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William C. Taylor Major professor

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# MODELING FREEWAY INTERCHANGE ACCIDENTS

Ву

Taegon Kim

A DISSERTATION

# Submitted to Michigan State University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Civil and Environmental Engineering

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#### ABSTRACT

### MODELING FREEWAY INTERCHANGE ACCIDENTS

Ву

Taegon Kim

The accident frequency and rate for the various components of freeway interchanges were identified and compared using accident data from the State of Michigan for the years 1982 through 1984. The accident rates at various types of interchanges were compared, and accident predictive algorithms for freeway interchange elements were developed.

A master data file which was composed of geometric, accident and traffic data was constructed by merging existing data bases. The data were then classified into 3 area types (urban, rural and fringe) and further classified into different types of interchanges based on the interchange type. The interchange types were grouped into 12 homogeneous groups based on the accident rate and variance. Accident predictive linear regression models were constructed and tested against data not used in calibrating the models. An analysis was made of those interchange groups exhibiting a value greater than 0.7 in multiple R coefficient.

Based upon the results of this study, the average accident rates on the ramp units are greater than those on the mainline and crossroad units; the interchange is a very important variable in predicting accidents; the average daily traffic (ADT) has the greatest explanatory power in predicting the accident frequency; and interchange lighting, freeway over or under the crossroad, and ramp control demonstrate the potential of being important variables if sufficient data are available to make additional stratifications. To my mother, mother-in-law, brothers

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and wife

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#### CHAPTER I

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#### INTRODUCTION

Fundamentally, an interchange simply provides an opportunity for traffic to transfer from one road to another. As used in a modern freeway system, an interchange plays a very important role in providing greater capacity, maintaining higher operating speeds, and reducing the probability of vehicular conflicts during this transfer (7).

As the Interstate Highway System was constructed, a large number of freeway interchanges were designed and constructed. The design standards for these freeway interchanges, however, were not derived from an analysis of past experience, since there was very little past experience upon which the design engineer could draw. Instead, most designs were modifications of existing freeway interchanges, since substantive knowledge for redesign of freeway interchanges was rather limited in regard to the performance expected from individual elements in terms of efficient traffic movement and adequate safety (2). With many freeway systems approaching their design life, the data are now available to evaluate the safety attributes of various freeway configurations and various freeway elements under traffic conditions.

Some evaluation of the geometric design and operational characteristics of interchanges has been done using the rate of traffic accidents as an evaluation parameter (1). However,

these safety analyses were not sufficiently detailed to allow freeway designers to select an optimal interchange design.

#### STATEMENT OF THE PROBLEM

In Michigan, freeway interchanges have been in use since the Davidson Freeway and the Ford Freeway were open to traffic in the early 1940's. There are approximately 700 interchanges in the state of Michigan. Of those interchanges, there are few, if any, exactly alike. The geometric interchange designs vary from the simple rural diamond interchange with at-grade intersections of the ramp with the crossroad to the urban multi-level directional freeway-to-freeway interchange with lane drops, multi-lane turning roadways, weaving lanes, and freeflow merges.

Research has indicated that accident rates are not uniform for the various interchange types or interchange elements. One study showed that the accident rate (346/100mvm) for a rural exit ramp is more than twice that (161/100mvm) of a rural entrance ramp (<u>1</u>). Interestingly enough, the reverse is true for urban interchanges with entrance ramps having an accident rate (718/100 mvm) that is twice that (378/100 mvm) of the exit ramp (<u>1</u>). While this study identified accident rates for various elements of a freeway interchange and compared those accident rates with each other, it did not compare the accident rate at various types of

interchanges, nor did it establish predictive algorithms based on design features of the freeway interchange elements.

The Michigan Department of Transportation recently completed a geometric inventory of its freeway interchanges, and has assigned accidents to elements. Thus, the geometric data, accident data, and traffic data (such as traffic volumes, population, no. of ramp lanes) could now be used to develop standards based upon the minimization of accidents, if models were available that expressed the relationship among these variables.

The purpose of this analysis of interchanges in Michigan is to: compare the accident rates in Michigan with those from the Interstate System Accident Research Study, Interim Report II by Cirillo, J. A.  $(\underline{1})$ ; identify accident rates as they relate to parameters of the interchange elements; and, finally, to establish interchange accident predictive models based upon accident rates on the elements which comprise the interchange.

The results of this study will provide guidance as design decisions are made during the reconstruction of the freeway system in Michigan.

#### CHAPTER II

#### LITERATURE REVIEW

In an analysis of the effect of location on accident rates on the interstate highway system, Julie A. Cirillo (<u>1</u>) used data collected by 20 State Highway Departments to compare accident rates on various roadway elements. The initial categorization was between-interchange units and atinterchange units respectively. These were then further divided into urban and rural sections. Each mainline unit was described by its proximity to an interchange. Units which were located at the same distance from two interchanges were divided equally between the two study units (<u>1</u>).

From the results of the between-interchange accident rate analysis, the results shown in Table II.1 were reported. Some of the important conclusions from this study were:

. The accident rate increased on urban sections as the study unit was positioned closer to an exit ramp with the highest rate occurring in those sections located less than 0.2 mile from the exit ramp. Also, as a study unit was stationed closer to the entrance ramp area, the accident rate increased, although not uniformly.

. On rural sections, the change in accident rates was not significantly altered as a unit was positioned closer to the interchange and in the exit direction it remained constant

(1).

The results of the at-interchange accident rates as shown in Table II.2, indicated that:

. The accident rate for urban interchanges was substantially higher than for rural interchanges, as these areas carried more traffic, making merging and diverging maneuvers more difficult.

. The exceptionally high accident rate on entrance ramps in urban areas might be caused by inadequate acceleration lanes, or lack of them, on many sections, necessitating vehicles to stop at the bottom of the ramp before moving into the traffic stream.

. The accident rate on the mainline within the interchange area decreased after the deceleration lane had been passed (1).

The general conclusions of this study were that: sections in proximity of interchanges experienced a higher accident rate than other sections; ramps have much higher accident rates than speed-change lanes; and these, in turn, have generally higher rates than the other portions of the main roadways (1).

In a study of the relationship between interchange design features and traffic safety, Joseph C. Oppenlander and Robert

F. Dawson (2) found that:

. Relatively safer designs were produced when the mainline freeway passed over the minor facility and when the ramp terminals were at least 750 ft. from the structure.

. On-ramps became high accident locations in urban areas, while in rural areas the off-ramps represented the greatest accident rate locations.

. Entrance terminals were improved with geometric designs that provided auxiliary lanes or deceleration lanes of 800 ft. or more. This eliminated traffic friction on the through lanes which resulted in reduced accident rates.

. Adequate sight distances were essential at entrance and exit terminals.

. Geometric designs for weaving maneuvers should provide weaving sections that are at least 800 ft. in length.

In another study of accidents and design features at interchanges, R. L. Fisher (3) found that:

. There were no accidents that could be ascribed to the curvature on loops which had radii of over 100 ft.

. Speed-change lanes of adequate length together with careful treatment of the terminals practically eliminated accidents at interchanges.

. All of the left-hand entrances and exits had a poor accident

record.

In a comparative freeway study concerning alignment and accidents at interchanges, John Vostrez and Richard A. Lundy (<u>4</u>) classified the ramp alignment into 6 types. These alignments, in order of low to high accident rates were straight level, straight upgrade, straight downgrade, curved level, curved upgrade, and curved downgrade respectively. They found that:

. With heavy truck traffic the straight upgrade was more detrimental than the straight downgrade while all of the curved classifications were the same.

. Fixed objects were involved in about 28 percent of all freeway interchange accidents. Piers, abutments and bridge rails were apparently the most vulnerable, with signs, guardrails, and light standards following in that order.

. Ramps associated with diamond-type interchanges were the safest type, and on-ramps generally had better accident rates than off-ramps. The downhill on-ramp was the safest type of on-ramp and the uphill off-ramp was the safest type off-ramp. Left-hand ramps (enters or leaves the freeway at high speed lane) had a higher accident rate than any other class.

In an analysis with regard to lighting of interchanges, M. S. Janoff, M. Freedman, and Decina, L. E. (<u>5</u>) reported

that:

. Complete Interchange Lighting (CIL) systems perform better than Partial Interchange Lighting (PIL) systems consisting of one, two, or four luminaries.

. Either CIL or PIL normally perform better than no lighting.

• PIL systems with fewer luminaries (one or two) frequently perform better than PIL systems with a greater number of luminaries (four).

. There is a trade-off between cost and traffic operations and safety factors in the design of freeway interchange lighting systems.

• Existing CIL systems should not be reduced to PIL systems if safety and traffic flow are important considerations.

In an investigation of factors affecting the design and location of freeway ramps from an operational viewpoint, William E. Tipton and Charles Pinnel (<u>6</u>) indicated that:

. Standard interchange designs cannot always fulfill the various desired movements at different interchanges. To obtain the most efficient operation at a specific interchange, it may be desirable to use a diamond type, an X-type, or possibly a combination of both of these. The X-type interchange includes an on-ramp upstream of the arterial street and off-ramp downstream of the arterial street for both the inbound and

outbound directions of travel.

. The configuration of an off-ramp located upstream of an onramp has considerable advantages over the reverse configuration. The studies indicated that an approximately 50 to 70 percent increase in on-ramp capacity could be obtained by removing traffic in advance of adding traffic to the freeway.

. The construction of stacked ramps rather than an off-ramp upstream of an on-ramp was not generally feasible due to the high cost, the lack of potential for stage construction and the additional right-of-way required. The stacked ramps, however, offer the advantages of elimination of weaving on the frontage road and less distance (approximately 460 ft.) required along the freeway to fit in the design.

. The type of interchange layout which has an off-ramp located upstream of an on-ramp both upstream and downstream of the arterial street is the most desirable. The exception would exist when the freeway capacity is reduced by this design as the freeway crosses the arterial street.

In a study of safety and operational requirements for interchanges  $(\underline{7})$ , it was found that:

• Simple ramps (such as the diamond ramp, the cloverleaf ramp with C-D roads, and direct connections) can reduce the accident rates as shown in Table II.3.

. Sufficient advance information on the type of interchange exit pattern ahead and path which a driver must follow to reach his desired destination should be provided.

. The relative safety of entrance terminals is enhanced with geometric designs that provide a long acceleration lane or auxiliary lanes, adequate sight distances for both freeway and ramp drivers, and freeway lanes on downgrades.

. The types of accidents that occur in the area of the exit terminal can be reduced if the design of entrance and exit terminals provides adequate speed-change lanes, control of access, and proper sight distances to encourage smooth traffic flow at proper operating speeds.

Based upon the literature review, the results are summarized as shown in Table II.4. An "X" represents that researches agree with each other on that factor. From the results in Table II.4, it might be summarized that:

. The accident rates for urban interchanges are higher than those for rural interchanges since urban areas carry more traffic, making merging and diverging maneuvers more difficult.

. While the accident rate on entrance ramps is higher than that on exit ramps in urban areas, the accident rate on exit ramps is higher than that on entrance ramps in rural areas.

. Ramps have much higher accident rates than the other

elements of the interchange.

. Ramp terminals should be positioned at least 750 ft. from the structures.

• Speed-change lanes of 800 ft. or more in length should be provided to reduce the accident rates.

. Adequate sight distances should be maintained at entrance and exit terminals.

. Left-hand exits and entrances should be avoided if possible because of poor accident rates, and adequate signs in advance should be provided if they are absolutely needed.

. On-ramps on upgrade are more hazardous than those on downgrade. Vertical alignment should be considered in the design of interchanges.

. Ramp type should be simple to reduce accidents related to confusion with complex ramp types.

. Interchange lighting systems reduce the accident rates on freeway interchanges.

While these research studies provide some useful information for the freeway designer, they do not provide a sufficient basis for detailed design purposes. For instance, they have not developed analytical tools to assist the designer in making trade offs between the cost of various freeway elements and the difference in the number of accidents that could be expected with each choice. The studies were often based upon dichotomous data (i.e., speed-change lanes

< 800 ft. versus those > 800 ft.), and thus do not provide data on accidents related to continuous variables which would allow an analyst to develop predictive algorithms based upon design features of the freeway interchange elements.

For example, it may not be possible to extend a speedchange lane from 700 ft. to 800 ft., but it would still be desirable to know the effect of lengthening it to 750 ft. The past studies would not assist in this analysis, since both 700 ft. and 750 ft. are less than the dividing point used in the preceding analysis. The same is true for other design features (adequate sight distance versus inadequate sight distance, ramps with a radius greater than 100 ft. versus those with a radius less than 100 ft., greater than 750 ft. in distances between ramp terminals and structures versus less than 750 ft.).

The purpose of this research is to establish accident predictive algorithms based upon geometric design features of the freeway interchange elements, and traffic data ( such as traffic volume, population, no. of ramp lanes).

EXII SIDE		=	ENTRANCE SI	IDE	
stance to exit-ramp nose ahead	Accident	Accident rate <sup>1</sup>	Diatance to entrance-ramp nose behind	Accident	Accident rate <sup>1</sup>
URBAN			URBAN		
	-	-		-	
ss than 0.2 miles	722	131	Less than 0.2 miles	426	122
0.2 - 0.4 miles	1,209	127	0.2 - 0.4 miles	1,156	125
0.5 - 0.9 miles	786	110	0.4 - 0.9 miles	655	105
1.0 - 1.9 miles	280	75	1.0 - 1.9 miles	278	<b>8</b> 4
2.0 - 3.9 miles	1667	63	2.0 - 3.9 miles	151	59
4.0 - 7.9 miles,	194	69	4.0 - 7.9 miles	200	£
ore than 8 miles <sup>3</sup>	•	:	More than & miles <u>3</u>	:	;
Rural			Rural		
s than 0.2 miles	160	76	Less than 0.2 miles	117	80
0.2 - 0.4 miles	459	75	0.2 - 0.4 miles	482	82
0.5 - 0.9 miles	559	69	0.4 - 0.9 miles	560	72
1.0 - 1.9 miles	479	69	1.0 - 1.9 miles	435	55
2.0 - 3.9 miles	222	68	2.0 - 3.9 miles	169	51
4.0 - 7.9 miles <sub>2</sub>	76	62	4.0 - 7.9 miles	52	40
ore than 8 miles <sup>3</sup>	:		More than 8 miles?	:	1

Accident rate by proximity to interchange ahead or behind  $(\underline{1})$ Table II.1

1 Number of Accidents per 100 million vehicle miles.
2 Small sample size.
3 No data available.

Table II.2 Accident rate by Interchange unit and area type  $(\underline{1})$ 

Interchange Unit					Irhan	
		Rural				
	Vehicle-miles 100 million	Accidents Number	Accident-rate <sup>1</sup>	Vehicle-miles 100 million	Accidents Number	Accident-rate <sup>1</sup>
Deceleration Lane	2.51	348	137	5.83	1,089	186
Exit Ramp	0.57	199	346	1.48	546	370
Area between speed-change lanes	6.52	554	85	11.87	1,982	167
Entrance Ramp	0.59	95	161	1.61	1,159	719
Acceleration Lane	3.68	280	76	8.40	1,461	174
Acceleration-Deceleration Lane	0.49	87	116	2.45	555	227
Total	14.36	1,563	109	31.64	6,792	214

the second second

Dome Trans		Accident rate	
капр туре	u	off	on & off
Diamond ramps	07.0	0.67	0.53
Cloverleaf ramps with collector-distributor roads <sup>2</sup>	0.45	0.62	0.61
Direct connections	0.50	0.91	0.67
Cloverleaf loops with collector-distributor roads <sup>2</sup>	0.38	0.40	0.69
Buttonhook ramps	0.64	0.96	0.80
Loops without collector-distributor roads	0.78	0.88	0.83
Cloverleaf ramps without collector-distributor roads	0.72	0.95	0.84
Trumpet ramps	0.84	0.85	0.85
Scissors ramps	0.88	1.48	1.28
Left-side ramps	0.93	2.19	1.91
Average	0.59	0.95	0.79

Accident rate by type of Freeway ramp  $(\underline{1})$ **Table II.3** 

1 Accidents per million vehicles. 2 Only the On & Off rate includes the accidents occurring on the collector-distributor roads.

4.2.1

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Factors	Cirillo	Oppenlander & Dawson	Fisher	Vostrez & Lundy	Janoff & Freedman	Tip Pin	iton & inel	Rowe	Ľ
On-ramps are more hazardous than Off-ramps in urban area	×	×							×
Off-ramps are more hazardous than on-ramps in rural area	×	×							×
Off-ramps are more hazardous than on-ramps				×					
Simplicity in ramp type reduces accidents							×		×
Speed-change lanes of sufficient length are needed		×	×						×
Vertical alignment effects accidents				×					×
Adequate sight distance reduces accidents		×							×
Ramp terminal design effects the accident rate	×	×							×
Interchange lighting reduces accidents					×				
Longer weaving sections reduce accidents		×							×
Fixed object accidents are the most common type of accidents	×	×		×					×
Left-hand exits and entrances are hazardous X represents that researches agree w	   vith each other	· of that factor.	×	×					

#### CHAPTER III

### DATA ACQUISITION

## III-1. Data Needed

The objectives of this research were to: 1) compare the accident rates in Michigan with those from the Interstate System Accident Research Study II, Interim Report II by J. A. Cirillo (<u>1</u>) and 2) develop and calibrate accident predictive models based upon accident rates on the elements which comprise a freeway interchange.

In the state of Michigan, there are approximately 700 freeway interchanges. The Michigan Department of Transportation recently completed a geometric inventory of its freeway interchanges, and merged the accident file to the geometric file to identify the number of accidents associated with each interchange element. Thus, the three types of data needed for this research were available from this file.

<u>Geometric data</u>: Data describing the elements of the freeway interchanges geometrically. The geometric data were collected from the Michigan Department of Transportation's Highway Accident Master Data file. The geometric data used in this study are:

1). Interchange Number
- 2). Interchange Element Code
- 3). Control Section
- 4). Milepoint
- 5). Prime Road (PR) Number
- 6). Beginning PR Milepoint
- 7). Ending PR Milepoint
- 8). Beginning Ramp Terminal Milepoint
- 9). Ending Ramp Terminal Milepoint
- 10). Geometric and Laneage Code
- 11). Ramp Terminal or Intersection Code
- 12). Ramp Terminal Lane Usage Code
- 13). Interchange Light Code
- 14). Interchange Type
- 15). Activity Density
- 16). Junction Type Code

Traffic data: Data describing the level of use of the freeway interchange elements. The traffic data are available from the Michigan Department of Transportation's TVM (Trunkline Vehicle Miles) Master Data file and Traffic Flow Map. The traffic data needed for this study are:

- 1). ADT (Average Daily Traffic) on Mainline
- 2). ADT (Average Daily Traffic) on Crossroad
- 3). ADT (Average Daily Traffic) on Ramp
- 4). Population of the county in which the interchange is

Accident data: Data on accidents that occurred on the freeway interchanges in Michigan. The accident data were collected from the Michigan Department of Transportation's Highway Accident Master Data file. The accident data needed for this study are:

- 1). Miscellaneous single vehicle accident
- 2). Overturn accident
- 3). Hit train accident
- 4). Hit parked vehicle accident
- 5). Backing accident
- 6). Parking accident
- 7). Pedestrian accident
- 8). Fixed object accident
- 9). Other object accident
- 10). Animal accident
- 11). Bicycle accident
- 12). Head-on accident
- 13). Angle straight accident
- 14). Rear-end accident
- 15). Angle turn accident
- 16). Side swipe same direction accident
- 17). Rear-end left-turn accident
- 18). Rear-end right-turn accident



- 19). Other drive way related accident
- 20). Angle drive way related accident
- 21). Rear-end drive way related accident
- 22). Side swipe opposite direction accident
- 23). Head-on left-turn accident
- 24). Dual left-turn accident
- 25). Dual right-turn accident

The accident data used for this study were data from 1982 to 1984. The geometric data base used for this study was completed by 1984, but many parts of the data base had been partly created before 1984.

The geometric data base completed in 1984 was used since the geometry had not changed significantly. The traffic volume data for 1983 was used since traffic volumes are updated with a traffic growth factor every 3 years. The population data based on this same year was used.

The master data file comprises the geometric data and the accident data. Merging the traffic data into the master data file and analyzing those data was done by computer programs (that is, FORTRAN and SPSS).

# <u>III-2. Sample Size</u>

The purpose of sampling is to gain information about the nature or distribution of elements in a particular population

without studying the entire population. In determining a sample size, there are two major considerations:

First, assumptions must be made about the underlying distribution of these elements when selecting a sample size. One common assumption is that the population is normally distributed. Under the normal distribution the same proportion of observations will always lie between the mean and a specified number of standard deviations below or above the mean. For example, 68.26 percent of the area under the normal distribution will be within one standard deviation of the mean, and 95.46 percent, within two standard deviations for any normally distributed variable.

Second, some decision must be made about the acceptable limits of error for the sample. This is usually done by specifying that the sample mean for a data item should be within some value **d** of the true average for a certain percentage of samples which is called the **level of confidence**. This level of confidence is denoted as  $100(1 - \alpha)$ , where  $\alpha$  is the fraction of the area under the normal distribution falling outside the confidence limits. Thus, in the case that **d** = 2 and  $\alpha$  = 0.05, ±2 units around the true value will include the estimated value 95 percent of the time (<u>8</u>).

There are two types of equations considered for determining a sample size: **sampling with replacement** and **sampling without replacement**. **Sampling with replacement** assumes that the sample **n** is small relative to the total

population size, but sampling without replacement does not. Under sampling with replacement, the equation for determining a sample size to achieve a precision of **d** units with  $100(1 - \alpha)$  percent confidence is

$$n = \frac{Z^{2} - (1/2)\alpha^{\sigma^{2}}}{d^{2}}$$

where n = sample size d = tolerable margin of error of mean value  $\sigma = \text{standard deviation of population distribution}$   $\alpha = \text{fraction of area under normal curve representing}$   $\text{events not within confidence level (thus, 1 - \alpha is desired level of confidence)}$  $Z_{1-(1/2)\alpha} = \text{standard normal statistic corresponding to 1 - \alpha confidence level}$ 

If the standard deviation of the population distribution is unknown, **s**(standard deviation of sample distribution) might be used instead as follows:

$$n = \frac{Z^{2}_{1-(1/2)\alpha}S^{2}}{d^{2}}$$

where s = standard deviation of sample distribution

Under **sampling without replacement**, the equation considered for determining a sample size is

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$$n_1 = \frac{n}{1 + n/N}$$

where n = number of sample observations with replacement  $n_1 = adjusted number$  of observations N = total population

In the state of Michigan, there are approximately 700 freeway interchanges. Suppose that there are an average of 4 ramps per freeway interchange. It is desired to know the number of accidents per ramp within **d** (tolerable margin of error) = 2,  $\mathbf{s}^2$  (sample variance in accidents per ramp) = 100, and  $\mathbf{z}$  = 1.96, assuming 95 % confidence level. Then,

$$n = \frac{(1.96)^{2} (100)}{(2)^{2}}$$
$$= 96.04$$
$$n_{1} = \frac{96.04}{1 + 96.04/2800}$$
$$= 92.855$$

Thus, under **sampling with replacement**, the sample size is at least 97 ramps, and under **sampling without replacement**, the

sample size is at least 93 ramps. The actual sample size to be used in this study will be determined following sufficient analysis to determine the probable value of the variance.

# III-3. Unit of Analysis

In the Interstate System Accident Research Study II, Interim Report II by Cirillo, J. A.  $(\underline{1})$ , the following analysis units of freeway interchange were included in the analysis:

- . Deceleration lanes including taper
- . Acceleration lanes including taper
- Exit ramps
- . Entrance ramps
- . Mainline units between speed-change lanes
- . Combined acceleration-deceleration lanes

Each analysis unit was analyzed based on whether the analysis unit was within an urban or rural area. The accidents occurring between interchanges were coded as a distance from either the interchange ahead or behind based on the distances to the exit-ramp nose and the entrance-ramp nose, respectively. However, in this study all exit ramps were combined, regardless of length, ADT, number of lanes, type of interchange, etc. The same was true for entrance ramps and

mainline sections. No analysis was made of accidents occurring on the cross roads. Thus, it is not possible to predict the total accident frequency or rate for an interchange.

The analysis units for this study will be further classified based on ADT, the interchange type and the length of the various elements. The population of the county in which the interchange exists will be used as a surrogate measure for activity density. The elements of the freeway interchanges will be considered in detail, and the following base analysis units will be included in this research:

. Mainline unit

. Crossroad unit

• On-ramp unit

• Off-ramp unit

The base units of analysis to be considered were defined as the following:

. Mainline units start at a point 500 ft. before the deceleration lane for the off-ramp and end at a point 500 ft. after the acceleration lane for the on-ramp;

. Crossroad units start at a point 250 ft. before the intersection of the on-ramp and the crossroad and end at a point 250 ft. after the intersection of the off-ramp and the crossroad;

. On-ramp units start at the point they meet the cross-road and end at the end of the acceleration lane;

. Off-ramp units start at the beginning of the deceleration lane on the freeway and end at the point the ramp meets the crossroad.

#### **III-4. Mathematical Inspection**

using the identified data, sample size, and units of analysis, models were constructed based upon the following analysis:

**Linear model:** The data were first analyzed using linear models. Suppose that interest lies in a certain (response) variable  $\mu$ , which is thought to be dependent on the functionally independent variables  $\mathbf{Z}_1, \mathbf{Z}_2, \ldots, \mathbf{Z}_s$ , that is,  $\mu = \mathbf{f}(\mathbf{Z}_1, \ldots, \mathbf{Z}_s)$ . Then, it is said that  $\mu$  obeys a linear model if

$$\mu = \mathbf{f} (\mathbf{Z}_1, \ldots, \mathbf{Z}_s)$$
$$= \sum_{j=1}^{k} \beta_j \mathbf{X}_j (\mathbf{Z}_1, \ldots, \mathbf{Z}_s)$$

where  $X_j$  = functions of the  $Z_j$  only  $\beta_1, \ldots, \beta_k$  = unknown parameters which enter into the above (9). **Regression Analysis**: As a statistical tool that utilizes the relation between two or more quantitative variables, regression analysis is used to predict one variable from the other or others. Regression analysis is based on a linear regression model which fits the scattered observations on a straight line by the least square method. There are two types of linear regression models: simple linear regression models and multiple linear regression models. A linear regression model which contains only one independent variable is called a simple linear regression model, while the linear regression model is called a multiple linear regression model. Thus, the simple linear regression model. Thus, the simple linear regression model can be stated as follows:

$$\mathbf{Y}_{i} = \boldsymbol{\beta}_{0} + \boldsymbol{\beta}_{1}\mathbf{X}_{i} + \boldsymbol{\epsilon}_{i}$$

- where  $Y_i$  = the value of the response variable in the ith trial  $\beta_0$  and  $\beta_1$  = parameters
  - $X_i$  = a known constant, namely, the value of the independent variable in the *i*th trial
  - $\epsilon_i = a$  random error term with mean  $\mathbf{E}(\epsilon_i) = 0$  and variance  $\sigma^2(\epsilon_i) = \sigma^2$ ,  $\epsilon_i$  and  $\epsilon_j$  are uncorrelated so that the covariance  $\sigma(\epsilon_i, \epsilon_j)$  for all i, j; i is not equal to j

i = 1, ..., n

<u>Method of Least Square</u>: In order to find good estimators of the regression parameters (i.e.,  $\beta_0$  and  $\beta_1$ ), the method of least squares was employed. Suppose that there is a sample observation (X<sub>i</sub>, Y<sub>i</sub>). Then the method of least squares considers the deviation of Y<sub>i</sub> from its expected value:

$$\mathbf{X}_{i} - (\boldsymbol{\beta}_{0} + \boldsymbol{\beta}_{1}\mathbf{X}_{i})$$

In particular, the method of least squares requires that the sum of the n squared deviations is considered. This criterion is denoted by Q:

$$Q = \sum_{i=1}^{n} \{\mathbf{Y}_{i} - (\boldsymbol{\beta}_{0} + \boldsymbol{\beta}_{1}\mathbf{X}_{i})\}^{2}$$

Thus, the estimators of  $\beta_0$  and  $\beta_1$  are those values  $b_0$  and  $b_1$ , respectively, that minimize the criterion Q for the given sample observations  $(X_i, Y_i)$  (10).

