

# Design of Traffic Control System at an intersection

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## Abstract

This project has established that the study of traffic control devices involves numerous procedures and time-consuming methods. However, these studies and methods have taught us how traffic engineers communicate with road users. Thus far, four studies have been conducted as part of this project. The first study is the spot speed study, which illustrates the speed limit on the road and explains how it is measured using one of three methods: the stopwatch method, the laser meter method, or the pneumatic road tube method. The second study is the sight distance study, which examines the distances available for drivers to observe while approaching an intersection. It involves two methods: the approach sight distance method and the departure sight distance method. The third study is the traffic signal warrant study, which indicates that the installation of a traffic signal at an intersection requires knowledge of the vehicle volumes over an eight-hour period on an average day. The warrants are then examined to determine if at least one of the nine conditions is met, allowing for the installation of a traffic signal to ensure safety. The fourth study is to develop a phase plan for the studied intersection. Based on the third study, it was revealed that the intersection needs a traffic light. The fourth study recommended a three-phase plan with an added lane on north-south street, Abi Bakr street. The first phase sets a dedicated phase for all volumes on west-east street, Al Qasar street. The second phase sets a dedicated phase for left-turn volume on north-south street, Abi Bakr street. The third phase sets a dedicated phase for through and right movement on north-south street, Abi Bakr street.

## Problem Statement

Intersection control involves different levels of regulation based on varying traffic conditions and safety considerations. Uncontrolled intersections are employed when there is low volume demand and sufficient sight distance on each leg. The basic rule is followed, where the driver approaching the intersection yields to the vehicle on the right, while the driver on the left waits their turn. Sign-controlled intersections come into play when sight distance is limited or traffic volumes increase. The Manual on Uniform Traffic Control Devices (MUTCD) provides specific guidelines for signage requirements. Finally, signalized intersections are implemented primarily due to high traffic volumes entering the intersection and a notable number of accidents occurring at that location. Traffic signals are used to regulate traffic flow, assigning right-of-way through a systematic green, yellow, and red signal sequence. Overall, intersection control adapts to different circumstances, progressing from uncontrolled to sign controlled and eventually signalized intersections to optimize safety and efficiently manage traffic flow.

## Objectives

The first study is the spot speed study, which shows the posted speed limit and describes how it is determined using the laser meter, stopwatch, or pneumatic road tube technologies. The sight distance study, which focuses at the distances that drivers can see as they approach an intersection, is the second study. The approach sight distance method and the departure sight distance method are the two techniques used. The third study, "Traffic Signal Warranties," shows that understanding the average daily vehicle volume over an eight-hour period is necessary before installing a traffic signal at an intersection.

The installation of a traffic signal to guarantee safety is then permitted provided at least one of the nine requirements is satisfied, which is determined through examination over the warranties. The development of a phase plan for the examined intersection is the goal of the fourth research. based on "Traffic Signal Warranties," the third research

## Methodology

- A laser meter method has been conducted at the intersection of Abi Bakr As Siddiq Rd and Al Qasar St road considering the distances and the angle of shooting the laser meter at the vehicle, a calibration has been made 10 times for a speed of 40km/h and it was successful, another sample of 100 vehicles has been taken again and we have still found out that the 50<sup>th</sup> and 85<sup>th</sup> percentile speeds were above the speed limit.
- The type of control at case study location is four-way stop-control the volumes on Abi Bakr As Siddiq Rd is much higher than Al Qasar St and this is, as mentioned, classified as principle arterial and principle collector. Thus, the four-way stop control is not appropriate for this intersection as the volumes is not approximately equal as recommended by section 2B.07 in MUTCD Therefore, The team suggest to install two-way stop control at the intersection. So, the humps and stop signs should remove from Abi Bakr As Siddiq Rd. The departure sight study is conducted on the intersections and used design rod sighting, Traffic cone, and safety clothes.
- A case study of traffic signal warrants has been made at the intersection of Abi Bakr As Siddiq Rd & Al Qasar St and took a video for eight hours divided into two consecutive hours of the day, the hours that has been observed was within the peak hour of an average day, the volumes of the vehicles has been conducted using excel.
- Developing of signal timing plans that assure safety and operation, satisfying the demand of vehicles following through the intersection, checking that the developed timing for vehicles is adequate with pedestrian requirements.

## Location

The case study was conducted in Riyadh city, Al Aarid district at the intersection of Abi Bakr As Siddiq RD and Al Qasar St is a four-lane road in each direction and is classified as a principal arterial. Al Qasar St, on the other hand, consists of two lanes and is classified as a lower-class road closer to a principle collector.

