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RESEARCH PAPER

Evaluation of Route Diversion Strategies Using Computer Simulation

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Abstract: This paper presents a CORSIM-based simulation approach to evaluate the effects of incident management and signal timing modifications on traffic operations along I-75 and alternative routes in Sarasota County, Florida, U.S.A. The County has developed special countywide signal timing plans on alternative routes to guide and direct motorists coming off the interstate (I-75) back onto the interstate at an appropriate location when a traffic incident happens on I-75. These special signal timing plans were developed for six incident conditions using the SYNCHRO signal timing software. Based on the SYNCRHO data provided by Sarasota County, a CORSIM data set is developed for the evaluation of the effectiveness of the route diversion plan. The findings from the CORSIM analysis indicate that the route diversion plans developed by the County are very effective in terms of traffic operations, reducing overall network delay by an average 21%. An additional sensitivity analysis was conducted for one of six incident conditions to examine the impact of diverted traffic volume on traffic operations. The results imply that the percentage of diverted traffic volume has a great impact on the total delay of the entire network. A 10% diverted traffic volume is found to give minimal total network delay based on the case study.

Key Words: freeway incident management; simulation; delay; diversion routes; signal timing

1 Introduction

Freeway incident management and traffic signal coordination programs are two of the three operational treatments for traffic delay reduction identified in the 2003 Annual Urban Mobility Report by the Texas Transportation Institute (TTI)[1]. The report indicates that several state and local transportation agencies, as well as the federal transportation program, have invested substantial funding in these two operational treatments and the future will include more of these programs in more cities. However, there is relatively little information to estimate the effect of these two operational treatments, especially the combined effects of incident management and traffic signal coordination programs, and the data collection and analysis procedures are not standardized.

The major incidents involving closure of I-75 in Sarasota County create havoc on the local roadway system, as non-local motorists who are directed onto the local roadway network scramble to find their way around. Sarasota County has developed special countywide signal timing and guide sign plans on alternative routes to direct motorists coming off the interstate back onto the interstate at an appropriate location. These special signal timing plans were developed using the SYNCHRO signal timing software and verified by the SIMTRAFFIC microscopic traffic simulation. SYNCHRO is a complete software package for modeling and optimizing traffic signal timings, but it lacks the ability to simulate a freeway and to consider the interactions between the freeway and the surface street. In this study, SYCHRO was used to develop the special timing data, and CORSIM was used to measure the system performance of the entire network.

This paper presents a methodology to estimate the effects of incident management and signal-timing modification using two computer simulation packages, SYNCHRO and CORSIM, and data transferring between these two programs. This paper also documents the application of the results of the CORSIM-based simulation method to evaluate and assist in the implementation of a demonstration route diversion plan for the I-75 corridor in Sarasota County. Assistance in creating

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a demonstration route diversion plan is a major objective of the project, “Traffic Incident Management in Sarasota County”, funded by the Federal Highway Administration (FHWA).

2 Literature review

There have been quite a few case studies for the evaluation of route diversion strategies using computer simulation. The literature offers some information and guides for using computer simulation to evaluate the route diversion strategies for traffic incident management.

Cragg and Demetsky[2] established a methodology for analyzing diversion strategies using the CORSIM simulation model to determine the effects of various incident types, duration of incidents, and volume levels on freeway traffic flow, and of diversion of freeway traffic onto the arterial network. They concluded that CORSIM is a valuable tool in evaluating the effects of incidents on system-wide traffic flows as well as on the physical capacity of ramp junctions and weaving sections for accommodating the diverted traffic.

Taylor and Narupiti[3] used the NETSIM simulation program to examine the effectiveness of traffic diversion and signal timing modification for various incident conditions on a hypothetical surface street network. The results of the study indicate that the strategy of traffic diversion combined with signal timing modification will become more effective in reducing the congestion on the affected traffic and overall network when the severity of the incident increases.

Lin and Kou[4] used SYNCHRO software and the SIMTRAFFIC microscopic traffic simulation program to conduct actual traffic simulations to compare travel times between an established alternative route and freeway with a major incident through a case study in Sarasota, Florida. This study examined the impacts of traffic conditions, signal timing strategies, incident duration, and the timing regard for the implementation of informed traffic diversion on average network delay and individual travel time. The simulation results not only verify the value of alternative route operations in response to a major freeway incident, but also provide magnitude of motorists’ benefits on travel time using an alternative route.

Birst and Smadi[5] conducted a case study on the I-29 corridor in Fargo, North Dakota using the INTEGRATION simulation program. The results of their study revealed that for a 20-minute freeway incident, the combination of Advance Traveler Information System (ATIS) and Advance Traffic Management Systems (ATMS) will provide the best performance in reducing travel time by 13% on city arterial streets, 28% on freeway mainline lanes, and 18% on the overall studied network. The study concluded that for the case study corridor, diversion of 8% of the traffic that will use the incident location on the freeway to arterials will achieve the best network performance.

Tarko and Tian[6] conducted an example analysis and handling of uncertainty with consideration of traffic diversion using the highway capacity manual method. This study defined the diversion behavior of drivers as volume elasticity. The delay function was developed to take into account the diversion behavior of drivers.

3 Existing conditions

Sarasota County has identified route diversion plans that are the best available to safely and efficiently move traffic off the interstate and back onto the interstate at a suitable location. The plans are designed to accommodate traffic diverted from I-75 in the event of a major incident that closes all or a portion of the interstate within the vicinity of Sarasota County. The studied I-75 segment is a six-lane north-south interstate freeway in the Sarasota urban area with four interchanges. The four interchanges in the area that will be a part of the study plan are as follows:

(1) State Road 72 (Clark Road)—Exit 205;

(2) State Road 758 (Bee Ridge Road)—Exit 207;

(3) State Road 780 (Fruitville Road)—Exit 210;

(4) University Parkway—Exit 213.

The two arterials at the west side of I-75, Cattlemen Road and Honore Avenue, are used as alternative routes. Both were analyzed as two-lane north-south minor arterials. Clark Road, Bee Ridge Road, Fruitville Road, and University Parkway are major east-west arterials with six lanes west of I-75; the posted speed limits range from 45 to 50 mph. Based on the initial results of SYNCHRO, the alternative route segments and signalized intersections operate at a service level of D or better during the peak afternoon hours under normal traffic conditions. Fig. 1 illustrates the CORSIM Simulation Network of I-75 and Diversion Routes.

4 Methodology

4.1 Selection of simulation models

Several simulation models are currently available to evaluate the route diversion plans for freeway incident management programs, but few have the ability to model both the freeway and arterials simultaneously, considering the effects of one on the other. CORSIM, a combination of NETSIM and FRESIM, allows for a system-wide analysis of the freeway and surrounding arterial network. In addition, CORSIM has the capability to model incidents on the freeway in the coded network. Traffic incidents may take the form of complete lane blockages or merely slowdowns resulting from incidents or other activities taking place on the shoulders. CORSIM can model both lane blockages and the rubbernecking phenomenon.