**Regression Procedure:** In selecting a regression procedure, there are three possible regression procedures which require the fitting of every possible regression equation. The **backward elimination** procedure which determines the "best" regression using all variables and then determines the best equation for each step in which the number of variables in the equation is reduced. The **forward selection** procedure inserts variables in turn until the regression equation is satisfactory. The **stepwise regression** procedure which is an improved version of **forward selection** procedure which examines the variables incorporated into the model at every stage of the regression, provides a judgement on the contribution made by each variable, and removes any variable which has a nonsignificant contribution at a later stage even if it may have been the best single variable at the early stage (<u>11</u>). The **stepwise regression** procedure was used for this study.

Using the geometric, traffic and accident data, the regression models were constructed for each unit of analysis. In the linear regression models, accident rates based on the different types of accident (i.e., total accident rate, injury accident rate, etc.) were the dependent variable, and the geometric and traffic data were the independent variables. In those instances where the relationship did not appear to be linear, the intrinsically linear regression model by transformation was used.

# CHAPTER IV

#### PROCEDURE

This study concerned itself with the development of linear regression models for predicting accidents occurring on freeway interchanges. One of the questions investigated in this research was a determination of whether stratified data or nonstratified data would result in better accident prediction models.

The units of analysis for constructing the accident predictive models for the total freeway interchange were based on individual predictive models for the following elements:

o Mainline unit

o Crossroad unit

o Ramp unit

Mainline units include the freeway lanes from a point 500 ft. before the deceleration lane for the off-ramp to a point 500 ft. after the acceleration lane of the on-ramp. Crossroad units include the roadway from a point 250 ft. before the intersection of the on-ramp and the crossroad to a point 250 ft. after the intersection of the off-ramp and the crossroad. Ramp units include the on-ramp units from the intersection of the cross-road to the end of the acceleration lane and the off-ramp units from the beginning of the deceleration lane on

the freeway to the intersection with the crossroad.

# Models constructed before data stratification

Based upon the above units of analysis, a linear regression model was constructed using the total data based on the following formula:

The best linear regression models of accident prediction on each unit of analysis was as follows:

# Model for Mainline Unit

 $Y = -8.0362 + 0.00021658X_1 + 0.05523X_2 + 0.000008697X_3 + 3.39985X_4 - 1.86537X_5$ 

where	Y = Total number of accidents per unit
	$X_1 = Average Daily Traffic (ADT)$
	X <sub>2</sub> = Lane mileage
	$X_3 = Population$
	$X_4 = Number of Off-ramps$
	$X_5 = Number of On-ramps$

For this model, the multiple regression coefficient  $(\mathbf{R})$  was 0.5624.

# Model for Crossroad Unit

 $Y = 5.9372 + 0.00019387X_1 + 0.01979X_2 + 0.000004297X_3$ 

where Y = Total number of accidents per unit  $X_1 = Average$  Daily Traffic (ADT)  $X_2 = Lane$  mileage  $X_3 = Population$ 

For this model, the multiple regression coefficient (R) was 0.386.

# Model for Ramp Unit

 $Y = -0.8302 + 0.00001575X_1 + 0.02555X_2 + 0.000000671X_3 + 0.26683X_4$ 

where	Y = Total number of accidents per unit
	X <sub>1</sub> = Average Daily Traffic (ADT)
	X <sub>2</sub> = Ramp lane mileage
	$X_3 = Population$
	$X_4 = Number of Off-ramps$

For this model, the multiple regression coefficient (R) was 0.323.

It was obvious that there was more variance in the accident data than that which could be satisfactorily explained by these linear regression models. Thus, a systematic method of stratifying the interchanges to reduce the variance, and increase the explanatory power of the models was undertaken.

As a simple test to determine whether stratification might be useful, a model of nighttime accidents on cloverleaf freeway interchanges was developed as follows:

 $Y = -2.4229 + 0.00004974X_1 + 0.05896X_2$ 

where Y = Dark accidents  $X_1 = Average Daily Traffic (ADT)$  $X_2 = Lane mileage$ 

For this model, the multiple regression coefficient (R) was 0.724. Thus, it appears that stratifying the data can lead to improved model reliability. The remaining question is whether the stratification procedure will result in useful data upon which design decisions can be made.

# Data Stratification

## IV-1. Data File Format

As described in the preceding section, the objectives of this research are to: 1) identify accident rates as they relate to parameters of the interchange elements; 2) compare the accident rates in Michigan with those from J. A. Cirillo; and 3) develop and calibrate interchange accident predictive models based on the accident rates on elements which comprise the interchange.

With the above objectives, the data needed were obtained from the databases of Michigan Department the of Transportation. After data were obtained, they were merged into the master data file using Fortran programs. The master data file contains elements from the geometric data file, the accident data file and the traffic data file. This master data file also includes a category code. Thus, the master data file can be sorted into specific data file sets as needed for research.

From the master data file, the categories used to format the data file sets needed for this research were:

- Activity Density
- . Interchange Type
- . Interchange Element

#### 1). Data file set by Activity Density

For the activity density, the master data file was

classified into 3 area types of activity density: urban; rural; and fringe. The number of interchanges and the percentage of each area type are:

- . Urban: 28.07 % (185 out of 659)
- . Rural: 49.47 % (326 out of 659)
- Fringe: 22.46 % (148 out of 659)

#### 2). Data file set by Interchange Type

For the freeway interchange type, the master data file was divided into 30 interchange types with the percentage and the total number of interchanges for each interchange type:

- . Diamond: 19.12 % (126 out of 659)
- Tight diamond: 11.68 % (77 out of 659)
- . Modified diamond: 4.10 % (27 out of 659)
- . Modified tight diamond: 4.10 % (27 out of 659)
- . Partial diamond: 2.73 % (18 out of 659)
- Partial tight diamond: 4.70 % (31 out of 659)
- Split diamond: .2.28 % (15 out of 659)
- Diamond plus 1 loop: 2.88 % (19 out of 659)
- Parclo A: 2.73 % (18 out of 659)
- Parclo A 4 quad: 6.98 % (46 out of 659)
- Parclo B: 3.03 % (20 out of 659)
- Parclo B 4 quad: 1.67 % (11 out of 659)

- Parclo AB: 4.10 % (27 out of 659)
- . Parclo AB 4 quad: 1.82 % (12 out of 659)
- . Cloverleaf: 1.37 % (9 out of 659)
- . Cloverleaf with CD roads: 1.21 % (8 out of 659)
- . Cloverleaf minus 1 loop: 0.46 % (3 out of 659)
- . Trumpet A: 1.37 % (9 out of 659)
- . Trumpet B: 1.37 % (9 out of 659)
- . Full directional: 1.52 % (10 out of 659)
- . Partial directional: 2.12 % (14 out of 659)
- . Directional Y: 1.21 % (8 out of 659)
- . General Directional: 0.76 % (5 out of 659)
- Partial directional Y: 4.40 % (29 out of 659)
- . Directional with loops: 1.37 % (9 out of 659)
- . General: 1.52 % (10 out of 659)
- . Urban diamond: 6.68 % (44 out of 659)
- SRI-A: 0.15 % (1 out of 659)
- SRI-B: 0.45 % (3 out 659)
- . Other: 2.12 % (14 out of 659)

These freeway interchange types represent the total interchanges in Michigan. Based upon the above freeway interchange types, data files for each interchange type were created, and the total number of accidents and the average number of accidents for each data file was found as shown in Table IV.1. Since many of the sample sizes were too small, these data files were collapsed into a smaller number of

groups based upon a similar mean accident rate and variance. These groups are shown in Table IV.2. The interchange types comprising each group are as follows:

- . Group 1: Diamond
- . Group 2: Tight diamond, Urban diamond
- . Group 3: Modified diamond, Modified tight diamond, Parclo A 4 quad
- . Group 4: Partial diamond, Partial tight diamond, Trumpet A, Partial Directional Y
- . Group 5: Split diamond, General directional, Other
- . Group 6: Diamond plus 1 loop, Parclo B 4 quad, Trumpet B, Directional Y
- . Group 7: Parclo AB, Partial directional
- . Group 8: Cloverleaf, Cloverleaf with CD roads, Cloverleaf minus 1 loop, Directional with loops
- . Group 9: Parclo A, Parclo B, Parclo AB 4 quad
- . Group 10: Full directional, General
- . Group 11: SRI-A
- . Group 12: SRI-B

A "t" test was run to determine if these groups were statistically significantly different. While not all groups were different from all other groups, all groups were different from at least one other group. The result of this analysis is shown in Table IV.3.

# 3). Data file set by Interchange Element

For the freeway interchange element, the master data file was classified into 33 elements of the freeway interchange as follows:

- . NB mainline
- . SB mainline
- . EB mainline
- . WB mainline
- . Crossroad
- . Spread on ramp from crossroad to freeway
- . Spread off ramp from freeway to crossroad
- . Tight on ramp from crossroad to freeway
- . Tight off ramp from freeway to crossroad
- . Loop on ramp from crossroad to freeway
- . Loop off ramp from freeway to crossroad
- . Collector distributor
- . On ramp from service road to freeway
- . Off ramp from freeway to service road
- . Service road from off ramp to crossroad
- . Service road from crossroad to on ramp
- . On ramp from crossroad to CD
- . Off ramp from CD
- . Ramp from CD to CD
- . Off ramp from CD to service road
- . On ramp from service road to CD

- . Directional loop ramp
- . Directional ramp
- . Loop ramp from CD to CD
- . Loop ramp from CD to crossroad
- . Loop ramp from crossroad to CD
- . Off ramp from freeway to CD
- . On ramp from CD to freeway
- . Turning roadway
- . Loop ramp from freeway to CD
- . Ramp from service road to service road
- . Service road
- . Other

These freeway interchange elements represent the freeway interchange in total. For this research the freeway interchange elements were collapsed into 4 analysis units based on the role on the freeway interchange:

. Mainline unit - NB mainline

SB mainline EB mainline WB mainline

- . Crossroad unit Crossroad
- On-ramp unit Spread on ramp from crossroad to freeway Tight on ramp from crossroad to freeway Loop on ramp from crossroad to freeway

On ramp from service road to freeway On ramp from CD to freeway . Off-ramp unit - Spread off ramp from freeway to crossroad Tight off ramp from freeway to crossroad Loop off ramp from freeway to crossroad Off ramp from freeway to service road Off ramp from freeway to CD Loop ramp from freeway to CD

The total number of accidents by each element and each group of elements is shown in Table IV.4 and IV.5 respectively.

#### 4). Data file set by Accident Type

With the above-described data file set, the types of accidents available on the accident data file were:

- . Miscellaneous single vehicle
- . Overturn
- . Hit train
- . Hit parked vehicle
- . Backing
- . Parking
- . Pedestrian
- Fixed object
- Other object

- . Animal
- . Bicycle
- . Head-on
- . Angle straight
- . Rear-end
- . Angle turn
- . Side swipe same
- . Rear-end left turn
- . Rear-end right turn
- . Other drive
- . Angle drive
- . Rear-end drive
- . Side swipe opposite
- . Head-on left turn
- . Dual left turn
- . Dual right turn

The number of accidents by type for each interchange element is shown in Table IV.6a through IV.6e. The number of accidents by collapsed interchange elements is shown in Table IV.7.

# 5). Data file set by Interchange groups with Activity density

Based upon the above interchange types and activity densities, the following combined data file sets were created:

# Urban Groups

- . Urban group 1
- Urban group 2
- Urban group 3
- . Urban group 4
- . Urban group 5
- . Urban group 6
- . Urban group 7
- . Urban group 8
- . Urban group 9
- . Urban group 10
- . Urban group 11
- . Urban group 12

# Rural Groups

- . Rural group 1
- . Rural group 2
- Rural group 3
- . Rural group 4
- . Rural group 5
- . Rural group 6
- . Rural group 7
- . Rural group 8
- . Rural group 9
- . Rural group 10

#### Fringe Groups

- . Fringe group 1
- . Fringe group 2
- Fringe group 3
- Fringe group 4
- . Fringe group 5
- Fringe group 6
- . Fringe group 7
- Fringe group 8
- . Fringe group 9
- . Fringe group 10

These data file sets represent the total data file by freeway interchange type and the analysis units considered. The total number of accidents in each cell based upon these categories was found, and the accident rate (accidents per interchange) for each analysis unit was also determined as shown in Table IV.8 through IV.38.

#### IV-2. Summary of Results by Groups

# 1). Summary of accident types by collapsed interchange elements

Based upon the accident types and the interchange elements described, the total number of accidents for each

accident type by each interchange element is shown in Table IV.39 through IV.41. From the results shown in these tables, the average number of accidents that occurred on the analysis units is shown in Table IV.42.

Mainline unit: 4464 accidents out of the total 9534 accidents that occurred on those analysis units occurred on the mainline unit (46.82 percent). The major types of accidents and the percentage of each major accident type were:

- . Rear-end: 39.83 % (1778 out of 4464)
- Fixed object: 27.76 % (1239 out of 4464)
- . Animal: 12.25 % (547 out of 4464)
- . Overturn: 8.2 % (364 out of 4464)
- Miscellaneous single vehicle: 3.3 % (148 out of 4464)

These major types of accidents represent 91.31 percent of the total accidents on the mainline unit.

**Crossroad unit:** 2536 accidents out of the total 9534 that occurred on those analysis units occurred on the crossroad unit (26.60 percent). The major types of accidents and the percentage of each major accident type were:

- Rear-end: 29.77 % (755 out of 2536)
- Fixed object: 16.56 % (420 out of 2536)
- Angle straight: 9.62 % (244 out of 2536)
- Angle turn: 8.16 % (207 out of 2536)

- . Rear-end drive: 4.53 % (115 out of 2536)
- . Head-on left turn: 3.94 % (100 out of 2536)

These major types of accidents represent 72.59 percent of all accidents on the crossroad unit.

**On-ramp unit:** 919 accidents out of the total 9534 accidents that occurred on those analysis units occurred on the on-ramp unit (9.64 percent). The major types of accidents and the percentage of each accident type were:

- Fixed object: 36.02 % (331 out of 919)
- . Rear-end: 33.51 % (308 out of 919)
- Overturn: 16.32 % (150 out of 919)

These major types of accidents represent 85.85 percent of the total accidents on the on-ramp unit.

**Off-ramp unit:** 1615 accidents out of the total 9534 accidents that occurred on those analysis units occurred on the off-ramp unit (16.94 percent). The major types of accidents and the percentage of each accident type were:

- Rear-end: 41.24 % (666 out of 1615)
- Fixed object: 30.4 % (491 out of 1615)
- Overturn: 10.46 % (169 out of 1615)

These major types of accidents represent 82.11 percent of all

accidents on the off-ramp unit.

#### 2). Summary of Urban Groups based on Analysis Units

Following stratification, some of the groups were too small to be modeled. An analysis of the sample size for each group is discussed below:

**Urban Group 1:** As shown in Table IV.8, the total number of accidents was small and the number of interchanges was 5. This group was excluded from further analysis.

**Urban Group 2:** As shown in Table IV.9, the number of interchanges was 50. The accident rate for the mainline unit was 5.86 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 3.66, and the major types of accidents were rear-end, angle straight, angle turn, fixed object, other drive, and angle drive. The accident rate for the on-ramp unit was 2.26, and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 2.04, and the major types of accident were rear-end and fixed object.

**Urban Group 3:** As shown in Table IV.10, the number of interchanges was 17. The accident rate for the mainline unit was 9.53 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate

for the crossroad unit was 6.18, and the major types of accidents were rear-end and angle turn. The accident rate for the on-ramp unit was 3.41, and the major types of accidents were fixed object and rear-end. For the off-ramp unit the accident rate was 4.82, and the major types of accident were rear-end and fixed object.

**Urban Group 4:** As shown in Table IV.11, the number of interchanges was 38. The accident rate for the mainline unit was 5.24 accidents per interchange (the lowest value among the urban groups), and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 3.37 (the lowest value among the urban groups), and the major types of accidents were angle straight, rear-end and hit parked vehicle. The accident rate for the on-ramp unit was 1 (the lowest value among the urban groups), and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 1.63, and the major types of accident were rear-end and fixed object (the off-ramp value is also the lowest among the urban groups).

**Urban Group 5:** As shown in Table IV.12, the number of interchanges was 21. The accident rate for the mainline unit was 8.90 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 5.52, and the major types of accidents were rear-end, angle straight, fixed object, and rear-end drive. The accident rate for the on-ramp unit was

2.14, and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 2.71, and the major types of accident were rear-end and fixed object. **Urban Group 6:** As shown in Table IV.13, the number of interchanges was 10. The accident rate for the mainline unit was 11 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 6, and the major type of accident was rear-end. The accident rate for the on-ramp unit was 3.5 (the highest value among the urban groups), and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 6, and the major types of accident were rear-end and fixed object (the off-ramp value is the highest among the urban groups).

**Urban Group 7:** As shown in Table IV.14, the number of interchanges was 12. The accident rate for the mainline unit was 7.75 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 6.5, and the major type of accident was rear-end. The accident rate for the on-ramp unit was 1.83, and the major type of accident was fixed object. For the off-ramp unit the accident rate was 2.5, and the major type of accident was rear-end.

**Urban Group 8:** As shown in Table IV.15, the number of interchanges was 7. This group was excluded from further analysis.

**Urban Group 9:** As shown in Table IV.16, the number of interchanges was 8. This group was excluded from further analysis.

**Urban Group 10:** As shown in Table IV.17, the number of interchanges was 11. The accident rate for the mainline unit was 15.0 accidents per interchange (the highest value for any urban group), and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 7.09 (the highest value for any urban group), and the major types of accidents were rear-end, fixed object and angle straight. The accident rate for the on-ramp unit was 1.27, and the major type of accident was rear-end. For the off-ramp unit the accident rate was 2.82, and the major types of accidents were rear-end and fixed object.

**Urban Group 11:** As shown in Table IV.18, the number of interchanges was 1. This group was excluded from further analysis.

**Urban Group 12:** As shown in Table IV.19, the number of interchanges was 3. This group was excluded from further analysis.

The highest and lowest accident rates for each analysis unit in the urban groups are:

- . Group 10 had the highest mainline accident rate (13.75)
- . Group 4 had the lowest mainline accident rate (5.24)
- . Group 10 had the highest crossroad accident rate (6.5)

- . Group 4 had the lowest crossroad accident rate (3.37)
- . Group 6 had the highest on-ramp accident rate (3.5)
- . Group 4 had the lowest on-ramp accident rate (1)
- . Group 6 had the highest off-ramp accident rate (6.0)
- . Group 4 had the lowest off-ramp accident rate (1.63)

#### 3). Summary of Rural Groups based upon Analysis Units

**Rural Group 1:** As shown in Table IV.20, the total number of interchanges was 106. The accident rate of the mainline unit was 5.03, and the major types of accidents were animal, fixed object, rear-end, and overturn. The accident rate for the crossroad unit was 2.25, and the major types of accidents were fixed object, animal, rear-end, angle straight, angle turn, and head-on. The accident rate for the on-ramp unit was 0.4 (the lowest value among the rural groups), and the major types of accidents were fixed object and overturn. For the off-ramp the accident rate was 1.18, and the major types of accidents were fixed object, rear-end, overturn, and animal.

**Rural Group 2:** As shown in Table IV.21, the number of interchanges was 47. The accident rate for the mainline unit was 5.57 accidents per interchange, and the major types of accidents were animal, fixed object and rear-end. The accident rate for the crossroad unit was 2.74, and the major types of accidents were fixed object, rear-end, angle straight, animal, angle turn. The accident rate for the on-ramp unit was 0.60,

and the major type of accident was fixed object. For the offramp unit the accident rate was 1.57, and the major types of accident were rear-end and fixed object.

**Rural Group 3:** As shown in Table IV.22, the number of interchanges was 43. The accident rate for the mainline unit was 5.93 accidents per interchange, and the major types of accidents were rear-end, fixed object, animal, and overturn. The accident rate for the crossroad unit was 4.19, and the major types of accidents were rear-end and fixed object. The accident rate for the on-ramp unit was 1.07, and the major types of accidents were fixed object, overturn and rear-end. For the off-ramp unit the accident rate was 2.47, and the major types of accident were rear-end and fixed object.

**Rural Group 4:** As shown in Table IV.23, the number of interchanges was 36. The accident rate for the mainline unit was 4.97 accidents per interchange (the lowest value among the rural groups), and the major types of accidents were rear-end, fixed object, animal and overturn. The accident rate for the crossroad unit was 1.06 (the lowest value among the rural groups), and the major types of accidents were fixed object and rear-end. The accident rate for the on-ramp unit was 0.44, and the major type of accident was fixed object. For the off-ramp unit the accident rate was 0.56 (the lowest value among the rural groups), and the major type of accident was fixed object.

Rural Group 5: As shown in Table IV.24, the number of


interchanges was 7. This group was excluded from further analysis.

**Rural Group 6:** As shown in Table IV.25, the number of interchanges was 27. The accident rate for the mainline unit was 7.41 accidents per interchange (the highest value among the rural groups), and the major types of accidents were rearend, fixed object, animal and overturn. The accident rate for the crossroad unit was 2.96, and the major types of accidents were rear-end and fixed object. The accident rate for the on-ramp unit was 0.74, and the major types of accidents were overturn and fixed object. For the off-ramp unit the accident rate was 1.74, and the major types of accidents were rear-end and fixed object.

**Rural Group 7:** As shown in Table IV.26, the number of interchanges was 17. The accident rate for the mainline unit was 6.94 accidents per interchange, and the major types of accidents were fixed object, rear-end, animal and overturn. The accident rate for the crossroad unit was 4.24, and the major types of accidents were rear-end and fixed object. The accident rate for the on-ramp unit was 1.18 (the highest value among the rural groups), and the major types of accidents were overturn and fixed object. For the off-ramp unit the accident rate was 2.53 (the highest value among the rural groups), and the rural groups), and the major types of accidents were rear-end and fixed object. **Rural Group 8:** As shown in Table IV.27, the number of interchanges was 8. This group was excluded from further

analysis.

Rural Group 9: As shown in Table IV.28, the number of interchanges was 29. The accident rate for the mainline unit was 6 accidents per interchange, and the major types of accidents were fixed object, rear-end, animal and overturn. The accident rate for the crossroad unit was 4.34 (the highest value among the rural groups), and the major types of accidents were fixed object and rear-end. The accident rate for the on-ramp unit was 0.90, and the major types of accidents were fixed object and overturn. For the off-ramp unit the accident rate was 2.31, and the major types of accidents were fixed object, rear-end, and overturn. Rural Group 10: As shown in Table IV.29, the number of interchanges was 6. This group was excluded from further analysis.

The highest and lowest accident rates for each analysis unit in the rural groups are:

•	Group	6	had	the	highest mainline accident rate (7.41)
•	Group	4	had	the	lowest mainline accident rate (4.84)
•	Group	9	had	the	highest crossroad accident rate (4.5)
•	Group	4	had	the	lowest crossroad accident rate (1.03)
•	Group	7	had	the	highest on-ramp accident rate (1.18)
•	Group	1	had	the	lowest on-ramp accident rate (0.39)
•	Group	7	had	the	highest off-ramp accident rate (2.53)

. Group 4 had the lowest off-ramp accident rate (0.54)

# 4). Summary of Fringe Groups based on Analysis Units

Fringe Group 1: As shown in Table IV.30, the total number of interchanges was 13. The accident rate of the mainline unit was 6, and the major types of accidents were animal, fixed object and rear-end. The accident rate for the crossroad unit was 3.85, and the major types of accidents were fixed object, rear-end, angle straight and angle turn. The accident rate for the on-ramp unit was 1.38, and the major types of accident were fixed object and overturn. For the off-ramp unit the accident rate was 3.23, and the major types of accidents were rear-end, fixed object and overturn.

Fringe Group 2: As shown in Table IV.31, the number of interchanges was 25. The accident rate for the mainline unit was 6.6 accidents per interchange, and the major types of accidents were rear-end, fixed object, overturn and animal. The accident rate for the crossroad unit was 3.6, and the major types of accidents were rear-end, fixed object, angle straight and angle turn. The accident rate for the on-ramp unit was 1.24 (the lowest value among the fringe groups), and the major types of accidents were fixed object and rear-end. For the off-ramp unit the accident rate was 3.36, and the major types of accident were rear-end and fixed object. Fringe Group 3: As shown in Table IV.32, the number of

interchanges was 40. The accident rate for the mainline unit was 7.48 accidents per interchange, and the major types of accidents were rear-end, fixed object, overturn and animal. The accident rate for the crossroad unit was 5.98 (the highest value among the fringe groups), and the major types of accidents were rear-end, fixed object, angle turn, angle straight and rear-end drive. The accident rate for the on-ramp unit was 2.18, and the major types of accidents were fixed object, rear-end and overturn. For the off-ramp unit the accident rate was 3.75, and the major types of accident were rear-end, fixed object and overturn.

Fringe Group 4: As shown in Table IV.33, the number of interchanges was 12. The accident rate for the mainline unit was 5.5 accidents per interchange (the lowest value among the fringe groups), and the major types of accidents were rearend and fixed object. The accident rate for the crossroad unit was 1.5 (the lowest value among the fringe groups), and the major type of accident was nothing to be considered. The accident rate for the on-ramp unit was 1.25, and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 1.25 (the lowest value among the fringe groups), and the major types of accident were rear-end and fixed object.

Fringe Group 5: As shown in Table IV.34, the number of interchanges was 6. This group was excluded from further analysis.

Fringe Group 6: As shown in Table IV.35, the number of interchanges was 11. The accident rate for the mainline unit was 7.27 accidents per interchange, and the major types of accidents were fixed object and rear-end. The accident rate for the crossroad unit was 4.82, and the major types of accidents were rear-end and fixed object. The accident rate for the on-ramp unit was 1.73, and the major type of accident was fixed object. For the off-ramp unit the accident rate was 4.36, and the major types of accidents were rear-end, fixed object and overturn.

Fringe Group 7: As shown in Table IV.36, the number of interchanges was 12. The accident rate for the mainline unit was 5.92 accidents per interchange, and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 3.67, and the major type of accident was fixed object. The accident rate for the on-ramp unit was 1.25, and the major type of accident was fixed object. For the off-ramp unit the accident rate was 2.5, and the major types of accidents were fixed object and rear-end. Fringe Group 8: As shown in Table IV.37, the number of interchanges was 14. The accident rate for the mainline unit was 13.71 accidents per interchange (the highest value among the fringe groups), and the major types of accidents were rear-end and fixed object. The accident rate for the crossroad unit was 5.71, and the major types of accidents were rear-end and fixed object. The accident rate for the on-ramp unit was

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2.93 (the highest value among the fringe groups), and the major types of accidents were rear-end and fixed object. For the off-ramp unit the accident rate was 3.79, and the major types of accidents were rear-end and fixed object.

Fringe Group 9: As shown in Table IV.38, the number of interchanges was 12. The accident rate for the mainline unit was 6.92 accidents per interchange, and the major types of accidents were rear-end, fixed object and animal. The accident rate for the crossroad unit was 4.83, and the major type of accident was rear-end. The accident rate for the on-ramp unit was 1.92, and the major type of accident was fixed object. For the off-ramp unit the accident rate was 4.58 (the highest value among the fringe groups), and the major types of accidents were fixed object and rear-end.

Fringe Group 10: As shown in Table IV.39, the number of interchanges was 2. This group was excluded from further analysis.

The highest and lowest accident rates for each analysis unit in the fringe groups are:

- . Group 8 had the highest mainline accident rate (12.8)
- . Group 4 had the lowest mainline accident rate (5.5)
- . Group 3 had the highest crossroad accident rate (5.98)
- . Group 4 had the lowest crossroad accident rate (1.5)
- . Group 8 had the highest on-ramp accident rate (2.73)

Group 4 had the lowest on-ramp accident rate (1.29)Group 6 had the highest off-ramp accident rate (4.8)

. Group 4 had the lowest off-ramp accident rate (1.25)

## 5). Comparison of the accident rates

From the results of the urban groups, group 4 had the lowest accident rates for any analysis units, whereas group 6 had the highest accident rates for the ramp units and group 10 had the highest accident rates for the mainline and crossroad units. In the rural groups, group 4 again had the lowest accident rates for any analysis units excluding the onramp unit for which group 1 had the lowest accident rate. Group 6, group 7 and group 9 had the highest accident rates for the mainline unit, the ramp units and the crossroad unit, respectively. For the fringe groups, group 4 once again had the lowest accident rates for the same analysis units as the rural groups excluding the on-ramp unit for which group 2 had the lowest accident rate. Group 3, group 8 and group 9 had the highest accident rates for the crossroad unit, the mainline and on-ramp units, and the off-ramp unit. respectively. These groups by the analysis units can be compared as shown in Table IV.45.