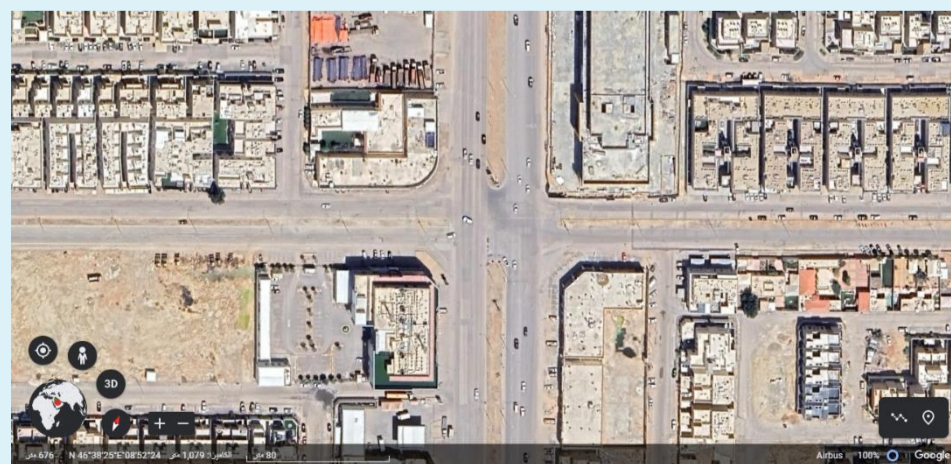


Figure. 1 Location of the intersection.

## Results

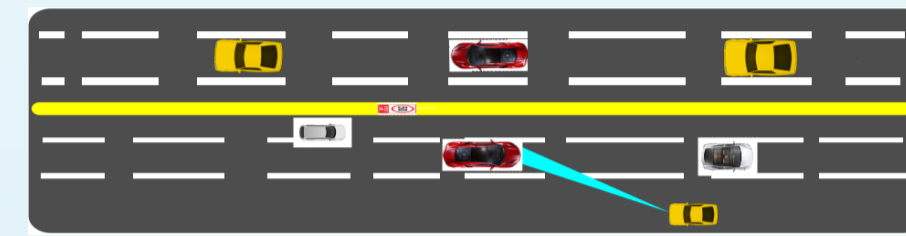


Figure 2. Laser meter spot speed procedure.

The posted speed limit on Abi Bakr As Siddiq Rd is 50 km/h, and based on our observations, it was found that the 85th percentile speed is 65.2 km/h, which is 23% higher than the posted speed limit. Therefore, a revision of the speed limit should be considered. This discrepancy in speeds can be attributed to the fact that the speed limit was previously set at 90 km/h and then abruptly reduced to 50 km/h within a short distance between the posted signs.

Table 1. Left-turn maneuver observations.

Date	2023/04/24	Major roadway width	15.2 m
Time of day	5:45 AM	No. of Lanes	4
Speed (Posted or 85%)	50 km/h	Minor Roadway Width	8.3 m
Traffic Controls Present	STOP sign and humps	No. of Lanes	2
Intersection Maneuver	Right turn and cross	Y	60 m
Weather	clear	X(R)	105 m
Horizontal Curve	N	X	52.5 m
Vertical Curve	N		

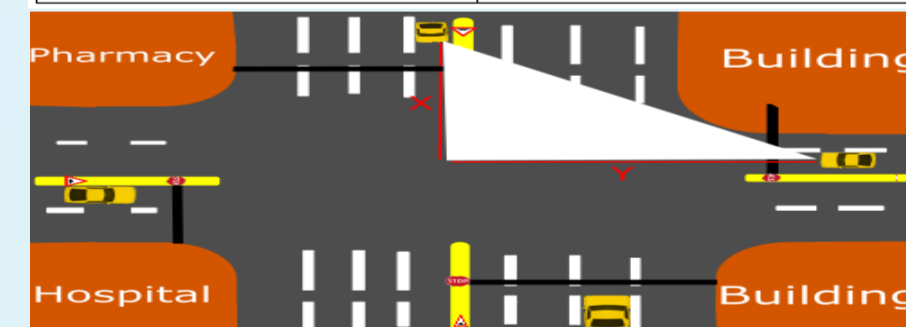


Figure.3 Abi Bakr Alsiddiq Rd and Al Qasar St first leg left-turn maneuver.

Table 2. Volumes observed per hour.

Time	Major Rd Vol (veh/h)			Minor St (veh/h)		High Vol
	NB	SB	TOTAL	EB	WB	
6-7 AM	1487	2526	4013	485	227	485
7-8 AM	1831	2481	4312	426	247	426
2-3 PM	2115	1828	3943	352	123	352
3-4 PM	2369	2684	5053	263	116	263
6-7 PM	2267	2703	4970	352	237	352
7-8 PM	2886	2843	5729	459	284	459
9-10 PM	2362	1765	4127	383	203	383
10-11 PM	2266	1736	4002	208	251	251

Table 3. Warranties check list.

