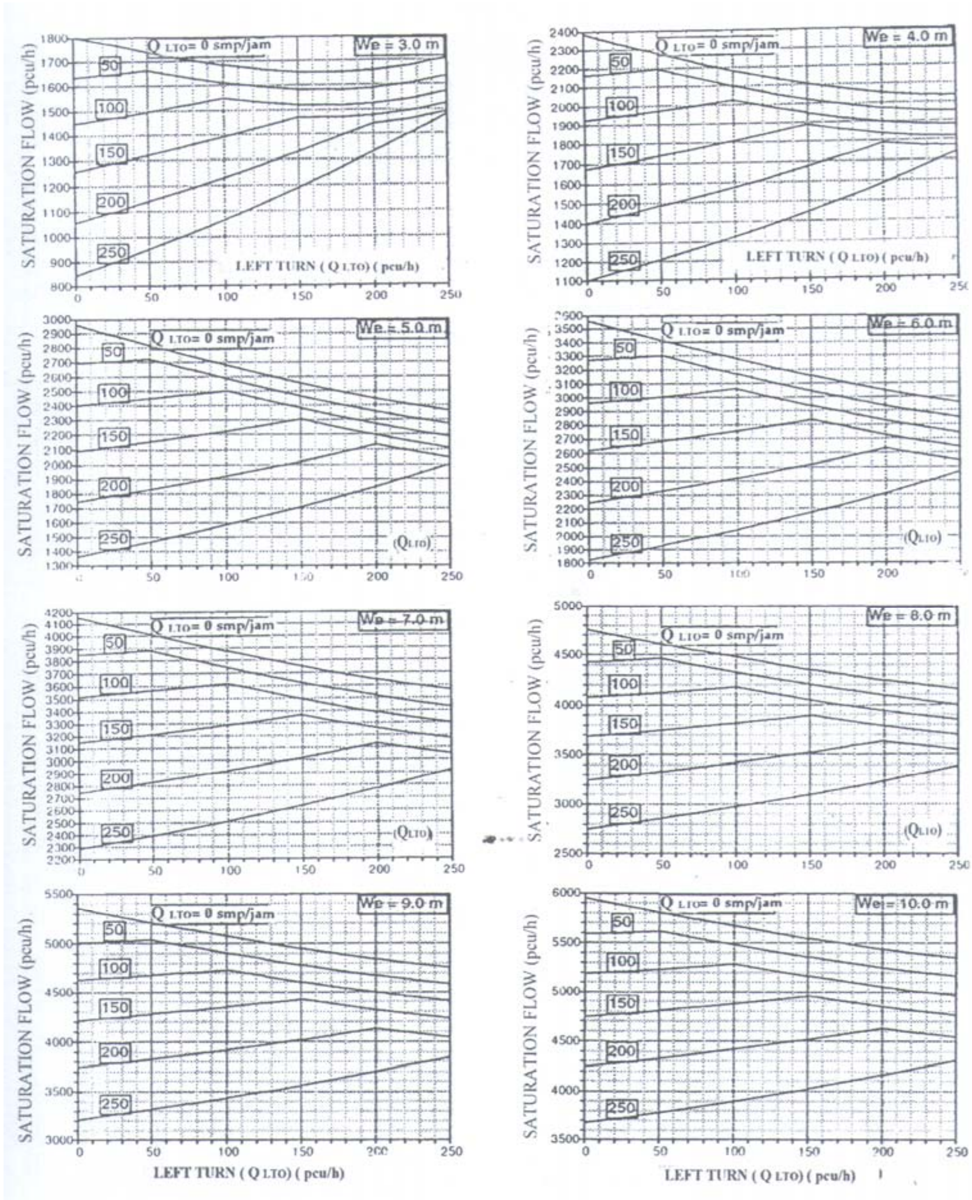


Figure 2.13 for approaches type O without separate left – turning lane

(Resource: IHCM 1997)

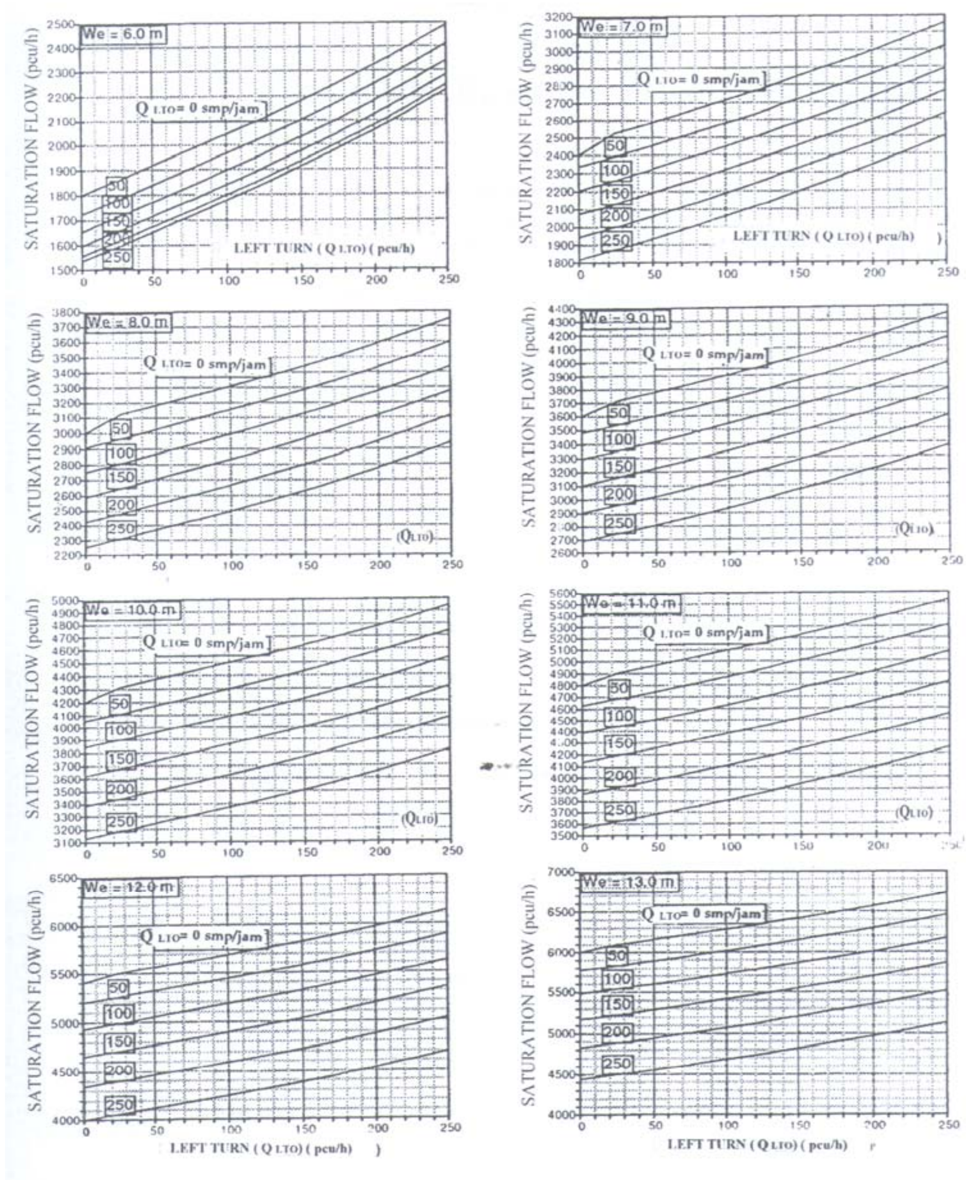


Figure 2.14 for approaches type O without separate left – turning lane

(Resource: IHCM 1997)

2.4.4 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 FCS . is determined from Table 2.11 as a function of the city size.

Table 2.11 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

(Resource: IHCM 1997)

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 2.12 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

(Resource: IHCM 1997)

The Gradient adjustment factor F_G is determined from

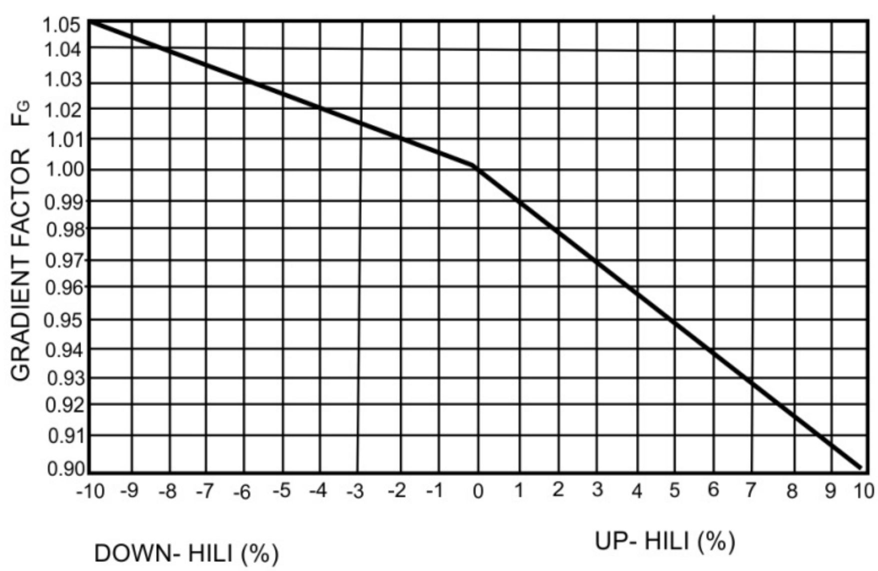


Figure 2.15 Adjustment factors for gradient F_G

(Resource: IHCM 1997)

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 :

FP = $[Lp/3 - (WA - 2) \times (Lp/3 - g) / W A]/g$ Where

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

WA = Width of the approach (m).

g = Green time in the approach (sec).

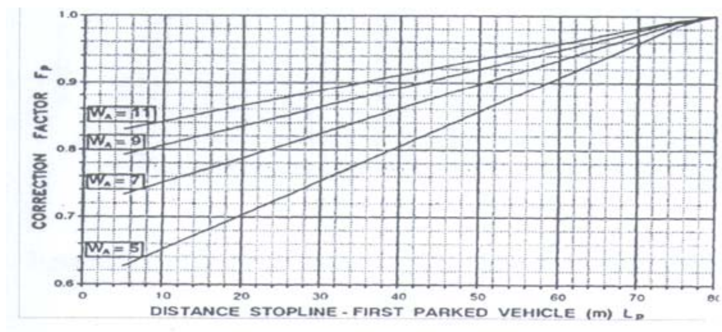
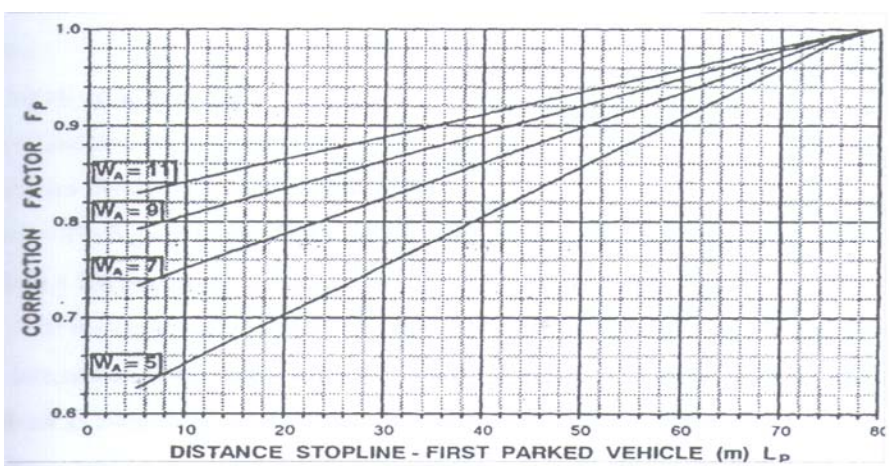


Figure 2.16 Adjustment factors for effect of parking and short left-turn lanes F_P

(Resource: IHCM 1997)

Determine the following correction factors for the base saturation flow value only 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

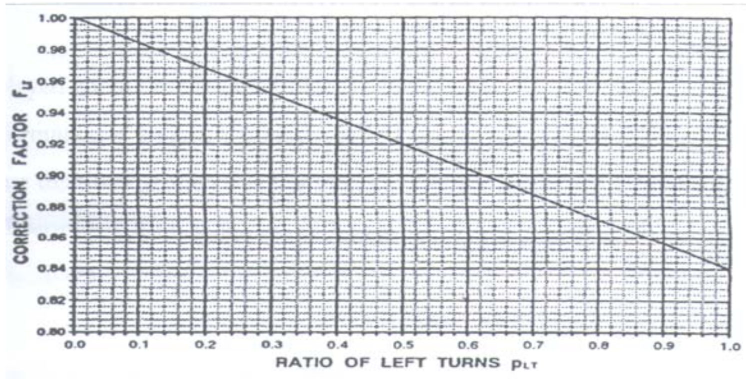


Figure 2.17 Correction factor for Left turns F_{LT}. (o n l y applicable for approach type P, two-way streets)

(Resource: IHCM 1997)

Calculate the adjusted value of saturation flow S :

$$S = S_{\square} + F_{cs} + F_{sf} + F_G + F_p + F_{rt} + F_{lt} \text{ pcu/hg}$$

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

2.4.6 Green Time

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

2.4.7 Capacity

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.

2.4.8 Queue Length

$$NQ = NQ_1 + NQ_2$$

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

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

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.

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

2.4.9 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 x $\frac{NQ}{Q \times c}$x 3600 where: c is the cycle time (sec) and Q the traffic flow (pcu/h) in the studied approach.

2.4.10 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.

2.4.11 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).

$$DT = c \times \frac{0.5x(1-GR)^2}{1-GR \times DS} + \frac{NQ1 \times 3600}{C}$$

where:

DT_j = 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:

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

Where:

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

psv = Proportion of stopped vehicle in the approach

pt = Proportion of turning vehicle in the approach

2.4.12 Previous studies

There is a former student at the University of Diponegoro carried out a study on Performance and design OF two intersections in Tripoli City, **WAYEL ABUZRIBA MOHAMED ZAYED**, 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 optimizing by coordination two intersections.

