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Project Summary Report 0-4073-S
Project 0-4073: Probability Generation of Frequency and Severity of Nonrecurring Congestion Due to Accidents to Improve Emissions Analysis

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PROJECT SUMMARY REPORT

Summary Report on Probability Generation of Frequency and Severity of Nonrecurring Congestion Due to Accidents to Improve Emissions Analysis

Studies focusing on a comprehensive quantification of the traffic delay and mobile emissions impacts of non-recurring congestion are rare in the U.S., and there is currently no methodology that can be readily used to measure non-recurring traffic delay and mobile emissions. Even though incident data sets have been analyzed, it is difficult to generalize the results from one city to another because factors influencing the occurrence of incidents vary across cities.

What We Did…

In this project, we examined and identified the data, methods, and tools necessary to integrate nonrecurring congestion from accidents into transportation and air quality modeling. Figure 1 illustrates three important aspects of the research. These include analyzing Texas accident data, probability generation of frequency and severity of accidents, and emission estimation of nonrecurring congestion due to accidents.

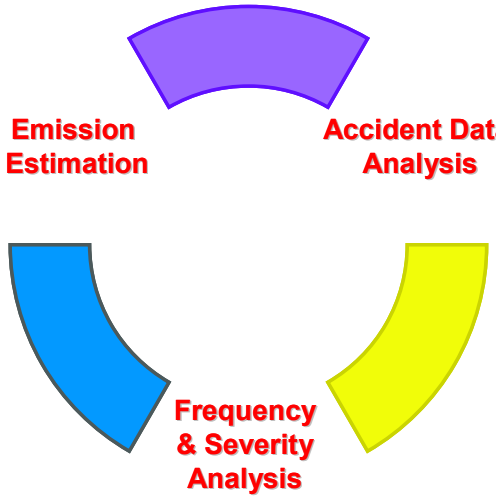

FIGURE 1 Three aspects of the research.

Analyzed Texas Accident Data

Texas accident data from the TxDOT System Accident Data File (or TRF accident file) and TranStar were analyzed.

TRF data for the analysis covered 9 years, from 1992 through 2000. Information was collected from Houston TranStar from January 2000 to early January 2003 concerning accident duration and lanes affected.

Accident data analyses were conducted by using the software @Risk, which is embedded in Microsoft Excel. Probability properties of accident frequency, duration, and lanes affected were identified.

Developed Approaches Updating Accident Probability Parameters

In this research, a Bayesian approach was introduced into the updating of probability parameters of accident frequency and severity based on the new accident information. This approach is able to tell whether accident information from, say, last month is more valuable than the accident data for previous years. The whole process was implemented in Microsoft Excel Spreadsheet and tests in Harris County were conducted.

The updating practice consisted of two scenarios. The first scenario used new information from the most recent data from the Houston TranStar on-line website to update the historical parameter distribution. New accident information captured from the Houston TranStar website was recorded for 5 weeks (April 11 - May 2, 2003, and June 2-16, 2003.)

The second scenario used the "pseudo new information" for multiple months to continuously update the historical parameter distributions. Accident frequency for 6 months (from July 2000 to December 2000), and duration and lane blockage for 7 months (from July 2002 to January 2003), were used to update the prior distribution of historical parameter 6 and 7 times (i.e., month by month), respectively.

Estimated Emissions of Nonrecurring Congestion Due to Accidents

Emissions from nonrecurring congestion due to accidents were estimated using microscopic calculation and macroscopic evaluation. Microscopic calculation estimates the emissions caused by each individual accident. Macroscopic evaluation evaluates the impacts of emissions caused by nonrecurring congestion due to accidents in the whole area.

In the microscopic evaluation of emission, a Microsoft Excel worksheet was designed to calculate the emissions caused by the individual accident. Lane affected and accident duration were two of the multiple inputs of the worksheet. Three days' real accident information, which was obtained from Houston TranStar, was used to test the calculation of the worksheet.

The macroscopic evaluation was based on the EPA required emission estimation model MOBILE6. Accident frequency, duration, and lane affected result in the changes to several input variables of MOBILE6. These variables are VMT by Facility, VMT by Hour, Speed VMT, and etc. All theses changes will result in a change of emission estimations by MOBILE6.

What We Found…

Texas Accident Data Follow Probability Distributions

By using the software @Risk, the distributions of accident data were identified. It was found that accident frequencies, including accident by time of day and by day of week, follow either the Negative Binominal Distribution (NBD) or the Poisson Distribution (PD).

Most of the distributions of accident duration followed the LogNormal Distribution (LD). However, the numbers of lanes affected by an accident followed the Binominal Distribution.

Based on accident information and corresponding traffic volumes, accident per million VMT by facility and county were also obtained. Figure 2 presents the accident rates per million VMT in Harris and Travis Counties. Basically, the accident per million VMT decreased in both counties recently.