### IV-3. Summary of Results



Based upon the results from each group of some sample interchanges, the average number of accidents on the mainline unit were generally higher than those on the other units as shown in Table IV.46. However, the accident rates on the ramp units were higher than those on the mainline unit as shown in Table IV.47 when the traffic volumes were considered with those average accidents.

The data file set to be used in modelling will be selected based on the Charts 4.1 through 4.4. The groups with less than 10 interchanges were excluded from the analysis. In the charts, the groups included for further analysis were marked by \*\*. The sample data file is shown in Table IV.44.



	Interchange Type	Mean Accident Rate	Variance	Number of Interchanges
-	Diamond	2.41	14.07	126
<u>ہ</u> .	Tight Diamond	3.72	27.07	17
m.	Modified Diamond	3.73	74.75	27
4.	Modified Tight Diamond	4.80	75.31	27
<u></u> ،	Partial Diamond	0.91	0.30	18
<i>6</i> .	Partial Tight Diamond	1.12	0.91	31
7.	Split Diamond	4.96	20.69	15
8.	Diamond plus 1 toop	2.91	7.08	19
<u>ہ</u> .	Parclo A	3.01	3.57	18
10.	Parclo A 4 Quad	77-7	74.24	76
11.	Parclo B	2.21	3.57	20
12.	Parclo B 4 Quad	3.78	6.97	11
13.	Parclo AB	4.51	42.60	27
. 71	Parclo AB 4 Quad	3.23	6.73	12
15.	Cloverleaf	4.21	2.91	6
16.	Cloverleaf with C-D Roads	4.48	3.30	8
17.	Cloverleaf minus 1 loop	4.43	1.97	3
18.	Trumpet A	2.65	1.30	6
19.	Trumpet B	2.17	5.82	6
20.	Full Directional	14.29	27.677	10
21.	Partial Directional	5.66	36.41	14
22.	Directional Y	3.97	7.49	8
23.	General Directional	4.94	18.42	5
24.	Partial Directional Y	1.17	1.34	29
25.	Directional with loops	4.23	3.57	6
26.	General	6.26	283.70	10
27.	Urban Diamond	3.32	27.65	77
28.	SRI-A	4.07		-
29.	SRI-B	6.93	3.13	3
30.	Other	4.11	20.41	14
Tota	le			659

Mean accident rate and Variance by Interchange Type Table IV.1 .3

	Interchange Group	Mean Accident Rate	Variance	Number of Interchanges
1. 6	Group 1	2.41	14.07	126
2. 6	Group 2	3.58	27.04	121
3. 6	Group 3	4.34	73.27	100
4. 6	Group 4	1.25	1.17	87
5. 6	Group 5	4.61	19.27	34
6.6	Group 6	3.15	6.86	27
7. 6	Group 7	4.90	39.82	41
8. 6	Group 8	4.31	2.82	29
9.6	sroup 9	2.75	4.41	50
10. G	sroup 10	10.27	364.43	20
11. 6	Group 11	4.07		-
12. G	sroup 12	6.93	3.13	£
Total				659

Table IV.2 Mean accident rate and Variance by Interchange Group

Classification of significance between Groups based on t-test Table IV.3

.

GROUP 12	s	SN	SN	s	SN	s	SN	s	s	SN	SN	
GROUP 11	SN	SN	SN	s	SN	SN	NS	SN	SN	SN		SN
GROUP 10	s	S	s	s	SN	s	SN	S	s		NS	SN
GROUP 9	SN	SN	SN	S	s	SN	s	S		S	NS	s
GROUP 8	s	SN	SN	s	SN	s	SN		S	s	SN	s
GROUP 7	s	SN	SN	s	NS	s		SN	s	SN	SN	SN
GROUP 6	NS	SN	SN	s	s		s	S	NS	s	SN	s
GROUP 5	s	SN	SN	S		s	NS	SN	S	SN	SN	SN
GROUP 4	s	s	s		s	s	s	S	s	s	s	s
GROUP 3	s	SN		s	SN	NS	NS	NS	SN	s	SN	NS
GROUP 2	s		SN	s	SN	NS	SN	SN	SN	s	SN	NS
GROUP 1		S	s	S	S	SN	s	S	SN	S	SN	s
GROUP	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 10	GROUP 11	GROUP 12

S represents that the mean accident rates between groups considered are significantly different at 5 % level of significance. NS represents that the mean accident rates between groups considered are not significantly different at 95 % level of significance.

01 NR MAINI INF	TOTAL NUMBER OF ACCIDENTS
	1215
02 SB MAINLINE	1165
03 EB MAINLINE	1040
04 WB MAINLINE	1044
09 CROSSROAD	2536
10 SPREAD ON RAMP FROM CROSSROAD TO FWY	308
11 SPREAD OFF RAMP FROM FWY TO CROSSROAD	716
12 TIGHT ON RAMP FROM CROSSROAD TO FWY	223
13 TIGHT OFF RAMP FROM FWY TO CROSSROAD	376
14 LOOP ON RAMP FROM CROSSROAD TO FWY	202
15 LOOP OFF RAMP FROM FWY TO CROSSROAD	254
16 COLLECTOR DISTRIBUTOR	120
17 ON RAMP FROM SERVICE RD TO FWY	155
18 OFF RAMP FROM FUY TO SERVICE RD	229
19 SERVICE RD FROM OFF RAMP TO CROSSROAD	787
20 SERVICE RD FROM CROSSROAD TO ON RAMP	408
21 ON RAMP FROM CROSSROAD TO CD	77
22 OFF RAMP FROM CD	36
23 RAMP FROM CD TO CD	12
24 OFF RAMP FROM CD TO SERVICE RD	3
25 ON RAMP FROM SERVICE RD TO CD	2
26 DIRECTIONAL LOOP RAMP	62
27 DIRECTIONAL RAMP	561
28 LOOP RAMP FROM CD TO CD	8
33 LOOP RAMP FROM CD TO CROSSROAD	11
34 LOOP RAMP FROM CROSSROAD TO CD	19
35 OFF RAMP FROM FWY TO CD	37
36 ON RAMP FROM CD TO FUY	31
37 TURNING ROADWAY	13
38 LOOP RAMP FROM FWY TO CD	3
39 RAMP FROM SERVICE RD TO SERVICE RD	8
41 SERVICE RD	164
42 OTHER	19

Table IV.4 Total number of Accidents by Uncollapsed Interchange Elements

TOTAL NUMBER OF ACCIDENTS BY COLLAPSED INTERC	
PSEU INIEKURANGE ELEMENIS	TUTAL NUMBER OF AUCTOENTS
	2536
	919
	1615
CIDENTS	9534
MAINLINE MAINLINE MAINLINE MAINLINE	
ROSSROAD	
EAD ON RAMP FROM CROSSROAD TO FUY HT ON RAMP FROM CROSSROAD TO FUY P ON RAMP FROM CROSSROAD TO FUY RAMP FROM SERVICE RD TO FUY RAMP FROM CD TO FUY	
PREAD OFF RAMP FROM FUY TO CROSSROAD 16HT OFF RAMP FROM FUY TO CROSSROAD 20P OFF RAMP FROM FUY TO CROSSROAD FF RAMP FROM FUY TO SERVICE RD FF RAMP FROM FUY TO CD 20P RAMP FROM FUY TO CD	

# Total number of Accidents by Collapsed interchange elements

.

	INTERCHANGE ELEMENTS	<b>MISCELLANEOUS</b>	OVERTURN	HIT TRAIN	HIT PARKED VEH.	BACKING	1
. 2	I NB MAINLINE	30	103		20	2	
0	SB MAINLINE	47	120		20	2	
8	S EB MAINLINE	31	ß		24		
9	WB MAINLINE	40	<b>6</b> 8		23	2	
S	P CROSSROAD	19	78		48	19	
¥	) SPREAD ON RAMP FROM CROSSROAD TO FWY	10	78		σ	ñ	
Ξ	I SPREAD OFF RAMP FROM FWY TO CROSSROAD	20	76		17	19	
1	? TIGHT ON RAMP FROM CROSSROAD TO FWY	5	20		2	2	
2	<b>3 TIGHT OFF RAMP FROM FWY TO CROSSROAD</b>	8	22		4	6	
14	LOOP ON RAMP FROM CROSSROAD TO FWY	7	41		2	ĸ	
11	5 LOOP OFF RAMP FROM FWY TO CROSSROAD	13	55		3		
5	5 COLLECTOR DISTRIBUTOR	1	8		-	-	
1	7 ON RAMP FROM SERVICE RD TO FWY	-	8		-	£	
¥	3 OFF RAMP FROM FWY TO SERVICE RD	4	11		-	4	
÷	<b>3 SERVICE RD FROM OFF RAMP TO CROSSROAD</b>	N	6		δ	13	
א גב	) SERVICE RD FROM CROSSROAD TO ON RAMP		5		15	8	
ين بر	1 ON RAMP FROM CROSSROAD TO CD		8		-		
2	2 OFF RAMP FROM CD		2			ñ	
ž	3 RAMP FROM CD TO CD	-	2			-	
2	OFF RAMP FROM CD TO SERVICE RD						
2	5 ON RAMP FROM SERVICE RD TO CD						
2	5 DIRECTIONAL LOOP RAMP	-	14		2		
2.	7 DIRECTIONAL RAMP	7	57		11	7	
2	3 LOOP RAMP FROM CD TO CD					-	
М	3 LOOP RAMP FROM CD TO CROSSROAD		-			-	
ž	LOOP RAMP FROM CROSSROAD TO CD		8				
ŝ	5 OFF RAMP FROM FWY TO CD		2		-		
Ř	5 ON RAMP FROM CD TO FWY		٤		£		
ñ	7 TURNING ROADWAY				-		
ñ	3 LOOP RAMP FROM FUY TO CD	-					
ñ	<b>7 RAMP FROM SERVICE RD TO SERVICE RD</b>						
4	1 SERVICE RD				4	-	
4	2 OTHER						
Ξ	JTAL NUMBER OF ACCIDENTS	248	862		217	103	

Table IV.6a Total number of Accidents by Each type of Accidents and Interchange Elements

. . . . .



1 NB MAINLINE 2 SB MAINLINE 3 EB MAINLINE 4 MB MAINLINE 9 CROSSROAD 0 SPREAD ON RAMP FROM FUY TO CROSSROAD 1 SPREAD OFF RAMP FROM FUY TO CROSSROAD 2 TIGHT ON RAMP FROM FUY TO CPOSSROAD 3 TIGHT OFF PAMP FROM FUY TO CPOSSROAD					
2 SB MAINLINE 3 EB MAINLINE 4 UB MAINLINE 9 CROSSROAD 1 SPREAD ON RAMP FROM CROSSROAD TO FWY 1 SPREAD OFF RAMP FROM FWY TO CROSSROAD 2 TIGHT ON RAMP FROM FUY TO CROSSROAD 3 TIGHT OFF PAMP FROM FUY TO CPOSSROAD	2	4	329	15	176
<ul> <li>3 EB MAINLINE</li> <li>4 UB MAINLINE</li> <li>9 CROSSROAD</li> <li>9 SPREAD ON RAMP FROM CROSSROAD TO FUY</li> <li>1 SPREAD OFF RAMP FROM FUY TO CROSSROAD</li> <li>2 TIGHT ON RAMP FROM EVY TO CROSSROAD</li> <li>3 TIGHT OFF PAMP FROM EVY TO CPOSSOAD</li> </ul>	ñ	£	324	14	150
4 UB MAINLINE 9 CROSSROAD 10 SPREAD ON RAMP FROM CROSSROAD TO FWY 1 SPREAD OFF RAMP FROM FWY TO CROSSROAD 2 TIGHT ON RAMP FROM FUY TO CROSSROAD 3 TIGHT OFF PAMP FROM FUY TO CPOSSROAD	2	-	301	21	105
9 CROSSROAD 0 SPREAD ON RAMP FROM CROSSROAD TO FWY 1 SPREAD OFF RAMP FROM FWY TO CROSSROAD 2 TIGHT ON RAMP FROM FUY TO CROSSROAD 3 TIGHT OFF PAMP FROM FUY TO CPOSSROAD	4	-	285	13	116
0 SPREAD ON RAMP FROM CROSSROAD TO FWY 1 SPREAD OFF RAMP FROM FWY TO CROSSROAD 2 Tight on Ramp From Crossroad to fwy 3 Tight off Pamp From Fuv to Cporserad	16	18	420	ŝ	76
1 SPREAD OFF RAMP FROM FUY TO CROSSROAD 2 TIGHT ON RAMP FROM CROSSROAD TO FUY 3 TIGHT OFF PAMP FROM FUY TO CPOASPOAD		-	118	4	7
2 TIGHT ON RAMP FROM CROSSROAD TO FWY 3 TIGHT OFF BAMP FROM FUY TO CPOSSDOAD		2	231	м	22
3 TIGHT DEE DAMP EDOM EUY TO CONSCONAN	2	2	83	2	-
		ñ	96	2	2
4 LOOP ON RAMP FROM CROSSROAD TO FWY	1	2	88		-
5 LOOP OFF RAMP FROM FWY TO CROSSROAD		2	92	-	4
6 COLLECTOR DISTRIBUTOR			38		-
7 ON RAMP FROM SERVICE RD TO FWY			29		
8 OFF RAMP FROM FWY TO SERVICE RD		4	65	-	
9 SERVICE RD FROM OFF RAMP TO CROSSROAD	-	-	63		2
O SERVICE RD FROM CROSSROAD TO ON RAMP	3	8	67	-	
1 ON RAMP FROM CROSSROAD TO CD			12	-	
2 OFF RAMP FROM CD			13		
3 RAMP FROM CD TO CD			4		-
4 OFF RAMP FROM CD TO SERVICE RD			2	-	
5 ON RAMP FROM SERVICE RD TO CD					
6 DIRECTIONAL LOOP RAMP			35		
7 DIRECTIONAL RAMP		-	215	4	6
8 LOOP RAMP FROM CD TO CD			4		
3 LOOP RAMP FROM CD TO CROSSROAD			4		
4 LOOP RAMP FROM CROSSROAD TO CD			80		
5 OFF RAMP FROM FUY TO CD			6		2
6 ON RAMP FROM CD TO FWY			13		
7 TURNING ROADWAY			6		
8 LOOP RAMP FROM FWY TO CD			-		
9 RAMP FROM SERVICE RD TO SERVICE RD			2		
1 SERVICE RD		-	14		
2 OTHER			5		

Table IV.6b Total number of Accidents by Each type of Accidents and Interchange Elements

NB MAINLINE SB MAINLINE EB MAINLINE WB MAINLINE CROSSROAD SPREAD ON RAMP FROM CROSSROAD TO FWY		HEAU-UN	ANGLE STRAIGHT	REAR-END	ANGLE TURN
SB MAINLINE EB MAINLINE WB MAINLINE CROSSROAD SPREAD ON RAMP FROM CROSSROAD TO FWY	-	16	19	466	-
EB MAINLINE WB MAINLINE CROSSROAD SPREAD ON RAMP FROM CROSSROAD TO FWY	-	11	ø	437	×
WB MAINLINE CROSSROAD SPREAD ON RAMP FROM CROSSROAD TO FWY		8	4	977	t
CROSSROAD SPREAD ON RAMP FROM CROSSROAD TO FWY		:	16	429	6
SPREAD ON RAMP FROM CROSSROAD TO FWY	22	67	244	755	207
		-	t	64	2
SPREAD OFF RAMP FROM FWY TO CROSSROAD	-	6	8	266	13
TIGHT ON RAMP FROM CROSSROAD TO FWY		2	7	62	2
TIGHT OFF RAMP FROM FWY TO CROSSROAD	2	2	0	192	6
LOOP ON RAMP FROM CROSSROAD TO FWY		-		50	-
LOOP OFF RAMP FROM FWY TO CROSSROAD	2	6	2	94	-
COLLECTOR DISTRIBUTOR			ŝ	55	2
ON RAMP FROM SERVICE RD TO FUY			6	105	
OFF RAMP FROM FWY TO SERVICE RD		2	2	123	-
SERVICE RD FROM OFF RAMP TO CROSSROAD	•	2	95	188	26
SERVICE RD FROM CROSSROAD TO ON RAMP	6		81	134	24
ON RAMP FROM CROSSROAD TO CD			-	24	
OFF RAMP FROM CD			-	16	
RAMP FROM CD TO CD				2	
OFF RAMP FROM CD TO SERVICE RD					
ON RAMP FROM SERVICE RD TO CD				2	
DIRECTIONAL LOOP RAMP		-		7	
DIRECTIONAL RAMP	-	6	15	207	t
LOOP RAMP FROM CD TO CD				m	
LOOP RAMP FROM CD TO CROSSROAD		-		4	
LOOP RAMP FROM CROSSROAD TO CD			-	7	
OFF RAMP FROM FWY TO CD			-	20	-
ON RAMP FROM CD TO FWY				10	-
TURNING ROADWAY			-	4	
LOOP RAMP FROM FUY TO CD				-	
RAMP FROM SERVICE RD TO SERVICE RD				6	
SERVICE RD	£		28	78	11
OTHER			4	6	-

Table IV.6c Total number of Accidents by Each type of Accidents and Interchange Elements

NB MAINLINE	SIDESWIPE SAME	REAR-END LEFT	REAR-END RIGHT	OTHER DRIVE	ANGLE DRIVE
	21		-	£	-
SB MAINLINE	8	6	2	-	-
EB MAINLINE	6	7	2		
WB MAINLINE	14	4	6	-	
CROSSROAD	80	95	34	62	<b>5</b> 7
I SPREAD ON RAMP FROM CROSSROAD TO FWY		-	-		
SPREAD OFF RAMP FROM FWY TO CROSSROAD	-	2	E		
LIGHT ON RAMP FROM CROSSROAD TO FWY	4	2			
I TIGHT OFF RAMP FROM FWY TO CROSSROAD	4	-	13		
LOOP ON RAMP FROM CROSSROAD TO FWY			-		
LOOP OFF RAMP FROM FWY TO CROSSROAD	-	-	t		
COLLECTOR DISTRIBUTOR	2	×			
ON RAMP FROM SERVICE RD TO FWY	-				
I OFF RAMP FROM FWY TO SERVICE RD	-	2	4		
> SERVICE RD FROM OFF RAMP TO CROSSROAD	11	21	13	r	6
I SERVICE RD FROM CROSSROAD TO ON RAMP	4	25	13	64	2
ON RAMP FROM CROSSROAD TO CD	-	-			
COFF RAMP FROM CD		-			
RAMP FROM CD TO CD					
OFF RAMP FROM CD TO SERVICE RD					
ON RAMP FROM SERVICE RD TO CD					
DIRECTIONAL LOOP RAMP	-	-			
<pre>&gt; DIRECTIONAL RAMP</pre>	5	~	-	2	
I LOOP RAMP FROM CD TO CD					
LOOP RAMP FROM CD TO CROSSROAD					
LOOP RAMP FROM CROSSROAD TO CD					
OFF RAMP FROM FUY TO CD	-				
ON RAMP FROM CD TO FWY	-		-		
TURNING ROADWAY					
LOOP RAMP FROM FWY TO CD					
) RAMP FROM SERVICE RD TO SERVICE RD					
SERVICE RD		8	8		-
C OTHER		3			

Total number of Accidents by Each type of Accidents and Interchange Elements Table IV.6d

01 NB MAINLINE 02 SB MAINLINE 03 EB MAINLINE 04 UB MAINLINE 04 UB MAINLINE 09 CROSSROAD 10 SPREAD ON RAMP FROM FUY TO CROSSROAD 11 SPREAD OFF RAMP FROM FUY TO CROSSROAD 12 TIGHT OFF RAMP FROM FUY TO CROSSROAD 13 TIGHT OFF RAMP FROM FUY TO CROSSROAD 14 LOOP ON RAMP FROM FUY TO CROSSROAD 15 LOOP OFF RAMP FROM FUY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	2 55 -				
02 SB MAINLINE 03 EB MAINLINE 04 WB MAINLINE 09 CROSSROAD 10 SPREAD ON RAMP FROM CROSSROAD TO FWY 11 SPREAD OFF RAMP FROM FWY TO CROSSROAD 12 TIGHT OFF RAMP FROM FWY TO CROSSROAD 13 TIGHT OFF RAMP FROM FWY TO CROSSROAD 14 LOOP ON RAMP FROM FWY TO CROSSROAD 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	2 5 2 L				
03 EB MAINLINE 04 WB MAINLINE 09 CROSSROAD 10 SPREAD ON RAMP FROM CROSSROAD TO FWY 11 SPREAD OFF RAMP FROM FWY TO CROSSROAD 12 TIGHT ON RAMP FROM FWY TO CROSSROAD 13 TIGHT OFF RAMP FROM FWY TO CROSSROAD 14 LOOP ON RAMP FROM FWY TO CROSSROAD 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	5 c -	2	-		
04 WB MAINLINE 09 CROSSROAD 10 SPREAD ON RAMP FROM CROSSROAD TO FWY 11 SPREAD OFF RAMP FROM FWY TO CROSSROAD 12 TIGHT ON RAMP FROM FWY TO CROSSROAD 13 TIGHT OFF RAMP FROM FWY TO CROSSROAD 14 LOOP ON RAMP FROM FWY TO CROSSROAD 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	2 5 1 2		-		
09 CROSSROAD 10 SPREAD ON RAMP FROM CROSSROAD TO FWY 11 SPREAD OFF RAMP FROM FWY TO CROSSROAD 12 TIGHT ON RAMP FROM FWY TO CROSSROAD 13 TIGHT OFF RAMP FROM FWY TO CROSSROAD 14 LOOP ON RAMP FROM FWY TO CROSSROAD 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	- 2 -	3	2		
10 SPREAD ON RAMP FROM CROSSROAD TO FUY 11 SPREAD OFF RAMP FROM FUY TO CROSSROAD 12 TIGHT ON RAMP FROM CROSSROAD TO FUY 13 TIGHT OFF RAMP FROM FUY TO CROSSROAD 14 LOOP ON RAMP FROM FUY TO CROSSROAD 15 LOOP OFF RAMP FROM FUY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	1 2	6	100	10	10
<ol> <li>SPREAD OFF RAMP FROM FUY TO CROSSROAD</li> <li>TIGHT ON RAMP FROM CROSSROAD TO FUY</li> <li>TIGHT OFF RAMP FROM FUY TO CROSSROAD</li> <li>LOOP ON RAMP FROM FUY TO CROSSROAD</li> <li>LOOP OFF RAMP FROM FUY TO CROSSROAD</li> <li>COLLECTOR DISTRIBUTOR</li> </ol>	-		2		-
12 TIGHT ON RAMP FROM CROSSROAD TO FWY 13 TIGHT OFF RAMP FROM FWY TO CROSSROAD 14 LOOP ON RAMP FROM FWY TO CROSSROAD 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR	-	2		-	80
<ul> <li>13 TIGHT OFF RAMP FROM FWY TO CROSSROAD</li> <li>14 LOOP ON RAMP FROM CROSSROAD TO FWY</li> <li>15 LOOP OFF RAMP FROM FWY TO CROSSROAD</li> <li>16 COLLECTOR DISTRIBUTOR</li> </ul>	•		2	-	
14 LOOP ON RAMP FROM CROSSROAD TO FWY 15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR			-	-	2
15 LOOP OFF RAMP FROM FWY TO CROSSROAD 16 COLLECTOR DISTRIBUTOR			Ļ		2
16 COLLECTOR DISTRIBUTOR					N
	2				-
17 ON RAMP FROM SERVICE RD TO FWY					
18 OFF RAMP FROM FWY TO SERVICE RD				-	
19 SERVICE RD FROM OFF RAMP TO CROSSROAD	7	-	7	7	2
20 SERVICE RD FROM CROSSROAD TO ON RAMP	8		10	ຍ	-
21 ON RAMP FROM CROSSROAD TO CD					
22 OFF RAMP FROM CD					
23 RAMP FROM CD TO CD					
24 OFF RAMP FROM CD TO SERVICE RD					
25 ON RAMP FROM SERVICE RD TO CD					
26 DIRECTIONAL LOOP RAMP					
27 DIRECTIONAL RAMP	2	4			
28 LOOP RAMP FROM CD TO CD					
33 LOOP RAMP FROM CD TO CROSSROAD					
34 LOOP RAMP FROM CROSSROAD TO CD					
35 OFF RAMP FROM FWY TO CD				-	
36 ON RAMP FROM CD TO FWY				-	
37 TURNING ROADWAY					
38 LOOP RAMP FROM FWY TO CD					
39 RAMP FROM SERVICE RD TO SERVICE RD					
41 SERVICE RD 42 OTHER	-		2	٣	-

Table IV.6e Total number of Accidents by Each type of Accidents and Interchange Elements

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	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
8	MISCELLANEOUS SINGLE VEHICLE	148	19	23	46 200
010 020	OVERTURN HIT TRAIN	564	8/	UCL	169
030	HIT PARKED VEHICLE	87	48	15	26
048	BACKING	¢	19	14	29
049	PARKING	11	16	£	
020	PEDESTRIAN	δ	18	6	14
090	FIXED OBJECT	1239	420	331	491
020	OTHER OBJECT	63	5	7	7
080	ANIMAL	547	64	٥	30
060	BICYCLE	2	22		5
141	HEAD - ON	46	67	4	19
144	ANGLE STRAIGHT	48	244	17	26
147	REAR-END	1778	755	308	666
-1 244	ANGLE TURN	14	207	6	22
0 342 0 7	SIDESWIPE SAME	52	8	6	8
345	REAR-END LEFT TURN	18	95	3	6
346	REAR-END RIGHT TURN	11	34	4	32
440	OTHER DRIVE	5	62		
777	ANGLE DRIVE	2	84		
147	REAR-END DRIVE	2	115	3	
543	SIDESUIPE OPPOSITE	7	6 6		2
545	HEAD-ON LEFT TURN	4	100	5	2
645	DUAL LEFT TURN	-	10	2	3
646	DUAL RIGHT TURN		10	3	12
101A	AL NUMBER OF ACCIDENTS	4464	2536	919	1616

.

