UNIVERSITAS INDONESIA

Pengaruh Ramp Metering Pengendali Arus Otomatis dengan Algorithma ALINEA pada Ruas Masuk Jalan Toll

(Menggunakan Software Simulasi AIMSUN 6.1)

TESIS

Diajukan sebagai salah satu syarat untuk memperoleh gelar Magister Teknik

PUPUT YUSDA APRILIANA

NPM.0906580395

FAKULTAS TEKNIK

PROGRAM STUDI TEKNIK SIPIL

KEKHUSUSAN MENEJEMEN INFRASTRUKTUR

DEPOK

JULI 2011

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Nama	: Puput Yusda Apriliana
NPM	: 0906580395
Tanda Tangan	:
Tanggal	: Juli 2011

HALAMAN PENGESAHAN

Tesis ini diajukan oleh :

Nama : Puput Yusda APRILIANA

NPM : 0906580395

Program Studi : TEKNIK SIPIL

Judul Tesis : Pengaruh Ramp Metering Pengendali Arus Otomatis dengan Algorithma ALINEA pada Ruas Masuk Jalan Toll (Menggunakan Software Simulasi AIMSUN 6.1)

Telah berhasil dipertahankan dihadapan Dewan Penguji dan diterima sebagai bagian persyaratan yang diperlukan untuk memperoleh gelar Master 2 Université d'Artois (Perancis) dan Magister Teknik pada Program Studi Teknik Sipil, Fakutas Teknik, Universitas Indonesia

DEWAN PENGUJI

Pembimbing : Daniel Jolly ( )

Pembimbing : Gildas Morvan ( )

Penguji : Daniel Jolly ( )

Penguji : Hamid Allaoui ( )

Penguji : Daniel Porumbel ( )

Ditetapkan di :

Tanggal :

Mengetahui : Kepala Departemen Teknik Sipil UI

(Prof. Irwan Katili)

KATA PENGANTAR / UCAPAN TERIMAKASIH

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Bethune-France, 22 Juni 2011

Puput Yusda Apriliana

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Nama : Puput Yusda Apriliana

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Program Studi : Manajemen Infrastruktur

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Pada tanggal: Juni 2011

Yang menyatakan,

(Puput Yusda Apriliana)

ABSTRAK

Nama : Puput Yusda Apriliana

Program Studi: Manajemen Infrastruktur

Judul : Pengaruh Ramp Metering Pengendali Arus Otomatis dengan Algorithma ALINEA pada Ruas Masuk Jalan Toll (Menggunakan Software Simulasi AIMSUN 6.1)

Tesis ini membahas tentang pengaruh penempatan *ramp metering* sebagai pengendali arus otomatis bagi kendaraan yang akan memasuki jalan toll. Tujuan dari penelitian ini adalah riset pengaturan secara otomatis jumlah kendaraan yang memasuki jalan toll agar tidak melampaui kapasitas maksimum jalan toll sehingga diharapkan mencegah terjadinya kemacetan dan menjaga efektifitas fungsi toll. Otomatisasi fungsi ramp metering menggunakan fungsi algoritma ALINEA (Asservissement Linéaire d'entrée sur Autoroute) pada simulasi AIMSUN 6.1. dengan menggunakan parameter waktu tempuh.

Kata Kunci:

Effektifitas, *ramp metering*, ALINEA, Aimsun 6.1

ABSTRACT

Name : Puput Yusda Apriliana

Study Program : Infrastrucure Management

Title : Influence of positioning ramp metering ALINEA in control quality of acces to a highway.

This thesis has focus study in the influence of placement of ramp metering which control flow of vehicles that will enter the highway to the effectiveness of control functions highway. With placement of ramp metering to automaticaly controlling the vehicles in entrance highway is expected to maintain current levels of highway density and thus increase effectiveness highway functions. Automation functions ramp metering using algorithm ALINEA in simulation AIMSUN 6.1. For analyse the effectiveness, time travel is used as parameter.

Keywords:

Effectiveness, ramp metering, ALINEA, Aimsun 6.1

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Table of Contents

1. Introduction

This research represents one of the requirements for obtaining the master's degree 2 at the University of Artois, Béthune, France. The aim of this project is to regulate the flow of cars entering the highway (ramp) to avoid exceeding the capacity of the road itself to prevent the formation of congestion. This problem will be solved using the simulation software traffic AIMSUN used by the LGI2A (Laboratory of Computer Engineering and Automatic Artois). The pattern of our studies (Figure 1.1) explains the principle of the device access control (ramp metering) on the highway.