	Met	Not met	Insufficient info	Not applicable
Warrant 1	✓	✗	✗	✗
Warrant 2	✓	✗	✗	✗
Warrant 3	✗	✗	✗	✓
Warrant 4	✗	✓	✗	✗
Warrant 5	✗	✓	✗	✗
Warrant 6	✗	✓	✗	✗
Warrant 7	✓	✗	✗	✗
Warrant 8	✓	✗	✗	✗
Warrant 9	✗	✗	✗	✓

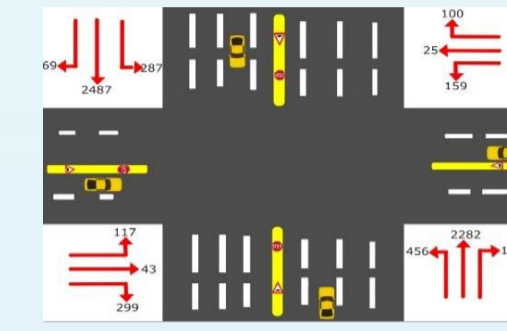


Figure 4. Current intersection layout ( 7-8 PM ).

Table 4. Phase diagram for current layout.

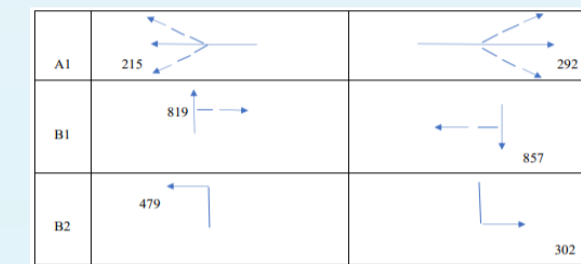


Table 5. Design for current layout ( 7-8 PM ).

Phase	Gi (s)	yi (s)	ari (s)	Ri (s)
A	54.3	3.28	3.97	258.45
B1	159.4	3.28	1.66	155.66
B2	89.1	3.28	1.66	225.98

Table 6. Design for current layout ( 7-8 PM ) with added lane.

Phase	Gi (s)	yi (s)	ari (s)	Ri (s)
A1	10.26	3.28	3.97	62.49
B1	30.15	3.28	1.66	44.91
B2	22.46	3.28	1.66	52.6

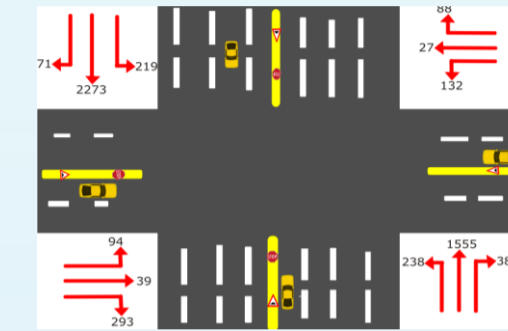
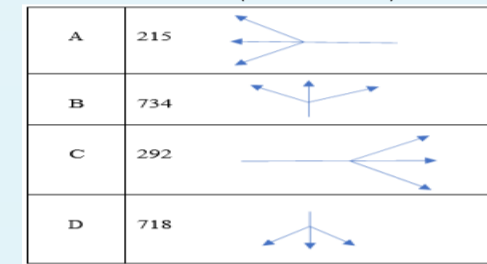


Figure 5. current intersection layout ( 7-8 AM ).

Table 7. Typical phase diagram design in Saudi Arabia (7 PM – 8 PM ).



Cycle length calculation for the typical Saudi Arabia design was approximately 5.5 min which leads to high delays, thus it is suggested to add a lane.

Table 8. Design for typical Saudi Arabia ( 7-8 AM ) with added lane.

phase	Gi (s)	yi (s)	ari (s)	Ri (s)
A	17.6	3.28	3.97	115.15
B	30.3	3.28	1.66	104.76
C	23.7	3.28	3.97	109.05
D	44	3.28	1.66	91.06

## Conclusion

Traffic control devices play a critical role in ensuring the safety of road users by effectively controlling, warning, and guiding drivers through the transportation network. The intersection of Abi Bakr As Siddiq RD and Al Qasar St has undergone four comprehensive traffic studies to determine the most suitable traffic control measures for this specific location. The primary objective of these studies is to collect essential data that will inform decision-making regarding the necessary traffic control measures, with a strong focus on enhancing safety and optimizing traffic flow at the intersection.

## QR Code

Report

