ARC '16

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http://dx.doi.org/10.5339/qfarc.2016.ICTSP2224

Mitigation of Traffic Congestion Using Ramp Metering on Doha Expressway

Muhammad Asif Khan[1], Ridha Hamila[1], Khaled Salah Shaaban[2]

[1]Qatar University, Department of Electrical Engineering, QA
[2]Qatar University, Department of Civil Engineering, QA

Email: mkhan@qu.edu.qa

Ramp metering is the most effective and widely implemented strategy for improving traffic flow on freeways by restricting the number of vehicles entering a freeway using ramp meters. A ramp meter is a traffic signal programmed with a much shorter cycle time in order to allow a single vehicle or a very small platoon of vehicles (usually two or three) per green phase. Ramp metering algorithms defines the underlying logic that calculate the metering rate. Ramp meters are usually employed to control vehicles at the on-ramp to enter freeway (mainline) to mitigate the impact of the ramp traffic on the mainline flow. However ramp meters can also be used to control traffic flow from freeway to freeway. The selection of appropriate ramp metering strategy is based on the needs and goals of the regional transportation agency. Ramp meters can be controlled either locally (isolated) or system-wide (coordinated). Locally controlled or isolated ramp meters control vehicles access based on the local traffic conditions on single ramp or freeway segment to reduce congestion locally near the local ramp. System-wide or coordinated controlled ramp meters are used to improve traffic conditions on a freeway segment or the entire freeway corridor. Ramp Meters can be programmed either fixed time or traffic responsive. Fixed metering uses pre-set metering rates with a defined schedule based on some historical traffic data. Fixed or pre-time metering addresses the recurring congestion problem, but fails in case of non-recurring congestion. Traffic responsive metering uses present traffic conditions to adjust its metering rate. Traffic data is collected using loop detectors or any other surveillance system on real time. Traffic responsive control can be implemented in both isolated and coordinated ramp meters. Some known traffic responsive algorithms include Asservissement Linéaire d'Entrée Auotroutière (ALINEA), Heuristic Ramp Metering Coordination (HERO), System Wide Adaptive Ramp Metering (SWARM), fuzzy logic, Stratified zone algorithm, Bottleneck algorithm, Zone algorithm, HELPER algorithm and Advanced Real Time Metering (ARM algorithm). These various algorithms are developed in various regions of the world and some of them are evaluated for quite a long period of time. However the difference in traffic parameters, driver's behaviors, road geometries and other parameters can affect the performance of the algorithm when implemented in a new location. Hence it is necessary

Cite this article as: Khan MA, Hamila R, Shaaban KS. (2016). Mitigation of Traffic Congestion Using Ramp Metering on Doha Expressway. Qatar Foundation Annual Research Conference Proceedings 2016: ICTSP2224 http://dx.doi.org/10.5339/qfarc.2016.ICTSP2224.

to investigate the performance of the ramp metering strategy prior to physical deployment. In this work, we chose Doha Expressway to deploy ramp metering for improvement in traffic conditions. Doha Expressway is a six-lane highway in Qatar that link the North of Doha to the South. The highway can be accessed through several on-ramps at different locations. The merging of ramp traffic to the freeway often causes congestion on the highway in several ways. It increases traffic density on the highway, reduce vehicles speed and causes vehicles to change lanes in the merging area. Hence in this research we first investigated the impact of ramp traffic on the mainline flow and identified the potential bottlenecks. Then ramp meters were installed at some of the on-ramps to evaluate the performance of each to improve the traffic flow on the mainline. The outcome of this study is to select the optimum metering strategy for each on-ramp with proposed modifications if required. Extensive simulations are carried out in PTV VISSIM traffic micro simulation software. The simulator is calibrated using real time traffic data and geometrical information.