CHAPTER III
METHODOLOGY

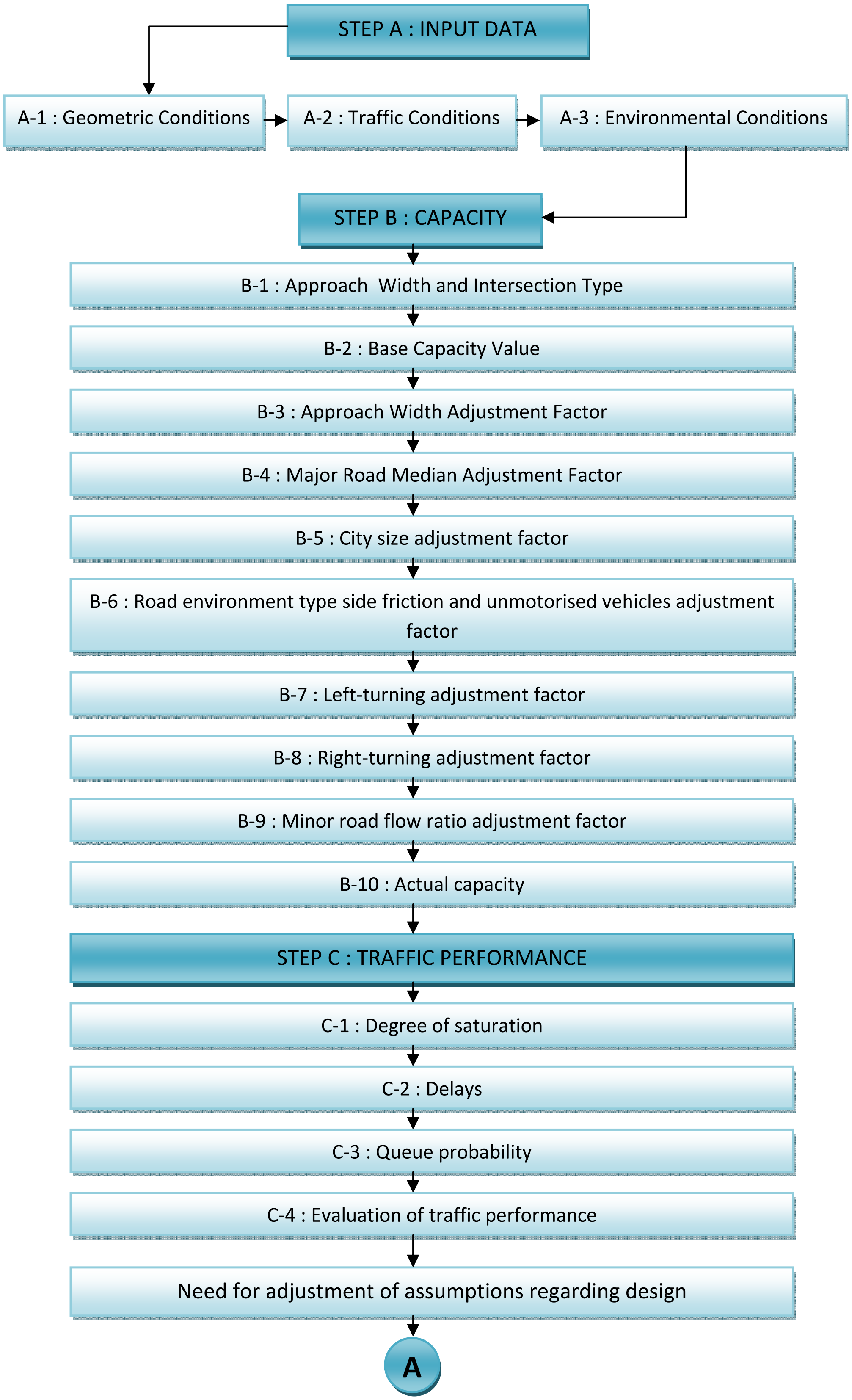
3.1 SELECTION OF LOCATION CASE STUDY

The location and intersections of this study is located at the city Derna of Libya, Consider the Republic Road region is one of the most important urban areas in Derna is busy traffic areas, especially in peak hours, one of the more developed regions the population in Libya. Select one intersections in the republic 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.

3.2 The steps of analysis

The survey will be conduct in one congested unsignalised intersections in Derna during the peak hour. The purpose of the survey is to obtain the information on road geometric, traffic flows, Field data collections will carry out at selected site using three types of equipment which are digital camera, digital stop watches, manual counters and trumpeter. The method of traffic data collection is manual data sheet. The trumpeter is used to measure distance between the intersections that function as a marker for distance the passage of vehicles .

The volume of traffic flow and road geometric conditions is of primary data obtained by field observation method of direct field measurements and traffic counting on manual data sheet, Calculations in this study to evaluate the performance of signal intersections are using the rules set by IHCM 1997.


STEP A : INPUT DATA
A-1 : Geometric Conditions
A-2 : Traffic Conditions
A-3 : Environmental Conditions
STEP B : CAPACITY
B-1 : Approach Width and Intersection Type
B-2 : Base Capacity Value
B-3 : Approach Width Adjustment Factor
B-4 : Major Road Median Adjustment Factor
B-5 : City size adjustment factor
B-6 : Road environment type side friction and unmotorised vehicles adjustment factor
B-7 : Left-turning adjustment factor
B-8 : Right-turning adjustment factor
B-9 : Minor road flow ratio adjustment factor
B-10 : Actual capacity
STEP C : TRAFFIC PERFORMANCE
C-1 : Degree of saturation
C-2 : Delays
C-3 : Queue probability
C-4 : Evaluation of traffic performance
Need for adjustment of assumptions regarding design
A

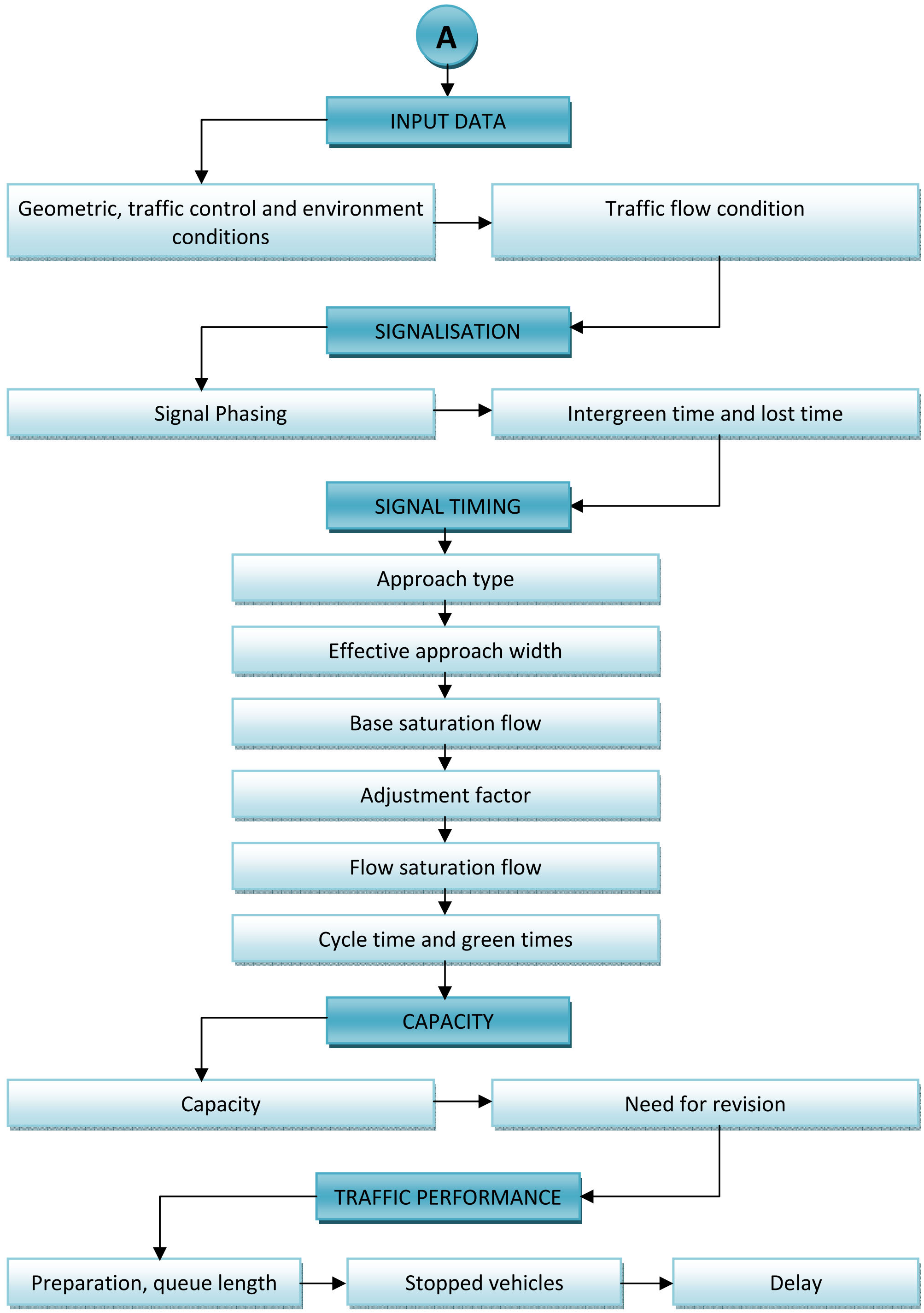


Figure 3.1 Flow chart of the performance analysis at Derna City

CHAPTER IV
DATA AND RESULTS OF ANALYSIS

As one unsignalized intersection in downtown derna is a fairly busy intersection , on the north side is a form of offices and real estate bank , on the south side is a form of Restaurants , on the west side is Immigration office and the former Office of Homeland Security and airline offices and the east side is Residential Complex . The data for this study were obtained by directly taking on the field and by using survey data from the real location , here is the data that are needed to carry out this research include:

1. Map of study area .
2. Data geometric of intersection .
3. Data on traffic flow volume for the intersections .

4.1 Data geometric condition of unsignalised and signalized intersection.

Data geometric condition of unsignalised intersection was obtained by direct measurement, the kinds of vehicle taken for this data are light vehicle and heavy vehicle .The implementation of the traffic count survey is conducted on Saturday 2. 2 . 2013 in the morning , in the afternoon and in the evening , as shown in the tables below :

Table 4.1 Geometry, traffic arrangements and environmental conditions for unsignalised intersection.

Code approach	North	South	West	East
City size	250,000 thousand			
Median Y/N	Y	Y	Y	Y
Turn right immediately Y/N	Y	Y	Y	Y
Type of road environment	COM	COM	COM	COM
Entry WEntry (m)	8	8	10	10
Exit W Exit (m)	8	8	10	10

a) Traffic flow data at unsignalised intersection in the morning .

Data volume of traffic crossing the road or obtained by surveying the traffic counting on intersections , The implementation of a traffic count survey conducted on Saturday 2 February 2013 in the morning .

Table 4.2 Traffic flow data at unsignalised intersection in the morning .

Period	Direction	Direction	Light Vehicles (LV)	Heavy Vehicle (HV)	Motorcycles (MC)	Total
Morning	North	LT	98	85	0	183
		ST	110	79	0	189
		RT	89	90	0	179
	South	LT	110	90	0	200
		ST	109	87	0	196
		RT	94	96	0	190
	West	LT	85	92	0	177
		ST	98	89	0	187
		RT	100	90	0	190
	East	LT	91	101	0	192
		ST	94	85	0	179
		RT	89	79	0	168

b) Traffic flow data at unsignalised intersection in the afternoon .

Data volume of traffic crossing the road or obtained by surveying the traffic counting on intersections , The implementation of a traffic count survey conducted on Saturday 2 February 2013 in the afternoon .

Table 4.3 Traffic flow data at unsignalised intersection in the afternoon .

Period	Direction	Direction	Light Vehicles (LV)	Heavy Vehicle (HV)	Motorcycles (MC)	Total
Afternoon	North	LT	90	92	0	182
		ST	109	80	0	189
		RT	95	78	0	173
	South	LT	87	85	0	172
		ST	102	95	0	197
		RT	79	89	0	168
	West	LT	110	80	0	190
		ST	102	86	0	188
		RT	89	90	0	179
	East	LT	90	79	0	169
		ST	82	86	0	168
		RT	94	91	0	185

c) Traffic flow data at unsignalised intersection in the evening .

Data volume of traffic crossing the road or obtained by surveying the traffic counting on intersections , The implementation of a traffic count survey conducted on Saturday 2 February 2013 in the evening .

Table 4.4 Traffic flow data at unsignalised intersection in the evening .

Period	Direction	Direction	Light Vehicles (LV)	Heavy Vehicle (HV)	Motorcycles (MC)	Total
Evening	North	LT	92	85	0	177
		ST	98	69	0	167
		RT	87	92	0	179
	South	LT	99	78	0	177
		ST	94	69	0	163
		RT	86	92	0	178
	West	LT	105	75	0	180
		ST	96	89	0	185
		RT	85	92	0	177
	East	LT	97	91	0	188
		ST	78	89	0	167
		RT	92	97	0	189

4.2 Analysis of the unsignalised intersection.

a) Data analysis unsignalized intersection in the morning:

1. Traffic flow

In the initial conditions is calculated total motor vehicle (MV) by multiplication (veh/h) with (pce) (light vehicles Lv = 1.0) (heavy vehicles Hv = 1.3) (motorcycles = 0.5) .

Table 4.5 Result total traffic flow (MV) and ratio of turning in unsignalized intersection.

Dir	Approach	Direction	Total motor vehicles (MV)		
			Veh/h	Pcu/h	Ratio of turning
North	Minor road	LT	183	209	0.33
		ST	189	213	
		RT	179	206	0.32
		TOTAL	551	628	
South	Minor road	LT	200	227	0.34
		ST	196	223	
		RT	190	219	0.33
		TOTAL	586	669	
west	Major road	LT	177	205	0.32
		ST	187	214	
		RT	190	217	0.34
		TOTAL	554	636	
East	Major road	LT	192	223	0.36
		ST	179	205	
		RT	168	192	0.31
		TOTAL	539	620	

2. Approach width and intersection type .

Calculate the average approach width for the whole intersection (As described steps in the second chapter).

