Interchange Design to Accommodate Ramp Metering System

Current Situation
Ramp metering is one of many tools that engineers use to improve the flow on highways. When traffic volumes are high, ramp metering allows additional vehicles to enter the highway at regular intervals. Significant research has gone into how to time the ramp signals to optimize highway traffic flows and how to design the ramps. While ramp metering promotes the efficiency of the main highway, it also has implications for the adjoining arterials. Appropriate interchange design could balance the efficiency gains on the highway and the impact on the arterials. However, relatively little research has been conducted on the overall design of interchanges to accommodate ramp metering.

Research Objectives
University of Florida researchers developed guidance on interchange design, with consideration of ramp metering, that is appropriate for planning and preliminary engineering.

Project Activities
Because there is little literature that treats the interaction of overall interchange design and ramp metering, the researchers reviewed ramp metering operational issues and on-ramp geometry design issues to determine relevant performance measures of ramp metering function. The researchers also determined that measures derived using TruckSim, a widely used truck traffic simulations tool, represented the most realistic truck and roadway characteristics.

The researchers simulated traffic flows on six interchange designs with and without ramp metering. The interchange design were (1) diamond, (2) diverging diamond interchange, (3) single-point urban interchange, (4) partial cloverleaf, (5) full cloverleaf with a collector-distributor, and (6) full cloverleaf without a collector-distributor. For each interchange design the following performance measures were used to assess the overall efficiency: percent time in queue override mode; ramp meter throughput; ramp meter delay; interchange volume throughput; and average travel speed.

The simulations showed that the diverging diamond interchange provided the most flexibility in achieving performance goals, but the simulations also provided detailed guidance about the location of control features, such as stop bars, and other design elements to help optimize ramp metering for various interchange configurations. Specific topics considered included ramp meter to freeway merge acceleration distance, multilane metering, performance measures, interchange configuration factors, and queue storage assessment.

This guidance is intended for incorporation into the Florida Department of Transportation’s Interchange Access Request User’s Guide. The guide provides engineers with information about how to prepare documents that support requests for new or modified access to limited access highways on the Florida State Highway System.

Project Benefits
The guidance developed in this project will lead to interchange designs with ramp metering that improve safety and efficiency.

For more information, please see www.fdot.gov/research/.