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Congestion- Responsive On-Ramp
Metering: Recommendation toward a
Statewide Policy

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Congestion- Responsive On-Ramp Metering: Recommendation toward a Statewide Policy

Develop recommendations for updating the statewide Ramp Metering (RM) policy to help Caltrans implement traffic responsive RM operations on a statewide basis.

WHAT IS THE NEED?

Freeway Ramp Metering (RM) is widely used on California freeways. RM operation is typically activated regularly on a time-of-day basis (e.g., AM peak and PM peak) regardless of traffic conditions.

Some California Department of Transportation (Caltrans) Districts operate RM for extended hours beyond the peak periods, but there is no guideline for RM activation based on freeway operating conditions. It is necessary to systematically evaluate the need and potential benefits of extending the current peak period RM operating policy to congestion-responsive RM operation.

WHAT WAS OUR GOAL?

The goal of this project was to develop recommendations toward a statewide policy of congestion- responsive freeway ramp metering (CRRM) operation. The research has been performed in the following approaches:

First an empirical "before" and "after" freeway corridor performance evaluation was performed on a selected set of California's freeway corridors, that had implemented congestion responsive ramp metering.

Next, other important policy and operational factors that impact the effectiveness of extended hours RM were evaluated:

- Traffic detector health
- Data quality and their potential impact on CRRM operation
- Immediate operation hours



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- RM light setting to “Green-Ball” or “Black”
- On-ramp storage capacity effects
- Alternative solutions to reduce/avoid queue-override
- Proper handling of institutional relevant issues to gain support from local jurisdictions

WHAT DID WE DO?

The research team developed recommendations toward a statewide policy for Freeway CRRM operations from a technical viewpoint instead of the policy itself.

The project team first investigated several freeway corridors in Caltrans Districts 6, 7, and 8 which operate RM in extended hours, then collected traffic data for those corridors to evaluate the benefit of the operation in extended hours. Table 1 below shows the final corridors that we selected for quantitative analysis.

Besides the quantitative analysis of the benefit for the operation of CRRM in extended hours, the researchers analyzed several other relevant factors including:

- The requirement for traffic detector and data for the operation of CRRM for 24/7
- The traffic light for RM to rest on green or black for operating off metering
- Immediate operation hours for the extension of RM operation
- The Ramp Storage Capacity for some specific locations
- Institutional issues related to the CRRM operation for 24/7, based on the need of traffic congestion instead of only for AM and PM peak hours

Caltrans District	County	Freeway Corridor	Corridor Length (miles)	Number of Metered On-Ramps	Extended Hours of Operation
6	Fresno	SR-41 Northbound	3.2	6	7:00 AM – 6:00 PM
8	Riverside	I-15 Northbound	9.5	7	5:00 AM – 8:00 PM
8	Riverside	SR-91 Eastbound	20.2	19	5:00 AM – 8:00 PM
8	Riverside	SR-91 Westbound	20.5	19	5:00 AM – 8:00 PM
8	San Bernardino	I-10 Eastbound	10.2	11	5:00 AM – 8:00 PM
8	San Bernardino	I-10 Westbound	10.3	13	5:00 AM – 8:00 PM
8	San Bernardino	I-210 Eastbound	17.6	14	5:00 AM – 8:00 PM
8	San Bernardino	US-60 Eastbound	7.6	8	5:00 AM – 8:00 PM
8	San Bernardino	US-60 Westbound	8.6	9	5:00 AM – 8:00 PM

Table 1: Corridors Selected to Serve the Study

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WHAT WAS THE OUTCOME?

The research outcome was meaningful recommendations to help Caltrans' Division of Traffic Operations develop consistent and implementable CRRM policies. This could overcome several of the known hardware, software, and freeway infrastructure and institutional constraints.

Most RM operations in California highways are currently for peak hours only. It would be beneficial to fully use the current infrastructure for RM to address non-recurrent congestions in off-peak hours and on the weekends. This research effort successfully showed that potential gains could be realized through the thoughtful implementation of CRRM strategy.

Before the extension of RM operation hours beyond the PEAK hours, it is recommended to update the traffic detector system to deliver good quality traffic data for RM operation. This is very critical since the "ON" and "OFF" time will completely depend on the traffic data input to the RM algorithm, particularly the occupancy of the immediate upstream detector of the on-ramp.

The operating hours could be extended progressively depending on the criticality of the location and data quality. It is very important to have supporting staff to regularly maintain the traffic detector stations and to keep them in good health condition and to produce high quality traffic data.

Field experiments indicated that RM queue-override function would deteriorate its performance. Therefore, larger on-ramp storage capacity would definitely improve RM performance if the demand is high. However, the extension of the onramp for freeway RM is cost prohibitive. A more economical way to conduct the proper coordination of RM with the corresponding arterial traffic signals control, which can improve overall system performance by fully and properly using the storage to reduce

or to completely avoid the use of "queue override". Practical implementation of a feasible coordination strategy at an onramp or along a freeway corridor will depend on road geometries and traffic situation of both freeway and arterial corridor.

To successfully implement CRRM, it is also important to implement public outreach and work closely with local jurisdictions such as government associations and their committees to gain their support. Different strategies would be necessary for different committees.

WHAT IS THE BENEFIT?

Implementation of CRRM is expected to improve the freeway performance along the freeway corridors. It will increase the vehicle throughput and decrease the delay or time spent.

The benefit of this research is to help Caltrans' Division of Traffic Operations develop new statewide ramp metering policies that are well suited across a wide range of freeway corridors, result in statewide safe, efficient and effective ramp metering operations, and yet maintain consistency across all Caltrans Districts.