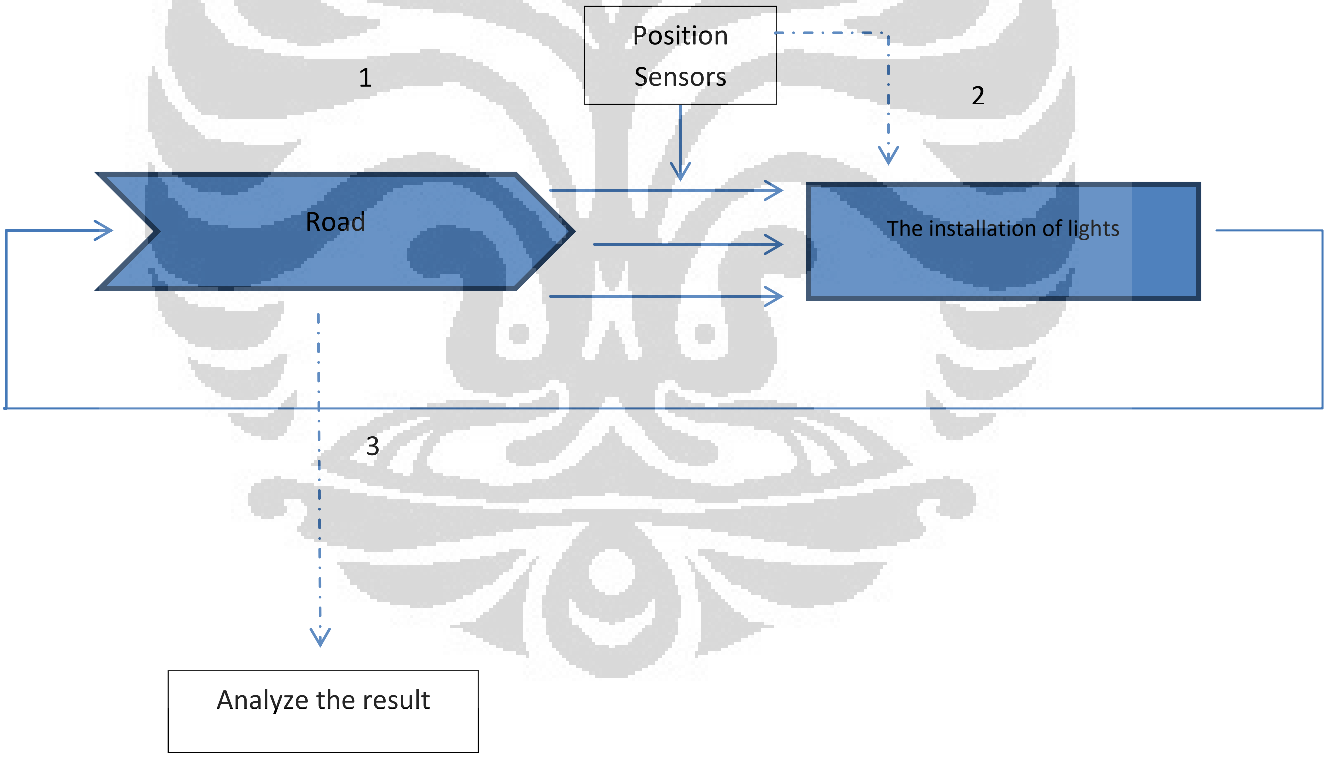

Figure 1.1 Diagram of the control of access to the highway

1. Analysis of data base to installation of the ramp metering
2. Installation of access control (ramp metering)
3. Analysis of results with the controller

2. Introduction to Software Parameters Used

2 .1 AIMSUN

AIMSUN is a tool for simulation of traffic used to analyze the dynamic traffic and test control strategies. AIMSUN simulation (like any simulation of a transport system) is characterized by a model of road transport system consists of the road infrastructure itself and the operating parameters of the system as the cycles of lights, signs, markings ground, etc.. The some applications AIMSUN:

a) The impact assessment of infrastructure design,
b) Environmental studies,
c) The pricing of highways,
d) The optimization of the control plan,
e) The management of urban and interurban traffic,
f) Managing public transport
g) The security analysis,
h) The evaluation of systems,
i) The development of transport models and new algorithms.

The simulation solves cost transportation problems (such as the establishment of a road marking or a fire plan) that we face. This project deals with the management of the entrance ramp of a highway with traffic lights.

AIMSUN has two components that allow for dynamic simulations: the microscopic and mesoscopic simulation. In our simulation, we use the microscopic approach which means that the behavior of each vehicle in the network is continuously modeled throughout the simulation period as he travels across the network, according to several models of motor vehicles (for example, changing lanes).

2.2 The modeling in exercise AIMSUN

2.2.1 Edition

In the editing phase you build the network with the required data such as sensor systems, traffic light, intersection, centroid, etc.

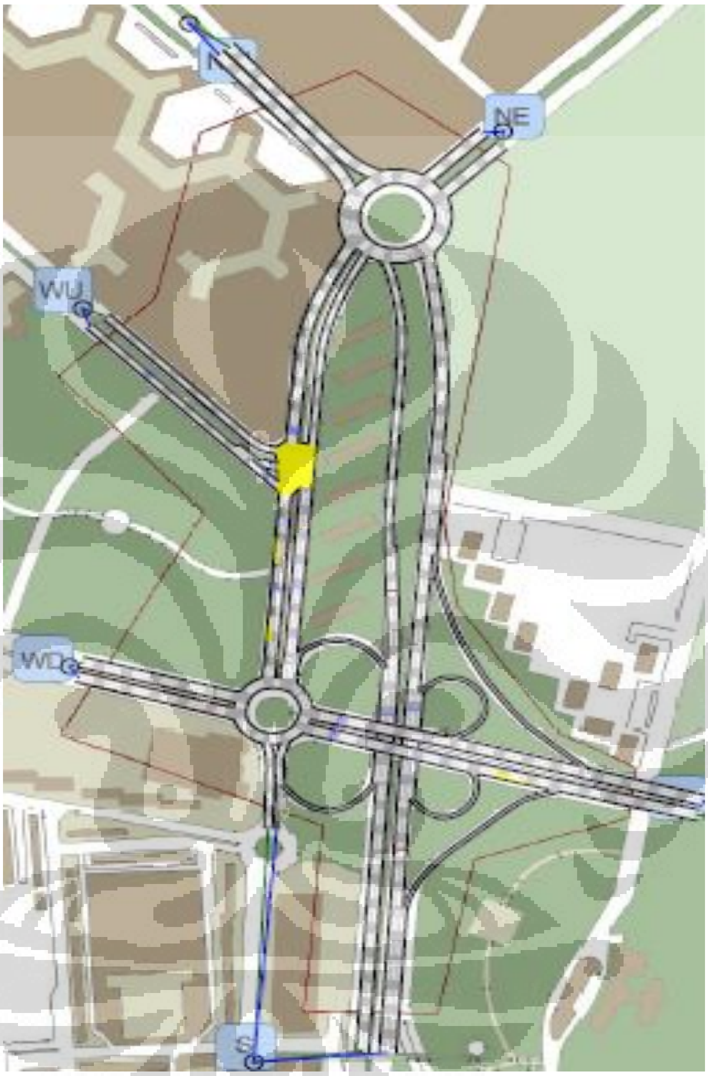

Figure 2.1. Edition

2.2.2 Traffic Management

These define the policy for the diversion of vehicles, control strategies, etc.

Figure 2.2. Traffic

2.2.3 Macroscopic modeling

With an Origin Destination matrix, we can make the transportation planning and analysis of demand and thus detect potential problems.

Figure 2. 3. Macroscopic modeling

2.2.4 Microscopic Simulation

In a microscopic simulation, the result is displayed dynamically in the form of time series.

