LTRC Technical Summary Report 400

LTRC Proj. No. 03-1SS ~ FHWA/LA. 06/400 ~ State Proj. No. 736-99-1116

March 2008

Louisiana Transportation Research Center

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Evaluation of Freeway Contraflow Evacuation Initiation and Termination Point Configurations

Introduction

Over the last five years, the departments of transportation (DOTs) in the 12 coastal states that were threatened by hurricanes have developed plans to implement contraflow traffic operations on freeways during evacuations. Although contraflow is widely viewed as a major advancement that allows highway agencies to increase evacuation effectiveness, it is not without drawbacks. Among the recognized shortcomings of contraflow evacuations are that they:

- eliminate inbound movement of traffic into the evacuation zone;
- present potential confusion for drivers, thereby increasing the likelihood of dangerous traffic conflicts;
- often restricts the ability of evacuees to make routing choices to reach their destinations, based on closures of exit and entry points along the intermediate contra-flow segment; and
- require increased levels of manpower and material/equipment for both the implementation and operation of the evacuation, as well as the need for longer lead times to configure roadways for this use.

Because of another limitation of contraflow, the lack of actual evacuation experience, this research was undertaken to help DOTs and emergency management agencies better prepare for the use of contra-flow in the future.

Objective

The specific research objectives developed to address issues of importance to emergency preparedness officials included:

- the temporal and spatial patterns by which traffic congestion develops and abates along the segments and
- the way in which varying levels of traffic demand impact the operational characteristics of contraflow segments.

The research was divided into two separate but overlapping projects. The first focused on issues associated with the contraflow entry area. The second focused on the vicinity of the termination where vehicles exited the segment.

Scope

The scope of this study was restricted by the amount of information currently available. Few studies have collected traffic flow parameters in detail during an evacuation. Among these were efforts to evaluate the characteristics of traffic operation within and near contraflow evacuation segments.

This report summarizes the results of two of these projects, focusing on the operational effects of the initiation point design of the New Orleans, Louisiana, Interstate 10 segment and the termination designs planned for several Atlantic and Gulf Coast states.

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Research Approach

The basic methodology used in this research involved the development of contraflow evacuation simulation models to estimate traffic flow, average speed, density, delay time, and amount of time required to discharge the contraflow during an evacuation. Since the contraflow operation in Louisiana encompasses a relatively small area, the CORSIM 5.0 microscopic simulation model was used to achieve the research objectives. Although the results gained here are based on simulation testing that could not be quantitatively validated against field data, there is strong reason to believe that results are valid, particularly in light of the qualitative data that were collected during the evacuation for Hurricane Ivan in the fall of 2004.

The terminal design assessment used models to evaluate termination points and involved a multi-design study in which simulation models for six different types of design categories were developed. The six "families" were created to represent the key characteristics of 13 terminations planned in seven hurricane-threatened states. The output data from all of these various models were used to quantify the traffic conditions (i.e., queuing, delay, travel speed, travel time, and total number of vehicles exiting the segments) in the vicinity of the termini and to compare the relative performance and benefits of the various designs under different traffic demand scenarios.

Conclusions

The results of these studies revealed several interesting findings about the contraflow evacuation plans. The most significant conclusion was that many of the current plans for evacuation initiation and termination points may likely restrict the ability of these segments to be used to their maximum effectiveness.

The evaluation of the proposed termination configurations provides strong evidence for two concepts. The first is that to work effectively, contraflow termination designs should incorporate split, rather than merge, designs. The second was the advantage that can be gained by systematically decreasing volume on contraflow evacuation routes. The research showed that volume decreases of 25 percent prior to the termination reduced the delay associated with the merge lane-drop by between 20 and 60 percent, depending on the configuration type. (This remains, however, a four-fold to eight-fold increase over the split configuration delays.) A 50 percent decrease in traffic volume reduced merge-associated delays by 80 percent (again, however, a two-fold increase over the delay versus the split design exists).

The evaluation of the New Orleans contraflow initiation point demonstrated several concepts relative to loading on contraflow segments. The most important is the critical role played by the entry point in effectively utilizing the segment and reducing the duration of congestion prior to the contraflow lanes. Since the inception of contraflow evacuation, emphasis has been placed on the termination designs because it has been assumed that they would dictate the effectiveness of the segment.

However, the research clearly demonstrates that the capacity of the segment can also be controlled to a great degree by the capacity of the entry point. In fact, the research suggests that the design in New Orleans, which is similar to the designs of many other states, will actually create a bottleneck that should lead to congested traffic conditions upstream of the cross-over.

Recommendations

Two main recommendations come from this study.

1. Better load traffic into the contraflow lanes in New Orleans in order to maximize the utilization of the segment. Traffic could be added at points after the cross-over, or, more desirably, loading schemes should be reconfigured to spatially spread the loading of the segment over several ramps prior to a cross-over.

2. Spread out evacuation traffic on contraflow segments as much as possible. This can be done most easily by routing traffic into all available directions, rather than just onto a few primary routes.

3. Designs of contraflow terminations should split rather than merge traffic whenever possible. The research showed that congestion and delays are increased as much as tenfold when four freeway lanes are merged into two. While merges are possible under lower volume conditions, plans that spread traffic volume spatially throughout the available road infrastructure will likely be more successful.