3. Capacity .

Calculate actual capacity from formula :

$$C = C\square + Fw + FM + Fcs + FRSU + FLT + FRT + FMI$$

Calculate (F) adjustment factors this depends on the information intersection .

Table 4. 6 Result capacity for unsignalised intersection

Base capacity C_0	Capacity adjustment factors (F)							Actual capacity C
	F_W	F_M	F_{CS}	F_{RSU}	F_{LT}	F_{RT}	F_{MI}	
3400	1.276	1.05	0.82	0.95	1.00	1.39	0.83	4094

4. Traffic performance:

Degree of saturation Ds is calculated using total traffic flow (pcu/h) over capacity (pcu / h) .And then calculate average traffic flow for all motor vehicles entering the intersection . (DT1) is depending on the degree of saturation after that calculate average traffic delay for major road (DTMA) and determination of average traffic delay for minor road (DTMI)

And then calculate average geometric delay (DG) and calculate average total delay (D) pcu/h . (As described steps in the second chapter).

Table 4.7 Result degree of saturation and average total delay for unsignalised intersection.

Q (pcu/h)	Ds (Q/C)	DT_1	DT_{MA}	DT_{MI}	DG	D	QP %	Objective
2550	0.62	6.36	4.74	7.91	4.38	10.74	18-38	Ds < 0.75

Q (pcu/h) total major road + minor road (As described steps in the appendix).

The degree of saturation here Ds = 0.62 < 0.75 that mean is good but we need to know the degree of saturation after (five years) because the result is very close to the rate degree of saturation .

$Qn = Q\ real\ (1 + I)^n$

Qn = Traffic volume for five years .

Q real = Traffic volume in this years .

I = The rate of population growth .

N = The number of years.

The rate of population growth in Libya for five years = 4.6% ,There is a difference between the percentage of population growth and growth rate, here was taking the rate of population growth because they are known to us, either population census cars is unknown and difficult to obtain.

Q2018 = 2550 (1+ 0.046) ^5

Q2018= 3193pcu / h

Ds = Q/C = 3193/ 4094= 0.78

DS = 0.78 > 0.75 (not good)

We must go to step two signalised intersections.

b) Data analysis unsignalised intersection in the afternoon :

1. Traffic flow

In the initial conditions is calculated total motor vehicle (MV) by multiplication with pce(light vehicles Lv = 1.0)(heavy vehicles Hv = 1.3) (motorcycles = 0.5) .

Table 4.8 Result total traffic flow (MV) and ratio of turning in unsignalized intersection.

Dir	Approach	Direction	Total motor vehicles (MV)		
			Veh/h	Pcu/h	Ratio of turning
North	Minor road	**LT**	182	210	0.34
		ST	189	213	
		RT	173	197	0.32
		TOTAL	544	620	
South	Minor road	**LT**	172	198	0.32
		ST	197	226	
		RT	168	195	0.32
		TOTAL	537	619	
West	Major road	**LT**	190	214	0.34
		ST	188	214	
		RT	179	206	0.32
		TOTAL	557	634	
East	Major road	**LT**	169	193	0.32
		ST	168	194	
		RT	185	213	0.36
		TOTAL	522	600	0.34

2. Approach width and intersection type .

Calculate the average approach width for the whole intersection (As described steps in the second chapter).

3. Capacity .

Calculate actual capacity from formula :

$$C = C\square + Fw + FM + Fcs + FRSU + FLT + FRT + FMI$$

Calculate (F) adjustment factors this depends on the information intersection .

Table 4. 9 Result capacity for unsignalised intersection

Base capacity C□	Capacity adjustment factors (F)							Actual Capacity C
	Fw	FM	Fcs	F_{RSU}	F_{LT}	F_{RT}	F_{MI}	
3400	1.276	1.05	0.82	0.95	1.00	1.37	0.833	4050

4. Traffic performance:

Degree of saturation Ds is calculated using total traffic flow (pcu/h) over capacity (pcu / h) .And then calculate average traffic flow for all motor vehicles entering the intersection . (DT1) is depending on the degree of saturation after that calculate average traffic delay for major road (DTMA) and determination of average traffic delay for minor road (DTMI)

And then calculate average geometric delay (DG) and calculate average total delay (D) pcu/h . (As described steps in the second chapter).

Table 4.10 Result degree of saturation and average total delay for unsignalised intersection.

Q (Pcu/h)	Ds (Q/C)	DT1	DT_{MA}	DT_{MI}	DG	D	QP %	Objectives
2471	0.61	6.24	4.66	7.80	4.38	10.62	13-33	DS <0.75

Q (pcu/h) total major road + minor road (As described steps in the appendix).

The degree of saturation here Ds = 0.61 < 0.75 that mean is good but we need to know the degree of saturation after (five years) because the result is very close to the rate degree of saturation .

$$Qn = Q\ real\ (1 + I)^{n}$$

Qn = Traffic volume for five years .
Q real = Traffic volume in this years .
I = The rate of population growth .
n = The number of years.

The rate of population growth in Libya for five years = 4.6% , There is a difference between the percentage of population growth and growth rate, here was taking the rate of population growth because they are known to us, either population census cars is unknown and difficult to obtain.

Q2018 = 2471 (1+ 0.046) ^5
Q2018= 3095pcu / h
Ds = Q/C = 3095/ 4050= 0.77
DS = 0.77 > 0.75 (not good)
We must go to step two signalised intersections.

c) Data analysis unsignalised intersection in the evening :

1. Traffic flow

In the initial conditions is calculated total motor vehicle (MV) by multiplication (veh/h) with (pce) (light vehicles Lv = 1.0) (heavy vehicles Hv = 1.3) (motorcycles = 0.5) .

Table 4.11 Result total traffic flow (MV) and ratio of turning in unsignalized intersection.

Dir	Approach	Direction	Total motor vehicles (MV)		
			Veh/h	Pcu/h	Ratio of turning
North	Minor road	**LT**	177	203	0.34
		ST	167	188	
		RT	179	207	0.35
		TOTAL	523	598	
South	Minor road	**LT**	177	201	0.34
		ST	163	184	
		RT	178	206	0.35
		TOTAL	518	591	
West	Major road	**LT**	180	203	0.33
		ST	185	212	
		RT	177	205	0.33
		TOTAL	542	620	
East	Major road	**LT**	188	216	0.34
		ST	167	194	
		RT	189	219	0.35
		TOTAL	544	629	0.33

2. Approach width and intersection type .

Calculate the average approach width for the whole intersection (As described steps in the second chapter).

3. Capacity.

Calculate actual capacity from formula :

C = C□ + Fw + FM + Fcs + FRSU + FLT + FRT + FMI

Calculate (F) adjustment factors this depends on the information intersection .

Table 4. 12 Result capacity for unsignalised intersection

Base capacity C□	Capacity adjustment factors (F)							Actual Capacity C
	Fw	FM	Fcs	FRSU	FLT	FRT	FMI	
3400	1.276	1.05	0.82	0.95	1.00	1.42	0.83	4183

4. Traffic performance:

Degree of saturation Ds is calculated using total traffic flow (pcu/h) over capacity (pcu / h) .And then calculate average traffic flow for all motor vehicles entering the intersection . (DT1) is depending on the degree of saturation after that calculate average traffic delay for major road (DTMA) and determination of average traffic delay for minor road (DTMI)

And then calculate average geometric delay (DG) and calculate average total delay (D) pcu/h . (As described steps in the second chapter).

Table 4.13 Result degree of saturation and average total delay for unsignalised intersection.

Q (Pcu/h)	Ds (Q/C)	DT1	DT_{MA}	DT_{MI}	DG	D	QP %	Objectives
2531	0.61	3.45	4.66	2.45	4.42	7.87	16-36	DS <0.75

Q (pcu/h) total major road + minor road (As described steps in the appendix).

The degree of saturation here Ds = 0.61 < 0.75 that mean is good but we need to know the degree of saturation after (five years) because the result is very close to the rate degree of saturation .

$$Q_n = Q_{real} (1 + I)^n$$

Qn = Traffic volume for five years .

Q real = Traffic volume in this years .

I = The rate of population growth .

n = The number of years.

The rate of population growth in Libya for five years = 4.6% , There is a difference between the percentage of population growth and growth rate, here was taking the rate of population growth because they are known to us, either population census cars is unknown and difficult to obtain.

Q2018 = 2531 (1+ 0.046) ^5

Q2018= 3170pcu / h

Ds = Q/C = 3170/ 4183= 0.76

DS = 0.76 > 0.75 (not good)

We must go to step two signalised intersections.

4.3 Analysis of the signalised intersection.

a) Data analysis signalised intersection in the morning :

1. Traffic flow

In the initial condition is calculated the ratio of the number of cars over five years.

Ratio of the number of cars (five years) = (Qn – Q real) / Q real

Ratio % = (3193 – 2550) / 2550 = 25 %

So all data multiplied by (1.25) until you get the total volume of traffic after five years.

Calculate the traffic flow in (pcu) for each vehicle type for protecting and opposed discharge conditions (whichever is relevant depending upon the signal phasing and permitted left – turning movements) . Using the following (pce).

Vehicle type	Pce	
	Protected approach	Opposed approach
Lv	1.0	1.0
Hv	1.3	1.3
MC	0.2	0.4

After that calculate the total traffic flow (Qmv) in veh/h and pcu/h and calculate the ratio of right – turning Prt and ratio of left- turning plt (As described steps in the second chapter).

Table 4.14 Result total traffic flow (MV) and ratio of turning in signalised intersection.

Apper – code	Dir	MV			Ratio of Turning	
		Veh/h	Pcu / h			
			Prot	Opp	P lt	P rt
North	**LT**	229	261	261	0.33	
	ST	237	267	267		
	RT	224	252	252		0.32
	TOTAL	690	780	780		
South	**LT**	251	285	285	0.34	
	ST	245	278	278		
	RT	239	275	275		0.31
	TOTAL	735	838	838		
West	**LT**	243	278	278	0.34	
	ST	234	267	267		
	RT	238	266	266		0.31
	TOTAL	715	811	811		
East	**LT**	240	278	278	0.36	
	ST	224	256	256		
	RT	210	240	240		0.33
	TOTAL	674	774	774		

2. Saturation flow:

The saturation flow (S) can be expressed as a product between a base saturation flow (S□) for a set standard condition and adjustment factor (F) for deviation of the actual conditions of a set of pre – determined (ideal) conditions , (As described steps in the second chapter).

S = S□ * Fcs * FSF * FG * Fp * FRT * FLT

We calculate (S□) from the table for approaches type (O) without separate right turning lane, depending on the value (We) , and the value of traffic flow (QLT-QLTO) left – turning movement .

Table 4.15 Result saturation flow pcu/h in signalised intersection.

Approach		We	Saturation flow pcu/h							
				All appr type				Only type p		
Dir	Type		S	Fcs	FSF	FG	FP	FRT	FLT	S
North	P	6.0	3600	0.82	0.95	1.00	1.0(	1.00	0.95	2665
South	P	6.0	3600	0.82	0.95	1.00	1.0(	1.00	0.95	2665
West	P	8.0	4800	0.82	0.95	1.00	1.0(	1.00	0.95	3553
East	P	8.0	4800	0.82	0.95	1.00	1.0(	1.00	0.94	3515

3. Capacity and degree of saturation :

In determining the capacity of the intersection and the degree of saturation for the initial conditions, must be determined whether the challenged opposed type (O) or protected (P), is defined as {pretext effective width (We), value basic saturation flow (So) , adjustment factors , the adjusted value of the saturation flow (S), the ratio current (FR), phase ratio (PR). Meanwhile adjustable cycle time (c) and a green (G) used data on survey results. Can then be calculated capacity (C) and the degree of saturation (DS) Based on the value of the adjusted saturation flow, the following tables present the results of the calculation capacity of the intersection and the degree of saturation for each approach (As described steps in the second chapter).

Table 4.16 Result capacity and degree of saturation for signalised intersection.

Dir	S pcu/h	Q pcu/h	G second	C pcu/h	Ds (Q/C)
North	2665	519	20	635	0.82
South	2665	553	21	667	0.83
West	3553	533	15	635	0.84
East	3553	496	14	586	0.83

4. Queue

Values obtained from the long queues of vehicles remaining in the previous phase (NQ1) plus the number of vehicles that arrive during the red (NQ2) Value (NQ1) determined by the degree of saturation (DS). For DS <0.5 NQ1 value = 0 while for DS> 0.5 then the value can be calculated NQ1.

DS value that will generate value NQ1 and NQ2 that great anyway. Due to a large current, it will also affect the length of the queue. Long queues that occur not only influenced by the value NQrmax but also influenced by the width of the entry, (As described steps in the second chapter).

Table 4.17 Result values queue for signalised intersection

Dir	Capacity Pcu/h	Degree of saturation	Green ratio	No of queuing vehicles (pcu)				Queue length QL **(M)**
				NQ1	NQ2	NQ_{TOT}	NQ_{MAX}	
North	635	0.82	0.24	1.41	11.46	12.87	20	67
South	667	0.83	0.25	1.88	12.21	14.09	24	80
West	635	0.84	0.18	2.04	12.01	14.05	22	55
East	586	0.83	0.17	1.87	11.18	13.05	20	50

5. Rate stopping :

Rate stopping (NS) is the rate-rate the number of stops per vehicle includes stops repeated in a queue before passing through an intersection high value of the rate stopping because the ratio of the number of vehicles queued traffic flow on an approach that is relatively large, (As described steps in the second chapter).

Table 4.18 Result rate stopping for signalised intersection.

Dir	Q (Pcu/h)	NQTOT	NS (Stop/pcu)	NSV (Pcu/h)	Average no of stop (stop/pcu)
North	519	12.87	0.96	499	0.65
South	553	14.09	0.98	542	
West	533	14.05	1.00	539	
East	496	13.05	1.00	501	

6. Delay

Delays that occur at intersections hotspot can be caused by traffic, (DT) and the delay caused by the geometry (DG) Delay due to traffic based on each movement of vehicles through intersections together, (As described steps in the second chapter).