Table IV.7 Accident types by Collapsed interchange elements



	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
0 MISCELLANEOUS SINGLE VEHICLE	2	-		-
0 OVERTURN	3			
U HII IKAIN	•			
U HIT PARKED VEHICLE B RACKING				
D PARKING	-			
) PEDESTRIAN				-
) FIXED OBJECT	\$	£	m	4
D OTHER OBJECT				-
) ANIMAL	8			-
) BICYCLE				
I HEAD-ON				
4 ANGLE STRAIGHT		-		
7 REAR-END	4	3		4
ANGLE TURN	-	5		
SIDESWIPE SAME				
REAR-END LEFT TURN		2		
S REAR-END RIGHT TURN				
DITHER DRIVE				
ANGLE DRIVE				
REAR-END DRIVE				
SIDESWIPE OPPOSITE				-
HEAD-ON LEFT TURN				
DUAL LEFT TURN				
DUAL RIGHT TURN				
AL NUMBER OF ACCIDENTS	26	15	3	13
4BER OF INTERCHANGES = 5				
DF ACCIDENTS / # OF INTERCHANGES	5.2	£	0.6	2.6

Accident types by Collapsed interchange elements of Urban group 1 Table IV.8

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000	MISCELLANEOUS SINGLE VEHICLE	∞ √	-	1	۰ <b>۰</b> ۳
020	HIT TRAIN	5	-	r	n
030	HIT PARKED VEHICLE	4	7	-	
048	BACKING	•	ſ	£	-
040	PARKING Dedeetdiau		2	÷	٣
	FILED OR LECT	- Y	+ <del>C</del>	- 22	ر کړ
020	OTHER OBJECT	4	ł	]	5-
080	ANIMAL	2			
060	BICYCLE	Ļ	2		2
141	HEAD-ON	4	З		-
144	ANGLE STRAIGHT	11	28	-	-
147	REAR-END	183	63	72	88
1 244	ANGLE TURN	2	14		-
342	SIDESUIPE SAME	6	2	4	2
345	REAR-END LEFT TURN	-	8	-	S
346	REAR-END RIGHT TURN	м	3		4
440	OTHER DRIVE		Э		
444	ANGLE DRIVE		12		
447	REAR-END DRIVE		12	•	
543	SIDESWIPE OPPOSITE				-
545	HEAD-ON LEFT TURN		6	-	
645	DUAL LEFT TURN				-
646	DUAL RIGHT TURN		-		
TOTA	IL NUMBER OF ACCIDENTS	293	183	113	152
NUMB	her of interchanges = 50				
		č	Ì	č	č
±0 #	· Accidents / # Of Interchanges	98°.C	3.00	7.00	2.04

Accident types by Collapsed interchange elements of Urban group 2 Table IV.9

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
l g	MISCELLANEOUS SINGLE VEHICLE	2		-	-
010	OVERTURN	4	-	6	2
020	HIT TRAIN				
030	HIT PARKED VEHICLE	2	£	-	2
048	BACKING		2	2	2
049	PARKING				
050	PEDESTRIAN				-
090	FIXED OBJECT	40	6	27	26
020	OTHER OBJECT	2		2	
080	ANIMAL	6			
060	BICYCLE		3		
141	HEAD-ON	~	Ŧ		2
144	ANGLE STRAIGHT		2		1 10
147	REAR-FND	100	55	16	3,8
244	ANGLE TURN	) )	10	)	1
342	SIDESWIPE SAME	2			
345	REAR-END LEFT TURN		2		
346	REAR-END RIGHT TURN		£		
440	OTHER DRIVE				
777	ANGLE DRIVE		£		
447	REAR-END DRIVE		3		
543	SIDESUIPE OPPOSITE	-			
545	HEAD-ON LEFT TURN		£		
645	DUAL LEFT TURN				
646	DUAL RIGHT TURN		3		-
101	AL NUMBER OF ACCIDENTS	162	105	58	82
NUME	BER OF INTERCHANGES = 17				
- - +	E ACCIDENTE / # OF INTEDCUANCLE	0 53	0, 1		<b>C</b> 0 7
5	T ACCIDENTS / # OF INTERCHANGES	cc.v	0.10	14.0	4.02

Table IV.10 Accident types by Collapsed interchange elements of Urban group 3

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
8 5 6	MISCELLANEOUS SINGLE VEHICLE OVERTURN	0 0	- v	-	- M
020	HIT TRAIN HIT PARKED VEHICLE PACKINC	2	12		- 0
040	PARKING PERKING	-	- /~	٢	L
090		49	× Ø	=	17
080					-
141	BICICCE HEAD-ON		-	-	
144	ANGLE STRAIGHT	2	34	2	;
147	REAR-END Angle Tippu	122	24	21	33
342	SIDESWIPE SAME	τ, η	r		
345	REAR-END LEFT TURN		2		'
546 440	REAR-END RIGHT TURN Other Drive		<b>5</b> 4		Ś
444	ANGLE DRIVE		Ň		
547 547	REAR-END DRIVE SIDESULIDE ODDOSITE		4 -		
545	HEAD-ON LEFT TURN		7		
645 646	DUAL LEFT TURN DUAL RIGHT TURN		-	-	
101A	AL NUMBER OF ACCIDENTS	199	128	38	62
NUMB	3ER OF INTERCHANGES = 38				
# OF	F ACCIDENTS / # OF INTERCHANGES	5.24	3.37	٢	1.63

Table IV.11 Accident types by Collapsed interchange elements of Urban group 4

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
8	MISCELLANEOUS SINGLE VEHICLE			- 1	
010	DOVERTURN	21		Ś	٥
030	HIT PARKED VEHICLE	Ś	S	-	
048	BACKING		4	1	
049	PARKING		-		
020	) PEDESTRIAN		2		
090	I FIXED OBJECT	54	13	8	11
070	OTHER OBJECT	-			
080	) ANIMAL	-			
80	BICYCLE .				
141	HEAD - ON	2	2		
144	ANGLE STRAIGHT	£	21	1	2
147	REAR-END	101	40	29	36
244	ANGLE TURN		4	-	
342	SIDESWIPE SAME	2			۴
345	REAR-END LEFT TURN		¢		
346	REAR-END RIGHT TURN				-
440	OTHER DRIVE		2		
777	ANGLE DRIVE		-		
447	REAR-END DRIVE		10		
543	SIDESWIPE OPPOSITE	-			
545	HEAD-ON LEFT TURN		5		
645	DUAL LEFT TURN				
646	DUAL RIGHT TURN				
I ji	AL NUMBER OF ACCIDENTS	187	116	45	57
NUME	IBER OF INTERCHANGES = 22				
ō #	)F ACCIDENTS / # OF INTERCHANGES	8.50	5.27	2.05	2.59

Table IV.12 Accident types by Collapsed interchange elements of Urban group 5

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	DEF-RAMP UNIT
8	MISCELLANEOUS SINGLE VEHICLE	ę			
010	OVERTURN	4		2	5
020	HIT TRAIN				
030	HIT PARKED VEHICLE			-	£
048	BACKING			-	1
070	PARKING		2		
020	PEDESTRIAN	-	2		-
090	FIXED OBJECT	31	8	12	13
070	OTHER OBJECT	۴	-		-
080	ANIMAL	5			
060	BICYCLE		-		
141	HEAD - ON	3	+		3
144	ANGLE STRAIGHT		8	2	-
147	REAR-END	53	19	11	29
1 244	ANGLE TURN		2	-	2
342	SIDESWIPE SAME	2		-	
345	REAR-END LEFT TURN	2	÷		
346	REAR-END RIGHT TURN		-		-
440	OTHER DRIVE		-		
777	ANGLE DRIVE		3		
147	REAR-END DRIVE		2		
543	SIDESWIPE OPPOSITE	2			
545	HEAD-ON LEFT TURN		7	-	
645	DUAL LEFT TURN				
646	DUAL RIGHT TURN		-		
101	AL NUMBER OF ACCIDENTS	110	60	35	60
	368 OF INTEDCHANCES - 10				
	DEN OF INTENCIONNES - 10				
4 OF	F ACCIDENTS / # OF INTERCHANGES	11	6	3.5	6

Table IV.13 Accident types by Collapsed interchange elements of Urban group 6


	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
00	10 MISCELLANEOUS SINGLE VEHICLE	∩ ₽-		~	<del>د</del> د
0	20 HIT TRAIN	J		ı	,
0	ISO HIT PARKED VEHICLE	-	-		-
0	148 BACKING				
0	149 PARKING				
0	150 PEDESTRIAN				
0	160 FIXED OBJECT	24	6	11	6
0	170 OTHER OBJECT				
0	180 ANIMAL	5			
0	90 BICYCLE	-	-		
-	41 HEAD-ON		-		Ļ
-	44 ANGLE STRAIGHT	-	5	-	
-	47 REAR-END	53	38	8	13
2	44 ANGLE TURN		8		
m 77	42 SIDESWIPE SAME				
m 7	45 REAR-END LEFT TURN		2		
M	46 REAR-END RIGHT TURN	2	ъ		2
4	40 OTHER DRIVE		3		
4	44 ANGLE DRIVE		5		
4	47 REAR-END DRIVE		-		
ŝ	43 SIDESUIPE OPPOSITE				
ŝ	45 HEAD-ON LEFT TURN		-		-
¢	45 DUAL LEFT TURN		-		
9	46 DUAL RIGHT TURN				
Т	OTAL NUMBER OF ACCIDENTS	93	78	22	30
z	UMBER OF INTERCHANGES = 12				
#	OF ACCIDENTS / # OF INTERCHANGES	7 75	6.5 6	1.83	2.5
		-		3	

Table IV.14 Accident types by Collapsed interchange elements of Urban group 7

	ACI	CIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
_	000 MISCELLANEO 010 OVERTURN	US SINGLE VEHICLE	γ	£	~	2
	020 HIT TRAIN					
	030 HIT PARKED	VEHICLE	-			1
-	048 BACKING			-	•	
	050 PEDESTRIAN				_	
	060 FIXED OBJEC	T	21	16	11	S
	070 OTHER OBJEC	T	-			
	080 ANIMAL		3			
	090 BICYCLE					
	141 HEAD-ON					
	144 ANGLE STRAIN	GHT	٢	2		
	147 REAR-END		35	38	3	6
7	244 ANGLE TURN			2		-
78	342 SIDESWIPE SI	AME				
	345 REAR-END LE	FT TURN				
	346 REAR-END RI	GHT TURN	t-		۲	-
-	440 OTHER DRIVE					
	444 ANGLE DRIVE			•		
	447 REAR-END DR.	IVE		-		
	543 SIDESWIPE OF	PPOSITE				
	545 HEAD-ON LEF	T TURN	1	-		
-	645 DUAL LEFT TI	URN				
	646 DUAL RIGHT	TURN				
	TOTAL NUMBER OF	ACCIDENTS	22	65	24	19
	NUMBER OF INTERCI	HANGES = 7				
	# OF ACCIDENTS /	# OF INTERCHANGES	10.3	67.6	3.43	2,71
					•	

Table IV.15 Accident types by Collapsed interchange elements of Urban group 8



	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCELLANEOUS SINGLE VEHICLE	1			3
010 OVERTURN	-		4	5
D20 HIT TRAIN				
330 HIT PARKED VEHICLE	2		£	
048 BACKING		1	-	
049 PARKING				
J50 PEDESTRIAN				
060 FIXED OBJECT	20	S	13	8
170 OTHER OBJECT	3		-	-
380 ANIMAL	F			
090 BICYCLE				-
141 HEAD-ON	-			м
144 ANGLE STRAIGHT	-	4		-
147 REAR-END	37	26	14	17
244 ANGLE TURN		2	2	-
42 SIDESWIPE SAME	-	-		-
45 REAR-END LEFT TURN	-	2	-	
546 REAR-END RIGHT TURN		2		
40 OTHER DRIVE		3		
44 ANGLE DRIVE				
47 REAR-END DRIVE		-	-	
43 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN	-	4		
245 DUAL LEFT TURN 246 DUAL RIGHT TURN				
OTAL NUMBER OF ACCIDENTS	70	56	38	17
UUMBER OF INTERCHANGES = 8				
# OF ACCIDENTS / # OF INTERCHANGES	8.75	7	4.75	5.13

Table IV.16 Accident types by Collapsed interchange elements of Urban group 9

.

ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCELLANEOUS SINGLE VEHICLE	4			1
010 OVERTURN	8	2	2	
020 HIT TRAIN				
030 HIT PARKED VEHICLE	-	2		-
048 BACKING				
049 PARKING	2			
050 PEDESTRIAN				-
060 FIXED OBJECT	39	13	0	10
070 OTHER OBJECT	2			
080 ANIMAL				
090 BICYCLE				
141 HEAD-ON	-	-		2
144 ANGLE STRAIGHT	£	12	-	ŝ
147 REAR-END	26	33	6	11
244 ANGLE TURN		6		
342 SIDESWIPE SAME	8			
345 REAR-END LEFT TURN		4		
346 REAR-END RIGHT TURN	<b>F</b>			
440 OTHER DRIVE		-		
444 ANGLE DRIVE		-		
447 REAR-END DRIVE				
543 SIDESWIPE OPPOSITE	-			
545 HEAD-ON LEFT TURN		2		
645 DUAL LEFT TURN		-		
646 DUAL RIGHT TURN				
TOTAL NUMBER OF ACCIDENTS	165	78	14	31
NUMBER OF INTERCHANGES = 12				
A OF ADDITION A H OF STATEOUS				

Table IV.17 Accident types by Collapsed interchange elements of Urban group 10

	-	-
<b>-</b> -	-	
-	-	
-	-	
-	-	
-	-	
-	-	
-	-	
4		4
6	-	5
9	-	ŝ
	v v	~ ~ ~ ~

Table IV.18 Accident types by Collapsed interchange elements of Urban group 11

ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCELLANEOUS SINGLE VEHICLE				-
010 OVERTURN		-		
OCU HII IKAIN				
USU HIT PARKED VEHICLE				
U48 BACKING				
049 PARKING				
050 PEDESTRIAN				
060 FIXED OBJECT		-	1	
070 OTHER OBJECT	2			
080 ANIMAL				
090 BICYCLE				
141 HEAD-ON				
142 ANGLE STRAIGHT				
14.7 DEAD-END	, ,	7		7
TT ALAR LAU	r	r		r
144 ANGLE LUKN				
54.2 SIDESWIPE SAME				
345 REAR-END LEFT TURN				
346 REAR-END RIGHT TURN				
440 OTHER DRIVE				
444 ANGLE DRIVE				
447 REAR-END DRIVE				
543 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN				
646 DUAL RIGHT TURN				
TOTAL NUMBER OF ACCIDENTS	\$	\$	F	5
NUMBER OF INTERCHANGES = 1				
# OF ACCIDENTS / # OF INTEDCHANCES	V	v	·	Ľ
# UF ALLIDENIS / # UF INIEKCHANGES	0	0		

Table IV.18 Accident types by Collapsed interchange elements of Urban group 11

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
l g	MISCELLANEOUS SINGLE VEHICLE				
010	OVERTURN HIT TPAIN	2	2	-	
030	HIT PARKED VEHICLE	~	-		
048	BACKING				
049	PARKING		-		
020	PEDESTRIAN				
090	FIXED OBJECT	3	3	2	5
070	OTHER OBJECT				
080	ANIMAL				
060	BICYCLE				
141	HEAD-ON				
144	ANGLE STRAIGHT	-		S	
147	REAR-END	22	16	13	5
244	ANGLE TURN		4		
342	SIDESWIPE SAME		-		
345	REAR-END LEFT TURN		-		
346	REAR-END RIGHT TURN				
440	OTHER DRIVE		2		
777	ANGLE DRIVE		-		
447	REAR-END DRIVE				
543	SIDESWIPE OPPOSITE				
545	HEAD-ON LEFT TURN				
645	DUAL LEFT TURN	-	-		
040	UUAL KIGHI IUKN				
101	AL NUMBER OF ACCIDENTS	30	33	19	10
NUM	BER OF INTERCHANGES = 3				
0 #	E ACCIDENTS / # DF INTERCHANGES	10	11	57.9	1, 73

Table IV.19 Accident types by Collapsed interchange elements of Urban group 12

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000	MISCELLANEOUS SINGLE VEHICLE OVERTURN	17 88	۲ ۲	ωţ	ъ 5
020	HIT TRAIN	3	2	2	2
030	HIT PARKED VEHICLE	5	4	1	S
048	BACKING				4
049	PARKING	-			
020	PEDESTRIAN	2	Ļ		<b>~</b>
090	FIXED OBJECT	126	74	17	45
020	CTHER OBJECT	7		-	
080	ANIMAL	184	37	4	11
060	BICYCLE		-		
141	HEAD-ON		11		
144	ANGLE STRAIGHT	1	17	2	
147	REAR-END	93	35	-	30
244	ANGLE TURN	-	13		
0 342	SIDESUIPE SAME	S			-
345	REAR-END LEFT TURN	2	6		
346	REAR-END RIGHT TURN		-		M
440	OTHER DRIVE	1	2		
777	ANGLE DRIVE		6		
147	REAR-END DRIVE		7		
543	SIDESUIPE OPPOSITE				-
545	HEAD-ON LEFT TURN		8		
645	DUAL LEFT TURN				
646	DUAL RIGHT TURN			-	-
Į	AL NUMBER OF ACCIDENTS	533	239	42	125
NUME	BER OF INTERCHANGES = 108				
10 #	F ACCIDENTS / # OF INTERCHANGES	4.94	2.21	0.39	1.16

Table IV.20 Accident types by Collapsed interchange elements of Rural group 1

OID         MISCELLANEOUS SINCLE VENICLE         1         2         2         2         2         7 <th< th=""><th></th><th>ACCIDENT TYPES</th><th>MAINLINE UNIT</th><th>CROSSROAD UNIT</th><th>ON-RAMP UNIT</th><th>OFF-RAMP UNIT</th></th<>		ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
0:0     HIT TANN       0:0     HIT TANN       0:0     HIT PARED VENICLE     10       0:0     BACKING       0:0     BACKING       0:0     BACKING       0:0     BACKING       0:0     BACKING       0:0     FIERD GALET       0:0     FIERD GALET       0:0     FIERD GALET       0:0     FICULE       0:	85	MISCELLANEOUS SINGLE VEHICLE OVERTURN	12 31		~ m	2
030     HIT PARKED VEHICLE     10     3       040     BACKING     2     1       050     FERSTRIM     71     21     13     29       050     FERSTRIM     71     21     13     29       050     FIRED OBJECT     71     21     11     1       050     FIRED OBJECT     71     21     13     29       050     FIRED OBJECT     71     5     11     1       050     MIRL     6     35     1     1       050     MIRL     6     35     1     1       050     MIRL     6     16     6     29       050     MIRL     6     16     6     29       14     ANGLE TURN     1     13     6     29       244     MIRL     1     13     5     5     5       244     MIRL     1     13     5     5     1       245     MIRL     1     13     5     5     1       246     MIRL     1     1     1     1       246     MIRL     1     1     1     1       246     MIRL     1     1     1     1 </td <th>020</th> <td>HIT TRAIN</td> <td></td> <td></td> <td>I</td> <td></td>	020	HIT TRAIN			I	
0.68     BACKING     2     1     1       0.69     PARKING     05     PARKING     2     1     1       0.60     PERSTRIAL     0     1     13     29       0.60     FIXED OBJECT     9     1     13     29       0.70     OTHER OBJECT     9     1     1     1       0.70     OTHER OBJECT     9     1     1     2       0.70     OTHER OBJECT     6     5     1     1       0.70     OTHER OBJECT     6     5     1     1       0.71     HER OBJECT     6     7     5     1     1       0.71     HER OFLIC     7     7     5     1     1     1       0.71     HER OFLIC     5     1     1     1     1       1.41     HELO OBLIC     5     1     1     1     1       3.45     REAR-END LEFT TURN     2     5     1     1     1       3.45     REAR-END LEFT TURN     2     5     1     1     1       3.45     REAR-END LEFT TURN     2     5     1     1     1       3.45     DRILE DRIVE     5     5     1     1     1	030	HIT PARKED VEHICLE	10	3		
049     PARKING     1       050     FRESTRIAN     71     21     13     29       050     OTHER 004ECT     9     1     1     1       050     OTHER 004ECT     9     15     1     1       070     OTHER 004ECT     9     15     1     1       070     OTHER 004ECT     64     15     1     1       070     014     RAD-ON     4     5     1     1       071     HEAD-ON     2     16     6     29       071     HEAD-ON     1     13     6     29       141     RAD-EN     1     13     6     29       147     RAN-END     1     13     6     29       24     ANGE TURN     2     3     3       345     STRESURE SAME     1     1     1       346     REAN-END IEIT TURN     2     3     3       346     REAN-END IEIT TURN     2     3     3       346     REAN-END IEIT TURN     2     3     3       346     REAN-END IEIT TURN     3     3     3       346     REAN-END IEIT TURN     3     3     3       346     REAN-END IEIT	048	BACKING		2		-
500     PEDESTRIAN     71     21     13     29       000     OTHER OBJECT     7     7     5     1     1       070     OTHER OBJECT     64     15     1     1     1       070     BICTCLE     64     15     1     1     1       070     BICTCLE     64     16     1     1       141     HEAD-ON     1     13     6     29       142     ANGLE STRAIGHT     2     16     1     1       144     ANGLE STRAIGHT     2     16     1     1       144     ANGLE STRAIGHT     2     16     1     1       144     ANGLE STRAIGHT     2     1     1     1       345     REAR-END     1     1     1     1       345     SIDESUIPE SAME     2     3     3       346     NOHER OF NER     3     3     3       347     ANGLE DITURN     3     3     3       346     DUAL LEFT TURN     5 <t< td=""><th>049</th><td>PARKING</td><td></td><td></td><td>-</td><td></td></t<>	049	PARKING			-	
000       FIXED OBJECT       71       21       13       29         070       OTHER OBJECT       9       5       1       1         070       OTHER OBJECT       64       15       1       1         070       OTHER OBJECT       64       15       1       1         070       DITCLE       64       15       1       1       1         14       HEAD-ON       2       16       6       29       1         14       HEAD-ON       5       13       6       29       1	020	PEDESTRIAN				
070       OTHER OBJECT       9       1       1         080       ANIML       5       1       1         080       ANIML       6       5       1       1         141       HEAD-ON       2       16       5       1       1         141       HEAD-ON       2       16       5       1	090	FIXED OBJECT	71	21	13	29
080       ANIMAL       64       15       1       1         070       BICYCLE       3       3       3         141       HEAD-OND       5       16       29         142       ANGLE STRAIGHT       2       16       2         147       REAR-END       56       19       6       29         147       REAR-END       56       19       6       29         147       REAR-END       1       13       6       29         345       REAR-END LEFT TURN       2       3       5       5       1       1         345       REAR-END RIGHT TURN       2       3       3       5	020	OTHER OBJECT	6			
000       BICYCLE       3       1         14.1       HEAD-ON       2       16       5         14.1       HEAD-ON       5       19       6       29         14.1       REAR-END       5       19       6       29         24.4       ANGLE TURN       1       13       6       29         34.5       SERR-END LEFT TURN       2       1       1       1         35.5       REAR-END LEFT TURN       2       3       5       1       1       1         35.6       SERR-END LEFT TURN       2       3       5       5       1 <td< td=""><th>080</th><td>ANIMAL</td><td>64</td><td>15</td><td>-</td><td>-</td></td<>	080	ANIMAL	64	15	-	-
1(1) HEAD-ON       1       5       1         1(4) HEAD-ON       2       16       2         1(4) ANGLE STRATIGHT       2       16       2         1(4) ANGLE URN       5       19       6       29         2(4) ANGLE URN       1       13       6       29         2(4) ANGLE URN       1       13       6       2         3(2) State Endo       EFT TUDN       2       3       1       1         3(2) STATE SAME       2       3       3       3       3       3       3         3(2) STATE RAME       2       3	060	BICYCLE		£		
14. ANGLE STRATIGHT       2       16       29       29       29       29       29       29       29       29       29       29       29       29       20       29       29       29       20       29       20       29       20       29       20       29       29       29       20       29       29       20       29       29       20       29       20       29       20       29       20       29       29       20       20       29       29       29       20       20       29       29       20       2	141	HEAD-ON	4	5	-	
147       REAR-END       56       19       6       29         244       MGLE TURN       1       13       6       29         342       REAR-END REIT TURN       2       3       1       1         345       REAR-END REIT TURN       2       3       1       1         346       REAR-END REIT TURN       2       3       1       1         346       REAR-END REIT TURN       2       3       3       3       3         440       OTHER DRIVE       3       3       5       3 <th>144</th> <td>ANGLE STRAIGHT</td> <td>2</td> <td>16</td> <td></td> <td></td>	144	ANGLE STRAIGHT	2	16		
24. ANGLE TURN       1       13       1         342. SIDESWIPE SAME       3       3       1         342. SIDESWIPE SAME       2       3       3         345. REAR-END LEFT TURN       2       3       3         346. REAR-END RIGHT TURN       2       3       3         44. ANGLE DRIVE       5       3       3         44. ANGLE DRIVE       5       1       3         44. ANGLE DRIVE       5       1       3         45. SIDESWIPE OPPOSITE       5       1       1         54. SIDESWIPE OPPOSITE       5       1       1         54. SIDESWIPE OPPOSITE       8       1       1         55. HEAD-ON LEFT TURN       8       1       1         54. SIDLAL LEFT TURN       8       1       1         54. DUAL LEFT TURN       64. DUAL LEFT TURN       1       1         54. SIDLAL LEFT TURN       64. DUAL RIGHT TURN       28       28       74         64. DUAL LEFT TURN       10       29 </td <th>147</th> <td>REAR-END</td> <td>56</td> <td>19</td> <td>6</td> <td>29</td>	147	REAR-END	56	19	6	29
342       SIDESWIPE SAME       3       1       1       3         345       REAR-END LEFT TURN       2       3       3         346       REAR-END RIGHT TURN       2       3       3         346       REAR-END RIGHT TURN       2       3       3         440       OTHER DRIVE       5       1       3         444       AGGE DRIVE       5       1       1       3         445       REAR-END DRIVE       8       1       1       4 <th>244</th> <td>ANGLE TURN</td> <td>-</td> <td>13</td> <td></td> <td>-</td>	244	ANGLE TURN	-	13		-
345       REAR-END LEFT TURN       2       3	342	SIDESWIPE SAME				1
346       REAR-END RIGHT TURN       5	345	REAR-END LEFT TURN	2	3		
440       OTHER DRIVE       5       3         444       ANGLE DRIVE       5       5         447       REAR-END DRIVE       5       5         447       REAR-END DRIVE       5       1         543       SIDESWIPE OPPOSITE       8       1         545       HEAD-ON LEFT TURN       8       1         645       DUAL LEFT TURN       1       1         645       DUAL RIGHT TURN       1       1         645       DUAL RIGHT TURN       262       129       28       74         101AL NUBER OF ACCIDENTS       262       129       28       74         NUBER OF INTERCHANGES = 47       5.7       7.0       0.00       1.57	346	REAR-END RIGHT TURN		-		ю
4.4 ANGLE DRIVE       3         4.7 REAR-END DRIVE       5         5.3 SIDESWIPE OPPOSITE       5         5.4 FEAD-ON LEFT TURN       8       1         5.4 BAD-ON LEFT TURN       8       1         6.4 DUAL LEFT TURN       1       1         6.4 DUAL RIGHT TURN       1       1         6.4 DUAL RIGHT TURN       262       129       28       74         10TAL NUMBER OF ACCIDENTS       262       129       28       74         NUMBER OF INTERCHANGES = 47       5.77       7.4       1.57       1.57	440	OTHER DRIVE		5		
47 REAR-END DRIVE       5         543 SIDESUIPE OPPOSITE       1         545 HEAD-ON LEFT TURN       8       1         645 DUAL LEFT TURN       1       1         646 DUAL RIGHT TURN       1       1         646 DUAL RIGHT TURN       262       129       28       74         10TAL NUMBER OF ACCIDENTS       262       129       28       74         NUMBER OF INTERCHANGES = 47       5.27       2.71       0.40       157	777	ANGLE DRIVE		3		
543       SIDESWIPE OPPOSITE       1       1       1         545       HEAD-ON LEFT TURN       8       1       1         645       DUAL LEFT TURN       1       1       1         645       DUAL LEFT TURN       1       1       1         646       DUAL RIGHT TURN       1       1       1         101AL NUMBER OF ACCIDENTS       262       129       28       74         NUMBER OF INTERCHANGES = 47       1       27       0.40       1<57	147	REAR-END DRIVE		5		
545       HEAD-ON LEFT TURN       8       1         645       DUAL LEFT TURN       1       1         646       DUAL RIGHT TURN       1       7         646       DUAL RIGHT TURN       1       7         646       DUAL RIGHT TURN       129       28       74         101AL NUMBER OF ACCIDENTS       262       129       28       74         NUMBER OF INTERCHANGES = 47       5       27       0.60       157	543	SIDESWIPE OPPOSITE		1		
645 DUAL LEFT TURN 646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS 262 129 28 74 NUMBER OF INTERCHANGES = 47 # OF ACCIDENTS / # OF INTERCHANGES = 47 # OF ACCIDENTS / # OF INTERCHANGES 5 57 2 76 0.60 1.57	545	HEAD-ON LEFT TURN		8	-	
646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS TOTAL NUMBER OF INTERCHANGES = 47 # OF ACTINENTS / # OF INTERCHANGES # OF ACTINENTS / # OF ACTINE	645	DUAL LEFT TURN		1		
TOTAL NUMBER OF ACCIDENTS 262 129 28 74 NUMBER OF INTERCHANGES = 47 # OF ACCIDENTS / # OF INTERCHANGES 5 57 2 72 0 60 1 57	646	DUAL RIGHT TURN				
NUMBER OF INTERCHANGES = 47 # OF ACTINENTS / # OF INTERCHANGES 5 5 5 72 0 40 1 57	Į	AL NUMBER OF ACCIDENTS	262	129	28	74
# VE ACCINENTS / # VE INTEDCUANCES 5 5 2 22 0 60 40 1 57	NUME	BER OF INTERCHANGES = 47				
+ OF AUCTURINS / # OF INTERCHANNES	io #	F ACCIDENTS / # OF INTERCHANGES	5.57	2.74	0.60	1.57