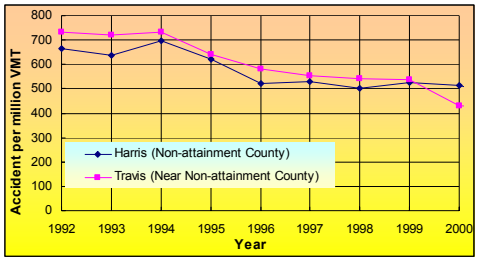

FIGURE 2 Accident Rates per Million VMT in Harris and Travis Counties.

Accident Frequency and Severity Can Be Updated

The probability parameters of accident frequency and severity can be updated in a timely manner. The practical updating results in Houston are shown in Table 1 (for scenario one) and Table 2 (for scenario two). It is shown that the prior or historical values of frequency, duration, and lane blockage were updated based on the corresponding new coming information.

Nonrecurring Congestion Due to Accidents Has Impacts on Emissions

In this research it is found that the nonrecurring congestion due to accidents has impacts on emissions. For three typical days, the extra emissions caused by accidents in Houston area varied from 143.69 lbs to 488.66 lbs for VOC, and from 53.41 lbs to

Table 1 Updating Summary of Probability Parameters for Accident Frequency, Duration, and Lane Affected (Scenario One).

	FREQUENCY	DURATION	LANES AFFECTED
Prior	73.66 (accidents/day)	36.08 (minutes/accident)	1.23 (lanes per accident)
New Data	200 accidents in 4days	36.03 (minutes/accident)	0.67 (lane per accident)
Posterior	57.43 (accidents/day)	36.079 (minutes/accident)	1.21 (lanes per accident)
Data Source	Houston TranStar	Houston TranStar	Houston TranStar
Test Bed	Houston, TX	Houston, TX	Houston, TX

Table 2 Updating Summary of Probability Parameters for Accident Frequency, Duration, and Lane Affected (Scenario Two).

	FREQUENCY (*For Friday*)	DURATION (*For Heavy Truck Minor Accidents*)	LANES AFFECTED (*For Heavy Truck Major Accidents*)
Historical Data	91.126 (accidents/day)	91.433 (minutes/accident)	2.100 (lanes/accident)
Final Updated Data	85.904 (accidents/day)	87.014 (minutes/accident)	1.925 (lanes/accident)
Data Source	TxDOT	Houston TranStar	Houston TranStar
Test Bed	Harris County, TX	Houston, TX	Houston, TX

Table 3 Extra Emissions Caused by Accidents in Houston.

DATE	EMISSION FACTOR	AMOUNT (lbs)
August 11st, 2003	VOC	488.6597
	NO_x	181.6301
August 14th, 2003	VOC	229.7247
	NO_x	154.576
August 22nd, 2003	VOC	143.6901
	NO_x	53.40822

181.66 lbs for NO_x. Table 3 lists the detailed results.

The nonrecurring accidents also have impacts on the emissions in the entire area. Table 4 lists the composite emission factors for three typical days in the whole Houston area. Since a small change in emission factors will result in a large change in total emission, the impact of nonrecurring congestion on total emission cannot be neglected.

The Researchers Recommend …

The researchers recommend further processing and testing of the accident data for other cities/counties in Texas. The Microsoft Excel worksheet developed for this project can be used in the implementation stage with necessary improvements. Knowledge of the emission impacts of nonrecurring congestion due to accidents in other areas is also necessary before additional conclusions can be drawn.

Table 4 Emission Estimation in Houston Area.

DATE	EMISSION FACTOR	COMPOSITE EMISSION FACTORS (g/mi)	
		With no Accident	With Accidents
August 11st, 2003	VOC	1.027	1.030
	CO	11.807	11.817
	NO_x	2.117	2.117
August 14th, 2003	VOC	1.027	1.028
	CO	11.807	11.810
	NO_x	2.117	2.117
August 22nd, 2003	VOC	1.027	1.027
	CO	11.807	11.809
	NO_x	2.117	2.117

For More Details . . .

This research is documented in Report 4073-1, *Research Report on Probability Generation of Frequency and Severity of Nonrecurring Congestion Due to Accidents to Improve Emissions Analysis*

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To obtain copies of a report: CTR Library, Center for Transportation Research, (512) 232-3138, email: ctrlib@uts.cc.utexas.edu

TxDOT Implementation Status
February 2004

The research investigated a method to quantify nonrecurring congestion. A method was developed that will enhance transportation efforts in meeting federal and state air quality conformity requirements. The results may be used to take credit for transportation control measures which reduce nonrecurring congestion.

For more information, contact the RMC 3 Research Engineer, Research and Technology Implementation Office, at (512) 465-7403.

Your Involvement Is Welcome!

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