Table 4.19 Result delay and average intersection delay (Sec/pcu) for signalised intersection .

Dir	DT (sec/pcu)	DG (Sec/pcu)	D (sec/pcu)	DTOTAL (pcu.sec)	Average intersection delay (sec/pcu)
North	38.23	4.15	42.38	21996	30.47
South	39.55	4.07	43.62	24122	
West	45.17	4.00	49.17	26208	
East	33.60	4.00	37.60	18650	

The degree of saturation here Ds < 0.85 that mean is good So that we need to design the signalised intersection depending on the new total capacity of the intersection to assess his performance this intersection.

b) Data analysis signalised intersection in the afternoon :

1. Traffic flow

In the initial condition is calculated the ratio of the number of cars over five years.

Ratio of the number of cars (five years) = (Qn – Q real) / Q real

Ratio % = (3095 - 2471) / 2471 = 25 %

So all data multiplied by (1.25) until you get the total volume of traffic after five years.

Calculate the traffic flow in (pcu) for each vehicle type for protecting and opposed discharge conditions (whichever is relevant depending upon the signal phasing and permitted left – turning movements) . Using the following (pce).

Vehicle type	Pce	
	Protected approach	Opposed approach
Lv	1.0	1.0
Hv	1.3	1.3
MC	0.2	0.4

After that calculate the total traffic flow (Qmv) in veh/h and pcu/h and calculate the ratio of right – turning Prt and ratio of left- turning plt (As described steps in the second chapter).

Table 4.20 Result total traffic flow (MV) and ratio of turning in signalised intersection.

Apper – code	Dir	MV			Ratio of Turning	
		Veh/h	Pcu / h			
			Prot	opp	P lt	P rt
North	**LT**	228	263	263	0.34	
	ST	236	266	266		
	RT	217	247	247		0.32
	TOTAL	681	776	776		
South	**LT**	220	253	253	0.32	
	ST	252	289	289		
	RT	215	250	250		0.32
	TOTAL	687	792	792		
West	**LT**	238	268	268	0.33	
	ST	241	273	273		
	RT	229	263	263		0.33
	TOTAL	708	804	804		
East	**LT**	212	242	242	0.32	
	ST	211	243	243		
	RT	232	266	266		0.33
	TOTAL	655	751	751		

2. Saturation flow:

The saturation flow (S) can be expressed as a product between a base saturation flow (S□) for a set standard conditions and adjustment factors (F) for deviation of the actual conditions of a set of pre – determined (ideal) conditions , (As described steps in the second chapter).

$$S = S_{\square} * Fcs * FSF * FG * Fp * FRT * FLT$$

We calculate (S□) from the table for approaches type (O) without separate right turning lane, depending on the value (We) , and the value of traffic flow (QLT-QLTO) left – turning movement .

Table 4.21 Result saturation flow pcu/h in signalised intersection.

Approach		We	Saturation flow pcu/h							
Dir	Type		S□	All appr type				Only type p		S
				Fcs	FSF	FG	FP	FRT	FLT	
North	P	6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665
South	P	6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665
West	P	8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553
East	P	8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553

3. capacity and degree of saturation :

In determining the capacity of the intersection and the degree of saturation for the initial conditions, must be determined whether the challenged opposed type (O) or protected (P), is defined as {pretext effective width (We), value basic saturation flow (So) , adjustment factors , the adjusted value of the saturation flow (S), the ratio current (FR), phase ratio (PR). Meanwhile adjustable cycle times (c) and a green (G) used data on survey results. Can then be calculated capacity (C) and the degree of saturation (DS) Based on the value of the adjusted saturation flow, the following tables present the results of the calculation capacity of the intersection and the degree of saturation for each approach (As described steps in the second chapter).

Table 4.22 Result capacity and degree of saturation for signalised intersection.

Dir	S pcu/h	Q pcu/h	G second	C pcu/h	Ds (Q/C)
North	2665	513	19	618	0.83
South	2665	539	20	650	0.83
West	3553	536	15	650	0.82
East	3553	509	14	607	0.84

4. Queue

Values obtained from the long queues of vehicles remaining in the previous phase (NQ1) plus the number of vehicles that arrive during the red (NQ2) Value (NQ1) determined by the degree of saturation (DS). For DS <0.5 NQ1 value = 0 while for DS> 0.5 then the value can be calculated NQ1 .

DS value that will generate value NQ1 and NQ2 that great anyway. Due to a large current, it will also affect the length of the queue. Long queues that occur not only influenced by the value NQrmax but also influenced by the width of the entry, (As described steps in the second chapter).

Table 4.23 Result values queue for signalised intersection

Dir	Capacity Pcu/h	Degree of saturation	Green ratio	No of queuing vehicles (pcu)				Queue length QL (M)
				NQ1	NQ2	NQTOTal	NQ_{MAX}	
North	618	0.83	0.23	1.87	11.12	12.99	20	67
South	650	0.83	0.24	1.88	11.65	13.53	21	70
West	650	0.82	0.18	1.73	11.74	13.47	22	55
East	607	0.84	0.17	2.04	11.23	13.27	22	55

5. Rate stopping:

Rate stopping (NS) is the rate-rate the number of stops per vehicle includes stops repeated in a queue before passing through an intersection high value of the rate stopping because the ratio of the number of vehicles queued traffic flow on an approach that is relatively large, (As described steps in the second chapter).

Table 4.24 Result rate stopping for signalised intersection.

Dir	Q (Pcu/h)	NQ_{TOT}	NS (Stop/pcu)	NSV (Pcu/h)	Average no of stop(stop/pcu)
North	513	12.99	1.00	513	0.67
South	539	13.53	0.99	534	
West	536	13.47	0.99	531	
East	509	13.27	1.00	509	

6. Delay

Delays that occur at intersections hotspot can be caused by traffic, (DT) and the delay caused by the geometry (DG) Delay due to traffic based on each movement of vehicles through intersections together, (As described steps in the second chapter).

Table 4.25 Result delay and average intersection delay (Sec/pcu) for signalised intersection .

Dir	DT (sec/pcu)	DG (Sec/pcu)	D (sec/pcu)	DTOTAL (pcu.sec)	Average intersection delay(sec/pcu)
North	41.23	4.00	46.23	23716	32.95
South	39.93	4.04	43.97	23700	
West	41.56	4.04	45.60	24442	
East	44.90	4.00	48.90	24891	

The degree of saturation here Ds < 0.85 that mean is good So that we need to design the signalised intersection depending on the new total capacity of the intersection to assess his performance this intersection.

c) Data analysis signalised intersection in the evening :

1. Traffic flow

In the initial condition is calculated the ratio of the number of cars over five years.

Ratio of the number of cars (five years) = (Qn – Q real) / Q real

Ratio % = (3170 – 2531) / 2531 = 0.25 %

So all data multiplied by (1.25) until you get the total volume of traffic after five years.

Calculate the traffic flow in (pcu) for each vehicle type for protecting and opposed discharge conditions (whichever is relevant depending upon the signal phasing and permitted left – turning movements) . Using the following (pce).

Vehicle type	Pce	
	Protected approach	Opposed approach
Lv	1.0	1.0
Hv	1.3	1.3
MC	0.2	0.4

After that calculate the total traffic flow (Qmv) in veh/h and pcu/h and calculate the ratio of right – turning Prt and ratio of left- turning plt (As described steps in the second chapter).

Table 4.26 Result total traffic flow (MV) and ratio of turning in signalised intersection.

Apper– code	Dir	MV			Ratio of Turning	
		Veh/h	Pcu / h			
			Prot	Opp	P lt	P rt
North	**LT**	221	253	253	0.34	
	ST	209	235	235		
	RT	224	259	259		0.35
	TOTAL	654	747	747		
South	**LT**	215	247	247	0.33	
	ST	247	283	283		
	RT	210	243	243		0.31
	TOTAL	672	773	773		
West	**LT**	238	268	268	0.33	
	ST	240	274	274		
	RT	228	263	263		0.33
	TOTAL	706	805	805		
East	**LT**	212	242	242	0.32	
	ST	215	247	247		
	RT	232	266	266		0.35
	TOTAL	859	755	755		

2. Saturation flow:

The saturation flow (S) can be expressed as a product between a base saturation flow (S□) for a set standard conditions and adjustment factors (F) for deviation of the actual conditions of a set of pre – determined (ideal) conditions , (As described steps in the second chapter).

S = S□ * Fcs * FSF * FG * Fp * FRT * FLT

We calculate (S□) from the table for approaches type (O) without separate right turning lane, depending on the value (We) , and the value of traffic flow (QLT-QLTO) left – turning movement .

Table 4.27 Result saturation flow pcu/h in signalised intersection.

Approach		We	Saturation flow pcu/h							
Dir	Type		S□	All appr type				Only type p		S
				Fcs	FSF	FG	FP	FRT	FLT	
North	P	6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665
South	P	6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665
West	P	8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553
East	P	8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553

3. Capacity and degree of saturation :

In determining the capacity of the intersection and the degree of saturation for the initial conditions, must be determined whether the challenged opposed type (O) or protected (P), is defined as {pretext effective width (We), value basic saturation flow (So) , adjustment factors , the adjusted value of the saturation flow (S), the ratio current (FR), phase ratio (PR). Meanwhile adjustable cycle times (c) and a green (G) used data on survey results. Can then be calculated capacity (C) and the degree of saturation (DS) Based on the value of the adjusted saturation flow, the following tables present the results of the calculation capacity of the intersection and the degree of saturation for each approach (As described steps in the second chapter).

Table 4.28 Result capacity and degree of saturation for signalised intersection.

Dir	S pcu/h	Q pcu/h	G second	C pcu/h	Ds (Q/C)
North	2665	494	19	626	0.79
South	2665	526	19	626	0.84
West	3553	537	15	658	0.82
East	3553	513	14	615	0.83

4. Queue

Values obtained from the long queues of vehicles remaining in the previous phase (NQ1) plus the number of vehicles that arrive during the red (NQ2) Value (NQ1) determined by the degree of saturation (DS). For DS <0.5 NQ1 value = 0 while for DS> 0.5 then the value can be calculated NQ1.

DS value that will generate value NQ1 and NQ2 that great anyway. Due to a large current, it will also affect the length of the queue. Long queues that occur not only influenced by the value NQrmax but also influenced by the width of the entry, (As described steps in the second chapter).

Table 4.29 Result values queue for signalised intersection

Dir	Capacity Pcu/h	Degree of saturation	Green ratio	No of queuing vehicles (pcu)				Queue length QL (M)
				NQ1	NQ2	NQTOT	NQMAX	
North	626	0.79	0.23	1.35	10.46	11.81	18	60
South	626	0.84	0.23	2.04	11.30	13.34	20	67
West	658	0.82	0.19	1.73	11.59	13.32	20	50
East	615	0.83	0.17	1.87	11.15	13.02	20	50

5. Rate stopping:

Rate stopping (NS) is the rate-rate the number of stops per vehicle includes stops repeated in a queue before passing through an intersection high value of the rate stopping because the ratio of the number of vehicles queued traffic flow on an approach that is relatively large, (As described steps in the second chapter).

Table 4.30 Result rate stopping for signalised intersection.

Dir	Q (Pcu/h)	NQTOT	NS (stop/pcu)	NSV (Pcu/h)	Average no of stop (stop/pcu)
North	494	11.81	0.96	475	0.66
South	526	13.34	1.00	526	
West	537	13.32	0.99	532	
East	513	13.02	1.00	513	

6. Delay

Delays that occur at intersections hotspot can be caused by traffic, (DT) and the delay caused by the geometry (DG) Delay due to traffic based on each movement of vehicles through intersections together, (As described steps in the second chapter).

Table 4.31 Result delay and average intersection delay(sec/pcu) for signalised intersection .

Dir	DT (sec/pcu)	DG (Sec/pcu)	D (sec/pcu)	DTOTAL (pcu.sec)	Average intersection delay(sec/pcu)
North	36.92	4.16	41.08	20294	28.68
South	41.70	4.00	45.70	24039	
West	41.06	41.06	45.10	19709	
East	43.35	43.35	47.35	24291	

The degree of saturation here Ds < 0.85 that mean is good So that we need to design the signalised intersection depending on the new total capacity of the intersection to assess his performance this intersection.