Table IV.21 Accident types by Collapsed interchange elements of Rural group 2

00         000000000000000000000000000000000000		ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
ID         ORDER/REM         23         B         13         14         <	8	MISCELLANEOUS SINGLE VEHICLE	0	2	2	2
0         III TRAIN         7         4         5           0         0         III PARKE VENCLE         7         4         4           0         0         0         0         1         2         1         4           0         0         0         0         0         0         0         0         0         4 <td>10</td> <td>OVERTURN</td> <td>23</td> <td>8</td> <td>13</td> <td>13</td>	10	OVERTURN	23	8	13	13
00         01         The Relevent CLE         7         4         5           00         00         00         00         1         2         1         4           00         00         00         00         1         2         1         3           00         00         00         00         1         2         3         1         8           00         0100         00         1         1         1         1         1           00         0100         04         1         1         1         1         1         1           00         0100         04         1         1         1         1         1         1         1           00         0100         05         1 <t< td=""><td>20</td><td>HIT TRAIN</td><td></td><td></td><td></td><td></td></t<>	20	HIT TRAIN				
0.8 RACING         1         2         1         4           0.9 RACING         1         2         1         3           0.9 RACING         1         2         1         3           0.9 RACING         7         3         3         1         3           0.0 RACING         7         2         1         1         2           0.0 RALE OLICIT         7         2         1         1         2           0.0 RALE OLICIT         3         2         1         1         2           0.0 RALE OLICIT         3         2         1         1         2         1           0.0 RALE TAIN         4         1         1         1         2         1         1         2           0.0 RALE TAIN         3         4         1         1         1         3	20	HIT PARKED VEHICLE	2	4		5
0         Restrict         1         2           0         PRESTRIAL         7         2           0         FIXED OBJECT         7         33         18         34           0         FIXED OBJECT         7         33         18         34           0         FIXED OBJECT         7         33         18         34           0         MARL         41         10         1         7           0         MARL         41         10         1         7           0         MARL         3         4         11         37           0         MARL         5         14         11         37           0         MARL         5         12         1         1         1           1         MARL         1         2         1	87	BACKING		-		4
Deficient         Deficient <thdeficient< th="">         Deficient         <thdeficient< th="">         Deficient         <thdeficient< th=""> <thdeficient< th=""> <thdef< td=""><td>\$</td><td>PARKING</td><td>-</td><td>2</td><td></td><td></td></thdef<></thdeficient<></thdeficient<></thdeficient<></thdeficient<>	\$	PARKING	-	2		
0         FIXE Object         75         33         18         34           00         0.01KR Object         7         1         1         2           00         0.01KR Object         2         1         1         2           00         0.01KR Object         3         1         1         2           00         0.01KR Object         3         2         1         2           0.01KR Object         3         4         1         1         2           1         4         2         1         2         1         2           1         4         2         4         4         1         3         3           1         4         2         4         4         1         3         3           1         2         2         2         2         3         3         3           1         2         3         2         3	20	PEDESTRIAN		2	-	
00 MINR GMECT         2         1         1         2           00 MINR GMECT         1         1         1         1           00 MINR GMECT         1         1         1         1           00 MINR GMECT         1         1         1         1           01 MINR GMECT         1         1         1         1           01 MINR GMECT         2         1         1         1           01 MINR GMECT         3         2         0         11         37           01 MINR GMECT         3         2         0         1         37           01 MINR GMECT         3         2         0         0         11         37           01 MINR GMECT         1         3         2         2         2         3         37           01 MINR GMECT         1         3         3         3         37         37         37         37           01 MINR GMET TORM         1         3         3         3         35         35         35         37         37         37         37         37         37         37         37         37         37         37         37         37	3	FIXED OBJECT	75	33	18	34
00         AVIMAL         6.1         10         1         2           00         00         00         0         0         0         0         0         0         1         <	2	OTHER OBJECT	2	-		
0         BITCLE         1         1           0         BITCLE         1         1           0         BITCLE         1         1           0         BITCLE         1         1           0         BITCLE         2         1           0         BITCLE         2         1           0         BITEL         3         2           0         BITEL         2         0           0         BITEL         2         0           0         BITEL         2         2           0         BITEL         1         2           0         MALE         1         2           1         2         2         2           1         2         2         2           1         2         2         2           1         2         2     <	8	ANIMAL	41	10	-	2
1         HELONO         3         9         1         1         37           2         KARE STRAINE         6         1         37         37           2         KARE TRAINE         6         0         11         37           2         KARE TRAINE         2         9         11         37           2         STREAPEO LET TRAN         1         2         3           2         STREAPEO RET TRAN         1         2         3           2         STREAPEO RET TRAN         1         2         3           3         STREAPEO RET TRAN         1         2         3           4         STREAPEO RET TRAN         1         2         3           5         STREAPEO RET TRAN         1         2         3           4         STREAPEO RET TRAN         1         3         3           5         STREAPEO RET TRAN         1         3         3           4         STREAPEO RET TRAN         1         3         3           5         STREAPEO RET TRAN         1         3         3           6         STREAPEO RET TRAN         1         3         3 <td< td=""><td>8</td><td>BICYCLE</td><td></td><td>-</td><td></td><td>-</td></td<>	8	BICYCLE		-		-
4, Matter Fakulin         4, 1, 1         1, 1         37           4, Matter Fakulin         5         4, 0         11         37           4, Matter Fakulin         5         4, 0         11         37           4, Matter Tusk         2         9         9         11         37           5, Stave Leb Lish Tusk         1         2         2         2         2         3           5, Stave Leb Right         1         2         2         2         3         3           6, Stave Leb Right         1         2         2         2         3         3           6, Matte Roll         1         2         2         2         3         3         3           6, Matte Roll         1         2         2         3 <td< td=""><td>1</td><td>HEAD-ON</td><td>M</td><td>6</td><td></td><td></td></td<>	1	HEAD-ON	M	6		
7         Release         53         40         11         37           2         State         2         2         11         37           2         State         2         2         11         37           2         State         1         2         1         1           2         State         1         2         3         3           3         State         1         2         3         3           4         More         1         2         3         3           4         More         1         2         3         3           4         More         1         2         3         3           5         State         1         1         1         3         3           6         More         1         1         1         3         3           1	3	ANGLE STRAIGHT	4	14		-
4. Matter Tusk         2         9         1           5. Statust tusk         1         2         9         1           6. Statust tusk         1         2         3         3           4. Matte Rive         1         1         6         3           5. Statust ter rusk         1         1         3         3           5. Statust ter rusk         1         1         3         3           6. Duut ter rusk         2         180         4.5         105           6. Duut ter rusk         2         3         3         3	13	REAR-END	85	40	11	15
2         Stetement size         2         9         1           6         Reveal Left Tues         1         2         3           6         Reveal Left Tues         1         2         3           6         Reveal Left Tues         1         2         3           6         Reveal Rotating         1         2         3           6         Reveal Rotating         1         1         0           3         Reveal Rotating         1         1         3           4         Rotating         1         1         3           6         Rotating         1         1         3           6         Rotating         23         180         46         106           6         Males of Accobaris         235         180         46         106           0         Accobaris         235         180         46         106         46         106           0         Accobaris         25.3         4.19         1.07         2.47         2.47	44	ANGLE TURN		6		
5. Rek-lep Left Tuak         1         2         1           6.0 Rek-lep Rupit Tuak         1         2         1           6.0 Rek-lep Rupit Tuak         1         2         2           6.0 Rek-lep Rupit         1         2         2         3           6.0 Rek-lep Rupit         1         1         2         3           6.0 Rupit Entrols         1         1         3           5.1 Rupit Entrols         1         1         3           5.0 Rule Reformance         1         1         3           4.0 Rule Reformance         1         7         3           4.0 Rule Reformance         1         1         3           4.0 Rule Reformances         253         180         4.6         106           Muster of Intreconnects         2.3         4.19         1.07         2.47	42	SIDESUIPE SAME	2			
66         Releve Right Tues         1         2         3           0.01RE ROLL         1         0         8         5           4.4         RAHE-ROL RUL         1         10         0           4.5         RAHE-ROL RUL         1         10         0           4.5         RAHE-ROL RUL         1         1         0           4.5         RAHE-ROL RUL         1         0         0           4.6         DAL RUL         1         3         3           4.6         DAL RUL         1         3         3           4.0         DAL RUL         1         3         3           4.10         N.4         1         3         3           4.10         N.4         1         3         3           AMBER OF ACCIDENTS         253         180         4.0         106           ACCIDENTS         5.33         4.19         1.07         2.47	52	REAR-END LEFT TURN	1	6		-
0.00 THE RAYE         1         8           4 Male RAYE         1         6           7 Revenue         1         1           6 RANE ROTE         1         1           7 RANE ROTE         1         1           6 RANE ROTE         1         1           6 RANE ROTE         1         7           7 REAL REFINE         1         7           6 DUAL REFINE         25         180         46         106           0.1 MARE OF ACCIDENTS         255         180         46         106           ONL MORE OF ACCIDENTS         253         180         46         106           OF ACCIDENTS         5.53         4.19         1.07         2.47	\$	REAR-END RIGHT TURN		2		M
4. Match         1         6           4. Match         1         10           3. Stelene protectine         1         1           3. Stelene protectine         7         7           4. Match         7         7           5. DUAL LEFT THAN         7         3           6. DUAL LEFT THAN         1         7           6. DUAL LEFT THAN         1         3           6. DUAL LEFT THAN         1         3           6. DUAL LEFT THAN         1         3           6. DUAL REINT THAN         1         3           0. ALCIDENTS         255         180         46         106           0. ACCIDENTS / # OF INTERCHANCES         5.03         4.19         1.07         2.47	66	DTHER DRIVE	1	8		
2/         Relie to DRICe         1         10           3         SIGSUP CONTR         7         7           3         SIGSUP CONTR         7         7           3         SIGNUP CONTR         1         3           4         DUAL REFT TORM         1         3           46         DUAL REFT TORM         1         3           40         LINE TORM         1         3           44         DUAL REFT TORM         1         3           46         DUAL REFORMERS         253         180         46         106           UNDER OF ACCIDENTS         253         180         46         106         407         106	44	ANGLE DRIVE		6		
3: Stelework         1           3: Stelework         7           4: Stelework         7           5: Durk LEFT UNW         7           4: Stelework         1           4: Durk LEFT UNW         1           4: Durk Refer of Accidents         255           10: Durk Merce         46           10: Durk Merce         46           10: Durk Merce         46           10: Durk Merce         5.93           4: 19         1.07	47	REAR-END DRIVE	-	10		
State         T         T         S <td>5</td> <td>SIDESWIPE OPPOSITE</td> <td></td> <td>-</td> <td></td> <td></td>	5	SIDESWIPE OPPOSITE		-		
45         DUAL LEFT TONN         1         3           66         DUAL REALT TONN         1         5         3           66         DUAL REALT TONN         1         5         106           01AL MUMER OF ACCIDENTS         255         180         46         106           DUMER OF INTERCHANCES         43         4         107         2.47           OF ACCIDENTS         5.93         4.19         1.07         2.47	52	HEAD-ON LEFT TURN		7		
60         DUAL RIGHT TURN         1         3           71AL WORER OF ACCIDENTS         235         180         4.6         106           AMBER OF INTERCONNECES         4.3         100         4.6         106           AMBER OF INTERCONNECES         4.3         1.07         2.47           OF ACCIDENTS         5.93         4.19         1.07         2.47	\$	DUAL LEFT TURN				
01AL MUMBER OF ACCIDENTS 255 180 46 106 MUBER OF INTERCHANGES = 4.3 OF ACCIDENTS / # OF INTERCHANGES 5.93 4.19 1.07 2.47	\$	DUAL RIGHT TURN		-		3
UNGER OF INTERCHANCES = 43 OF ACCIDENTS / # OF INTERCHANCES 5.93 4.19 1.07 2.47	6	AL NUMBER OF ACCIDENTS	255	180	46	106
OF ACCIDENTS / # OF INTERCHANGES 5.93 4.19 1.07 2.47	N	BER OF INTERCHANGES = 43				
	ö	IF ACCIDENTS / # OF INTERCHANGES	5.93	4.19	1.07	2.47

Table IV.22 Accident types by Collapsed interchange elements of Rural group 3

Statistic states



	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCEI 010 OVERTL	LLANEOUS SINGLE VEHICLE URN	7 16	£		7
020 HIT TI	RAIN	,			
048 BACKIN	ARKED VEHICLE NG	<b>~</b> ~	-		-
049 PARKII	DN D	J	-		
050 PEDES	TRIAN				
060 F1XED	OBJECT	57	14	6	10
070 OTHER	OBJECT	2			
080 ANIMAI		28	4		
090 BICYCI	LE				
141 HEAD-(	NO	1	<del>, -</del>		
144 ANGLE	STRAIGHT		-		
147 REAR-E	END	57	10	2	2
244 ANGLE	TURN		1		
342 SIDESI	WIPE SAME	3			
345 REAR-I	END LEFT TURN	3	2		
346 REAR-E	END RIGHT TURN				
440 OTHER	DRIVE				
444 ANGLE	DRIVE				
447 REAR-E	END DRIVE		-		
543 SIDESI	WIPE OPPOSITE				
545 HEAD-(	ON LEFT TURN				
645 DUAL F	LEFT TURN RIGHT TURN				
TOTAL NUMB	ER OF ACCIDENTS	179	38	16	20
NUMBER OF	INTERCHANGES = 37				
# OF ACCIDE	ENTS / # OF INTERCHANGES	7 - 84	1.03	0.43	0.54
				1	

. . . . . . . . .

Table IV.23 Accident types by Collapsed interchange elements of Rural group 4

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 M	ISCELLANEOUS SINGLE VEHICLE VERTURN				3
020 HI 030 HI	IT TRAIN IT PARKED VEHICLE	~			
048 84	ACKING		-		
049 PJ 050 PE	ARKING Edestrian	-			
060 F1	IXED OBJECT	21	2	-	5
020	THER OBJECT		c	-	
	N I MAL	٥	2		
141 HE	I UTULE E AD - ON	-			
144 AN	NGLE STRAIGHT	-	4		
147 RE	EAR-END	12	5		3
244 AN	NGLE TURN		2		
1 342 SI	IDESWIPE SAME				
345 RE	EAR-END LEFT TURN	-			
346 RE	EAR-END RIGHT TURN	-			
10 077	THER DRIVE				
14 47 AF	NGLE DRIVE		<del>.</del>		
447 Rt	EAR-END DRIVE		2		
543 SI	IDESWIPE OPPOSITE				
045 DL	LAL LEFT TURN		-		
646 DL	UAL RIGHT TURN				
TOTAL A	NUMBER OF ACCIDENTS	50	20	2	٤
NUMBER	OF INTERCHANGES = 6				
# OF AC	CCIDENTS / # OF INTERCHANGES	8.33	3.33	0.33	1.83

Table IV.24 Accident types by Collapsed interchange elements of Rural group 5

•

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
I					
000	) MISCELLANEOUS SINGLE VEHICLE	7	2	2	2
010	) OVERTURN	24	5	7	6
020	) HIT TRAIN				
030	) HIT PARKED VEHICLE	¢			1
048	3 BACKING				
049	PARKING				
050	) PEDESTRIAN	2			
090	) FIXED OBJECT	56	14	6	14
020	) OTHER OBJECT	2			
080	) ANIMAL	36	3	-	4
060	) BICYCLE				
141	HEAD-ON	-	£		
144	ANGLE STRAIGHT	M	\$		N
147	7 REAR-END	58	18	м	16
244	ANGLE TURN		5		
342	SIDESWIPE SAME	£			
345	<b>REAR-END LEFT TURN</b>	1	6	-	
346	S REAR-END RIGHT TURN		-		
440	) OTHER DRIVE		5		
777	ANGLE DRIVE		5		
244	7 REAR-END DRIVE		3		
543	SIDESWIPE OPPOSITE	-			
545	HEAD-ON LEFT TURN		-		
645	5 DUAL LEFT TURN				
979	5 DUAL RIGHT TURN				F
10	AL NUMBER OF ACCIDENTS	200	80	20	47
NUM	IBER OF INTERCHANGES = 27				
0	DF ACCIDENTS / # OF INTERCHANGES	7.41	2.96	0.74	1.74

Table IV.25 Accident types by Collapsed interchange elements of Rural group 6

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
	000 MISCELLANEOUS SINGLE VEHICLE	-=	- ~	o	4
	020 HIT TRAIN	:	,		
-	030 HIT PARKED VEHICLE	2			
-	048 BACKING		-	-	
-	049 PARKING				
-	050 PEDESTRIAN				
-	060 FIXED OBJECT	39	13	5	23
-	070 OTHER OBJECT	S			1
-	080 ANIMAL	18	-		
-	090 BICYCLE				
	141 HEAD-ON	4	4		-
	144 ANGLE STRAIGHT		t	-	2
-	147 REAR-END	36	20	3	11
	244 ANGLE TURN		6		-
89	342 SIDESWIPE SAME	۴			
)	345 REAR-END LEFT TURN		4		
	346 REAR-END RIGHT TURN	1	-		
	440 OTHER DRIVE		-		
•	444 ANGLE DRIVE		2		
-	447 REAR-END DRIVE		8		
	543 SIDESWIPE OPPOSITE				
	545 HEAD-ON LEFT TURN		4	-	
	645 DUAL LEFT TURN				
-	646 DUAL RIGHT TURN				
	TOTAL NUMBER OF ACCIDENTS	118	72	20	43
-	NUMBER OF INTERCHANGES = 17				
-	# OF ACCIDENTS / # OF INTERCHANGES	6.94	4.24	1.18	2.53

Table IV.26 Accident types by Collapsed interchange elements of Rural group 7

00 MISCELLANEOUS SINGLE VEHICLE 10 OVERTURN 20 HIT TRAIN 28 BACKING 28 BACKING		CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
0 OVERTURN 10 HIT TRAIN 10 HIT PARKED VEHICLE 28 BACKING	1	2		4
0 HIT TRAIN 0 HIT PARKED VEHICLE 8 BACKING	6		σ	14
0 HIT PARKED VEHICLE 8 backing				
B BACKING	2		4	
9 PARKING				
) PEDESTRIAN				-
D FIXED OBJECT	48	11	14	17
D OTHER OBJECT				
) ANIMAL	6	2		2
) BICYCLE				
HEAD-ON	F			
		7		
	- !	<del>,</del>		¢
REAR-END	47	16	8	æ
ANGLE TURN	-	ñ	-	
SIDESUIPE SAME	2	<b>~</b>		
REAR-END LEFT TURN		-		
REAR-END RIGHT TURN	-			
DITHER DRIVE		2		
ANGLE DRIVE		2		
<pre></pre>				
SIDESWIPE OPPOSITE				
HEAD-ON LEFT TURN				
DIAL LET TUDA				
S DUAL RIGHT TURN				
AL NUMBER OF ACCIDENTS	122	44	36	46
IBER OF INTERCHANGES = 7				
DF ACCIDENTS / # OF INTERCHANGES	17.43	6.29	5.14	6.57

Table IV.27 Accident types by Collapsed interchange elements of Rural group 8

ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
00 MISCELLANEOUS SINGLE VEHICLE	11	2	3	-
110 OVERTURN	17	7	7	10
120 HIT TRAIN				
<b>30 HIT PARKED VEHICLE</b>	4	2		2
48 BACKING			-	
49 PARKING	-			
50 PEDESTRIAN				-
60 FIXED OBJECT	51	32	11	27
70 OTHER OBJECT	5			
80 ANIMAL	38	4		2
90 BICYCLE		2		
41 HEAD-ON	5	¢ -	-	
44 ANGLE STRAIGHT	۱.			2
47 DEAD-FUD	07	2 8C	~	18
ANGLE TIDN	2	j œ	ı	i –
A CIPICITORN		0		-
42 SIDESWIPE SAME				
45 REAR-END LEFT TURN	-	6		-
46 REAR-END RIGHT TURN		S		-
40 OTHER DRIVE		6		
44 ANGLE DRIVE		ъ		
47 REAR-END DRIVE		7		
43 SIDESUIPE OPPOSITE		-		
45 HEAD-ON LEFT TURN		ý.		
45 DIJAI LEFT TIJRN		ŀ		
46 DUAL RIGHT TURN			۴	-
OTAL NUMBER OF ACCIDENTS	174	126	26	67
UMBER OF INTERCHANGES = 28				
of Accircuite / # of lutroculanere	2	C L	5	

Table IV.28 Accident types by Collapsed interchange elements of Rural group 9

000 MISCELLANEOUS SINGLE VEHICLE 010 OVERTURN 020 HIT TRAIN 030 HIT PARKED VEHICLE 048 BACKING	t			-
020 HIT TRAIN 030 HIT PARKED VEHICLE 048 BACKING				
030 HIT PARKED VEHICLE 048 BACKING				
048 BACKING	-			
049 PARKING				
050 PEDESTRIAN				
060 FIXED OBJECT	6	ſ	2	4
070 OTHER OBJECT		ſ		
080 ANIMAL	5	2		
090 BICYCLE				
141 HEAD-ON	2			
144 ANGLE STRAIGHT				
147 REAR-END	7	ñ		
244 ANGLE TURN				1
342 SIDESWIPE SAME				
345 REAR-END LEFT TURN				
346 REAR-END RIGHT TURN				
440 OTHER DRIVE				
444 ANGLE DRIVE		-		
447 REAR-END DRIVE		-		
543 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN				
645 DUAL LEFT TURN				
646 DUAL RIGHT TURN				
TOTAL NUMBER OF ACCIDENTS	28	10	2	5
NUMBER OF INTERCHANGES = 6				
# OF ACCIDENTS / # OF INTERCHANGES	4.67	1.67	0.33	0.83

Table IV.29 Accident types by Collapsed interchange elements of Rural group 10

ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
00 MISCELLANEOUS SINGLE VEHICLE	3			
110 OVERTURN	4		5	2
D20 HIT TRAIN				
30 HIT PARKED VEHICLE	4			
148 BACKING		-		2
049 PARKING	-			
050 PEDESTRIAN				
060 FIXED OBJECT	21	14	σ	7
J70 OTHER OBJECT	-			
380 ANIMAL	22	5		
090 BICYCLE				
141 HEAD-ON				
144 ANGLE STRAIGHT	-	7	-	-
147 REAR-END	21	Ø	2	26
244 ANGLE TURN		7		
342 SIDESWIPE SAME		1		
345 REAR-END LEFT TURN		3		
546 REAR-END RIGHT TURN		-		-
440 OTHER DRIVE		-		
44 ANGLE DRIVE		-		
447 REAR-END DRIVE		-		
543 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN				
545 DUAL LEFT TURN				
546 DUAL RIGHT TURN				
IOTAL NUMBER OF ACCIDENTS	78	50	18	42
VUMBER OF INTERCHANGES = 13				
4 OE ACCIDENTS / # OE INTEDCHANCES	×	3 85	1 78	7 72

Table IV.30 Accident types by Collapsed interchange elements of Fringe group 1

000 MISCELLANEOUS SINGLE VEHICLE 010 OVERTURN	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
010 OVERTURN	2	3		1
	18		4	4
020 HIT TRAIN				
030 HIT PARKED VEHICLE	-	2	-	-
048 BACKING	2	-	-	ĸ
049 PARKING				
050 PEDESTRIAN				
060 FIXED OBJECT	65	14	12	22
070 OTHER OBJECT	2	-		
080 ANIMAL	11	£		
090 BICYCLE		٣		
141 HEAD-ON	4			-
144 ANGLE STRAIGHT		11	<b>,</b>	
147 REAR-END	72	26	1	46
244 ANGLE TURN	-	10	-	5
342 SIDESWIPE SAME	-			
345 REAR-END LEFT TURN		3		
346 REAR-END RIGHT TURN	1			2
440 OTHER DRIVE		2		
444 ANGLE DRIVE		2		
447 REAR-END DRIVE		4		
543 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN		£		
545 DUAL LEFT TURN		-		-
646 DUAL RIGHT TURN				
TOTAL NUMBER OF ACCIDENTS	165	6	31	78
NUMBER OF INTERCHANGES = 24				
# OF ACCIDENTS / # OF INTERCHANGES	6.88	3.75	1.29	3.50

Table IV.31 Accident types by Collapsed interchange elements of Fringe group 2

000 MISCELLANEOUS SINGLE VEHICLE 010 OVERTURN 020 HIT TRAIN 030 HIT PARKED VEHICLE 048 BACKING 049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	<b>7</b> 0 9-0 8/2	88 t 4. M	2 21	3
010 OVERTURN 020 HIT TRAIN 030 HIT PARKED VEHICLE 048 BACKING 049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	29 27 2 2 - 6 2	8 t 4 1 3 t 1	21	•
020 HIT TRAIN 030 HIT PARKED VEHICLE 048 BACKING 049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	8 - 5 8 - 5 9 - 5	4 1 31		15
030 HIT PARKED VEHICLE 048 BACKING 049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	8 - 2 8 2 - 5 2 - 2	4 1 31		
048 BACKING 049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	1 2 8 2 1 7 7 2	1 4 31	3	4
049 PARKING 050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	2 87 7 7 7	31		4
050 PEDESTRIAN 060 FIXED OBJECT 070 OTHER OBJECT	78 7 15	4 31		
060 FIXED OBJECT 070 OTHER OBJECT	78 7 15	31	2	
070 OTHER OBJECT	15		31	38
	15		•	1
080 ANIMAL		2	-	ĸ
090 BICYCLE		4		
141 HEAD-ON	~	0	-	-
144 ANGLE STRAIGHT	-	20	-	
147 REAR-END	138	87	22	69
244 ANGLE TURN	-	29		2
342 SIDESWIPE SAME	2	1		
345 REAR-END LEFT TURN	-	4		-
346 REAR-END RIGHT TURN		4	2	4
440 OTHER DRIVE		4		
444 ANGLE DRIVE		٥		
447 REAR-END DRIVE		10		
543 SIDESWIPE OPPOSITE		3		
545 HEAD-ON LEFT TURN	-	8		
645 DUAL LEFT TURN		-		-
646 DUAL RIGHT TURN		-		4
TOTAL NUMBER OF ACCIDENTS	299	239	87	150
NUMBER OF INTERCHANGES = 40				
# OF ACCIDENTS / # OF INTERCHANGES	7.48	5.98	2.18	3.75

Table IV.32 Accident types by Collapsed interchange elements of Fringe group 3

A COUNTY OF A COUN

	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	DEF-RAMP UNIT
1 8	MISCELLANEOUS SINGLE VEHICLE	-			
010	OVERTURN	ŝ	-	-	2
020	HIT TRAIN				
030	HIT PARKED VEHICLE	-	2		
048	BACKING			-	-
570	PARKING				
050	PEDESTRIAN		-	1	-
090	FIXED OBJECT	24		5	4
020	OTHER OBJECT	1			
080	ANIMAL	2			
060	BICYCLE		1		
141	HEAD-ON				1
144	ANGLE STRAIGHT	2	ñ		
147	REAR-END	26	4	6	5
544	ANGLE TURN		2		
of GF	SIDESWIPE SAME	3			-
345	REAR-END LEFT TURN	1	-		
346	REAR-END RIGHT TURN				
077	OTHER DRIVE		-		
777	ANGLE DRIVE				
177	REAR-END DRIVE		2		
543	SIDESUIPE OPPOSITE				
545	HEAD-ON LEFT TURN				
645	DUAL LEFT TURN			1	
646	DUAL RIGHT TURN				
10	AL NUMBER OF ACCIDENTS	99	18	15	15
NUM	BER OF INTERCHANGES = 12				
#	F ACCIDENTS / # OF INTERCHANGES	5.5	1.5	1.25	1.25

Table IV.33 Accident types by Collapsed interchange elements of Fringe group 4

000 MIS	AUCIDENT TIPES	MAINLINE UNII	CROSSROAD UNII	ON-RAMP UNIT	DEF-RAMP UNIT
	SCELLANEOUS SINGLE VEHICLE RETURN	7	-		- ~
114 020	TRAIN				J
030 HIT	PARKED VEHICLE	-		-	
048 BACI	KING SKING			-	
049 PARI	K I NG				
050 PEDI	DESTRIAN				
060 FIXI	(ED OBJECT	21	3	8	8
070 OTHI	IER OBJECT				
080 ANI	MAL	-			
090 BIC	:YCLE				
141 HEAL	NO-Q		1		
144 ANG	ILE STRAIGHT		2		
147 REAI	.R-END	28	12	ŝ	11
244 ANG	ILE TURN		5		2
342 SIDI	DESUIPE SAME				
345 REAI	RR-END LEFT TURN		2		
346 REAI	RR-END RIGHT TURN				-
440 OTHI	IER DRIVE		-		
444 ANG	ILE DRIVE		-		
447 REAI	R-END DRIVE		3		
543 SIDI	ESUIPE OPPOSITE				
545 HEAI	D-ON LEFT TURN		4		-
645 DUAI	AL LEFT TURN			-	
646 DUA	AL RIGHT TURN				-
TOTAL NU	MBER OF ACCIDENTS	55	35	15	27
NUMBER OI	DF INTERCHANGES = 6				
# OF ACC)	IDENTS / # OF INTERCHANGES	9.17	5.83	2.5	4.5
				1	1