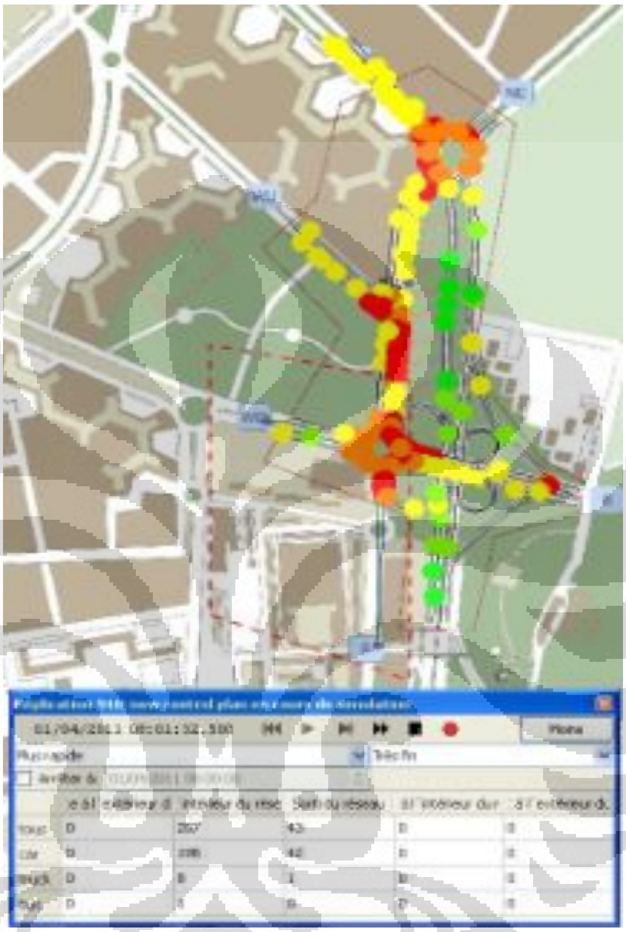

Figure 2.4. A microscopic simulation

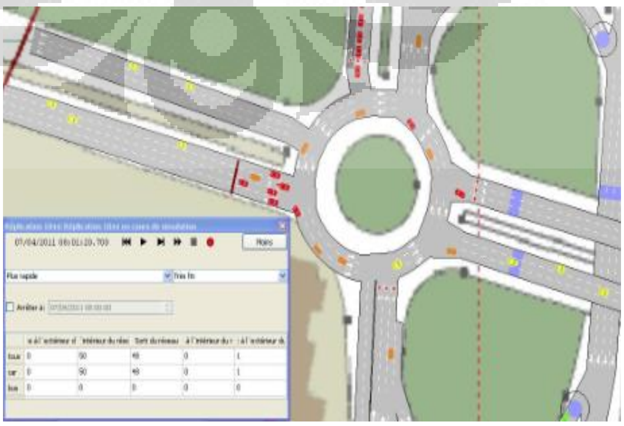

Figure 2.5. Microscopic modeling 2

2.2.5 3D

Partly 3D was used to move around a 3D view by placing the camera, construct buildings and vehicles in 3D format

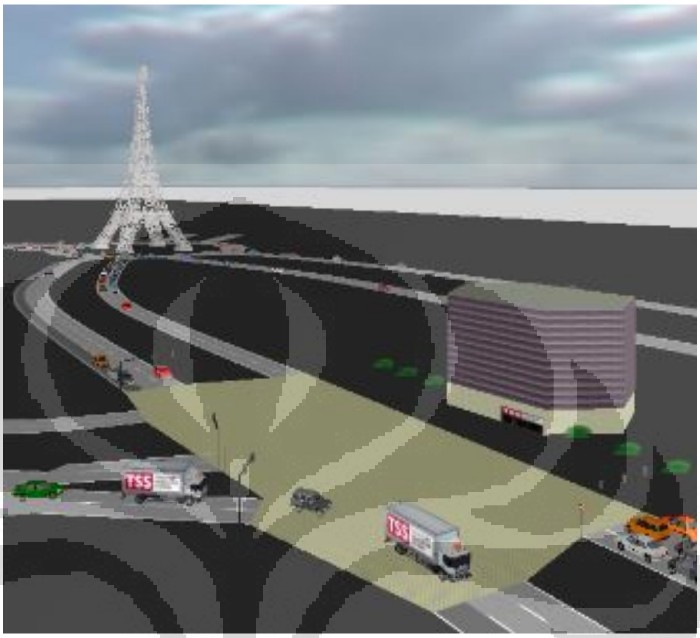

Figure 2.6. 3D

Figure 2.7. B 3D

2.2.6 Integration

In some integration we combine the modes Mesoscopic, microscopic and macroscopic so we can find the interaction between them.

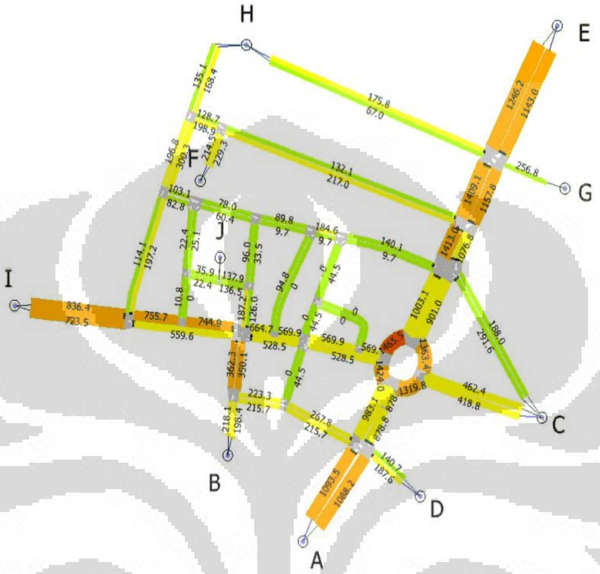

Figure 2.8. Integration

2.3. Schedule research activity

	March		April				May				June				July	
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Activities	AIMSUN training					Implementation and research									Jury	

2.4. Parameter Measurement

According to Kim et al. (2010), the average travel time in traffic is a parameter that is often used to evaluate the effectiveness of a road network "Time travel is the most intuitive measure of effectiveness to road users, transportation agency operators and decision makers "

By knowing the variation of travel time before and after installation of the control system of access to the motorway, it is possible to measure its effectiveness. The efficiency e of the access control can be measured as follows:

$$E = \frac{((T_0 - T_1) \times 100\%)}{T_0}$$

T_0: time course without using logarithms ALINEA

T_1: time course using ALINEA

The first data we got are a set of discrete data on the number of vehicles, from the entrance ramp and the distance from the highway 500 m before the merger. For simplicity we call the reference point N where the data derived from the car entrance ramp, and the point E is a vehicle data input highway 500 m before the merger boom, and the point W is the last point of the highway.