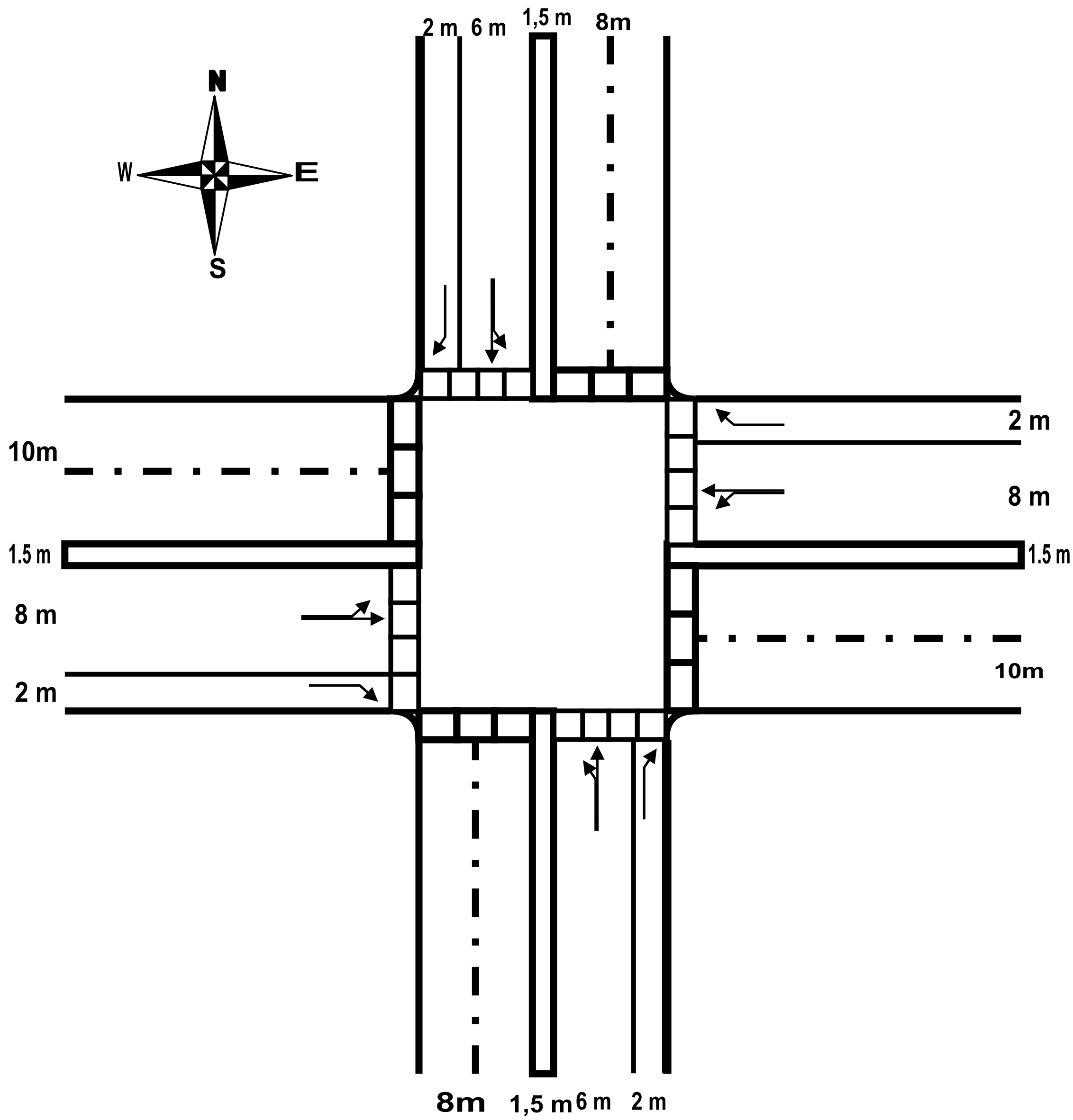


Figure 4.1 Signalised Intersection Four Phases with RTOR

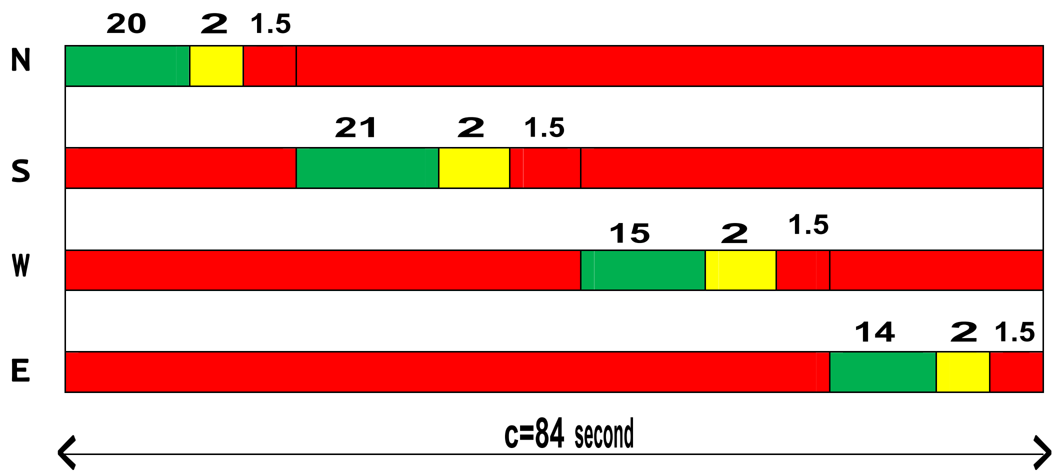


Figure 4.2 Time sequence diagram for signalised intersection (Morning)

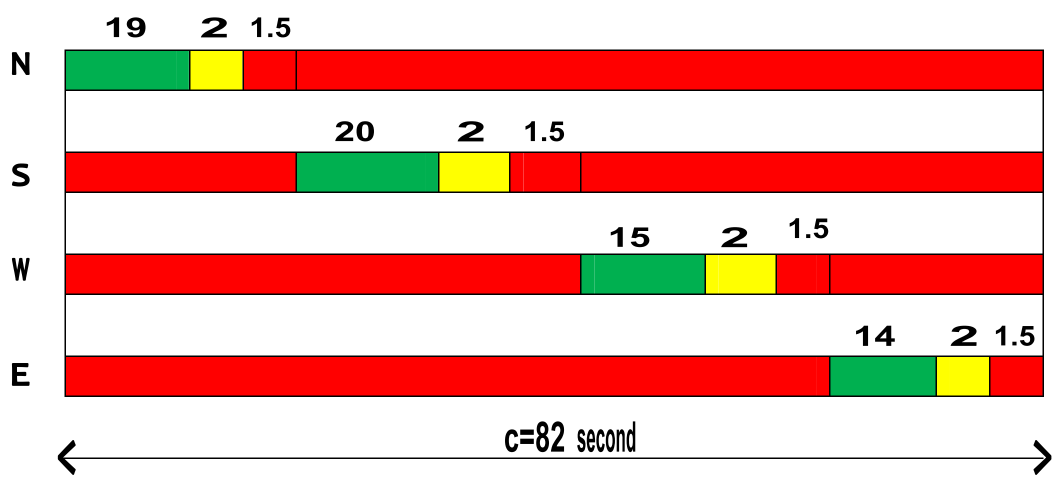


Figure 4.3 Time sequence diagram for signalised intersection (Afternoon)

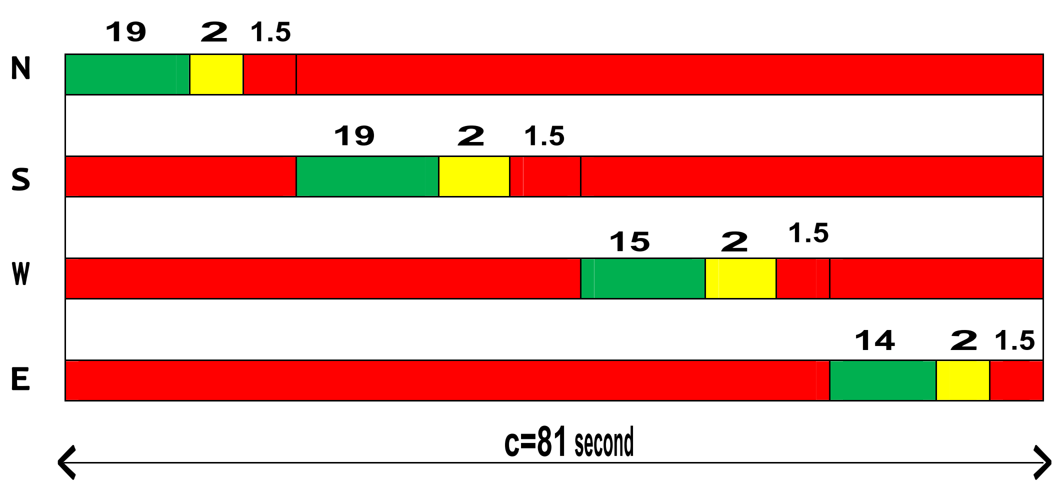


Figure 4.4 Time sequence diagram for signalised intersection (Evening)

CHAPTER V
CONCLUSIONS & RECOMMENDATION

5.1 Conclusions

Studies have been conducted on capacity of the busiest intersections in the coastal city of Derna an unsignalised intersection. To analysis the performance of the intersection and achieved a solution to avoid the problem of the increasing volume of traffic and traffic accidents. This intersection consists of four legs and branches in Republic Street and real estate street. This intersection contains median across the intersection and non-marks on the road, using the manual methods of Indonesian highway capacity manual (IHCM 1997).

By analyzing the flow volume at the unsignalised intersection at peak hours, we conclude from the results and analysis of traffic data on the degree of saturation less than the maximum , was in the range (0.61-0.62) and less than 0.75 and queue probability between (13 -38)% and this is in the acceptable and good limits. but there is no marks on the road and the safety is not good .

The degree of saturation is calculated after five years from now to see if the results will be good or not, The information about the rate of population growth in the city which is 4.6%, was calculated for the degree of saturation in the unsignalised intersection. We conclude that from the traffic and analysis data after five years, the degree of saturation between (0.76-0.78) which is higher than the allowable limit is 0.75 and this is not good and not safety.

Here we need to analysis and design the signalized intersection through the ratio of the number of cars after five years, we can deduce from the traffic and data analysis, the degree of saturation between (0.79-0.84) and less than the allowable degree of saturation is 0.85 and the cycle time between (81-84) second and this is also in the allowable limit is 120 seconds .

5.2 Recommendations

Through the study and results , we conclude that the calculation of the degree of saturation at the unsignalised intersection shows that it is good and allowed , but does not have a safety and there is no sign on the road and this is not good . The calculation of the degree of saturation after five years shows large values and it is not allowed in the Indonesian code (IHCM 1997) , The calculation on ability of the signalised intersection, it is found that it is very convenient and the values are in the allowable limits so we recommend the following:

- Advised to design the signalised intersection depending on the capacity and volume of the flow and the information obtained from the analysis of the intersection.

- Advised to change private transport into public transport to get rid of congestion and obstruction of traffic on the road .

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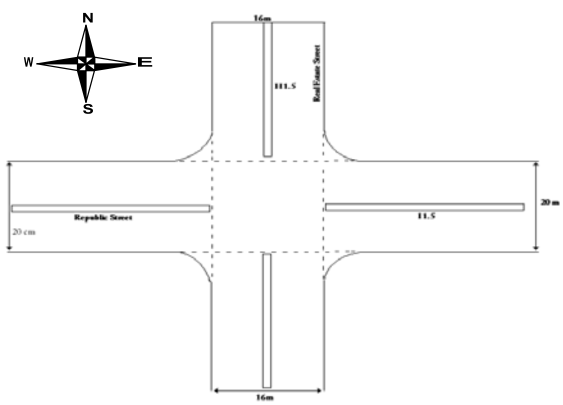
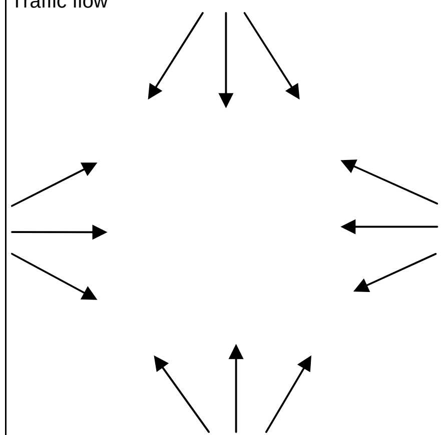
APPENDIX

UNSIGNALISED INTERSECTIONS FORM USIG-I: GEOMETRY TRAFFIC FLOW	Date : 02-02-2013	Handled by:
	City : Derna	Province : East Libya
	Major road: Republic Street	
	Minor road: Real Estate Street	
	Case: Data 1	Period: morning

Intersection geometry



Traffic flow



1	TRAFFIC COMPOSITION%		LV%		HV%		MC%		Pcu-factor		K-factor	
	TRAFFIC FLOW	Direction	Light Vehicles LV		Heavy vehicles HV		Motorcycles		Total motor vehicles MV			Unmotorised veh.
	Approach (1)	(2)	Veh/h (3)	pce=1.0 pcu/h (4)	veh /h (5)	pce=1.3 pcu/h (6)	veh/h (7)	pce=0.5 pcu/h (8)	veh/h (9)	pcu/h (10)	Ratio of turning (11)	UM veh/h (12)
2	Minor road:	LT	98	98	85	111	0	0	183	209	0.33	0
3		ST	110	110	79	103	0	0	189	213		0
4	N	RT	89	89	90	117	0	0	179	206	0.32	0
5		Total	297	297	254	331	0	0	551	628		0
6	Minor road:	LT	110	110	90	117	0	0	200	227	0.34	0
7		ST	109	109	87	114	0	0	196	223		0
8	S	RT	94	94	96	125	0	0	190	219	0.33	0
9		Total	313	313	273	356	0	0	586	669		0
10	Total minor road A+C		610	610	527	687	0	0	1137	1297		0
11	Major road	LT	85	85	92	120	0	0	177	205	0.32	0
12		ST	98	98	89	116	0	0	187	214		0
13	W	RT	100	100	90	117	0	0	190	217	0.34	0
14		Total	283	283	271	353	0	0	554	636		0
15	Major road:	LT	91	91	101	132	0	0	192	223	0.36	0
16		ST	94	94	85	111	0	0	179	205		0
17	E	RT	89	89	79	103	0	0	168	192	0.31	0
18		Total	274	274	265	346	0	0	539	620		0
19	Total major road B+D		557	557	536	699	0	0	1093	1256		0
20	Major+minor	LT	384	384	368	479	0	0	752	863	0.34	0
21		ST	411	411	340	442	0	0	751	853		0
22		RT	372	372	355	462	0	0	727	834	0.33	0
23	Total major + minor		1167	1167	1063	1383	0	0	2230	2550	0.67	0
24	Total minor/(total major + minor) ratio									0.51	UM/MV	0

UNSIGNALISED INTERSEGTIONS FROM USIG-II -ANALYSIS	Date: 02-02-2013	Handled by:
	City: Derna	City size: 250.000
	Major road: Republic street	Road environment: COM
	Minor road: Real estate street	Side friction: Low
	Case: data 1	Period: morning

1. Approach width and intersection type

Alter-native	No. of inter-section arms	Approach width (m)							No. of lanes Fig. B-12		Inter section type IT Tab B-1:1
		Minor Road			Major Road			Average approach width W_1			
		W_A	W_C	W_{AC}	W_B	W_D	W_{BD}		Minor road	Major road	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	4	8	8	8	10	10	10	9	4	4	444