Table IV.34 Accident types by Collapsed interchange elements of Fringe group 5

00     MISTELLAMEOUS STAGLE VEHICLE     4     1     10       00     VERTURAN     6     1     10       00     MIT PAAKED VEHICLE     5     1     2       00     MIT PAAKED VEHICLE     3     5     2       00     MITED OBJECT     2     1     1       00     FIERD OBJECT     2     1     1       00     MITED OBJECT     3     2     1       00     MITED OBJECT     2     1     1       00     MITED OBJECT     3     2     1       00     MITED OBJECT     3     1     3       00     MITED OBJECT     3     1     3       00     MITED OBJECT     1     3     1       00     MITED OBJECT <td< th=""><th>OD         MISCELLAREOUS STATE VENTCLE         4         10           0.00         MISCELLAREOUS STATE VENTCLE         6         1         10           0.00         MIT TAIN         6         1         10           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         26         8         15         15           0.00         PACKING         26         8         15         15         15           0.00         PACKING         26         3         2         16         16         15           0.00         MIT REALANC         2         3         2         13         2         18           0.00         MIT REALANC         2         3         3         13         2         18           0.00         MIT REALANC         2         3         2         18         15           0.00         MIT REALANC         2         3         2         18         14           14.4</th><th></th><th>ACCIDENT TYPES</th><th>MAINLINE UNIT</th><th>CROSSROAD UNIT</th><th>ON-RAMP UNIT</th><th>OFF-RAMP UNIT</th></td<>	OD         MISCELLAREOUS STATE VENTCLE         4         10           0.00         MISCELLAREOUS STATE VENTCLE         6         1         10           0.00         MIT TAIN         6         1         10           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         3         2         2           0.00         MIT PARKED VENTCLE         26         8         15         15           0.00         PACKING         26         8         15         15         15           0.00         PACKING         26         3         2         16         16         15           0.00         MIT REALANC         2         3         2         13         2         18           0.00         MIT REALANC         2         3         3         13         2         18           0.00         MIT REALANC         2         3         2         18         15           0.00         MIT REALANC         2         3         2         18         14           14.4		ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
010         OVERTURN         6         1         10           030         HIT PRAKIN         5         2           040         PAKING         5         15           050         FEDESTRIAN         2         1           050         FEDESTRIAN         2         1           050         FEDESTRIAN         2         1         2           050         FEDESTRIAN         2         1         2         1           050         FEDESTRIAN         2         1         2         1           050         FEDESTRIAN         2         2         1         1           050         FEDESTRIAN         2         2         1         1           050         FEDESTRIAN         3         2         1         1         1           050         FEDESTRIAN         2         1         2         1         1         1           14         FED-ON         2         3         2         1	010         0F6K10km         6         1         10         10           030         HT PARKE VEHCLE         3         2         2         2           030         HT PARKE VEHCLE         3         3         1         1         2           030         HT PARKE VEHCLE         3         5         1         2         2           030         HT PARKE VEHCLE         3         5         1         1         2         2           030         PRESTRIAM         26         8         15         1         1         2         2         2         2         2         2         2         2         1 <t< td=""><td>18</td><td>D MISCELLANEOUS SINGLE VEHICLE</td><td>4</td><td></td><td></td><td></td></t<>	18	D MISCELLANEOUS SINGLE VEHICLE	4			
20       H11 TAAIN       2       1       2       2       2       1       2       2       1       2       1       2       1       2       1       2       1       2       1       1       2       1       1       2       1       1       1       2       1       1       1       2       1	000         NIT PALN         2           000         NIT PARKEN VEHICLE         3           000         BACKING         5           000         BACKING         5           000         PEDESTRIAN         7           000         P	010	0 OVERTURN	6	1		10
030       HIT PARKED VEHICLE       3       2         030       AXXING       5       1       5         040       PAKKIN       2       8       15       15       15         050       FIDESTRIAN       2       8       15       15       15       15         050       FIDESTRIAN       2       8       15       15       15       15         050       FIDESTRIAN       2       2       14       2       14       15       15       15         070       OTICLE       1       3       2       14       15       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       16       17       17       17       16       17       17       17       16       17       17       17       16       17       16       17       16       17       16       17       16       16       16 <td>30       HIT PARKED VEHICLE       3       2         0.00       BACKING       5       1       5         0.00       BACKING       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       OTHER OBJECT       1       2       15       15         0.00       MILL       2       2       11       15       16         0.00       MILL       2       2       1       1       17       16</td> <td>020</td> <td>D HIT TRAIN</td> <td></td> <td></td> <td></td> <td></td>	30       HIT PARKED VEHICLE       3       2         0.00       BACKING       5       1       5         0.00       BACKING       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       FEDESTRIAN       26       8       15       15         0.00       OTHER OBJECT       1       2       15       15         0.00       MILL       2       2       11       15       16         0.00       MILL       2       2       1       1       17       16	020	D HIT TRAIN				
048       BACKING       1       1       15       16       15       16	0.6 PACKING         1         2           0.6 PACKING         0.0 PECRIAN         15         15           0.0 PECRIAN         2         8         15         15           0.0 PECRIAN         2         8         15         15           0.0 PECRIAN         2         2         15         15           0.0 PECRIAN         2         2         15         15           0.0 PECRIAN         2         2         14         15         15           0.0 PECRIA         2         2         14         15         15         15           0.0 PECRIA         2         14         2         14         15         16         17           1.4 FADCON         2         13         2         2         14         14         16         17           1.4 FADCON         2         13         2         14         2         18         17           1.4 FADCON         2         13         2         14         18         18           2.4 ADEL FUNAN         1         2         2         18         18         18           2.4 ADEL FUNAN         1         2         18         18	030	D HIT PARKED VEHICLE	3			
0,0       PAKING       1<	00         PARKING         1         15         15           00         FIXE BOBSTRIAN         26         8         15         15           00         FIXE BOBJECT         2         8         15         15           00<	048	B BACKING				2
050       FEBESTRIM       1 <td< td=""><td>050         FIXESTRIAN         1           050         FIXESTRIAN         2         1           070         OTTER DELECT         1         2           070         OTTER DELECT         1         2           070         OTTER DELECT         2         1           070         DITER DELECT         2         1           14         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         1           34         ANCLET TURN         1         2           35         EACE-EDL LETT TURN         1</td><td>570</td><td>9 PARKING</td><td></td><td></td><td></td><td></td></td<>	050         FIXESTRIAN         1           050         FIXESTRIAN         2         1           070         OTTER DELECT         1         2           070         OTTER DELECT         1         2           070         OTTER DELECT         2         1           070         DITER DELECT         2         1           14         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         2           34         EACE-EDL LETT TURN         1         1           34         ANCLET TURN         1         2           35         EACE-EDL LETT TURN         1	570	9 PARKING				
000       FIXED OBJECT       26       8       15       15         000       OFTER OBJECT       1       2       15       15         000       OFTER OBJECT       9       2       15       15         000       DITCLE       9       2       3       1       1         000       DITCLE       9       2       3       1       1         14       MEAD       5       4       3       1 </td <td>0.00         FIXED 06.LECT         26         8         15         15           0.00         MINAL         9         2         1         1           0.00         MICCLE         3         2         1         1           1.4         MALE STRAIGHT         5         2         1         1           1.4         MALE STRAIGHT         2         1         1         1         1           1.4         MALE STRAIGHT         2         1         3         2         1</td> <td>050</td> <td>0 PEDESTRIAN</td> <td></td> <td></td> <td>-</td> <td></td>	0.00         FIXED 06.LECT         26         8         15         15           0.00         MINAL         9         2         1         1           0.00         MICCLE         3         2         1         1           1.4         MALE STRAIGHT         5         2         1         1           1.4         MALE STRAIGHT         2         1         1         1         1           1.4         MALE STRAIGHT         2         1         3         2         1	050	0 PEDESTRIAN			-	
070         OTHER OBJECT         1           080         ANIML         9         2           080         ANIML         9         2           080         BLYCLE         9         2           141         HEAD-ON         5         4         1           142         ANGLE STRAIGHT         24         13         2         1           144         ANGLE STRAIGHT         24         13         2         18           147         REAR-END         24         13         2         18           342         SIESUIPE SAME         3         2         18         1           342         SIESUIPE SAME         1         3         2         18           344         MAGE DOTIVE         1         3         3         3         18           344	070 OTHER GAJECT         1           070 OTHER GAJECT         1           070 MINAL         9         2           070 MINAL         5         3           147 REAR ENTIOHIN         2         1           147 REAR ENDIOHING         2         1           147 REAR ENDIOHING         2         1           245 ANDE TURN         1         3           345 REAR END IGHT TURN         1         3           345 REAR END IGHT TURN         1         3           346 REAR END IGHT TURN         1         3           347 REAR END IGHT TURN         1         3           348 REAR END IGHT TURN         1         3           444 AUGE DINTER         1         4           345 REAR END IGHT TURN         1	060	0 FIXED OBJECT	26	8	15	15
080 ANIMAL     9     2       080 ANIMAL     9     2       080 BICYCLE     3     1       14. ARGD-ON     14. ARGD-ON     1       14. ARGD-ON     2     1       14. ARGD-ON     2     1       14. REA-END     2     1       24. ANGLE TURN     2     1       24. ANGLE TURN     2     1       24. ANGLE TURN     1     3       24. ANGLE DURLE     1     2       24. ANGLE DURLE     1     2       24. ANGLE DURLE     1     3       25. SIDESUIPE OPOSITE     1     3       26. ANGLE DURLE     1     4       27. SIDESUIPE OPOSITE     1     4       28. SIDESUIPE OPOSITE     1     5       29. SIDESUIPE OPOSITE     1     4       26. BULL RIGHT TURN     1     4       27. SIDESUIPE OPOSITE     1     4       28. SIDESUIPE OPOSITE     1     4       29. SIDESUIPE OPOSITE     1     4       26. SIDIL RUR	080         MIML         9         2           0.80         MIML         5         3           0.80         BICYCLE         3         3           0.40         BICYCLE         3         3           1.4         MGLE STRAIGHT         5         3           1.4         MGLE STRAIGHT         5         13           1.4         MGLE TURN         2         18           3.4         REAR-END LEFT TURN         1         3           3.4         REAR-END LEFT TURN         1         3           3.4         REAR-END LEFT TURN         1         2           3.4         REAR-END LEFT TURN         1         2           4.4         MGLE DRIVE         1         2           4.4         MGLE DRIVE         1         2           4.4         MGLE DRIVE         1         2           4.5         DOL LEFT TURN         1         4	070	D OTHER OBJECT	1			
090       BICYCLE       3       3       1         141       HEAD-ON       5       2       7       1         141       HEAD-ON       5       2       1       1         141       HEAD-ON       24       13       2       18         147       REALE-END       24       13       2       18         244       ANGE TURN       2       3       2       18         345       REAR-END RIGHT TURN       1       3       1       1         345       REAR-END RIGHT TURN       1       3       2       18         346       REAR-END RIGHT TURN       1       3       2       18         346       REAR-END RIGHT TURN       1       3       2       14         440       OTHER DRIVE       1       3       2       14         440       OTHER DRIVE       1       2       2       14         447       REAL-END DRIVE       1       4       4       4         545       HEAD-ON LEFT TURN       1       4       4       4         545       HEAD-ON LEFT TURN       1       4       4       4 <t< td=""><td>090       BICYCLE       3       1         141       HEAD-ON       5       4       1         147       Redue Stratch       5       4       1       1         147       Redue Stratch       2       1       1       1       1         147       Redue Stratch       2       1       2       1       1         147       Redue Turku       2       1       2       1       1         242       Ance Turku       1       3       2       18       1       1         245       Stext-End End Turku       1       2       2       1</td><td>080</td><td>D ANIMAL</td><td>ه</td><td>2</td><td></td><td></td></t<>	090       BICYCLE       3       1         141       HEAD-ON       5       4       1         147       Redue Stratch       5       4       1       1         147       Redue Stratch       2       1       1       1       1         147       Redue Stratch       2       1       2       1       1         147       Redue Turku       2       1       2       1       1         242       Ance Turku       1       3       2       18       1       1         245       Stext-End End Turku       1       2       2       1	080	D ANIMAL	ه	2		
141       HED-ON       3       1         142       ANGLE STRAICHT       5       2       1         142       ANGLE STRAICHT       5       2       1         144       ANGLE STRAICHT       24       13       2       1         245       ANGLE TURN       24       13       2       1         345       SERR-END       2       1       3         345       ERAR-END LEFT TURN       1       3       2         346       FRAR-END RIGHT TURN       1       3       2         346       FRAR-END RIGHT TURN       1       2       1         346       FRAR-END RIGHT TURN       1       2       1         444       ANGLE DRIVE       2       2       1         444       ANGLE DRIVE       1       2       1         444       ANGLE DRIVE       1       2       2       1         444       ANGLE DRIVE       1       2       2       1         444       ANGLE DRIVE       1       1       2       2       1         444       ANGLE DRIVE       1       1       2       1       1       1       1	141       HEAD-ON       3       1       1         147       RAGLE STRAIGHT       5       4       1       1         147       RAGLE STRAIGHT       5       4       1       1         147       RAGLE STRAIGHT       24       32       21       1       1         244       MGLE TURN       24       32       21       2       1       1         342       SIDESUPE SAME       1       3       2       1	060	0 BICYCLE				
14.       ANGLE STRAIGHT       5       4       ANGLE STRAIGHT       5       13       24       13       24       18       1         14.7       REAR-END       24       ANGLE TURN       24       13       2       18       1         24.4       ANGLE TURN       24       SIDESUIPE EST       1       3       2       18       1	14.       ANGLE STRAIGHT       5       1       1         14.       ANGLE STRAIGHT       5       1       1         14.       REAR-END       24       1       5       1         24.       SHOELET TURN       2       1       1         34.5       REAR-END LEFT TURN       1       2       1         34.5       REAR-END LEFT TURN       1       2       1         34.6       REAR-END RIVE       1       2       1         34.7       REAR-END RIVE       1       2       1         34.6       ROUTE ROUTE       1       2       1         34.8       ANGLE DRIVE       1       1       1         34.8       SIDE-SUPE OPPOSITE       1       1       1         34.8       SIDE-SUPE OPPOSITE       1       1       1         34.8       DUAL RIGHT TURN       1       1       1         34.8       DUAL RIGHT TURN       1       1 <t< td=""><td>141</td><td>1 HEAD-ON</td><td></td><td>2</td><td></td><td>-</td></t<>	141	1 HEAD-ON		2		-
147       REAR-END       24       13       2       18         244       ANGLE TURN       5       5       7       1         342       SIDESNIPE SAME       3       2       18       1         342       SIDESNIPE SAME       1       3       2       11       1       1         345       REAR-END LEFT TURN       1       2       2       1	147       ReR-END       24       13       2       18         244       MIGLE TURN       1       5       1       1         342       ELESUIPE SAME       1       3       1       1         342       ELESUIPE SAME       1       3       1       1       1         345       ERA-END IGHT TURN       1       2       1	144	4 ANGLE STRAIGHT	Ś	4		-
24. ANGLE TURN     5     1       342 SIDESWIPE SAME     342 SIDESWIPE SAME     1       345 REAR-END LEFT TURN     1     2       346 REAR-END LEFT TURN     1     2       346 REAR-END RIGHT TURN     1     2       346 REAR-END RIGHT TURN     1     2       346 REAR-END RIGHT TURN     1     2       347 REAR-END DRIVE     1     2       444 ONLE RIVE     1     2       445 REAR-END DRIVE     1     4       446 DUAL LEFT TURN     1     4       545 HEAD-ON LEFT TURN     1     4       545 HEAD-ON LEFT TURN     1     4       545 DUAL LEFT TURN     1     4       546 DUAL RIGHT TURN     1     4       547 NUMBER OF ACCIDENTS     80     53     19     48       548 DUAL LEFT TURN     10     10     10     10	24. MGLE TURN       5       1         342 SIDESUIPE SAME       1       3       1         345 REAR-END LEFT TURN       1       2       1         346 REAR-END LEFT TURN       1       2       2         346 REAR-END LEFT TURN       1       2       2         346 REAR-END RIGHT TURN       1       2       2         440 OTHER DRIVE       1       2       2         543 ERD-END LEFT TURN       1       2       2         543 ERD-ON LEFT TURN       1       2       4         545 END-END RIVE       1       4       4         545 END-END RIVE       1       4       4         545 DUAL LEFT TURN       80       53       19       48         540 LIAL RIVEN       80       53       19       48         540 LIAL RIVEN       80       5.30       1.90       4.8         541 LEFT TURN       1.90       1.90       4.8	147	7 REAR-END	24	13	2	18
342SIDESUIPE SAME345REAR-END LEFT TURN345REAR-END RIGHT TURN346REAR-END RIGHT TURN346REAR-END RIGHT TURN347RALE DRIVE346RAR-END RIVE447RAR-END RIVE353SIDESUIPE OPPOSITE547RAR-END DRIVE543SIDESUIPE OPPOSITE545HEAD-ON LEFT TURN645DUAL LEFT TURN646DUAL LEFT TURN646DUAL LEFT TURN646DUAL RIGHT TURN646DUAL RIGHT TURN646DUAL RIGHT TURN647NUMBER OF ACCIDENTS8053707L NUMBER OF ACCIDENTS400F30400	342SIDESUIPE SAME345REAR-END LEFT TURN345REAR-END RIGHT TURN346REAR-END RIGHT TURN346REAR-END RIVE346REAR-END DRIVE347REAR-END DRIVE348REAR-END DRIVE347REAR-END DRIVE348SIDESUIPE OPPOSITE348SIDESUIPE OPPOSITE349SIDE349SIDESUIPE OPPOSITE349SIDESUIPE OPPOSITE349SIDESUIPE OPPOSITE344SIDESUIPE OPPOSITE344SIDESUIPE OPPOSITE345SIDESUIPE OPPOSITE346DIAL LEFT TURN347NUMBER OF ACCIDENTS348OF ACCIDENTS349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE349SIDE <trr< td=""><td>244</td><td>4 ANGLE TURN</td><td></td><td>2</td><td></td><td>-</td></trr<>	244	4 ANGLE TURN		2		-
345       REAR-END LEFT TURN       1       3         346       REAR-END RIGHT TURN       1       2         340       OTHER DRIVE       1       2         440       OTHER DRIVE       2       2         444       ANGLE DRIVE       2       2         447       REAR-END DRIVE       2       2         447       REAR-END DRIVE       1       2         453       SIDESWIPE OPPOSITE       1       4         543       SIDESWIPE OPPOSITE       1       4         545       BEAD-ON LEFT TURN       4       4         645       DUAL RIGHT TURN       1       4         645       DUAL RIGHT TURN       1       4         645       DUAL RIGHT TURN       1       4         645       DUAL RIGHT TURN       5       79         646       DUAL RIGHT TURN       5       79         646       DUAL RIGHT TURN       5       79         645       DUAL RIGHT TURN       5       78         1014. NUBER OF INTERCHARGES = 10       5       79         40       5       70       40	345       REAR-END LEFT TURN       1       2         346       REAR-END RIGHT TURN       2         346       REAR-END RIGHT TURN       2         440       OTHER DRIVE       2         444       DRIVE       2         445       SIDESUIPE OPPOSITE       1         545       SIDESUIPE OPPOSITE       1         545       DIAL LEFT TURN       4         645       DIAL LETT TURN       1         645       DIAL RIGHT TURN       1         645       DIAL LETT TURN       1         645       DIAL RIGHT TURN       1         646       DIAL RIGHT TURN       1         101AL NUMBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10       1.90       1.90       4.80	342	2 SIDESWIPE SAME				
346       REAR-END RIGHT TURN       2         440       OFHER DRIVE       2         444       ANGLE DRIVE       2         444       ANGLE DRIVE       2         444       ANGLE DRIVE       2         447       REAR-END DRIVE       5         543       SIDESWIPE OPPOSITE       1         543       SIDESWIPE OPPOSITE       1         545       HEAD-ON LEFT TURN       4         645       DUAL LEFT TURN       1         645       DUAL RIGHT TURN       1         646       DUAL RIGHT TURN       1         01AL NUMBER OF ACCIDENTS       80       53         10AL NUMBER OF INTERCHANGES = 10       10       48	346       REAR-END RIGHT TURN       2         440       OTHER DRIVE       2         444       ANGLE DRIVE       2         447       ANGLE DRIVE       5         543       ERA-END DRIVE       4         543       ERA-END DRIVE       1         543       ERA-END DRIVE       1         543       ERA-END DRIVE       4         545       ELOPOSTIF       1         545       ELOPOSTIF       1         545       ELOPOSTIF       1         545       ELOPOSTIF       1         545       DUAL LEFT TURN       1         645       DUAL RIGHT TURN       1         645       DUAL RIGHT TURN       80       53         101AL NUMBER OF INTERCHARES = 10       1       9         # OF ACCIDENTS / # OF INTERCHARES       8.00       5.30       1.90       4.80	345	5 REAR-END LEFT TURN	1	£		
4.0       OTHER DRIVE       1         4.4.       ANGLE DRIVE       2         4.4.       ANGLE DRIVE       5         4.4.       REAR-END DRIVE       5         5.3       SIDESWIPE OPPOSITE       1         5.4.7       REAR-END DRIVE       4         5.4.7       REAR-END DRIVE       1         5.4.7       BEAD-ON LEFT TURN       4         6.45       DUAL LEFT TURN       1         6.45       DUAL LETT TURN       1         6.45       DUAL REAT TURN       1         6.45       DUAL REAT TURN       1         6.46       DUAL RIGHT TURN       1         6.46       DUAL RIGHT TURN       1         6.46       DUAL RIGHT TURN       1         MDBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10       000       53       19       48	40OTHER DRIVE44ANGLE DRIVE44S45REAR-END DRIVE53SIDESWIPE OPPOSITE54HEAD-ON LEFT TURN54HEAD-ON LEFT TURN64DUAL LEFT TURN64DUAL LEFT TURN64DUAL RIGHT TURN64DUAL RIGHT TURN64NUMBER OF ACCIDENTS10NUMBER OF ACCIDENTS805310NUMBER OF INTERCHANGES = 10# OF ACCIDENTS / # OF INTERCHANGES8.005.301.904.601.90 <td>346</td> <td>5 REAR-END RIGHT TURN</td> <td></td> <td>2</td> <td></td> <td></td>	346	5 REAR-END RIGHT TURN		2		
44. ANGLE DRIVE       2         4.7 REAR-END DRIVE       5         5.3 SIDESWIPE OPPOSITE       1         5.43 SIDESWIPE OPPOSITE       4         5.45 HEAD-ON LEFT TURN       4         645 DUAL LEFT TURN       1         645 DUAL LEFT TURN       1         646 DUAL RETTURN       1         646 DUAL RETTURN       1         646 DUAL RETTURN       1         640 DUAL RIGHT TURN       1         641 RIGHT TURN       1         645 DUAL RIGHT TURN       1         646 DUAL NUMBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10       0       0       0       0       0	44. ANGLE DRIVE24.7 REAR-END DRIVE55.3 SIDESWIPE OPPOSITE15.4 EAD-ON LEFT TURN45.4 EAD-ON LEFT TURN16.4 DUAL LEFT TURN16.4 DUAL LEFT TURN16.4 DUAL LEFT TURN36.4 DUAL LEFT TURN36.4 DUAL LEFT TURN36.4 DUAL LEFT TURN36.4 DUAL LEFT TURN805.3 NUMBER OF ACCIDENTS8077NUMBER OF INTERCHANGES = 101.90# OF ACCIDENTS / # OF INTERCHANGES8.005.301.904.605.3077.8077.90	440	D OTHER DRIVE		-		
4.7 REAR-END DRIVE       5         5.3 SIDESWIPE OPPOSITE       1         5.43 SIDESWIPE OPPOSITE       4         5.45 HEAD-ON LEFT TURN       4         5.45 DUAL LEFT TURN       4         6.45 DUAL LEFT TURN       1         6.45 DUAL LEFT TURN       1         6.46 DUAL REFT TURN       1         6.46 DUAL RIGHT TURN       1         6.46 DUAL RIGHT TURN       1         701AL NUMBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10       000       53       19       48	4.7       REAR-END DRIVE       5         5.3       SIDESWIPE OPPOSITE       1         5.4       BEAD-ON LEFT TURN       4         5.4       BEAD-ON LEFT TURN       1         6.4       DUAL RIGHT TURN       1         10       K       1         11       NUMBER OF INTERCHANGES = 10       1         12       MUBER OF INTERCHANGES       8.00       5.30         4       O       1.90       4.80	777	4 ANGLE DRIVE		2		
543 SIDESWIPE OPPOSITE 1 4 4 555 HEAD-ON LEFT TURN 545 BUAL LEFT TURN 1 1 646 DUAL RIGHT TURN 546 DUAL RIGHT TURN 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	543SIDESUIPE OPPOSITE1545HEAD-ON LEFT TURN4545DUAL LEFT TURN646DUAL REFT TURN646DUAL RIGHT TURN617NUMBER OF ACCIDENTS80537014NUMBER OF ACCIDENTS80537014NUMBER OF INTERCHANGES = 10# OF ACCIDENTS / # OF INTERCHANGES8.005.301.904.807.907.907.907.80 </td <td>447</td> <td>7 REAR-END DRIVE</td> <td></td> <td>5</td> <td></td> <td></td>	447	7 REAR-END DRIVE		5		
545 HEAD-ON LEFT TURN 645 DUAL LEFT TURN 646 DUAL RIGHT TURN 646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS 80 53 19 48 NUMBER OF INTERCHANGES = 10 # OF ACCIDENTS 4 OF INTERCHANGES = 10	545       HEAD-ON LEFT TURN       4         645       DUAL LEFT TURN       1         646       DUAL RIGHT TURN       80       53       19       48         IOTAL NUMBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10         k of ACCIDENTS / # OF INTERCHANGES       8.00       5.30       1.90       4.80	543	3 SIDESWIPE OPPOSITE	1			
645 DUAL LEFT TURN 646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS 80 53 19 48 NUMBER OF INTERCHANGES = 10 # OF ACCIDENTS # OF INTERCHANGES = 10	645 DUAL LEFT TURN 646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS NUMBER OF INTERCHANGES = 10 # OF ACCIDENTS / # OF INTERCHANGES # OF ACCIDENTS / # OF INTERCHANGES	545	5 HEAD-ON LEFT TURN		4		
646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS 80 53 19 48 NUMBER OF INTERCHANGES = 10	646 DUAL RIGHT TURN TOTAL NUMBER OF ACCIDENTS NUMBER OF INTERCHANGES = 10 # OF ACCIDENTS / # OF INTERCHANGES 8.00 5.30 7.90 7.80 7.80 7.80 7.80 7.80 7.80 7.80	645	5 DUAL LEFT TURN		-		
TOTAL NUMBER OF ACCIDENTS 80 53 19 48 NUMBER OF INTERCHANGES = 10	Total NUMBER OF ACCIDENTS       80       53       19       48         NUMBER OF INTERCHANGES = 10       10       4.80         # OF ACCIDENTS / # OF INTERCHANGES       8.00       5.30       1.90       4.80	646	6 DUAL RIGHT TURN				
NUMBER OF INTERCHANGES = 10	NUMBER OF INTERCHANGES = 10 # OF ACCIDENTS / # OF INTERCHANGES 8.00 5.30 1.90 4.80	<b>1</b> [0	TAL NUMBER OF ACCIDENTS	80	53	19	48
	# OF ACCIDENTS / # OF INTERCHANGES 8.00 5.30 1.90 4.80	NUN	WBER OF INTERCHANGES = 10				
# UF ALLIDENIS / # UF INFRUMANCES 8.00 4.00		*	JF ACCIDENTS / # OF INTERCHANGES	8.00	5.30	1_90	4 - 80

Table IV.35 Accident types by Collapsed interchange elements of Fringe group 6



	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCELLANEOUS SINGLE VEHICLE	- (	,	۰ -	4
UTU UVEKTUKN D20 HIT TRAIN	>	n	n	\$
030 HIT PARKED VEHICLE	3			
048 BACKING				-
049 PARKING				
050 PEDESTRIAN	2	-		
060 FIXED OBJECT	19	12	5	11
070 OTHER OBJECT				
080 ANIMAL	6			-
090 BICYCLE				
141 HEAD-ON	-	-		2
144 ANGLE STRAIGHT		2		
147 REAR-END	30	6	3	2
244 ANGLE TURN		7		
342 SIDESWIPE SAME				
345 REAR-END LEFT TURN		-		
346 REAR-END RIGHT TURN			-	
440 OTHER DRIVE		2		
444 ANGLE DRIVE				
447 REAR-END DRIVE		ñ		
543 SIDESWIPE OPPOSITE				
545 HEAD-ON LEFT TURN		4	-	
645 DUAL LEFT TURN		-		
646 DUAL RIGHT TURN		-	~	
TOTAL NUMBER OF ACCIDENTS	71	77	15	30
NUMBER OF INTERCHANGES = 12				
# OF ACCIDENTS / # OF INTERCHANGES	5.92	3.67	1.25	2.5