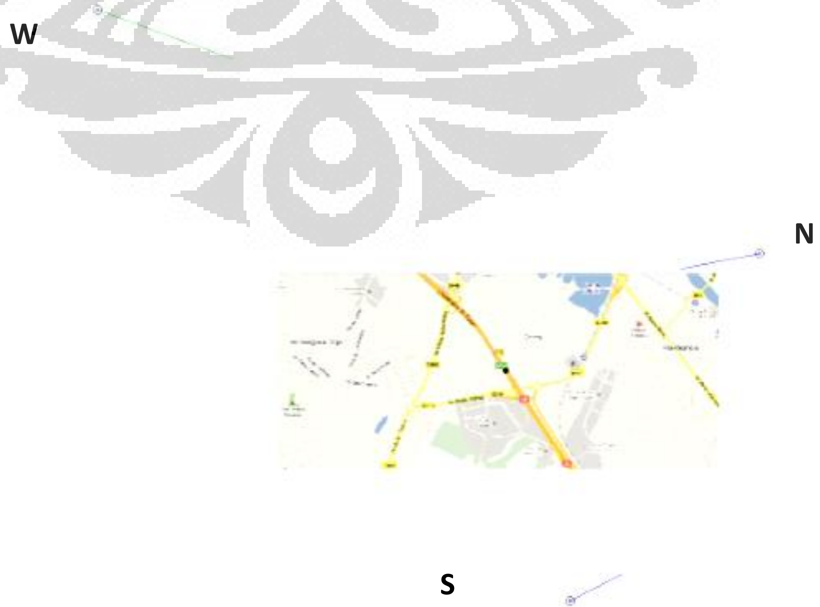

Figure 2.9. Mapp O / D

The problem here is the effect of placement on a highway measuring devices to control access. The case study concerns a segment of the A6 motorway to Paris at the entrance to No. 7 (Grigny –Ris Orangis). Data were provided by Hasanne Abouaissa, lecturer at the University of Artois

2.5. Regulation of access to the highway according to the algorithm ALINEA

According to Papageorgiou (2008) definition of the ALINEA is *" a local ramp metering strategy feedback that attempt to maximize the throughput by maintaining a freeway desires occupancy on the main road."*

The goal is to let a number of vehicles per hour passing through the ramp. This controls the maximum flow of vehicles that can pass through it.

There are two important parameters to define a flow measurement.

a) One is the maximum number of vehicles allowed to pass every time (usually one but sometimes two). It is supposed to be fixed.
b) The other is the maximum flow allowed to pass through the count in a period of time.

Figure 2.10. Figure regulation

The principle of access control can be explained as:

> *"The principle of access control on the highway or urban expressways is to regulate the flow of entry ramps with traffic lights to minimize conflicts of insertion converged access and thus maximize the ability Highway and fluidity. So the first goal of this type of action is to distribute the application in space and time on the differences between the network and at the same time limited the recurring congestion during periods of high demand (peak morning and evening) "*(Habib Salem, 2006)

The diagram below is used to position the sensors needed to run the ALINEA algorithm.

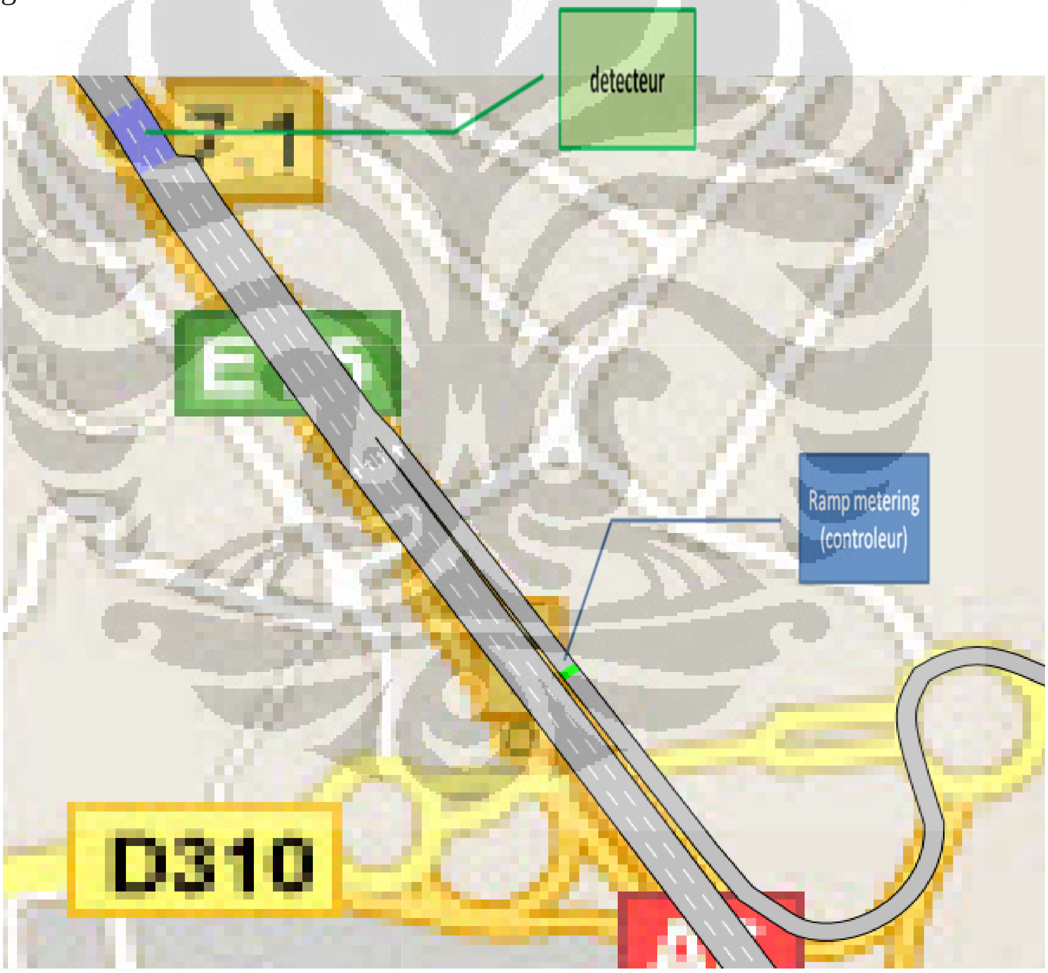

Figure 2.11. sensor placement and access control

The algorithm ALINEA (Asservissement Linéaire d'Entrée sur Autoroute)

The form of enslavement for the regulation of access is:

$$r_{(k)} = r_{m(k-1)} + K_R(O_c - O_{m(k-1)})$$

where

$r_{(k)}$: The flow is calculated to be applied to the ramp to control the next time interval,

$rm_{(k-1)}$: is the flux measured by the ramp to the previous interval,

K_R : Is a constant control parameter.

Oc : Is the critical occupancy (at which there is saturation, derived from the flow / rate) in current section,

$Om_{(k-1)}$: Is the occupancy rate measured at the previous time interval in current section).