2. Capacity

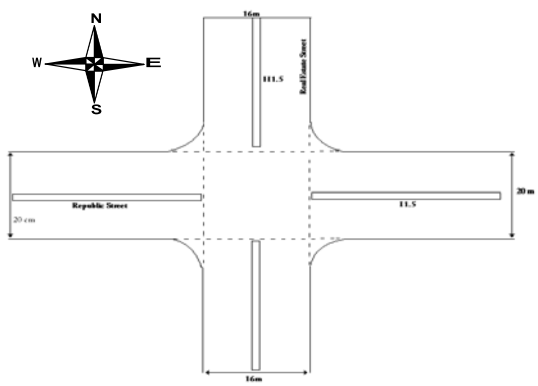
Alter-native	Base capacity Co pcu/h Table B-2:1 (20)	Capacity adjustment factors (F)							Actual capacity C pcu/l
		Av. appr. width F_W Fig. B-3:1	Major road median F_M Table B-4:1	City size F_{CS} Tab.B-5:1	Road envir side fric. F_{RSU} Tab. B-6:1	Left – turning F_{LT} Fig. B-7:1	Right turning F_{RT} Fig. B-8:1	Ratio Minor/total F_M Fig B-9:1	
		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
1	3400	1.276	1.05	0.82	0.95	1.00	1.39	0.83	4094

3. Traffic performance

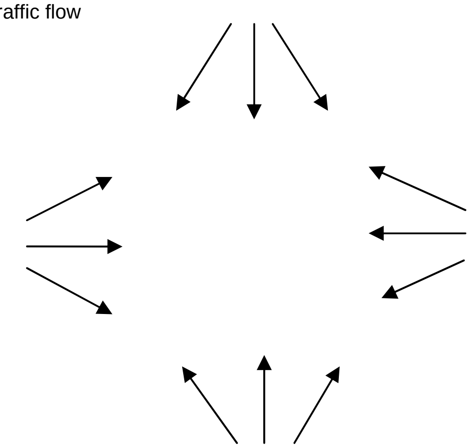
Alter-native	Traffic flow Q pcu/h USIG-1 Row 23/Col 10 (30)	Degree of saturation DS= Q/C (30)(28) (31)	Int.section Traffic delay DT1 Fig C-2:1 (32)	Major road Traffic delay DTMA Fig.g-2:2 (33)	Minor road Traffic delay DTMi (34)	Int. section Geometric Delay DG (35)	Int. section Delay D (32)+(35) (36)	Queue Portability QP % Fig.C-3:1 (37)	Objectives (38)
1	2550	0.62	6.36	4.74	7.91	4.38	10.74	18 – 38	DS <0.75

UNSIGNALISED INTERSECTIONS FORM USIG-I: GEOMETRY TRAFFIC FLOW	Date : 02-02-2013	Handled by:
	City : Derna	Province : East Libya
	Major road: Republic Street	
	Minor road: Real Estate Street	
	Case: Data 2	Period: afternoon

Intersection geometry



Traffic flow



Major road median												
1	TRAFFIC COMPOSITION%		LV%		HV%		MC%		Pcu-factor		K-factor	
	TRAFFIC FLOW	Direction	Light Vehicles LV		Heavy vehicles HV		Motorcycles		Total motor vehicles MV			Unmotorised veh.
	Approach (1)	(2)	Veh/h (3)	pce=1.0 pcu/h (4)	veh /h (5)	pce=1.3 pcu/h (6)	veh/h (7)	pce=0.5 pcu/h (8)	veh/h (9)	pcu/h (10)	Ratio of turning (11)	UM veh/h (12)
2	Minor road: N	LT	90	90	92	120	0	0	182	210	0.34	0
3		ST	109	109	80	104	0	0	189	213		0
4		RT	95	95	78	102	0	0	173	197	0.32	0
5		Total	294	294	250	326	0	0	544	620		0
6	Minor road: S	LT	87	87	85	111	0	0	172	198	0.32	0
7		ST	102	102	95	124	0	0	197	226		0
8		RT	79	79	89	116	0	0	168	195	0.32	0
9		Total	268	268	269	351	0	0	537	619		0
10	Total minor road A+C		562	562	519	677	0	0	1081	1239		0
11	Major road W	LT	110	110	80	104	0	0	190	214	0.34	0
12		ST	102	102	86	112	0	0	188	214		0
13		RT	89	89	90	117	0	0	179	206	0.32	0
14		Total	301	301	256	333	0	0	557	634		0
15	Major road: E	LT	90	90	79	103	0	0	169	193	0.32	0
16		ST	82	82	86	112	0	0	168	194		0
17		RT	94	94	91	119	0	0	185	213	0.36	0
18		Total	266	266	256	334	0	0	522	600		0
19	Total major road B+D		567	567	512	667	0	0	1079	1234		0
20	Major+minor	LT	377	377	336	437	0	0	713	814	0.33	0
21		ST	395	395	347	452	0	0	742	847		0
22		RT	357	357	348	453	0	0	705	810	0.33	0
23	Total major + minor		1129	1129	1031	1342	0	0	2160	2471	0.66	0
24	Total minor/(total major + minor) ratio									0.50	UM/MV	0

UNSIGNALISED INTERSEGTIONS FROM USIG-II -ANALYSIS	Date: 02-02-2013	Handled by:
	City: Derna	City size: 250.000
	Major road: Republic street	Road environment: COM
	Minor road: Real estate street	Side friction: Low
	Case: data 2	Period: afternoon

1. Approach width and intersection type

Alter-native	No. of inter-section arms (1)	Approach width (m)							No. of lanes Fig. B-12		Inter section type IT Tab B-1:1 (11)
		Minor Road			Major Road			Average approach width W_1 (8)			
		W_A (2)	W_C (3)	W_{AC} (4)	W_B (5)	W_D (6)	W_{BD} (7)		Minor road (9)	Major road (10)	
2	4	8	8	8	10	10	10	9	4	4	444

2. Capacity

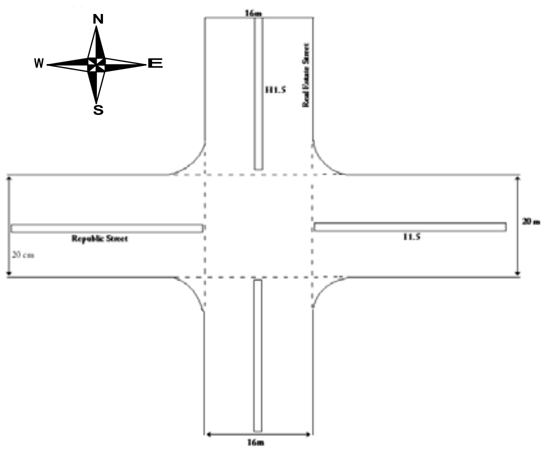
Alter-native	Base capacity Co pcu/h Table B-2:1 (20)	Capacity adjustment factors (F)							Actual capacity C pcu/l (28)
		Av. appr. width F_W Fig. B-3:1 (21)	Major road median F_M Table B-4:1 (22)	City size F_{CS} Tab.B-5:1 (23)	Road envir side fric. F_{RSU} Tab. B-6:1 (24)	Left – turning F_{LT} Fig. B-7:1 (25)	Right turning F_{RT} Fig. B-8:1 (26)	Ratio Minor/total F_M Fig B-9:1 (27)	
2	3400	1.276	1.05	0.82	0.95	1.00	1.37	0.833	4050

3. Traffic performance

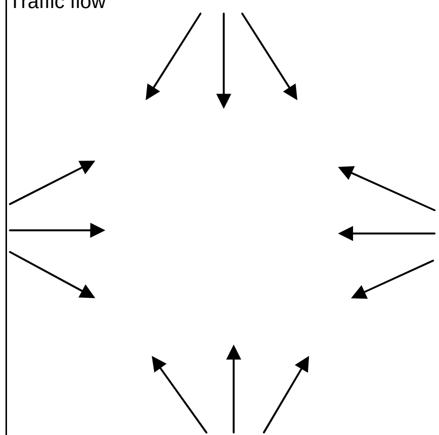
Alter-native	Traffic flow Q pcu/h USIG-1 Row 23/Col 10 (30)	Degree of saturation DS= Q/C (30)(28) (31)	Int.section Traffic delay DT1 Fig C-2:1 (32)	Major road Traffic delay DTMA Fig.g-2:2 (33)	Minor road Traffic delay DTMi (34)	Int. section Geometric Delay DG (35)	Int. section Delay D (32)+(35) (36)	Queue Protability QP % Fig.C-3:1 (37)	Objectives (38)
2	2471	0.61	6.24	4.66	7.80	4.38	10.62	13 - 33	DS <0.75

UNSIGNALISED INTERSECTIONS FORM USIG-I: GEOMETRY TRAFFIC FLOW		
	Date : 02-02-2013	Handled by:
	City : Derna	Province : East Libya
	Major road: Republic Street	
	Minor road: Real Estate Street	
	Case: Data 3	Period: evening

Intersection geometry



Traffic flow



	Major road median											
1	TRAFFIC COMPOSITION%		LV%		HV%		MC%		Pcu-factor		K-factor	
	TRAFFIC FLOW	Direction	Light Vehicles LV		Heavy vehicles HV		Motorcycles		Total motor vehicles MV			Unmotorised veh.
	Approach (1)	(2)	Veh/h (3)	pce=1.0 pcu/h (4)	veh /h (5)	pce=1.3 pcu/h (6)	veh/h (7)	pce=0.5 pcu/h (8)	veh/h (9)	pcu/h (10)	Ratio of turning (11)	UM veh/h (12)
2	Minor road: N	LT	92	92	85	111	0	0	177	203	0.34	0
3		ST	98	98	69	90	0	0	167	188		0
4		RT	87	87	92	120	0	0	179	207	0.35	0
5		Total	277	277	246	321	0	0	523	598		0
6	Minor road: S	LT	99	99	78	102	0	0	177	201	0.34	0
7		ST	94	94	69	90	0	0	163	184		0
8		RT	86	86	92	120	0	0	178	206	0.35	0
9		Total	279	279	239	312	0	0	518	591		0
10	Total minor road A+C		556	556	485	633	0	0	1041	1189		0
11	Major road W	LT	105	105	75	98	0	0	180	203	0.33	0
12		ST	96	96	89	116	0	0	185	212		0
13		RT	85	85	92	120	0	0	177	205	0.33	0
14		Total	286	286	256	334	0	0	542	620		0
15	Major road: E	LT	97	97	91	119	0	0	188	216	0.34	0
16		ST	78	78	89	116	0	0	167	194		0
17		RT	92	92	97	127	0	0	189	219	0.35	0
18		Total	267	267	277	362	0	0	544	629		0
19	Total major road B+D		553	553	533	696	0	0	1086	1249		0
20	Major+minor	LT	393	393	404	526	0	0	797	919	0.36	0
21		ST	366	366	316	411	0	0	682	777		0
22		RT	350	350	373	485	0	0	723	835	0.33	0
23	Total major + minor		1109	1109	1093	1422	0	0	2202	2531	0.69	0
24	Total minor/(total major + minor) ratio									0.47	UM/MV	0

UNSIGNALISED INTERSEGTIONS FROM USIG-II -ANALYSIS	Date: 02-02-2013	Handled by:
	City: Derna	City size: 250.000
	Major road: Republic street	Road environment: COM
	Minor road: Real estate street	Side friction: Low
	Case: data 3	Period: evening

1. Approach width and intersection type

Alter-native	No. of inter-section arms	Approach width (m)							No. of lanes Fig. B-12		Inter section type IT Tab B-1:1
		Minor Road			Major Road			Average approach width W_1	Minor road	Major road	
		W_A	W_C	W_{AC}	W_B	W_D	W_{BD}				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
3	4	8	8	8	10	10	10	9	4	4	444

2. Capacity

Alter-native	Base capacity Co pcu/h Table B-2:1 (20)	Capacity adjustment factors (F)							Actual capacity C pcu/l
		Av. appr. width F_W Fig. B-3:1 (21)	Major road median F_M Table B-4:1 (22)	City size F_{CS} Tab.B-5:1 (23)	Road envir side fric. F_{RSU} Tab. B-6:1 (24)	Left – turning F_{LT} Fig. B-7:1 (25)	Right turning F_{RT} Fig. B-8:1 (26)	Ratio Minor/total F_M Fig B-9:1 (27)	(28)
3	3400	1.276	1.05	0.82	0.95	1.00	1.42	0.83	4183

3. Traffic performance

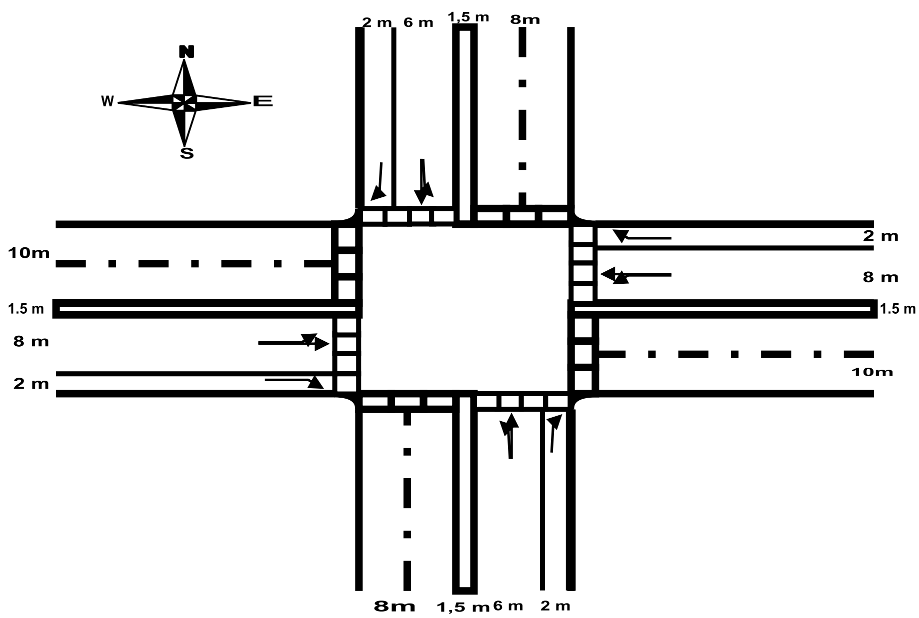
Alter-native	Traffic flow Q pcu/h USIG-1 Row 23/Col 10 (30)	Degree of saturation DS= Q/C (30)(28) (31)	Int.section Traffic delay DT1 Fig C-2:1 (32)	Major road Traffic delay DTMA Fig.g-2:2 (33)	Minor road Traffic delay DTMi (34)	Int. section Geometric Delay DG (35)	Int. section Delay D (32)+(35) (36)	Queue Portability QP % Fig.C-3:1 (37)	Objectives (38)
3	2531	0.61	3.45	4.66	2.45	4.42	7.87	16 - 36	DS <75

