Ramp Metering in Work Zones

Description

Ramp meters are traffic signals installed on on-ramps to control the frequency with which vehicles enter the flow of traffic on the mainline. Ramp metering has traditionally been viewed as a permanent active freeway management technique to mitigate and reduce the effect of recurring congestion. Recently, however, departments of transportation (DOTs) have begun using it on a temporary basis to mitigate the effects of nonrecurring congestion resulting from highway construction activities.

How This Will Help

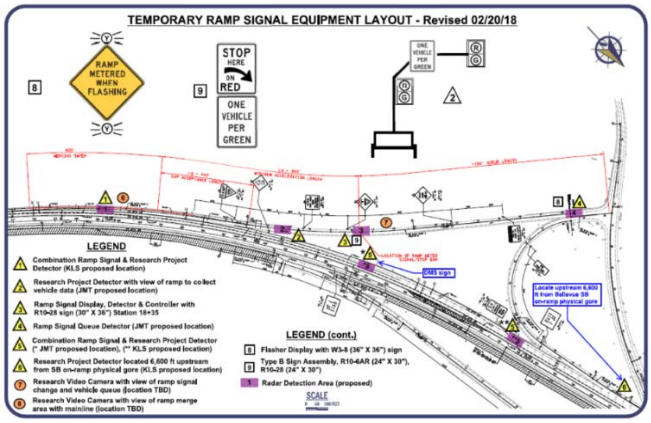
- Reduces mainline congestion and overall delay, while increasing mobility through the network and traffic throughput.
- Generally reduces travel times, even when considering time in queue on the ramp.
- Improves safety by allowing vehicles to merge smoothly onto the mainline and reduces the need for vehicles on the mainline to reduce speed.

Application Techniques

The overall functionality of the temporary ramp metering system remains unchanged from that of a permanent deployment. The system uses a set of essential components and equipment to maintain functionality:

- Temporary signal heads, either green/red signal heads or green/yellow/red signal heads to control the flow of traffic from the ramp to the mainline.
- Detectors to measure traffic conditions (speed and occupancy) on the mainline and occupancy and queue length (queue detector upstream) on the ramp.
- Signing at the start of the ramp to warn vehicles of upcoming conditions and near the signal head to instruct vehicles to exit the ramp one at a time on a green signal.

Ramp-metering systems operate under static, fixed timing, or variable timing to dynamically respond to mainline traffic conditions. When operating under fixed timing, the system is activated during a predetermined period of time (peak hours, special events, etc.) and meters traffic onto the mainline at a predetermined rate. When operating on variable timing, the system uses mainline traffic data to activate only when warranted by mainline occupancy and speed, and meters traffic at a rate that is also adjusted based on mainline traffic conditions. When and if the ramp becomes congested, the ramp signal can discharge vehicles at a faster rate to alleviate ramp congestion and prevent vehicles from queuing on the adjacent roadway.



Implementation Considerations

When deciding whether to implement a temporary ramp-metering system during highway construction, agencies should consider:

- Mainline congestion resulting from highway construction activities (i.e., temporary reduction in capacity of mainline by either lane/shoulder closures, or reduced lane width that causes traffic backups during peak periods).
- Safety issues at merge points and on the mainline (i.e., increase in crash risk within the construction zone because of merging volume conflicts).

For the work zone ramp meter to be effective, DOTs are advised that the combined vehicular volume on the right lane (or receiving lane) and the ramp should not exceed 1,600 vehicles per hour per lane (ramp volumes not to exceed 400–600 vehicles per hour).

Key geometric issues to consider when investigating ramp metering include inadequate acceleration length, mainline weaving problems caused by closely spaced ramps, and limited sight distances on a horizontal or crest vertical curve.

Ramp geometry is often a barrier to implementing a ramp meter once it is determined that a ramp meter system is warranted at a particular location. An acceleration lane and adequate storage to accommodate queues resulting from metered traffic are needed to accommodate the ramp-metering setup.

DOTs should conduct a public-outreach campaign that proactively disseminates information, clearly communicates the benefits, and familiarizes the public with ramp metering to encourage support.

Implementation Examples

Deploying ramp meters under work zone conditions is limited and there are only three known instances, two during the peak period and one off peak:

- MN Route 52 Bridge Deck Replacement Project, Rochester, Minnesota, (April 18 to July 1, 2016) during AM/PM peak periods (**NCHRP 03-111**).
- I-279 Parkway North Improvement Project, Ohio Township, Allegheny County, Pennsylvania (April 23 to August 26, 2018, during AM/PM peak periods) (**NCHRP 03-111**).
- Deployed at seven different work zones in urban Columbia, Missouri, during off-peak conditions. These two-to-one lane closures were located near five different ramps on either I-70 or US-63 (Edara et al. 2012).

Highlights

1. **Speeds increased on the mainline during both ramp-meter configurations:**
   - **Variable meter operation observed an 11–14 mph (right/left lane) increase.**
   - **Fixed meter operation observed a 5–8 mph (right/left lane) increase.**
2. **Traffic volumes on the mainline increased between 10 and 20 percent.**
3. **Travel times improved (on average greater than 20 percent).**
4. **Ramp-meter implementation cost ranged from $50,000 to $75,000 (single unit) with a payback period of 5 months.**
5. **Ideal traffic volume (ramp plus right lane) should be approximately 1600 vph, although higher volumes can be considered.**
6. **Ramp-meter compliance ranged between 60 and 90 percent (no enforcement).**

Ramp metering controls the platooning effect, allowing mainline traffic to travel with less disturbance (L/lane increase ~ 250 vph, R/Lane increase ~ 400 vph).