Table IV.36 Accident types by Collapsed interchange elements of Fringe group 7



	ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
00 00	MISCELLANEOUS SINGLE VEHICLE	5	3		3
010	OVERTURN	6	5	8	5
020	HIT TRAIN				
030	HIT PARKED VEHICLE	5			
048	BACKING	-			
049	PARKING				
020	PEDESTRIAN				-
090	FIXED OBJECT	65	21	13	14
020	OTHER OBJECT	-			
080	ANIMAL	ه	2	F	-
060	BICYCLE				-
141	HEAD - ON	2	-		
144	ANGLE STRAIGHT	- <b>-</b> 1			-
147	REAR-END	62	32	19	25
244	ANGLE TURN	ŝ	£		
342	SIDESUIPE SAME	5			
345	REAR-END LEFT TURN		-		
346	REAR-END RIGHT TURN		-		2
440	OTHER DRIVE	£			
777	ANGLE DRIVE	-	£		
447	REAR-END DRIVE	-	£		
543	SIDESWIPE OPPOSITE				
545	HEAD-ON LEFT TURN	-	2		
645	DUAL LEFT TURN				
646	DUAL RIGHT TURN		2		
TOTA	IL NUMBER OF ACCIDENTS	192	80	41	53
NUMBI	ier of interchanges = 15				
# OF	* ACCIDENTS / # OF INTERCHANGES	12.80	5.33	2.73	3.53

Table IV.37 Accident types by Collapsed interchange elements of Fringe group 8

ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
000 MISCELLANEOUS SINGLE VEHICLE 010 OVERTURN	4 M	2	۶ M	40
020 HIT TRAIN 030 HIT PARKED VEHICLE	-			
048 BACKING 049 PARTING			-	-
050 PEDESTRIAN		-		1
060 FIXED OBJECT	28 •	2	13	21
000 ANIMAL	- 1	_		~
090 BICYCLE				
141 HEAD-ON	-	-		
144 ANGLE STRAIGHT		2		
147 REAR-END	32	13	2	17
244 ANGLE TURN	-	7		3
342 SIDESUIPE SAME	2	-		
345 REAR-END LEFT TURN		2		
346 REAR-END RIGHT TURN				
440 OTHER DRIVE		01		
444 ANGLE UKIVE		~ 、		
44/ KEAK-ENU UKIVE 5/3 SIDESUIDE ODDOSITE		0		
543 SIVESWIPE UPPOSITE		u		
24.5 NIAI LEFT TURN		n		
646 DUAL RIGHT TURN				
TOTAL NUMBER OF ACCIDENTS	83	53	23	55
NUMBER OF INTERCHANGES = 14				
# OF ACCIDENTS / # OF INTERCHANGES	5.93	3.79	1.64	3.93

Table IV.38 Accident types by Collapsed interchange elements of Fringe group 9

000       MISCELLANEOUS SINCLE VENICLE       1       1       1         010       MISCELLANEOUS SINCLE VENICLE       1       1       1         010       WIT TRANS       1       1       2         010       WIT TRANS       1       1       2         010       MIT MAKED VENICLE       1       1       2         010       MISCELLANEOUS SINCLE       1       1       2         010       MISCELLANEOUS SINCLE       1       1       2         010       MISCELLANEOUS SINCLE       1       1       2         011       MISCELLANEOUS SINCLE       1       1       2         011       MISCELLANEOUS SINCLE       1       1       2       1         011       MISCELLANEOUS SINCLE       1       1       2       1         011       MISCELLANEOUS SINCLE       2       1       2       1         011       MISCELLANEOUS SINCLE       2       1       1       2       1         011       MISCELLANEOUS SINCLE       2       2       2       1       2       1         011       MISCELLANEOUS SINCLE       2       2       2       2       1 <t< th=""><th></th><th>ACCIDENT TYPES</th><th>MAINLINE UNIT</th><th>CROSSROAD UNIT</th><th>ON-RAMP UNIT</th><th>OFF-RAMP UNIT</th></t<>		ACCIDENT TYPES	MAINLINE UNIT	CROSSROAD UNIT	ON-RAMP UNIT	OFF-RAMP UNIT
010         ORTUNM         1         1         1           020         NIT PARIN         1         1         1         1           030         NIT PARIN         1         1         2         1         2           030         NIT PARIN         1         1         1         2         2         2           030         PRESTRIAN         1         1         1         1         2         2           030         PRESTRIAN         1         1         1         2         1         1           030         PRESTRIAN         1	00	MISCELLANEOUS SINGLE VEHICLE				
00       NIT PANN       1         000       NIT PANED VENICLE       1         000       MAKED VENICLE       1         000       DESTRIAN       1         11       3       1         11       3       1         11       3       1         11       3       1         11       3       1         11       3       1         12       4       1         13       5       1         14       MERED NET       1         15       1       1         16       1       3         24       MERED NET       1         25       0AL LET TURN       2         26       0AL LET	010	OVERTURN			-	-
000 NIT PARED VEHICLE 1 010 NIT PARED VEHICLE 1 010 PIERTIAM 010 PIERTIAM 010 PIERTIAM 011 PIER OBJECT 010 OTHER OBJECT 010 OTHER OBJECT 010 OTHER OBJECT 010 OTHER OBJECT 011 ALL 011 ALL 01	020	HIT TRAIN				
0.6 PACKING         1         0.6 PACKING         0.6 PACKING         1	030	HIT PARKED VEHICLE	-			
0.0 FERSIAL         1         1         2           0.0 FINE OBJECT         1         1         3         1           1.4 ABJECT         2         1         3         1           1.4 ABJECTORINE         2         2         1         1           1.4 ABJECTORINE         2         1         3         1           1.4 ABJECTORINE         2         1         1         1           2.5 BAJELE SAME         2         1         1         1           2.5	048	BACKING				
050       FIESE RIAM       1       1       2         050       FIESE RIAM       1       1       1       2         070       OFFER DALECT       1       1       1       2         070       OFFER DALECT       1       1       1       2         070       OFFER DALECT       1       1       2       1       2         070       OFFER DALECT       1       1       3       1       1         070       OFFICE       1       1       3       1       1         071       HEAD-ON       24       1       3       1	049	PARKING				
060         FIXED OBJECT         12         1         2           060         FIXED OBJECT         1         1         1         2           080         MINL         1         1         1         1         2           080         BICYCLE         1         1         1         1         1         2           080         BICYCLE         1         1         1         1         1         1         1         1           141         HELE STAILENT         1 <td>020</td> <td>PEDESTRIAN</td> <td></td> <td></td> <td></td> <td></td>	020	PEDESTRIAN				
070 OTHER OBJECT       1       1       1         070 OTHER OBJECT       1       1       1         080 BLOCEL       1       1       1         030 BLOCEL       1       1       1         141 READ-ON       1       1       1         142 REAL FLO       24       1       3       1         244 MOLE TIVEN       26       2       1       1         245 REAL FLO       26       1       3       1         245 REAL FLO       2       1       1       1         245 REAL FLO       2       1       1       1         345 REAL FLO       2       1       1       5         345 REAL FLO	090	FIXED OBJECT	12	-		2
000         MIML         1         1           0.01         BICTCLE         1         1           0.11         HEALEND         26         1         1           1.41         HEALEND         26         1         3         1           1.41         HEALEND         26         1         3         1           1.41         HEALEND         26         1         3         1           3.45         REALEND         26         1         1         1           3.45         REALEND         2         1         1         1           3.45         REALEND LIEFT TURN         2         1         1         1           3.45         REALEND LIEFT TURN         2         1         1         1           3.45         REALEND LIEFT TURN         2         1         1         1           4.40         OTHER DRIVE         2         1         1         1           4.40         OTHER DRIVE         2         1         1         1           4.41         DICHENT TURN         4.00         DICHENDRIK         5         1           5.         DIAL RIGHT TURN         4.10	020	OTHER OBJECT			-	
00       BICYCLE       1       1       1         14.       HKD-ON       1       1       1         14.       MGLE TINKI       1       1       1         14.       MGLE TURN       24       1       3       1         24.       MGLE TURN       26       1       3       1         24.       MGLE TURN       2       1       1       1         25.       REA-END RIGHT TURN       2       1       1       1         35.       REA-END RIGHT TURN       2       1       1       1       1         36.       REA-END RIGHT TURN       2       1 <t< td=""><td>080</td><td>ANIMAL</td><td>-</td><td></td><td></td><td></td></t<>	080	ANIMAL	-			
11       1	80	BICYCLE				
14. MGLE STRICH       1       1       1       1       1         14. RGLE STRICH       26       1       3       1       1       1         14. REAR-END       26       1       3       1       3       1       1       1       1         34. SERVEND       26       1<	141	HEAD - ON		-		
147       REAR-END       26       1       3       1         244       ANGLE TURN       2       1       1         345       REAR-END RIGHT TURN       2       1       1         345       REAR-END RIGHT TURN       2       1       1         346       REAR-END RIGHT TURN       2       1       1         346       REAR-END RIGHT TURN       2       1       1         346       REAR-END RIGHT TURN       2       1       1         444       REAR-END RIGHT TURN       2       2       5         545       FEAD-ONL LEFT TURN       2       5       5         545       FEAD-ONL LEFT TURN       4       7       5         545       FEAD-ONL LEFT TURN       3       5       5         545       FEAD-ONL LEFT TURN       4       7       5       5         545       FEAD-ONL LEFT TURN       3       3       5       5         545<	144	ANGLE STRAIGHT	-	-		-
24. AndLe TURN       2       1         3.2. SIDESURE SAME       3.2. SIDESURE SAME       1         3.4. SIDESURE SAME       2       1         4.0 OTHER DRIVE       1       1         4.1. ANGLE DRIVE       1       1         5.3 SIDESURE DROSITE       1       1         5.4 BAD-ON LEFT TURN       1       1         5.5 DUAL LEFT TURN       3       7       5         6.5 DUAL LEFT TURN       4       7       5         6.5 DUAL LEFT TURN       4       7       5         6.6 DUAL NUBER OF ACCIDENTS       4       7       5         10.1 AL UNBER OF INTERCHANGES = 2       20.5       4       3.5       2.5	147	REAR-END	26	-	ñ	-
342       SIDESUIPE SAME       1         345       REAR-END LEFT TURN       2         346       REAR-END LEFT TURN       2         346       REAR-END LEFT TURN       2         346       REAR-END DRIVE       1         347       REAR-END DRIVE       1         347       REAR-END DRIVE       1         347       REAR-END DRIVE       1         347       REAR-END DRIVE       1         348       FIGD-OUL EFT TURN       1         348       FIGD-OUL EFT TURN       1         349       LIEFT TURN       1         345       SIDE-SUPE OPPOSITE       1         345       SIDE-SUPE       1         345       SIDE-SUP       1         345       SIDE-SUP       1 <td>244</td> <td>ANGLE TURN</td> <td></td> <td>2</td> <td></td> <td></td>	244	ANGLE TURN		2		
34. Rear-eud left Turn       2         34. Rear-eud right Turn       2         44. Andle Dative       1         44. Andle Dative       1         44. Andle Dative       1         45. Rear-end Dative       1         54. Rear-end Dative       1         54. Rear-end Dative       1         54. Rear-end Dative       1         54. Bed-ou Left Turn       1         54. Bed-ou Left Turn       1         54. Bed-ou Left Turn       1         54. Dual Left Turn       1         54. Dual Left Turn       1         55. Dual Left Turn       1         56. Dual Left Turn       1         56. Dual Left Turn       1         56. Dual Left Turn       1         66. Dual Reinft Turn       1         67. Lot Number of Accidents       41       8       7       5         101A LUMBER of INTERCHANGES = 2       20.5       4       3.5       2.5	342	SIDESWIPE SAME			-	
34. REAR-EUN RIGHT TURN       2         44.0 OTHER DRIVE       1         44.4 ANGLE DRIVE       1         44.4 ANGLE DRIVE       1         44.4 ANGLE DRIVE       1         45.3 SIDESUIPE OPOSITE       1         54.5 IFEAD-ON LEFT TURN       1         64.5 DUAL LEFT TURN       1         64.6 DUAL RIGHT TURN       7         65.0 DUAL LEFT TURN       7         64.6 DUAL RIGHT TURN       7         64.6 DUAL RIGHT TURN       7         64.6 DUAL RIGHT TURN       7         65.7       4         7       5         7       5         8 OF ACCIDENTS / # OF INTERCHANGES = 2       2.5         8 OF ACCIDENTS / # OF INTERCHANGES       20.5       2.5	345	REAR-END LEFT TURN				
4.0 OTHER DRIVE14.4. ANGLE DRIVE4.4 NGLE DRIVE4.7 REAR-END DRIVE5.4 SIDESAUPE OPPOSITE5.43 SIDESAUPE OPPOSITE5.4 DAI LEFT TURN5.45 DUAL LEFT TURN6.4 DIAL REFT TURN6.45 DUAL LEFT TURN6.4 DIAL REFT TURN6.45 DUAL LEFT TURN6.4 DIAL REFT TURN6.46 DUAL REFT TURN6.4 DIAL REFT TURN6.47 NUMBER OF ACCIDENTS4.1 B7 NUMBER OF INTERCHANGES = 2# OF ACCIDENTS20.5 4# OF ACCIDENTS20.5 48 OF ACCIDENTS20.5 48 OF ACCIDENTS20.5 48 OF ACCIDENTS2.5 2.5	346	REAR-END RIGHT TURN		2		
4.4. ANGLE DRIVE14.7 REAR-END DRIVE4.75.3 SIDESWIPE OPPOSITE5.43 SIDESWIPE OPPOSITE5.45 DUAL LEFT TURN5.45 DUAL LEFT TURN5.46 DUAL RETTURN5.47 NUMBER OF ACCIDENTS7.11 NUMBER OF ACCIDENTS7.11 NUMBER OF INTERCHANGES = 28.07 ACCIDENTS / # OF INTERCHANGES7.11 NUMBER OF INTERCHANGES<	440	OTHER DRIVE				
47       REAR-END DRIVE       1         543       SIDESUIPE OPPOSITE       1         545       HEAD-ON LEFT TURN       1         645       DUAL LEFT TURN       6         646       DUAL REFT TURN       7       5         645       DUAL REFT TURN       7       5         646       DUAL RIGHT TURN       41       8       7       5         101AL NUBER OF ACCIDENTS       41       8       7       5         NUBER OF INTERCHANGES = 2       20.5       4       3.5       2.5	777	ANGLE DRIVE				
543SIDESUIPE OPPOSITE545HEAD-ON LEFT TURN645DUAL LEFT TURN646DUAL REFT TURN646DUAL REFT TURN64741877	447	REAR-END DRIVE			-	
545HEAD-ON LEFT TURN645DUAL LEFT TURN646DUAL RIGHT TURN646DUAL RIGHT TURN107AL NUMBER OF ACCIDENTS4187787787879NUMBER OF ACCIDENTS4187777778077847787879<	543	SIDESWIPE OPPOSITE				
645DUAL LEFT TURN646DUAL RIGHT TURN646DUAL RIGHT TURNTOTAL NUMBER OF ACCIDENTS418775NUMBER OF INTERCHANGES = 2# OF ACCIDENTS / # OF INTERCHANGES20.546ACCIDENTS / # OF INTERCHANGES20.54	545	HEAD-ON LEFT TURN				
646 DUAL RIGHT TURN         TOTAL NUMBER OF ACCIDENTS       41       8       7       5         NUMBER OF INTERCHANGES = 2         # OF ACCIDENTS / # OF INTERCHANGES       20.5       4       3.5       2.5	645	DUAL LEFT TURN				
Total Number of accidents     41     8     7     5       NUMBER of INTERCHANGES = 2     *     *     *     *     *     *       # OF ACCIDENTS / # OF INTERCHANGES     20.5     4     *     3.5     2.5	646	DUAL RIGHT TURN				
NUMBER OF INTERCHANGES = 2 # OF ACCIDENTS / # OF INTERCHANGES 20.5 4 3.5 2.5	TOTA	VL NUMBER OF ACCIDENTS	41	8	2	5
NUMBER OF INTERCHANGES = 2 # OF ACCIDENTS / # OF INTERCHANGES 20.5 4 3.5 2.5						
# OF ACCIDENTS / # OF INTERCHANGES 20.5 4 3.5 2.5	NUMB	BER OF INTERCHANGES = 2				
	# 0F	: ACCIDENTS / # OF INTERCHANGES	20.5	4	3.5	2.5
		•				

Table IV.39 Accident types by Collapsed interchange elements of Fringe group 10

Table IV.40 Accident types by Urban groups

		ACCIDENT TYPES	GROUP 1	GROUP 2	C GROUP 3	GROUP	4 GROUP	5 GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 1	0 GROUP 1	11 GROUP	12
	8	MISCELLANEOUS SINGLE VEHICLE	٣	15	4	11	8	\$	7	4	4	Ŷ	1		
	010	OVERTURN	t	18	16	15	29	16	13	25	12	27	-	5	
	020	HIT TRAIN													
	030	HIT PARKED VEHICLE	2	52	80	18	16	9	м	4	m	0		r	
	048	BACKING		14	¢	5	12	2	-	t	m	¢			
	049	PARKING	-	m		10	r	2		-		2		2	
	020	PEDESTRIAN	-	12	-	4	S	2				2			
	090	FIXED OBJECT	22	189	101	8	124	68	83	6	60	135	4	20	
	020	OTHER OBJECT	-	7	4	2	-	м		2	S	M	2		
	080	ANIMAL	6	2	6	2	-	2	5	M					
	060	BICYCLE		Ξ	4	-	3	-	2		-				
	141	HEAD-ON		6	S	2	5	2	m		4	6			
	144	ANGLE STRAIGHT	-	119	12	65	80	13	19	\$	1	32	-	Ξ	
	147	REAR-END	16	587	216	245	303	133	157	131	106	249	19	85	
	244	ANGLE TURN	9	43	14	14	17	2	12	M	10	8		ŝ	
1	342	SIDESWIPE SAME		20	M	2	2	m	2		ñ	12		2	
0	345	REAR-END LEFT TURN	m	40	2	15	19	m	m		4	ŝ		2	
3	346	REAR-END RIGHT TURN		53	4	1	7	M	80	M	M	4			
	440	OTHER DRIVE		4		2	4	-	m		ñ	-		2	
	777	ANGLE DRIVE		16	m	4	-	M	ŝ	-		-		2	
	277	REAR-END DRIVE		19	m	ŝ	12	m	2	m	2			m	
	543	SIDESWIPE OPPOSITE	-		-	-	-	2	2			-			
	545	HEAD-ON LEFT TURN		16	4	2	8	80	m	2	ŝ	4			
	645	DUAL LEFT TURN		:		4	2	2	~			-	2	2	
	646	DUAL RIGHT TURN		2	4	-	-	2							
	101	AL NUMBER OF ACCIDENTS	Ľ	1205	421	550	699	304	335	282	240	517	30	144	

	ACCIDENT TYPES	GROUP	I GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP	6 GROUP	7 GROUP	8 GROUP	9 GROUP	10 GROUP 11	GROUP 12	
80	MISCELLANEOUS SINGLE VEHICLE	26 2	17	15	10	4	13	S	2	17				
010	OVERTURN	132	45	57	38	4	67	29	35	41	2			
020	HIT TRAIN													
030	HIT PARKED VEHICLE	13	13	16	2	-	7	2	7	8	-			
048	BACKING	S	m	2	r	-		2		•				
049	PARKING	-	-	m						-				
020	PEDESTRIAN	4		3		-	2		-					
090	FIXED OBJECT	263	135	161	119	35	104	87	106	122	17			
020	OTHER OBJECT	8	6	M	m	-	2	7		5	-			
080	ANIMAL	236	81	54	35	0	45	20	15	45	7			
060	BICYCLE	-	r	2						2				
141	HEAD-ON	11	10	12	2	-	4	6	-	12	2			
144	ANGLE STRAIGHT	22	19	21	m	9	18	4	5	9				
147	REAR-END	160	112	173	8	£	100	5	83	88	1			
244	ANGLE TURN	14	15	6	2	2	2	10	9	6	2			
342	SIDESWIPE SAME	6	-	2	M		4	-	m		-			
345	REAR-END LEFT TURN	1	5	12	9	-	10	4		8				
346	REAR-END RIGHT TURN	4	4	S		-		2		4				
440	OTHER DRIVE	m	S	6	2		2	-	2	9				
777	ANGLE DRIVE	9	4	9		-	5	2	2	4	-			
447	REAR-END DRIVE	7	2	:	M	2	m	8		7	-			
543	SIDESUIPE OPPOSITE	-	-	-	-		-			-				
545	HEAD-ON LEFT TURN	11	6	7			-	5		\$				
645	DUAL LEFT TURN		-			-								
646	DUAL RIGHT TURN	2		4			-			2				
TOTA	AL NUMBER OF ACCIDENTS	276	498	591	321	96	380	269	275	396	67			I

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groups	
Rural	
γd	
types	
Accident	
IV.41	
Table	

	ACCIDENT TYPES	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP	s group	7 GROUP	B GROUP S	o group	10 GROUP 11 GROUP 12	
000	MISCELLANEOUS SINGLE VEHICLE	3	7	19	-	-	4	6	14	1	-		
010	OVERTURN	14	33	R	0	:	17	21	50	15	m		
020	HIT TRAIN												
030	HIT PARKED VEHICLE	t	Ś	13	4	4	r	3	6	-	-		
048	BACKING	4	80	6	2	2	2	-	2	M			
049	PARKING	-		2					-	-			
050	PEDESTRIAN			9	M		-	m	2	-			
090	FIXED OBJECT	52	115	178	39	57	65	77	164	69	22		
020	OTHER OBJECT		r	6	-		-		2	2	-		
080	ANIMAL	27	14	22	м	-	11	7	14	12	-		
60	BICYCLE		r	4	-				-				
141	HEAD-ON		9	14	-	-	9	4	r	2	-		
144	ANGLE STRAIGHT	12	22	22	8	4	12	2	9	2	Μ		
147	REAR-END	59	183	317	46	<b>%</b>	67	47	202	64	42		
244	ANGLE TURN	6	18	34	m	8	9	7	9	=	2		
342	SIDESUIPE SAME	-	-	m	4				Ś	m	-		
345	REAR-END LEFT TURN	4	7	9	2	m	4	-	2	2			
346	REAR-END RIGHT TURN	5	4	10		-	2	-	m		2		
440	OTHER DRIVE	-	r	4	-	-	-	2	4	2			
777	ANGLE DRIVE	-	4	6		-	2		4	7			
447	REAR-END DRIVE	-	5	10	2	m	S	ñ	Ś	6	-		
543	SIDESUIPE OPPOSITE		-	2		-	-						
545	HEAD-ON LEFT TURN		~	6		S	4	5	m	5			
645	DUAL LEFT TURN		2	2			-	-					
646	DUAL RIGHT TURN	-		2		-		2	2				
101	L NUMBER OF ACCIDENTS	200	747	622	134	171	215	163	504	219	87		

Table IV.42 Accident types by Fringe groups
OFF-RAMP	rss	2.04	4.82	1.63	2.59	6.00	2.50	rss	rss	2.58	rss	rss	1.16	1.57	2.47	0.54	rss	1.74	2.53	rss	2.39	rss	3.23	3.50	3.75	1.25	rss	4.80	2.50	3.53	3.93	rss
ON-RAMP	rss	2.26	3.41	1.00	2.05	3.50	1.83	rss	LSS	1.17	rss	SSI	0.39	0.60	1.07	0.43	rss	0.74	1.18	rss	0.93	rss	1.38	1.29	2.18	1.25	rss	1.90	1.25	2.73	1.64	rss
CROSSROAD	TSS T	3.66	6.18	3.37	5.27	6.00	6.50	rss	rss	6.50	rss	SS1	2.21	2.74	4.19	1.03	rss	2.96	4.24	rss	4.50	rss	3.85	3.75	5.98	1.50	rss	5.30	3.67	5.33	3.79	rss
MAINLINE	rss	5.86	9.53	5.24	8.50	11.00	7.75	rss	rss	13.75	rss	rss	76.7	5.57	5.93	4.84	rss	7.41	6.94	rss	6.21	rss	6.00	6.88	7.48	5.50	rss	8.00	5.92	12.80	5.93	rss
GROUP	URBAN GROUP 1	URBAN GROUP 2	URBAN GROUP 3	URBAN GROUP 4	URBAN GROUP 5	URBAN GROUP 6	URBAN GROUP 7	URBAN GROUP 8	URBAN GROUP 9	URBAN GROUP 10	URBAN GROUP 11	URBAN GROUP 12	RURAL GROUP 1	RURAL GROUP 2	RURAL GROUP 3	RURAL GROUP 4	RURAL GROUP 5	RURAL GROUP 6	RURAL GROUP 7	RURAL GROUP 8	RURAL GROUP 9	RURAL GROUP 10	FRINGE GROUP 1	FRINGE GROUP 2	FRINGE GROUP 3	FRINGE GROUP 4	FRINGE GROUP 5	FRINGE GROUP 6	FRINGE GROUP 7	FRINGE GROUP 8	FRINGE GROUP 9	FRINGE GROUP 10

The average number of Accidents per interchange by units used Table IV.43

LSS means the sample size is less than 10 interchanges.

File
Data
Sample
IV.44
Table

∍	4	~	-	0	0	
>	0	0	0	0	0	
>	~	2	m	-	-	
-	12	Ξ	14	0	~	
971	176	224	222	212	210	
68(780	687583	275341	275341	275341	275341	
19600	19600	10600	10600	10600	10600	
-			-	-	-	
v	~	~	~	~	2	
v	~	~	~	~	2	
2	13	13	13	13	13	
0	0	0	0	0	0	
8 8	84	82	8 2	84	84	
2298	2286	0//2	776	1076	1084	
2210	2198	658	665	970	626	
2	20	ß	33	ñ	33	
n	4	•	~		2	
261	261	728	728	729	729	

Descriptions	Interchange No.	Interchange Element	County No.	Beginning Milepoint	Ending Milepoint	Geometric and Laneage Code	Ramp Terminal or Intersection Code	Interchange Lighting Code	Interchange Type	Activity Density	Number of On-ramps	Number of Off-ramps	Freeway crossing over or under the crossroad	Average Daily Traffic	Population of the county	Lane mileage (in 1/100 mile unit)	Total accidents	Fixed object accidents	Angle turn accidents	Rear-end accidents
olumn Range	1 - 4	5-6	8-9	11 - 14	17 - 20	23 - 24	25 - 26	<b>29 - 3</b> 0	53 - 34	35	56 - 38	59 - 41	12 - 44	5 - 51	52 - 58	59 - 65	56 - 68	59 - 71	72 - 74	72 - 77
0				-					<i>(</i> -)		1.1	(* )	7	~			2	5		



Comparison of the analysis units by groups based on the highest and lowest Table IV.45 Co accident rates 

Lowest	*				*						*		
Lowest On	*			*							*		
Lowest Cr	*				*						*		
Lowest Mn	¥				*						*		
Highest Of		*					*					*	
Highest On		*					*						×
Highest Cr			*					¥		¥			
Highest Mn L			*			*							×
Groups	Jrban Group 4	Jrban Group 6	Jrban Group 10	Rural Group 1	Rural Group 4	kural Group 6	tural Group 7	tural Group 9	ringe Group 2	ringe Group 3	ringe Group 4	ringe Group ó	ringe Group 8

Mn: Mainline Rate Cr: Crossroad Rate On: On-ramp Rate Of: Off-ramp Rate

Group	Accidents/Int. on Mainline	Accidents/Int. on Crossroad	Accidents/Int. on On-ramp	Accidents/Int. on Off-ramp
UGROUP 2	9	2.5	1.67	4.5
UGROUP 3	11	6	6	4
UGROUP 6	12	6	4	ى ك
UGROUP 9	9	4.5	0	m
FGROUP 2	10.67	5	4	5.67

Table IV.46 The average number of accidents per interchange by sample units

Accident Rate on Off-ramp	0.425 0.522 4.374 0.937 0.317
Accident Rate on On-ramp	0.181 0.307 0.531 0.265 0.210
Accident Rate on Crossroad	0.098 0.172 0.240 0.117 0.133
Accident Rate on Mainline	0.058 0.127 0.169 0.102 0.118
Group	UGROUP 2 UGROUP 2 UGROUP 6 UGROUP 9 FGROUP 2

The average accident rate per interchange by sample units Table IV.47



.