If the occupancy rate in current section on the highway exceeds the critical occupancy, then the free flow of the slip decreases.

A minimum flow setting is applied on the ramp if the result of calculation gives a value too low. The maximum flow on the ramp is about 1300 vhs / h drip (5 vhs every 40 seconds). The time interval is important for the time responsiveness of the system, it is equivalent to the time aggregation level as ground loops.

Loop lift queue can be positioned on the ramp to prevent the rise of cap from disturbing the intersection downstream. In this case, when the occupancy rate of this loop is critical (detection the stopper), the algorithm makes to free the flow of the ramp, drop by drop, until the occupancy rate drops below the critical threshold.

3. Traffic modeling

The main steps in the implementation phase of our project are: training AIMSUN software and its functions, calibration, validation, simulation and data analysis.

After modeling the infrastructure in the simulation system and imported the data flow in the form of a matrix Origin Destination[1] (OD) traffic we can calibrate the model.

We are interested in this research to the implementation of this software to solve traffic problems. We describe particular processes of calibration, validation, simulation and data analysis.

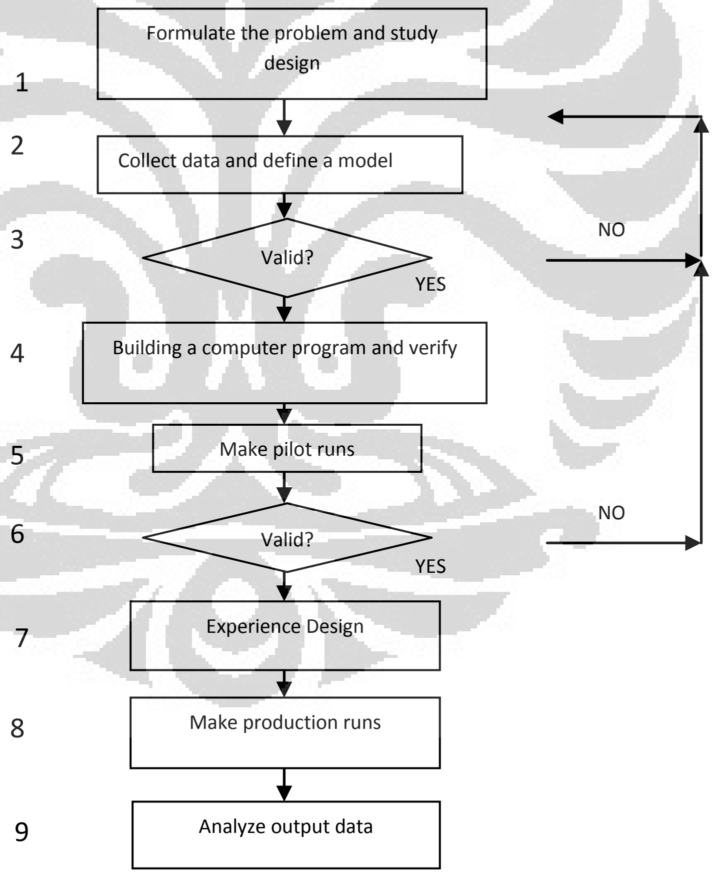

Figure 3.1 Steps in a simulation study
Source: user manual AIMSUN

[1] Définition d'une matrice OD : Est un tableau de nombres positifs représentant la distribution, pour une période déterminée, de la demande entre des couples de points générateurs de déplacements (Daneh Pajouh, 2005)

3.1 Calibration

According to (Huber, 2007), the calibration is "The set of operations which establish, under specified conditions, the relationship between indicated by a capital gains or measuring instruments measuring system and the corresponding known values of the measurand"

The purpose of calibration process is similar to a state close to actual conditions in the hope we can find the results more reliable simulation.

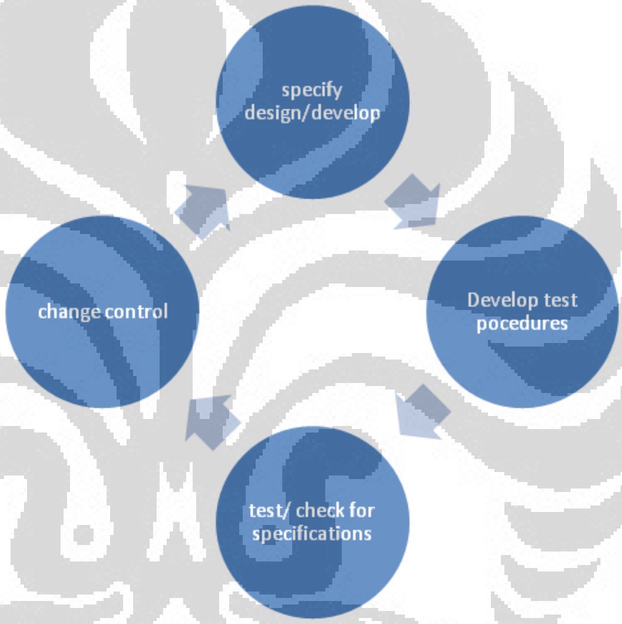

Figure 3.2. The principles of qualification and validation (source: Huber, 2007)

Here, the calibration of the model for the parameters of the type of vehicle simulated: a car. (Figure 3.3)

Nom	Valeur Moyenne	Déviation	Min	Max	Unités
Longueur	4	0.5	3.4	4.6	mètres
Largeur	2	0	2	2	mètres
Vitesse Max Désirée	115	25	10	125	Km/h
Accélération Max	3	0.2	2.6	3.4	m/s2
Décélération Normale	5	0.25	3.5	5.5	m/s2
Décélération Max	6	0.5	5	7	m/s2
Acceptation de Vitesse	1.1	0.1	1	1.4	
Distance Min entre Véh	5	0.3	2.5	500	mètres
Temps de Céder le Passage	0	0	0	0	Secs
Acceptation de Guidage	85	5	75	100	%
Facteur de Sensitivité	1	0	1	2	
Espace Inter-véhiculaire Minimum	3	0.1	0.5	15	Secs