FORM SIG-I

SIGNALIZED INTERSECTION Form SIG-I : GEOMETRY TRAFFIC CONTROL ENVIRONMENT	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	
	City size : 250.000.	
	Case : date 1	
	Period : morning	

EXISTING SIGNAL PHASES

g = G =	g = G =	g = G =	g = G =	Cycle time : c = Total lost time : LT = ∑ IG =



SITE CONDITIONS

Approach code	Road environment type	Side friction H/L	Median Y/N	Gradient +/- %	Left-turn on Red Y/N	Distance to parked vehicle (m)	Approach width (m)			
							Approach W_A	Entry W ENTRY	LT on Red W LTOR	Exit W EXIT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
N	COM	L	Y		Y		8.00	6.00	2.00	8.00
S	COM	L	Y		Y		8.00	6.00	2.00	8.00
W	COM	L	Y		Y		10.00	8.00	2.00	10.00
E	COM	L	Y		Y		10.00	8.00	2.00	10.00

FORM SIG-II

SIGNALIZED INTERSECTION Form SIG-H : TRAFFIC CONTROL	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	Case : data 1
		Period : morning

Appr code	Dir.	TRAFFIC FLOW MOTORISED VEHICLES (MV): Light Vehicles (LV) pce protected = 1.0 pce opposed = 1.0 veh/h	LV pcu/h Prot	LV pcu/h Opp	Heavy Vehicles (HV) pce protected = 1.3 pce opposed = 1.3 veh/h	HV pcu/h Prot	HV pcu/h Opp	Motorcycles (MC) pce protected = 0.2 pce opposed = 0.4 veh/h	MC pcu/h Prot	MC pcu/h Opp	Total Motor vehicles MV veh/h	MV pcu/h Prot	MV pcu/h Opp	Ratio of turning p LT Eq.(13)	Ratio of turning p RT Eq.(14)	UNMOT. VEH Flow UM veh/h	UNMOT. VEH Ratio UM/MV Eq.(15)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
N	LT/	123	123	123	106	138	138	0	0	0	229	261	261	0.33		0	0
	ST	138	138	138	99	129	129	0	0	0	237	267	267			0	0
	RT/RTOR	111	111	111	113	141	141	0	0	0	224	252	252		0.32	0	0
	TOTAL	372	372	372	318	408	408	0	0	0	690	780	780			0	0
S	LT	138	138	138	113	147	147	0	0	0	251	285	285	0.34		0	0
	ST	136	136	136	109	142	142	0	0	0	245	278	278			0	0
	RT/RTOR	118	118	118	121	157	157	0	0	0	239	275	275		0.33	0	0
	TOTAL	392	392	392	343	446	446	0	0	0	735	838	838			0	0
W	LT	128	128	128	115	150	150	0	0	0	243	278	278	0.34		0	0
	ST	123	123	123	111	144	144	0	0	0	234	267	267			0	0
	RT/RTOR	125	125	125	113	141	141	0	0	0	238	266	266		0.33	0	0
	TOTAL	376	376	376	339	435	435	0	0	0	715	811	811			0	0
E	LT	114	114	114	126	164	164	0	0	0	240	278	278	0.36		0	0
	ST	118	118	118	106	138	138	0	0	0	224	256	256			0	0
	RT/RTOR	111	111	111	99	129	129	0	0	0	210	240	240		0.31	0	0
	TOTAL	343	343	343	331	431	431	0	0	0	674	774	774			0	0
	LT																
	ST																
	RT/RTOR																
	TOTAL																
	LT																
	ST																
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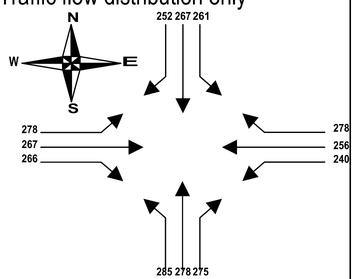
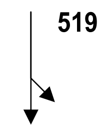
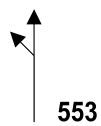
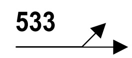
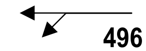
	LT																
	ST																
	RT/RTOR																
	TOTAL																

FORM SIG - IV

SIGNALISED INTERSECTION	Date : 02.02.2013	Handled by :
Form SIG.IV : SIGNAL TIMING	City : Derna	Case : 4 phase
CAPACITY	Intersection : Republic Street	Period : morning

Traffic flow distribution only	Phase 1	Phase 2	Phase 3	Phase 4
				

Appr Code	Green In Phase no	Appr Type	Ratio of turning vehicles P lto	P lt	P rt	RT-flow pcu/h Own Dir Q rt Lt	Oppos dir Q rto Lto	Eff Width (m) W e Eq.(18) Eq.(19)	Saturation flow pcu/h: Base Value pcu/h S_o Eq.(20) Fig.C.3:2 Fig.C.3:3	Adjustment factors, All appr type: City Size F_{CS} Tab.C-4:1	Side friction F_{SF} Tab.C-4:2	Gradient F_G Fig.C.3:2	Parking F_P Eq.(21)	Only type P: Right turns F_{RT} Eq.(22)	Left Turns F_{LT} Eq.(23)	Adjusted Value pcu/h S Eq.(24)	Traffic Flow pcu/h Q	Flow Ratio FR Q/S Eq.(26)	Phase Ratio PR = FRcrit IFR Eq.(28)	Green Time Sec G Eq.(30)	Capacity pcu/h S x g/c C Eq.(32)	Degree Of saturation Q/C Eq.(33)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
N	1	P		0.33	0.33			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	519	0.19	0.28	20	635	0.82
S	2	P		0.34	0.32			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	553	0.21	0.30	21	667	0.83
W	3	P		0.34	0.32			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553	533	0.15	0.22	15	635	0.84
E	4	P		0.36	0.31			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.94	3515	496	0.14	0.20	14	586	0.83

Total lost time	14	Unadjustment cycle time	C_{US} (sec) Eq	84	IFR=	0.69
LTI (sec)		Adjustment cycle time	C (sec) Eq	84	$\sum FR_{CRIT}$	

LTI =(1.5*2 +1.5*2 + 1.5*2 + 1.5*2)+2=14

FORM SIG-V

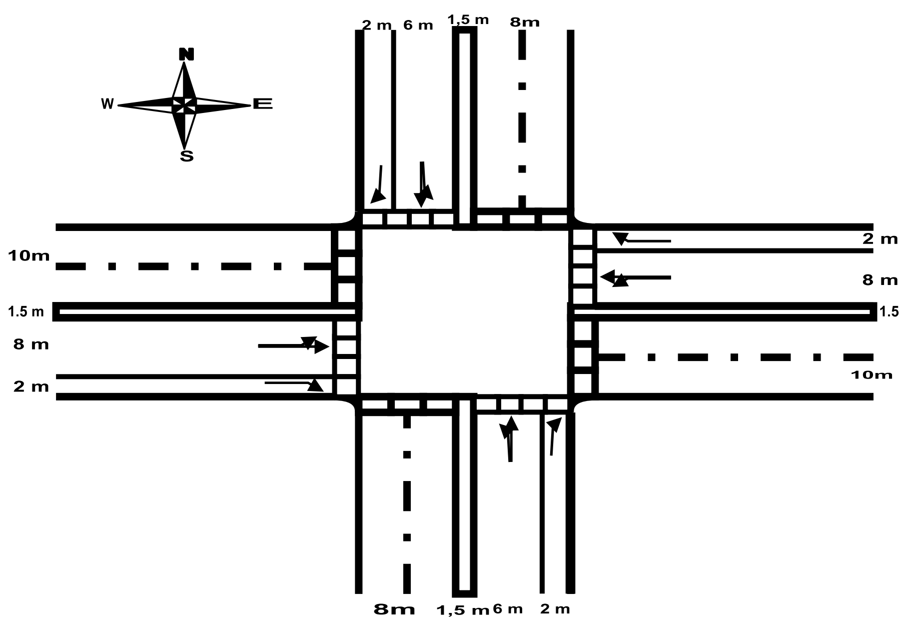
SIGNALISED INTERSECTION		Date :02.02.2013	Handled by :
Form SIG.IV :	QUEUE LENGTH	City : Derna	Case : data 1
	STOP RATE	Intersection :	Period : morning
	DELAY	Cycle Time :	

Approach code	Traffic Flow pcu/h Q	Capacity pcu/h C	Degree of Saturation DS = Q/C	Green ratio GR = g/c	No. of queuing vehicles (pcu)				Queue length (m) QL Eq.(38)	Stop Rate stops/pcu NS Eq.(39)	No. of Stops pcu/h N_{SV} Eq.(40)	Delay			
					NQ_1 Eq.(34.1)	NQ_2 Eq.(35)	Total NQ_1+NQ_2 NQ Eq.(37)	NQ_{MAX} Fig.E-2:2				Average Traffic delay sec/pcu DT Eq.(42)	Average Geometric delay sec/pcu DG Eq.(43)	Average delay sec/pcu D = DT+DG (13)+(14)	Total Delay Pcu.sec D x Q (2)+(15)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
N	519	635	0.82	0.24	1.41	11.46	12.87	20	67	0.96	499	38.23	4.15	42.38	21996
S	553	667	0.83	0.25	1.88	12.21	14.09	24	80	0.98	542	39.55	4.07	43.62	24122
W	533	635	0.84	0.18	2.04	12.01	14.05	22	55	1.00	539	45.17	4.00	49.17	26208
E	496	586	0.83	0.17	1.87	11.18	13.05	20	50	1.00	501	33.60	4.00	37.60	18650
LOTR (all) rt	1102											0.0	6.00	6.00	6612
Flow adj. Qadj :										Total:	2081			Total:	97588
Total flow Qtot :	3203									Average no. of stops/pcu	0.65			Average intersection delay sec/pcu	30.47

SIGNALIZED INTERSECTION Form SIG-I : GEOMETRY TRAFFIC CONTROL ENVIRONMENT	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	
	City size : 250.000.	
	Case : date 2	
	Period : afternoon	

EXISTING SIGNAL PHASES

g = G =	g = G =	g = G =	g = G =	Cycle time : c = Total lost time : LT = ∑ IG =



SITE CONDITIONS

Approach code	Road environment type	Side friction H/L	Median Y/N	Gradient +/- %	Left-turn on Red Y/N	Distance to parked vehicle (m)	Approach width (m)			
							Approach W_A	Entry W_{ENTRY}	LT on Red W LTOR	Exit W_{EXIT}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
N	COM	L	Y		Y		8.00	6.00	2.00	8.00
S	COM	L	Y		Y		8.00	6.00	2.00	8.00
W	COM	L	Y		Y		10.00	8.00	2.00	10.00
E	COM	L	Y		Y		10.00	8.00	2.00	10.00

SIGNALIZED INTERSECTION Form SIG-H : TRAFFIC CONTROL	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	Case : data 2
		Period : afternoon

Appr code	Dir.	TRAFFIC FLOW MOTORISED VEHICLES (MV)														UNMOT. VEH	
		Light Vehicles (LV) pce protected = 1.0 pce opposed = 1.0			Heavy Vehicles (HV) pce protected = 1.3 pce opposed = 1.3			Motorcycles (MC) pce protected = 0.2 pce opposed = 0.4			Total Motor vehicles MV			Ratio of turning		Flow UM veh/h	Ratio UM/MV
		veh/h	pcu/h		veh/h	pcu/h		veh/h	pcu/h		veh/h	pcu/h		p LT Eq.(13)	p RT Eq.(14)		Eq.(15)
			Prot	Opp		Prot	Opp		Prot	Opp		Prot	Opp				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
N	LT	113	113	113	115	150	150	0	0	0	228	263	263	0.34		0	0
	ST	136	136	136	100	130	130	0	0	0	236	266	266			0	0
	RT/RTOR	119	119	119	98	128	128	0	0	0	217	247	247		0.32	0	0
	TOTAL	368	368	368	313	408	408	0	0	0	681	776	776			0	0
S	LT	109	109	109	111	144	144	0	0	0	220	253	253	0.32		0	0
	ST	128	128	128	124	161	161	0	0	0	252	289	289			0	0
	RT/RTOR	99	99	99	116	151	151	0	0	0	215	250	250		0.32	0	0
	TOTAL	336	336	336	351	456	456	0	0	0	687	792	792			0	0
W	LT	138	138	138	100	130	130	0	0	0	238	268	268	0.33		0	0
	ST	133	133	133	108	140	140	0	0	0	241	273	273			0	0
	RT/RTOR	116	116	116	113	147	147	0	0	0	229	263	263		0.33	0	0
	TOTAL	387	387	387	321	417	417	0	0	0	708	804	804			0	0
E	LT	113	113	113	99	129	129	0	0	0	212	242	242	0.32		0	0
	ST	103	103	103	108	140	140	0	0	0	211	243	243			0	0
	RT/RTOR	118	118	118	114	148	148	0	0	0	232	266	266		0.35	0	0
	TOTAL	334	334	334	321	417	417	0	0	0	655	751	751			0	0
	LT																
	ST																
	RT/RTOR																
	TOTAL																
	LT																
	ST																
	RT/RTOR																
	TOTAL																
	LT																
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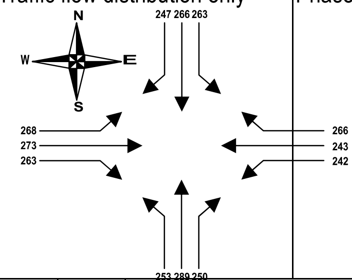
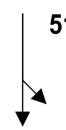
	ST																
	RT/RTOR																
	TOTAL																
	LT																
	ST																
	RT/RTOR																
	TOTAL																

