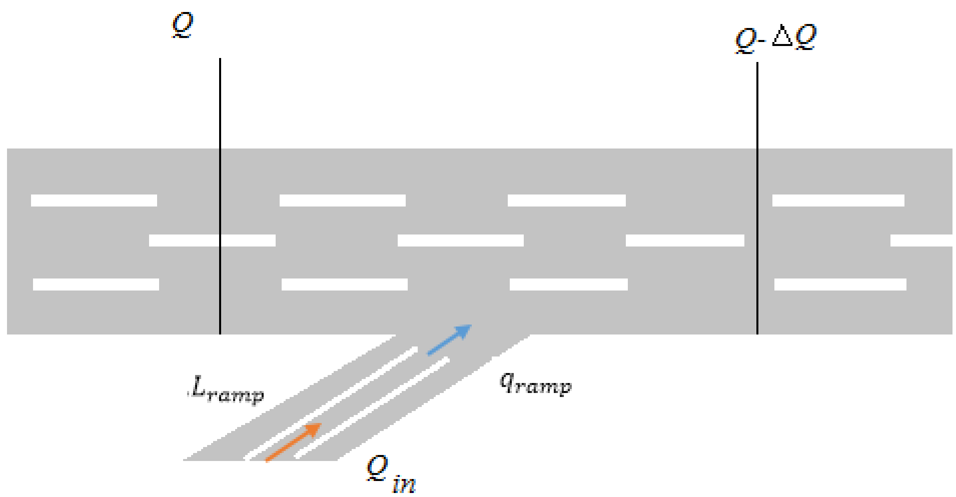
RAMP FLOW CONTROL



The queue on the on-ramp has to be controlled for efficient operation of the corridor and to minimize the impact of the ramp backup on the local streets. This is achieved by modulating the queue build-up rate in response to the rate of arrival Q_{in}.

$$dq = q_{ramp} - Q_{in}$$

The number of vehicles on the ramp at any time t

$$dqt = (q_{ramp} - Q_{in})t + \delta_x$$

Where δ_x is the number of vehicles on the ramp before the start of measurement

Total vehicle length on the ramp

$$L_{veh}(q_{ramp} - Q_{in})t + \delta_x L_{veh}$$

Percentage R_{occ} of ramp capacity occupied

$$\frac{L_{veh}(q_{ramp} - Q_{in})t + \delta_x L_{veh}}{L_{ramp}} = R_{occ}$$

where L_{ramp} is the total length of all lanes on the ramp.

Equating $\delta_x = 0$ and solving for q_{ramp} provides the prescription for controlling the percentage of the ramp capacity occupied

$$Q_{in} - \frac{R_{occ} L_{ramp}}{L_{veh} t} = q_{ramp}$$

And for differential main lane flow ΔQ for an N lane facility

$$q_{ramp} = N\frac{\left(5280 - n_{upstream}L_{veh}\right)}{n_{upstream}L_{veh}}(\Delta Q)$$

Or for a desired density control

$$q_{ramp} = N\left(n_{goal}v_{upstream} - Q_{upstream}\right)$$

Equating the two together we may write

$$Q_{in} - \frac{R_{occ}L_{ramp}}{L_{veh}t} - N\frac{\left(5280 - n_{upstream}L_{veh}\right)}{n_{upstream}L_{veh}}(\Delta Q) = 0$$

Or

$$Q_{in} - \frac{R_{occ}L_{ramp}}{L_{veh}t} - N\left(n_{goal}v_{upstream} - Q_{upstream}\right) = 0$$

Depending on the quantity you are trying to control (either a desired density or a desired flow rate)

We may solve for ΔQ or n_{goal} in accommodation to the ramp capacity and demand.

$$\Delta Q = \frac{Q_{in} - \frac{R_{occ}L_{ramp}}{L_{veh}t}}{N\frac{\left(5280 - n_{upstream}L_{veh}\right)}{n_{upstream}L_{veh}}}$$

Or

$$n_{goal} = \frac{Q_{in} - \frac{R_{occ}L_{ramp}}{L_{veh}t} + NQ_{upstream}}{Nv_{upstream}}$$