Figure 3.3. parameter car

Calibration results

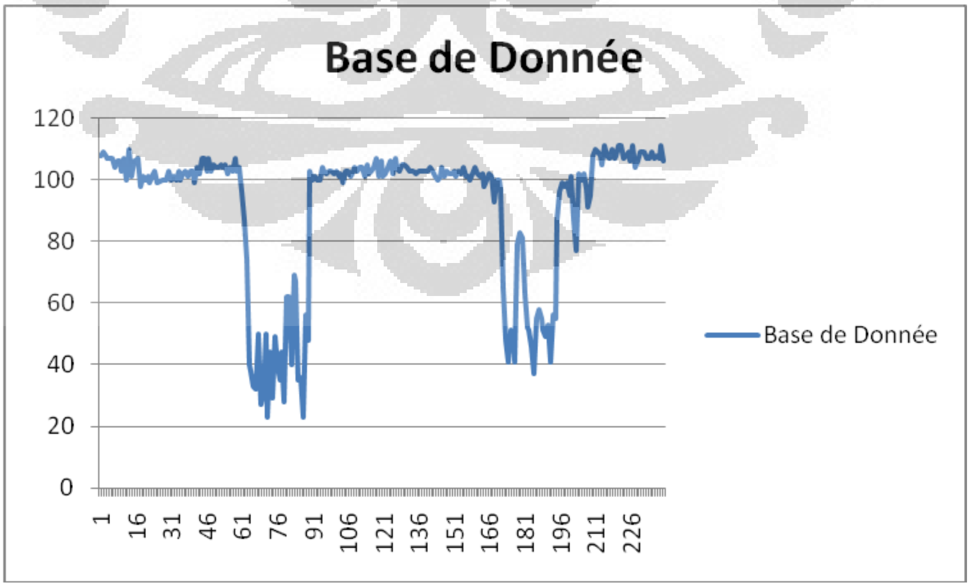

Figure 3.4. graphic database

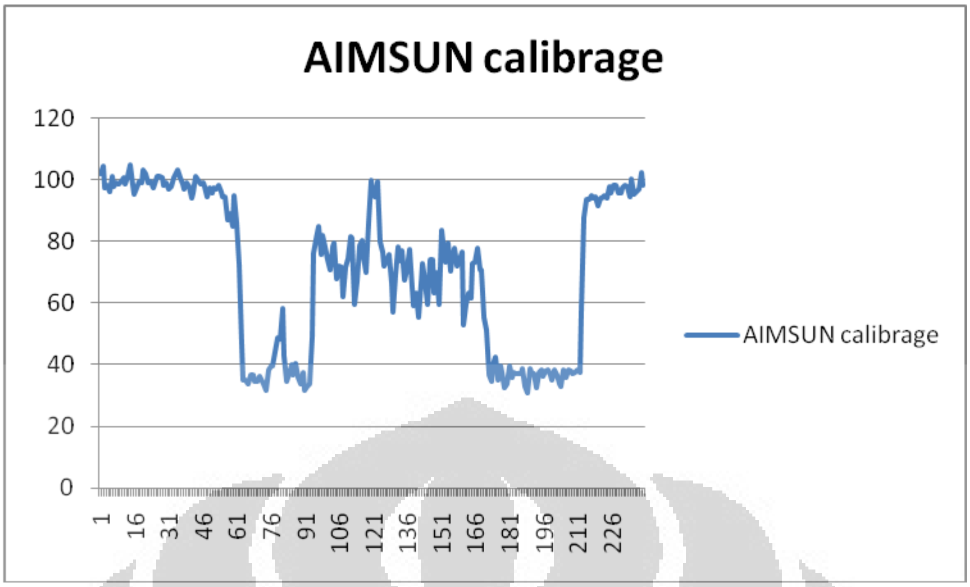

Figure 3.5. graphic calibration results

3.2 Validation

After the calibration process, the data obtained are validated by a statistical correlation (Pearson). This gives a correlation coefficient of 0.7.

