A VISSIM SIMULATION APPROACH TO ENHANCE LEVEL OF SERVICE OF CLOVERLEAF INTERCHANGES AT GREATER CAIRO

By

Ahmed Nabil Hafez Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
CIVIL ENGINEERING - PUBLIC WORKS

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Key Words:
Weaving; Ramp Metering; Cloverleaf Interchange; ALINEA

Summary:

This study examines the effect of application of different "Ramp Metering" techniques on selected cloverleaf interchanges in Greater Cairo-Ring Road. Several site investigations and surveys were conducted to determine the geometric characteristics of cloverleaf interchanges of Greater Cairo-Ring Road then these interchanges were grouped based on their characteristics and one interchange was randomly selected from each group. Further site surveys were conducted to collect data about the traffic volumes of the selected interchanges. Using these data, a microsimulation model was developed using VISSIM software to assess the current conditions of traffic operation and the effect of applying different "Ramp Metering" techniques. The results were presented in terms of measures of performance such as level of service, time of delay and average vehicles speeds. Two "Ramp Metering" techniques were applied (fixed rate "Ramp Metering" and ALINEA algorithm "Ramp Metering"). Each technique was applied with different scenarios and parameters.

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Abstract

Urban freeway demand that frequently exceeds capacity has caused Transportation agencies to consider many options to reduce congestion. A series of solutions that falls under the Active Traffic Management (ATM) banner have shown promising potential. Perhaps the most popular ATM strategy is "Ramp Metering". This strategy involves limiting the access of vehicles to freeways at an entrance ramp. Accordingly, freeway throughput, speeds, and travel time reliability may be increased. In addition, the number of traffic incidents may be decreased.

This study examines the effect of application of different "Ramp Metering" techniques on selected cloverleaf interchanges in Greater Cairo-Ring Road. Several site investigations and surveys were conducted to determine the geometric characteristics of cloverleaf interchanges of Greater Cairo-Ring Road then these interchanges were grouped based on their characteristics and one interchange was randomly selected from each group. Further site surveys were conducted to collect data about the traffic volumes of the selected interchanges. Using these data, a microsimulation model was developed using VISSIM software to assess the current conditions of traffic operation and the effect of applying different "Ramp Metering" techniques. The results were presented in terms of measures of performance such as level of service, time of delay and average vehicles speeds. Two "Ramp Metering" techniques were applied (fixed rate "Ramp Metering" and ALINEA algorithm "Ramp Metering"). Each technique was applied with different scenarios and parameters.

The results of this study showed that applying ramp metering at the entrance of loops of cloverleaf interchanges could reduce the interchange average delay, increase average vehicles speeds and reduce the confliction between the vehicles of the on-ramp and the vehicles of the main stream. It is worth mentions that application of ALINEA "Ramp Metering" shows more efficient performance measures than that for Fixed Rate.

Chapter 1 : Introduction

1.1. Background

In the recent decades, demand for travel is continuously increasing worldwide with different growth rates based on several factors as economy growth, car ownership etc. Also, the demand growth rate is higher within metropolitan areas, particularly urban areas, where most of the economic activities are located. The growth rate of the demand result in a significant effect on the road networks which their capacities growth cannot meet the increasing demand. Consequently, motorways, which are usually expected to provide a level of service and a mobility higher than those of other road types in urban streets, are experiencing extensive daily traffic congestion and often reaches stop-and-go state during peak periods. In addition, adding capacity of road infrastructure is not always an available option due to various social, spatial, financial and environmental constraints.

For this respect, alternative techniques are used to mitigate the effect of the growing demand on the performance of the road networks (i.e. Intelligent Transportation Systems (ITS)). ITS technologies aim at optimal utilization of available infrastructure by incorporating distributed control and coordination system to provide a safer, efficient and reliable transportation system. In Cairo, many corridors with high speed limit and capacity carry large traffic volumes such as Ring Road, Autostrad, Regional Ring Road, 26th corridor, etc. The Ring Road is the most important corridor in Cairo because of it has a total length of 110 km, carries around 140,000 vehicles per day and has a higher rate of accidents compared to similar size roads. This research aims to investigate the effect of operating ITS for improving the motorways LOS by regulating the traffic at the interchange.

Intelligent transport systems vary in technologies applied from basic management systems such as car navigation, traffic signal control systems, container management systems, variable message signs, automatic number plate recognition or speed cameras to monitor applications such as security CCTV systems and to more advanced applications that integrate live data and feedback from a number of other sources such as parking guidance and information systems.

Ramp metering (RM) is an important Intelligent Transportation System tool which aims at improving performance of motorway systems. RM is widely used all around the world to regulate on-ramp traffic and is commonly regarded as one of the most direct and efficient countermeasures to mitigate traffic congestion on motorways (Papageorgiou, 2003). RM improves performance of motorways by regulating on-ramp flow to keep mainline flow under its capacity.

1.2. Problem Statement

A major congestion problem could be identified from the above context where high interflow between the intersecting highways at the cloverleaf interchange. Thus, the weaving segment at the interchange LOS reduces resulting in high traffic density, lower speed and increasing travel time. This research aims at mitigating the congestion effects on weaving sections at cloverleaf interchanges in Cairo region using the ramp metering