SIGNALISED INTERSECTION	Date : 02.02.2013	Handled by :
Form SIG.IV : SIGNAL TIMING	City : Derna	Case : 4 phase
CAPACITY	Intersection : Republic Street	Period : afternoon

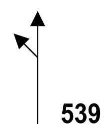
Traffic flow distribution only



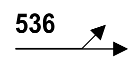
Phase 1



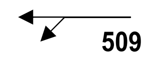
Phase 2



Phase 3



Phase 4



Appr Code	Green In Phase no	Appr Type	Ratio of turning vehicles			RT-flow pcu/h		Eff Width	Saturation flow pcu/h								Traffic Flow pcu/h	Flow ratio FR	Phase Ratio PR = FRcrit / IFR	Green Time Sec	Capacity pcu/h S x g/c	Degree Of saturation
						Own Dir	Oppos dir	(m)	Base Value pcu/h	Adjustment factors						Adjusted Value pcu/h						
										All appr type				Only type P								
			P ltor	P lt	P rt	Q rt Lt	Q rto Lt	W e Eq.(18) Eq.(19)	S o Eq.(20) Fig.C.3:2 Fig.C.3:3	City Size F_{CS} Tab.C-4:1	Side friction F_{SF} Tab.C-4:2	Gradient F_G Fig.C.3:2	Parking F_P Eq.(21)	Right turns F_{RT} Eq.(22)	Left turns F_{LT} Eq.(23)	S Eq.(24)	Q	Q/S Eq.(26)	IFR Eq.(28)	G Eq.(30)	C Eq.(32)	Q/C Eq.(33)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
N	1	P		0.34	0.32			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	513	0.19	0.28	19	618	0.83
S	2	P		0.32	0.32			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	539	0.20	0.29	20	650	0.83
W	3	P		0.33	0.33			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553	536	0.15	0.22	15	650	0.82
E	4	P		0.32	0.35			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553	509	0.14	0.21	14	607	0.84

Total lost time LTI (sec)	14	Unadjustment cycle time C_{US} (sec)	82	IFR= $\sum FR_{CRIT}$	0.68
		Adjustment cycle time C (sec)	82		

LTI =(1.5*2 +1.5*2 + 1.5*2 + 1.5*2)+2=14

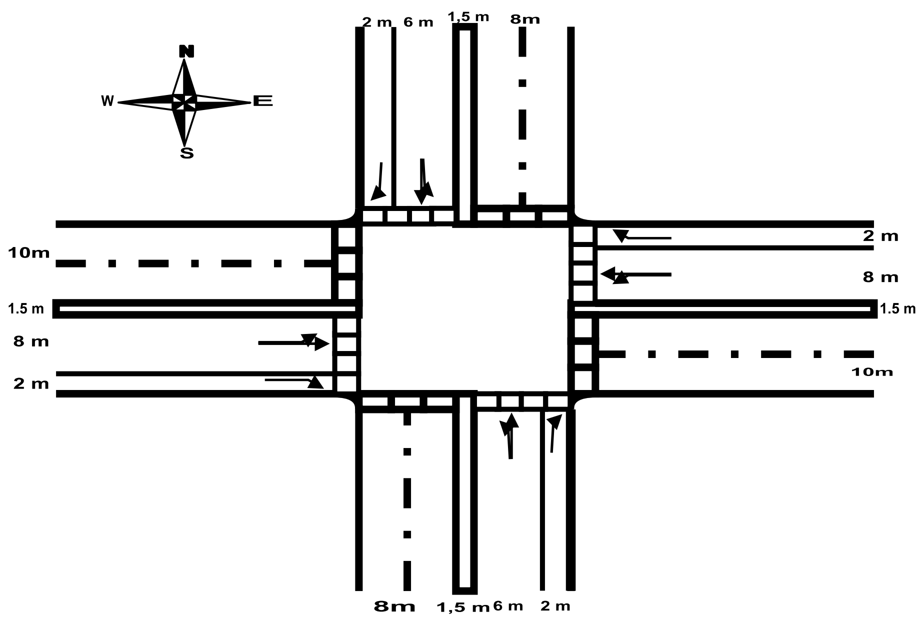
SIGNALISED INTERSECTION	Date :02.02.2013	Handled by :
Form SIG.IV : QUEUE LENGTH	City : Derna	Case : Data 2
STOP RATE	Intersection : republic street	Period : afternoon
DELAY	Cycle Time :	

Approach code	Traffic Flow pcu/h	Capacity pcu/h	Degree of Saturation	Green Ratio	No. of queuing vehicles (pcu)				Queue length (m)	Stop rate stops/pcu	No. of Stops pcu/h	Delay			
			DS = Q/C	GR = g/c	NQ_1	NQ_2	Total NQ_1+NQ_2 NQ	NQ_{MAX}				Average Traffic delay sec/pcu	Average Geometric delay sec/pcu	Average delay sec/pcu D = DT+DG	Total Delay Pcu.sec D x Q
	Q	C			Eq.(34.1)	Eq.(35)	Eq.(37)	Fig.E-2:2	QL Eq.(38)	NS Eq.(39)	N_{SV} Eq.(40)	DT Eq.(42)	DG Eq.(43)	(13)+(14)	(2)+(15)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
N	513	618	0.83	0.23	1.87	11.12	12.99	20	67	1.00	513	41.23	4.00	46.23	23716
S	539	650	0.83	0.24	1.88	11.65	13.53	21	70	0.99	534	39.93	4.04	43.97	23700
W	536	650	0.82	0.18	1.73	11.74	13.47	22	55	0.99	531	41.56	4.04	45.60	24442
E	509	607	0.84	0.17	2.04	11.23	13.27	22	55	1.00	509	44.90	4.00	48.90	24891
LOTR (all)	1026											0.0	6.0	6.0	6156
Flow adj. Qadj :										Total:	2087			Total:	102905
Total flow Qtot :	3123									Average no. of stops/pcu	0.67	Average intersection delay sec/pcu			32.95

SIGNALIZED INTERSECTION Form SIG-I : GEOMETRY TRAFFIC CONTROL ENVIRONMENT	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	
	City size : 250.000.	
	Case : date 3	
	Period : evening	

EXISTING SIGNAL PHASES

g = G =	g = G =	g = G =	g = G =	Cycle time : c = Total lost time : LT = ∑ IG =



SITE CONDITIONS

Approach code	Road environment type	Side friction H/L	Median Y/N	Gradient +/- %	Left-turn on Red Y/N	Distance to parked vehicle (m)	Approach width (m)			
							Approach W_A	Entry W_{ENTRY}	LT on Red W_{LTOR}	Exit W_{EXIT}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
N	COM	L	Y		Y		8.0	6.0	2.0	8.00
S	COM	L	Y		Y		8.0	6.0	2.0	8.00
W	COM	L	Y		Y		10.0	8.0	2.0	10.00
E	COM	L	Y		Y		10.0	8.0	2.0	10.00

SIGNALIZED INTERSECTION Form SIG-H : TRAFFIC CONTROL	Date : 02.02.2013	Handled by :
	City : Derna	
	Intersection : Republic Street	Case : data 3

														Period : evening			
Appr code	Dir.	TRAFFIC FLOW MOTORISED VEHICLES (MV)														UNMOT. VEH	
		Light Vehicles (LV) pce protected = 1.0 pce opposed = 1.0			Heavy Vehicles (HV) pce protected = 1.3 pce opposed = 1.3			Motorcycles (MC) pce protected = 0.2 pce opposed = 0.4			Total Motor vehicles MV			Ratio of turning		Flow UM veh/h	Ratio UM/MV
		veh/h	pcu/h		veh/h	pcu/h		veh/h	pcu/h		veh/h	pcu/h		p LT	p RT		
			Prot	Opp		Prot	Opp		Prot	Opp		Prot	Opp	Eq.(13)	Eq.(14)		Eq.(15)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
N	LT	115	115	115	106	138	138	0	0	0	221	253	253	0.34		0	0
	ST	123	123	123	86	112	112	0	0	0	209	235	235			0	0
	RT/RTOR	109	109	109	115	150	150	0	0	0	224	259	259		0.35	0	0
	TOTAL	347	347	347	307	400	400	0	0	0	654	747	747			0	0
S	LT	109	109	109	106	138	138	0	0	0	215	247	247	0.33		0	0
	ST	128	128	128	119	155	155	0	0	0	247	283	283			0	0
	RT/RTOR	99	99	99	111	144	144	0	0	0	210	243	243		0.31	0	0
	TOTAL	336	336	336	336	437	437	0	0	0	672	773	773			0	0
W	LT	138	138	138	100	130	130	0	0	0	238	268	268	0.33		0	0
	ST	128	128	128	112	146	146	0	0	0	240	274	274			0	0
	RT/RTOR	111	111	111	117	152	152	0	0	0	228	263	263		0.33	0	0
	TOTAL	377	377	377	329	428	428	0	0	0	706	805	805			0	0
E	LT	113	113	113	99	129	129	0	0	0	212	242	242	0.32		0	0
	ST	107	107	107	108	140	140	0	0	0	215	247	247			0	0
	RT/RTOR	118	118	118	114	148	148	0	0	0	232	266	266		0.35	0	0
	TOTAL	338	338	338	321	417	417	0	0	0	659	755	755			0	0
	LT																
	ST																
	RT/RTOR																
	TOTAL																
	LT																
	ST																
	RT/RTOR																
	TOTAL																
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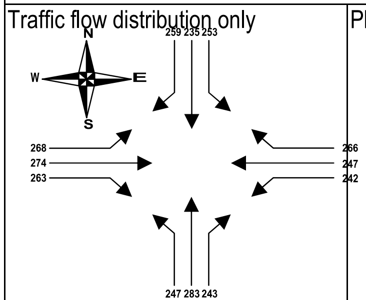
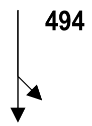
	TOTAL																

SIGNALISED INTERSECTION	Date : 02.02.2013	Handled by :
Form SIG.IV : SIGNAL TIMING	City : Derna	Case : 4 phase
CAPACITY	Intersection : Republic Street	Period : evening

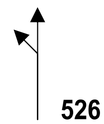
Traffic flow distribution only



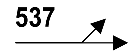
Phase 1



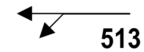
Phase 2



Phase 3



Phase 4



Appr Code	Green In Phase no	Appr Type	Ratio of turning vehicles			RT-flow pcu/h		Eff Width (m)	Saturation flow pcu/h: Base Value pcu/h	Adjustment factors: All appr type				Only type P		Adjusted Value pcu/h	Traffic Flow pcu/h	Flow ratio FR	Phase Ratio PR = FRcrit	Green Time Sec	Capacity pcu/h S x g/c	Degree Of Saturation
			P ltor	P lt	P rt	Own Dir Q rt Lt	Oppos dir Q rto Lt	W e Eq.(18) Eq.(19)	S o Eq.(20) Fig.C.3:2 Fig.C.3:3	City size F_{CS} Tab.C-4:1	Side friction F_{SF} Tab.C-4:2	Gradient F_G Fig.C.3:2	Parking F_P Eq.(21)	Right turns F_{RT} Eq.(22)	Left turns F_{LT} Eq.(23)	S Eq.(24)	Q	Q/S Eq.(26)	IFR Eq.(28)	G Eq.(30)	C Eq.(32)	Q/C Eq.(33)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
N	1	P		0.34	0.35			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	494	0.19	0.28	19	626	0.79
S	2	P		0.33	0.31			6.0	3600	0.82	0.95	1.00	1.00	1.00	0.95	2665	526	0.20	0.29	19	626	0.84
W	3	P		0.33	0.33			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553	537	0.15	0.22	15	658	0.82
E	4	P		0.32	0.35			8.0	4800	0.82	0.95	1.00	1.00	1.00	0.95	3553	513	0.14	0.21	14	615	0.83

Total lost time LTI (sec)	14	Unadjustment cycle time	C_{US} (sec) Eq.(29)	81	IFR= $\sum FR_{CRIT}$	0.68
		Adjustment cycle time	C (sec) Eq.(31)	81		

LTI =(1.5*2 +1.5*2 + 1.5*2 + 1.5*2)+2=14

SIGNALISED INTERSECTION	Date :02.02.2013	Handled by :
Form SIG.IV : QUEUE LENGTH	City : Derna	Case : Data 3
STOP RATE	Intersection :	Period : evening
DELAY	Cycle Time :Republic street	

Approach code	Traffic Flow pcu/h	Capacity pcu/h	Degree of Saturation DS	Green ratio GR	No. of queuing vehicles (pcu)				Queue length (m)	Stop Rate stops/pcu	No. of Stops pcu/h	Delay			
					NQ_1	NQ_2	Total NQ_1+NQ_2	NQ_{MAX}				Average Traffic delay sec/pcu	Average Geometric delay sec/pcu	Average delay sec/pcu	Total Delay Pcu.sec
	Q	C	= Q/C	= g/c			NQ		QL	NS	N_{SV}	DT	DG	D = DT+DG	D x Q
					Eq.(34.1)	Eq.(35)	Eq.(37)	Fig.E-2:2	Eq.(38)	Eq.(39)	Eq.(40)	Eq.(42)	Eq.(43)	(13)+(14)	(2)+(15)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
N	494	626	0.79	0.23	1.35	10.46	11.81	18	60	0.96	475	36.92	4.16	41.08	20294
S	526	626	0.84	0.23	2.04	11.30	13.34	20	67	1.00	526	41.70	4.00	45.70	24039
W	537	658	0.82	0.19	1.73	11.59	13.32	20	50	0.99	532	41.06	4.04	45.10	19709
E	513	615	0.83	0.17	1.87	11.15	13.02	20	50	1.00	513	43.35	4.00	47.35	24291
LOTR (all)	1010											0.0	6.0	6.0	6060
Flow adj. Qadj :										Total:	2046			Total:	88333
Total flow Qtot :	3080									Average no. of stops/pcu	0.66			Average intersection delay sec/pcu	28.68