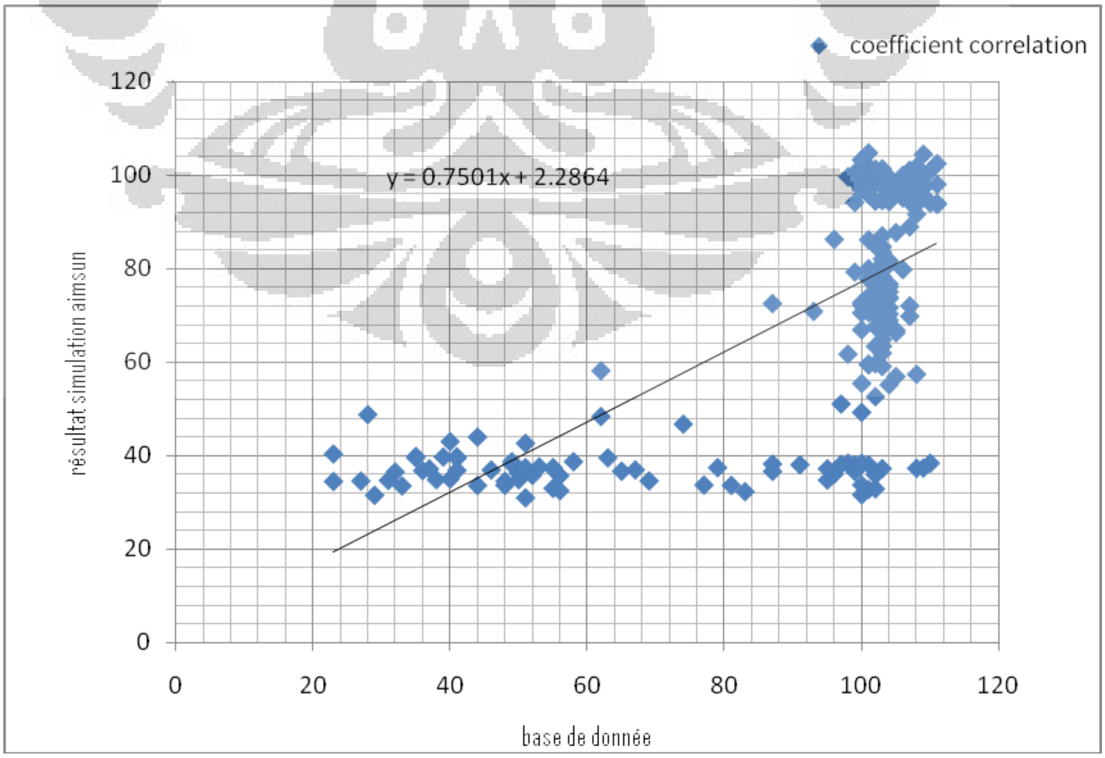

Figure 3.6. graphic correlation coefficient

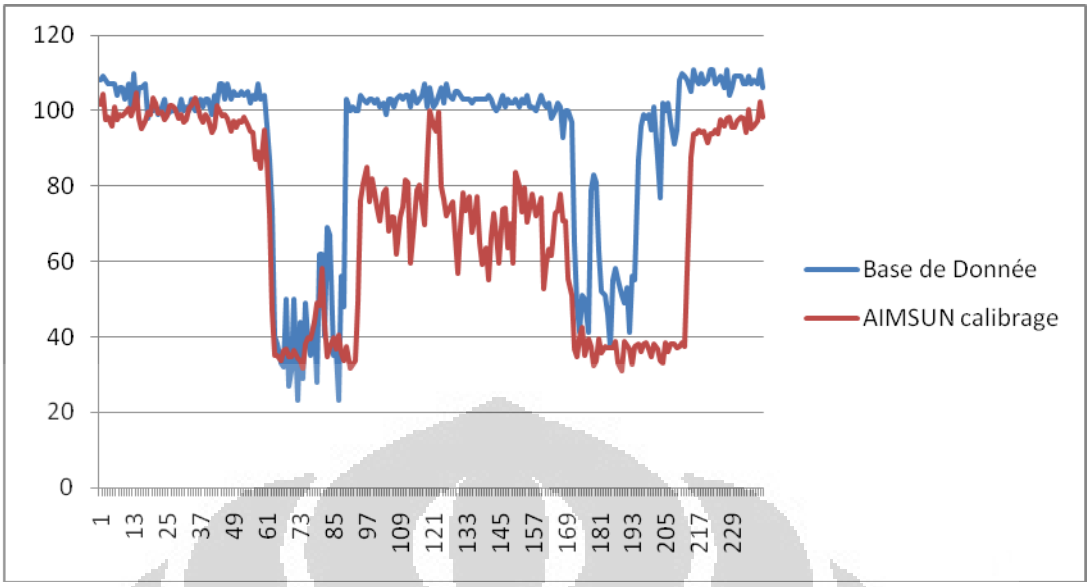

Figure 3.7. Comparison Chart

The differences can be explained by several reasons, including:

1. The geographical configuration of the object is not modeled exactly the same.
2. The conditioning parameters are not similar
3. Variations of this type of vehicle used in the simulation are different.
4. Information about the real incomplete.
5. Limitations of the copyright in the calibration process and to recognize the software AIMSUN

4. MODEL

We consider as a case study, the traffic from the A6 motorway in the city of Paris. We have the following actual data: average speed of vehicles and speeds of vehicles (rail and highway) collected over 24 hours every 6 minutes. Analysis of the data flow and speed can observe the problems that arise on the network (Figure 1.2):

- The vehicle density is high and congestion are formed in the morning between 6am and 9am with an average speed of 57.25 km / h
- In the evening between 17h and 21 h with an average speed of 58.27 km / h possible because of the crowds at these times
- Traffic its function a little slow in the morning until 9 h after 17h with an average speed of 67.64 km / hour.

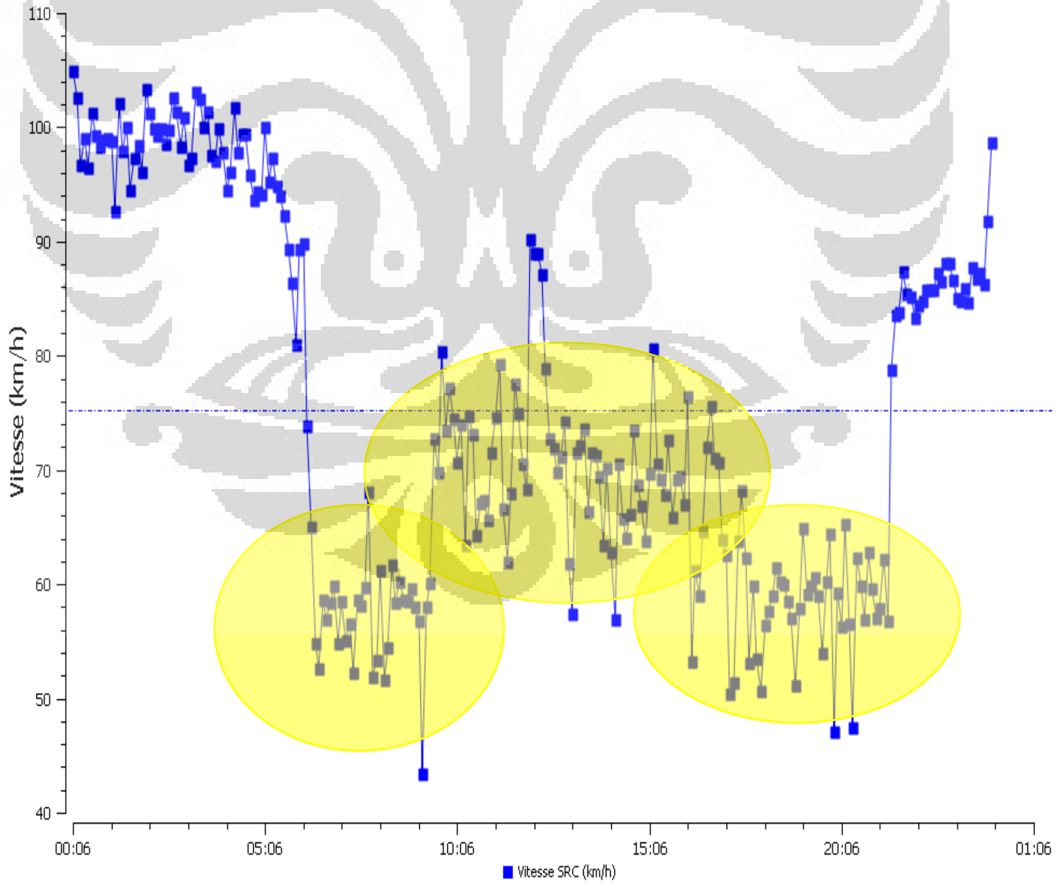

Figure 4.1. model

4.1 Implementation

Packaging flow ALINEA-Access Control

Debit	: 70
Minimum flow	: 7
Maximum flow	: 70
Occupancy rate desired downstream	: 26
Interval Calculation	: 40 seconds

Figure 4.2. positioning sensor and ramp

A. Detector

Reason for investment this detector because this part of the bottle neck of highway.

B. Controller (access control)

The reason for the placement of access control because it was simulate by the author during training to find the placement of access control more effective.

4.2 Results

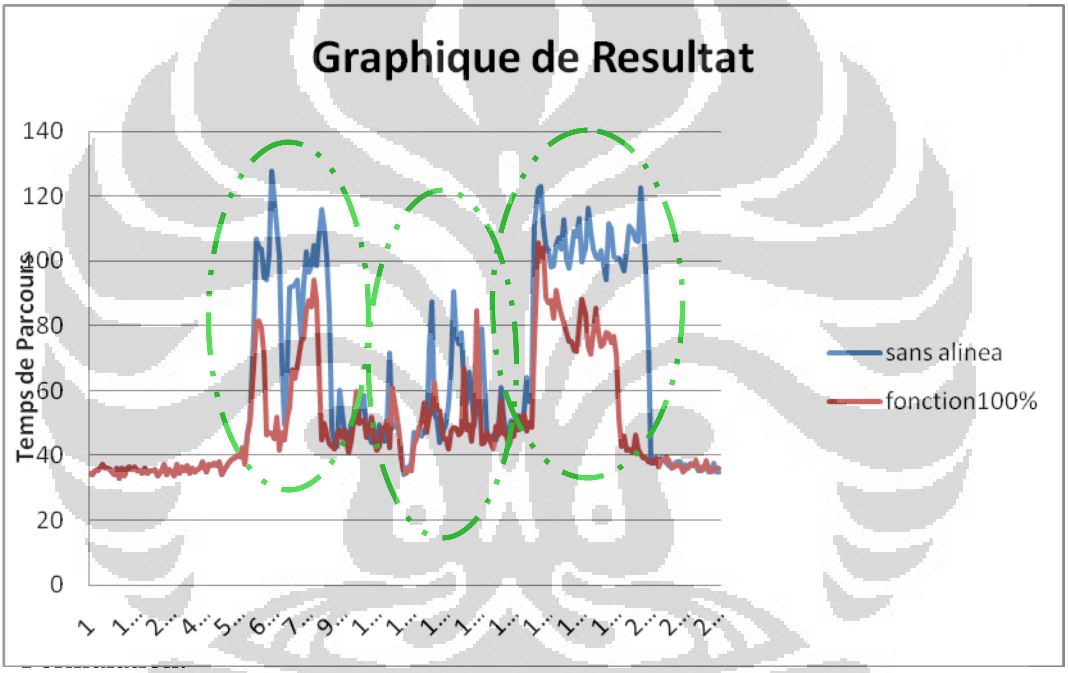

Figure 4.3. graphic result ALINEA

$$Effectiveness\ ALINEA = \frac{T_0 - T_1}{T_0}\ X\ 100\%$$

$T_0 = Time\ Travel\ before\ using\ ALINEA$

$T_1 = Time\ Travel\ with\ ALINEA$(S)

$$Effectiveness\ ALINEA = \frac{61{,}87 - 49{,}98}{61{,}87}\ X\ 100\% = 19{,}22\%$$

From simulation results, we can conclude that the average travel time has decreased by 19.22% overall after using ALINEA.

4.3 Results of Speed

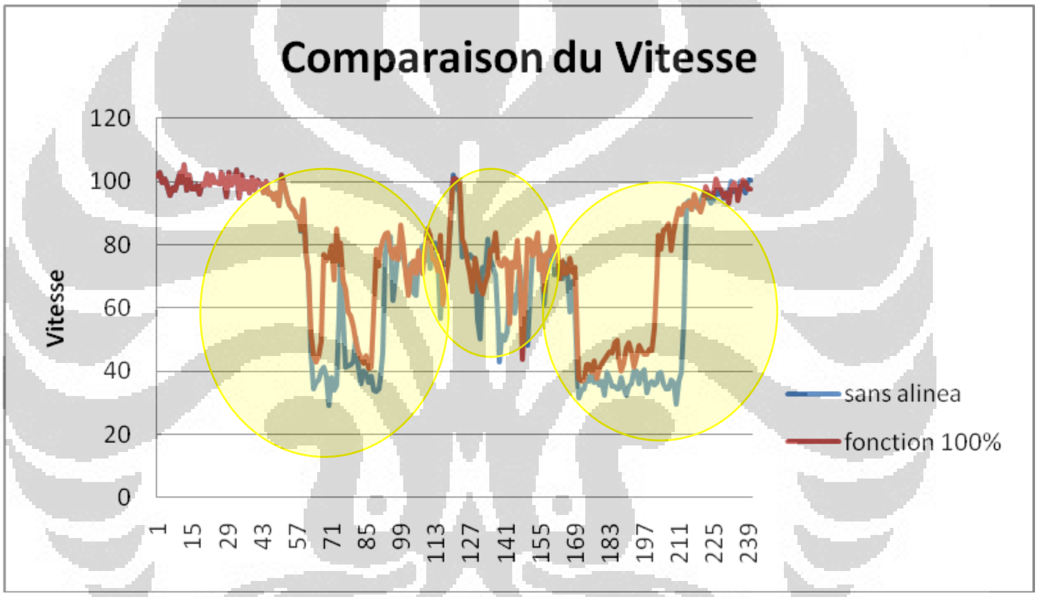

Figure 4.4. Speed results

The speed graph shows that the rate increases after use of ALINEA with increasing average speed 10.17%

5. Conclusion

These regulations facilitate access to the current section. They also avoid the accident-prone situations such as training of accordions in a massive flow of entry into current section.

With the traffic simulation AIMSUN in use according ALINEA algorithm can improve the efficiency of highway, especially during traffic jam.

Travel time increases greatly for users of the ramp, but the overall gain in travel time is significant because the gain in travel time for users of the highway for a traffic volume much larger. The overall gain in travel time in the current section is about 19.22% (figures confirmed by the examples in the field places), and the gain in speed after using ALINEA 10.17% saw more flux ALINEA.

6. Outlook

I would say that this project was interested in and rewarding I had many lessons on the management of transport. I'm sure it will be very useful for my work in the Ministries of Transport in Indonesia.

Some difficulties during the trial of the training laboratory:

- Some terms of transport and traffic are limited, so it takes more time and effort to understand the software AIMSUN
- The traffic rules among the various rules of the State of the authors (Indonesia) and the Country French, so authors must adapt to this condition.
- Mistranslation of certain features AIMSUN software (software functions of the English language is less precise translated into French)
- Little time to understand the traffic, a process of simulation, training and familiarize themselves with the software at the same time

Here are some perspectives of this work:

1. Future researchers may improve the accuracy of simulation results with a better calibration so that the percentage of validation can be increased.
2. Researchers can conduct similar studies using different measurement parameters.
3. Using a wide variety of parameters used vehicles
4. Researchers can also examine the level of pollution and fuel consumption by AIMSUN
5. For future studies to conduct research that is a more integrated analysis of the effectiveness of access control frame rates Highway

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