Chart 4.2 Data file set by Urban Groups



Chart 4.3 Data file set by Rural Groups



Chart 4.4 Data file set by Fringe Groups

#### CHAPTER V

#### MODELS

Having determined that models constructed on the total data base did not produce results sufficiently reliable to use in selecting alternative design parameters, the stratified data set was used for further analyses. As described in chapter IV, the data had been stratified by activity density (urban, rural and fringe) and by interchange design groups. The data records were divided into cells representing this two way classification, and models were constructed for each of the analysis units within a cell. Only those cells with at least 10 interchanges were modeled. These models were based upon the following formula:

 $Y = f(X_1, X_2, X_3, X_4, X_5)$ 

where Y = Number of accidents on road segment (i) X<sub>1</sub> = Population (in 1000's) of the county X<sub>2</sub> = Lane mileage of the analysis unit (in 0.01 mile units) X<sub>3</sub> = Number of on-ramps X<sub>4</sub> = Number of off-ramps X<sub>5</sub> = Average Daily Traffic (ADT)

### V.1 Models constructed on the Mainline Unit

Using stepwise linear regression, the following models provided the highest  $(\mathbf{R}^2)$  value for each group.

# A. Models constructed based on the total accidents on the mainline units

1. Model of urban group 2

 $Y = -19.910 + 0.000816X_5$ 

where 
$$Y = Total$$
 number of Accidents on road segment (i)  
 $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.5441, based on 19 interchanges (38 road segments).

2. Model of urban group 3

 $Y = -14.551 + 0.00115X_{s}$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.9025, based on 11 interchanges (22 road segments).

3. Model of urban group 5

$$Y = -42.267 - 0.038X_1 + 0.00215X_5$$

where Y = Total number of accidents on road segment (i)  $X_1 = Population$  (in 1000's) of the county  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7839, based on 11 interchanges (28 road segments).

- 4. Model of rural group 1
  - $Y = 0.937 0.00880X_1 + 0.000657X_5$
- where Y = Total number of accidents on road segment (i)  $X_1 = Population$  (in 1000's) of the county  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7336, based on 50 interchanges (99 road segments).

5. Model of rural group 2

$$Y = 4.650 + 0.000258X_{s}$$

where 
$$Y = Total number of accidents on road segment (i)  $X_5 = Average Daily Traffic (ADT)$$$

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.3547, based on 27 interchanges (54 road segments).

6. Model of rural group 3

 $Y = -5.007 + 0.030X_2 + 0.000354X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7150, based on 25 interchanges (49 road segments).

7. Model of rural group 4

$$Y = 3.435 + 0.060X_2 - 8.534X_3 + 0.000289X_5$$

where Y = Total number of accidents on road segment (i)

 $X_2$  = Lane mileage  $X_3$  = Number of on-ramps  $X_5$  = Average Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8262, based on 23 interchanges (55 road segments).

8. Model of rural group 6

 $Y = 0.182 + 0.000410X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient (R) was 0.4087, based on 18 interchanges (48 road segments).

9. Model of rural group 7

 $Y = -6.247 + 0.069X_2 + 0.000316X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT) From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.6497, based on 12 interchanges (26 road segments).

9. Model of rural group 9

 $Y = -27.865 + 11.561X_3 + 0.000585X_5$ 

where Y = Total number of accidents on road segment (i)  $X_3 = Number$  of on-ramps  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.6290, based on 19 interchanges (38 road segments).

10. Model of fringe group 2

 $Y = 7.932 - 0.067X_2 + 0.000685X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8200, based on 14



interchanges (28 road segments).

11. Model of fringe group 3

 $Y = -9.340 - 0.00629X_1 + 0.062X_2 + 0.000566X_5$ 

where Y = Total number of accidents on road segment (i)  $X_1 = Population$  (in 1000's) of the county  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.6872, based on 26 interchanges (52 road segments).

12. Model of fringe group 8

 $Y = -7.127 + 0.149X_2$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage

From the above linear regression model, the multiple regression coefficient (R) was 0.7452, based on 10 interchanges (26 road segments).

13. Model of fringe group 9

$$Y = 5.488 + 0.077X_2$$

where Y = Total number of accidents on road segment (i)  $X_2 = Lane mileage$ 

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7162, based on 10 interchanges (20 road segments).

### V.2 Models constructed on the crossroad unit

Using stepwise linear regression, the following models provided the highest  $(\mathbf{R}^2)$  value for each group.

A. Models constructed based on the total accidents on the crossroad units

1. Model of urban group 3

 $Y = -57.966 + 0.553X_2 + 0.00257X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)



From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8590, based on 11 interchanges (11 road segments).

2. Model of urban group 4

 $Y = -21.355 + 0.425X_2 + 0.00167X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8656, based on 11 interchanges (11 road segments).

3. Model of rural group 1

 $Y = -3.654 + 0.00348X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7063, based on 50

interchanges (50 road segments).

4. Model of rural group 2

 $Y = 1.959 + 0.00246X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.6711, based on 27 interchanges (27 road segments).

- 5. Model of rural group 3  $Y = 0.257 + 0.00235X_5$
- where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8034, based on 25 interchanges (25 road segments).

6. Model of rural group 6

 $Y = -175.947 + 0.373X_2 + 48.619X_4$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_4 = Number$  of off-ramps

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8795, based on 12 interchanges (12 road segments).

7. Model of rural group 7

 $Y = 4.597 + 0.00144X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average Daily Traffic (ADT)$ 

From the above linear regression model, the multiple regression coefficient (R) was 0.8525, based on 10 interchanges (10 road segments).

8. Model of rural group 9

 $Y = -0.514 + 0.00384X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average Daily Traffic (ADT)$ 



From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.8356, based on 19 interchanges (19 road segments).

9. Model of fringe group 2

$$Y = 4.077 + 0.00283X_5$$

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.7534, based on 14 interchanges (14 road segments).

## V.3 Models constructed on the on-ramp units

Using stepwise linear regression, the following models provided the highest  $(\mathbf{R}^2)$  value for each group.

A. Model constructed based on the total accidents on the onramp units

1. Model of urban group 2

 $Y = 4.723 - 0.00118X_5$ 

where Y = Total number of accidents on road segment (i)  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient (R) was 0.5051, based on 17 interchanges (18 on-ramps).

# B. Models constructed based on the fixed object accidents on the on-ramp units

1. Model of urban group 2

 $Y = 0.883 + 0.039X_2 - 0.000605X_5$ 

where Y = Total number of accidents on road segment (i)  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient (R) was 0.7388, based on 17 interchanges (18 on-ramps).

#### V.4 Models constructed on the off-ramp unit

Using stepwise linear regression, the following models

provided the highest  $(\mathbf{R}^2)$  value for each group.

A. Model constructed based on the total accident rate on the off-ramp units

1. Model of urban group 2

 $Y = 8.236 - 0.00236X_1 + 0.271X_2 - 0.000565X_5$ 

where Y = Total number of accidents on road segment (i) $<math>X_1 = Population$  (in 1000's) of the county  $X_2 = Lane$  mileage  $X_5 = Average$  Daily Traffic (ADT)

From the above linear regression model, the multiple regression coefficient (R) was 0.9091, based on 17 interchanges (19 off-ramps).

B. Models constructed based on the fixed object accidents on the off-ramp units

1. Model of urban group 2

 $Y = 3.226 - 0.00102X_1$ 

where Y = Total number of accidents on road segment (i)  $X_1 = Population$  (in 1000's) of the county



From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.5034, based on 17 interchanges (19 off-ramps).

# <u>C. Models constructed based on the rear-end accidents on the</u> off-ramp units

1. Model of urban group 2

 $Y = -0.267 + 0.152X_2$ 

where Y = Total number of accidents on road segment (i) X<sub>2</sub> = Lane mileage

From the above linear regression model, the multiple regression coefficient  $(\mathbf{R})$  was 0.6195, based on 17 interchanges (19 off-ramps).

#### Summary of Results

Based upon the above models, the sign of each variable term was recorded for each group as shown in Table V.1. Some general observations that resulted from a review of these models were as follows:

 On the mainline unit of urban freeway interchanges, all the models have a positive sign in the average daily traffic term as would be expected.

2. On the mainline unit of rural freeway interchanges, all the models again have a positive sign in the average daily traffic term. Also, all the models have a positive sign in the lane mileage term. This indicates that the number of accidents increases with the length of the road segment. Most of the models have a positive sign in the number of on-ramps term, indicating that the number of accidents on the rural mainline unit increases where there are more on-ramps.

3. On the mainline unit of fringe freeway interchanges, all the models again have a positive sign in the average daily traffic term. This is consistent with the results in the urban and rural areas. Also, most of the models have a positive sign in the lane mileage term, indicating that the number of accidents is greater for the longer fringe mainline units.

4. On the crossroad unit of urban freeway interchanges, all the models have a positive sign in the lane mileage and average daily traffic terms, indicating that the number of accidents increases with the longer crossroad units and increased traffic.

5. On the crossroad unit of rural and fringe freeway interchanges, all the models have a positive sign in the average daily traffic term.

6. There were an insufficient number of models of the on-ramp

and off-ramp accident frequency to draw any general conclusions.

7. Attempts to model specific accident types (fixed object accidents, rear-end accidents) did not improve the model accuracy ( $\mathbf{R}^2$  value). Therefore, models built on predicting total accidents were retained for further testing.

8. Relatively high values of **R** were achieved for group 3 interchange mainline and crossroad units in all three categories (urban, rural and fringe). Group 3 interchanges include Modified Diamond, Modified Tight Diamond and Parclo A 4 Quad. Thus, it may be possible to accurately predict the accidents to be expected at these interchanges.

9. Group 2 interchanges (Tight Diamond and Urban Diamond) were not easily modeled, with low values of **R** resulting from the urban and rural mainline models. The fringe area model fit the data better, with an **R** value of 0.8200.

10. In the rural area, group 4 interchange (Partial Diamond, Partial Tight Diamond, Trumpet A and Partial Directional Y) models showed a good fit for both the crossroad and the mainline segments. There was an insignificant sample of this interchange group in the urban and fringe areas, so no models were constructed for this interchange groups.

Classification of signs of variable terms used in the models constructed Table V.1

		M	ц	M	н Н	Σ	D	ں ر	Ľ.	с U	Щ	υ	Ő	R	ΟF	ង
Variables used	+	1	+	1	+	1	+	1	+	1	+	1	+	1	+	1
Population		Ъ		1	г	ı								1		8
Lane mileage			Ŋ		4	Ч	e		Ч				Ч		3	
Number of On-ramps			2	Л												
Number of Off-ramps									Ч							
Avg. Daily Traffic	ى ك		6		2		m		9		г			Ч		٦

UM means Urban Mainline. RM means Rural Mainline. FM means Fringe Mainline. UC means Urban Crossroad. RC means Rural Crossroad. FC means Fringe Crossroad. ONR means Orfanps.

	Σ	A I NL I NE			CROSSF	ROAD			ON-RAMP			OFF-RAMF	
	TA	FA	RA	TA	FA	RA	AA	TA	FA	RA	ΤA	FA	RA
URBAN GROUP 2	19							17	12		17	17	12
URBAN GROUP 3	11	11	11	:									
URBAN GROUP 4				:	:		11						
URBAN GROUP 5	11												
RURAL GROUP 1	50			50			50						
RURAL GROUP 2	27			27									
RURAL GROUP 3	25			25									
RURAL GROUP 4	23	23	23										
RURAL GROUP 6	18			12									
RURAL GROUP 7	12			10									
RURAL GROUP 9	19			19									
FRINGE GROUP 2	14												
FRINGE GROUP 3	26			26									
FRINGE GROUP 8	10		10										
FRINGE GROUP 9	10												

Table V.2 Number of interchanges for each group of the analysis unit

Table V.3 Multiple R Coefficient for Each group of Analysis Unit

TA         FA         RA         TA         FA           URBAN GROUP 2         0.5441         0.8590         0.6144           URBAN GROUP 3         0.9025         0.7480         0.8134         0.8590           URBAN GROUP 4         0.9025         0.7480         0.8134         0.8590           URBAN GROUP 5         0.9025         0.7480         0.8134         0.8556         0.6144           URBAN GROUP 1         0.7336         0.7633         0.7633         0.6171         0.6171           RURAL GROUP 2         0.7336         0.7534         0.8054         0.6171         0.6171           RURAL GROUP 2         0.7150         0.7661         0.8054         0.6171         0.6711           RURAL GROUP 2         0.7150         0.7661         0.8054         0.6771         0.6771           RURAL GROUP 2         0.7150         0.7661         0.8054         0.6771         0.8054           RURAL GROUP 2         0.6497         0.6497         0.6497         0.8525         0.7534           RURAL GROUP 2         0.6290         0.6497         0.6570         0.7534         0.7534           RURAL GROUP 2         0.6497         0.6670         0.7534         0.7534         0.7	MAIN	LINE		CROSSR	OAD			ON-RAMP			OFF-RAMP	
URBAN GROUP         2         0.5441         0.8540         0.8590           URBAN GROUP         3         0.9025         0.7480         0.8134         0.8590           URBAN GROUP         4         0.9025         0.7480         0.8134         0.8590           URBAN GROUP         5         0.7839         0.7661         0.8656         0.6144           URBAN GROUP         5         0.77336         0.7063         0.7063           RURAL GROUP         2         0.7354         0.8054         0.6711           RURAL GROUP         3         0.7150         0.8034         0.8034           RURAL GROUP         3         0.7150         0.8034         0.8034           RURAL GROUP         4         0.8056         0.6711         0.8034           RURAL GROUP         0.0.8026         0.7661         0.8034         0.8755           RURAL GROUP 7         0.6497         0.6290         0.6875         0.8755           RURAL GROUP 9         0.6290         0.7534         0.7534           RURAL GROUP 2         0.8200         0.7534         0.7534           RURAL GROUP 2         0.6872         0.7534         0.7534           RURAL GROUP 2         0.6872 <th>TA</th> <th>FA RA</th> <th>TA</th> <th>FA</th> <th>RA</th> <th>¥</th> <th>TA</th> <th>FA</th> <th>RA</th> <th>TA</th> <th>FA</th> <th>RA</th>	TA	FA RA	TA	FA	RA	¥	TA	FA	RA	TA	FA	RA
URBAN         GROUP         3         0.9025         0.7480         0.8590         0.6144           URBAN         GROUP         0         0.8656         0.6144         0.8656         0.6144           URBAN         GROUP         5         0.7336         0.7063         0.6711         0.6711           URBAN         GROUP         2         0.7336         0.7063         0.6711           RURAL         GROUP         2         0.7150         0.6711         0.6711           RURAL         GROUP         3         0.7150         0.6711         0.6711           RURAL         GROUP         3         0.7150         0.8034         0.8034           RURAL         GROUP         0         0.8262         0.7661         0.8034           RURAL         GROUP         0         0.8262         0.7661         0.8755           RURAL         GROUP         0         0.6497         0.8525         0.8555           RURAL         GROUP         0         0.6290         0.7534           FRINGE         GROUP         0         0.8356         0.7534           FRINGE         GROUP         0         0.6872         0.7534	toup 2 0.5441						0.5051	0.7388		0.9091	0.5034	0.6195
URBAN GROUP 4         0.8656         0.6144           URBAN GROUP 5         0.7336         0.7063           URBAN GROUP 7         0.7336         0.7063           URBAN GROUP 2         0.7336         0.7063           RURAL GROUP 2         0.3547         0.6711           RURAL GROUP 3         0.7150         0.6711           RURAL GROUP 3         0.7150         0.8034           RURAL GROUP 4         0.8262         0.7661         0.8034           RURAL GROUP 7         0.4087         0.8795         0.8795           RURAL GROUP 7         0.6497         0.8525         0.8525           RURAL GROUP 9         0.6290         0.8356         0.7534           FRINGE GROUP 2         0.8200         0.6529         0.7534	ROUP 3 0.9025 0.	7480 0.813	4 0.8590									
URBAN GROUP 5         0.7339         0.7063           RURAL GROUP 1         0.7336         0.7063           RURAL GROUP 2         0.3547         0.6711           RURAL GROUP 2         0.3547         0.6711           RURAL GROUP 3         0.7150         0.6711           RURAL GROUP 4         0.8262         0.7661         0.8034           RURAL GROUP 4         0.8262         0.7661         0.8054           RURAL GROUP 6         0.4087         0.8795         0.8795           RURAL GROUP 7         0.6497         0.8525         0.8525           RURAL GROUP 9         0.6290         0.8356         0.7534           FRINGE GROUP 2         0.8200         0.7534         0.7534	SOUP 4		0.8656	0.6144		0.6170						
RURAL GROUP 1       0.7336       0.7063         RURAL GROUP 2       0.3547       0.6711         RURAL GROUP 3       0.3547       0.6711         RURAL GROUP 4       0.3547       0.6714         RURAL GROUP 4       0.3262       0.7150       0.8034         RURAL GROUP 4       0.8262       0.7661       0.8054         RURAL GROUP 6       0.4087       0.8795       0.8795         RURAL GROUP 7       0.6497       0.8525       0.8525         RURAL GROUP 9       0.6290       0.8356       0.7534         FRINGE GROUP 2       0.6872       0.7534       0.7534	ROUP 5 0.7839											
RURAL GROUP 2         0.3547         0.6711           RURAL GROUP 3         0.7150         0.6713           RURAL GROUP 4         0.8262         0.7661         0.8034           RURAL GROUP 4         0.8262         0.7661         0.8054           RURAL GROUP 6         0.4087         0.8795         0.8795           RURAL GROUP 7         0.6497         0.8525         0.8525           RURAL GROUP 9         0.6290         0.8356         0.7534           FRINGE GROUP 2         0.8200         0.7534         0.7534	ROUP 1 0.7336		0.7063			0.6283						
RURAL GROUP 3         0.7150         0.8034           RURAL GROUP 4         0.8262         0.7661         0.8034           RURAL GROUP 6         0.4087         0.8795         0.8795           RURAL GROUP 7         0.4087         0.8525         0.8525           RURAL GROUP 9         0.6290         0.8356         0.8356           FRINGE GROUP 2         0.8200         0.6273         0.7534	ROUP 2 0.3547		0.6711									
RURAL GROUP 4         0.8262         0.7661         0.8054           RURAL GROUP 6         0.4087         0.8795           RURAL GROUP 7         0.4087         0.8795           RURAL GROUP 7         0.6497         0.8525           RURAL GROUP 9         0.6290         0.8356           FRINGE GROUP 2         0.8200         0.7534           FRINGE GROUP 3         0.6872	toup 3 0.7150		0.8034									
RURAL GROUP 6         0.4087         0.8795           RURAL GROUP 7         0.6497         0.8525           RURAL GROUP 9         0.6290         0.8356           FRINGE GROUP 2         0.8200         0.7534           FRINGE GROUP 3         0.6672         0.7534	ROUP 4 0.8262 0.	7661 0.805										
RURAL GROUP 7         0.6497         0.8525           RURAL GROUP 9         0.6290         0.8356           FRINGE GROUP 2         0.8200         0.7534           FRINGE GROUP 3         0.6872	ROUP 6 0.4087		0.8795									
RURAL GROUP 9         0.6290         0.8356           FRINGE GROUP 2         0.8200         0.7534           FRINGE GROUP 3         0.6872	toup 7 0.6497		0.8525									
FRINGE GROUP 2 0.8200 0.7534 FRINGE GROUP 3 0.6872	toup 9 0.6290		0.8356									
FRINGE GROUP 3 0.6872	3ROUP 2 0.8200		0.7534									
	3ROUP 3 0.6872											
FRINGE GROUP 8 0.7452 0.8416	3ROUP 8 0.7452	0.841	2									
FRINGE GROUP 9 0.7162	3ROUP 9 0.7162											







#### CHAPTER VI

#### CALIBRATION

In order to test the above models, all models which had a multiple R coefficient greater than 0.7 and were based on more than 10 interchanges for the mainline and crossroad units were considered. However, all the groups for the ramp units were considered during the calibration procedure since samples of ramp data collected were so small. The linear regression models were constructed for each group of mainline, crossroad and ramp units based on population (1000's) of the county  $(X_1)$ , lane mileage (in 0.01 mile unit) of the analysis unit  $(X_2)$ , number of on-ramps  $(X_3)$ , number of off-ramps  $(X_4)$ , average daily traffic (ADT)  $(X_5)$  and the total number of accidents.

#### VI. 1 Models for the Mainline Unit

1. Model of urban group 3

 $Y = -14.551 + 0.00115X_5$ 

From the above linear regression model, the predicted values for each interchange not used in constructing the model for this group were found, and these were compared with the actual values as shown in Table VI.1.
2. Model of urban group 5

$$Y = -42.267 - 0.038X_1 + 0.00215X_5$$

From the above linear regression model, the predicted values and the actual values are shown in Table VI.2.

3. Model of rural group 1

 $Y = 0.937 - 0.00880X_1 + 0.000657X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.3.

4. Model of rural group 3

 $Y = -5.007 + 0.030X_2 + 0.000354X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.4.

5. Model of rural group 4

 $Y = 3.435 + 0.060X_2 - 8.534X_3 + 0.000289X_5$ 

From the above linear regression model, the predicted values



and the actual values are shown in Table VI.5.

6. Model of fringe group 2

 $Y = 7.932 - 0.067X_2 + 0.000685X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.6.

7. Model of fringe group 8

 $Y = -7.127 + 0.149X_2$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.7.

8. Model of fringe group 9

 $Y = 5.488 + 0.077X_2$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.8.

### V.2 Models for the crossroad unit

1. Model of urban group 3

$$Y = -57.966 + 0.553X_2 + 0.00257X_5$$

From the above linear regression model, the predicted values and the actual values are shown in Table VI.9.

2. Model of urban group 4

$$Y = -21.355 + 0.425X_2 + 0.00167X_5$$

From the above linear regression model, the predicted values and the actual values are shown in Table VI.10.

3. Model of rural group 1

 $Y = -3.654 + 0.00348X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.11.

4. Model of rural group 3

 $Y = 0.257 + 0.00235X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.12.

5. Model of rural group 6

$$Y = -175.947 + 0.373X_2 + 48.619X_4$$

From the above linear regression model, the predicted values and the actual values are shown in Table VI.13.

6. Model of rural group 7

 $Y = 4.597 + 0.00144X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.14.

7. Model of rural group 9

 $Y = -0.514 + 0.00384X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.15.

8. Model of fringe group 2

 $Y = 4.077 + 0.00283X_5$ 

From the above linear regression model, the predicted values



and the actual values are shown in Table VI.16.

### V.3 Models for the on-ramp unit

1. Model of urban group 2

$$Y = 4.723 - 0.00118X_1$$

From the above linear regression model, the predicted values and the actual values are shown in Table VI.17.

### V.4 Models for the off-ramp unit

1. Model of urban group 2

 $Y = 8.236 - 0.00236X_1 + 0.271X_2 - 0.000565X_5$ 

From the above linear regression model, the predicted values and the actual values are shown in Table VI.18.

### Summary of Results

Based upon the results of model calibration, the following conclusions were drawn:

1. Out of the urban and rural mainline groups, group 3 which



comprises the interchange types of Modified Diamond, Modified Tight Diamond and Parclo A 4 Quad predicts the observed values well as shown in Graphs 1 and 4. These models indicate that the number of accidents on the urban freeway interchanges of Modified Diamond, Modified Tight Diamond and Parclo A 4 Quad types depends primarily on the average daily traffic (ADT) and increases with increased traffic. However, models to predict the number of accidents on the rural freeway interchanges of the same types also include the lane mileage variable with the accident frequency increasing with the length of the road segment.

2. Out of the fringe mainline groups, group 2 and group 8 demonstrated good prediction capability as shown in Graphs 6 and 7. Group 2 comprises Tight Diamond and Urban Diamond types. Group 8 comprises Cloverleaf, Cloverleaf with CD roads, Cloverleaf minus 1 loop and Directional with loops types. In group 2, the models indicate that the number of accidents on these types of interchanges depend on the lane mileage and average daily traffic (ADT). However, in group 8, the number of accidents on these types of interchanges depends only on the lane mileage and increases with the length of road segment.

3. Out of the rural crossroad groups, group 3 and group 7 predict the observed values well as shown in Graphs 12 and 14. Group 3 comprises Modified Diamond, Modified Tight Diamond and Parclo A 4 Quad. Group 7 comprises Parclo AB and Partial

Directional. The number of accidents on these types of interchanges depends on the average daily traffic (ADT) and increases with the increased traffic. This is consistent with the results of other groups.

4. Out of the urban off-ramp groups, group 2 which comprises Modified Diamond, Modified Tight Diamond and Parclo A 4 Quad types has a good prediction for the observed values as shown in Graph 18. The number of accidents on these types of interchanges depends on the population, lane mileage and average daily traffic (ADT), and increases with less population, longer length and reduced traffic.

5. Out of the remaining groups, 3 groups had at least one negative predicted value and most of the remaining groups gave poor predictions for the observed values. This might be result of the existence of outliers within the data. If the outliers are removed, better predictions for the remaining groups could be expected.



Actual Values	Rank	Predicted Values	Rank
Actual Values	3 2 1 4	Predicted Values 118.32 215.62 129.36 68.88	3 1 2 4

## Table VI.1 Comparison of Actual and Predicted values of Total accident frequency in UM-Group 3







Actual Values	Rank	Predicted Values	Rank
Actual Values 72 229 15 8	2 1 3 4	Predicted Values 154.60 280.08 -24.34 71.80	2 1 4 3

## Table VI.2 Comparison of Actual and Predicted values of total accident frequency in UM-Group 5







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Actual Values	Rank	Predicted Values	Rank
23	3	16.36	7
0	17	54.40	1
21	5	16.32	8
11	10	15.50	9
3	15	7.34	17
45	1	35.28	2
13	9	26.84	3
7	13	15.14	10
18	8	26.06	4
11	10	9.60	14
22	4	17.00	6
27	2	20.32	5
8	12	9.44	15
3	15	12.32	13
7	13	9.38	16
20	6	12.84	12
19	7	14.28	11

### Table VI.3 Comparison of Actual and Predicted values of Total accident frequency in RM-Group 1





Actual Values	Rank	Predicted Values	Rank
52 39 19 26 11 11 10 21 10	1 2 5 3 6 8 4 8	29.68 24.33 10.58 12.94 7.78 6.74 7.02 75.96 21.34	2 3 6 5 7 9 8 1 4

## Table VI.4 Comparison of Actual and Predicted values of Total accident frequency in RM-Group 3





Actual Values	Rank	Predicted Values	Rank
45	2	14.64	3
5	6	9.30	5
4	7	14.52	4
20	3	19.54	2
6	5	37.70	1
3	8	3.60	8
12	4	4.70	7
69	1	7.80	6

# Table VI.5 Comparison of Actual and Predicted values of Total accident frequency in RM-Group 4







Actual Values	Rank	Predicted Values	Rank
23	2	45.23	2
17	4	33.17	3
19	3	27.92	4
14	5	21.45	5
60	1	75.59	1

## Table VI.6 Comparison of Actual and Predicted values of Total accident frequency in FM-Group 2



.



Actual Values	Rank	Predicted Values	Rank
Actual Values	1 4 2 3	153.56 77.38 79.67 49.86	1 3 2 4

## Table VI.7 Comparison of Actual and Predicted values of Total accident frequency in FM-Group 8






Actual Values	Rank	Predicted Values	Rank
Actual Values	Rank 2 1 3 4	38.24 35.69 31.46 37.61	1 3 4 2

### Table VI.8 Comparison of Actual and Predicted values of Total accident frequency in FM-Group 9

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# Table VI.9 Comparison of Actual and Predicted values of Total accident frequency in UC-Group 3







Actual Values	Rank	Predicted Values	Rank
46 11 28 4	1 3 2 4	35.85 49.46 45.87 4.22	3 1 2 4

Table VI.10 Comparison of Actual and Predicted values of Total accident frequency in UC-Group 4





Actual Values	Rank	Predicted Values	Rank
3	10	$\begin{array}{c} 2.26\\ 16.08\\ 17.23\\ 10.61\\ 2.61\\ 2.37\\ 9.99\\ 5.05\\ 49.94\\ 5.74\\ 6.79\\ 18.62\\ 0.87\\ 22.45\\ 9.57\\ 3.65\\ 22.45\\ 9.57\\ 3.65\\ 22.45\end{array}$	16
10	4		6
4	8		5
2	12		7
1	13		14
12	3		15
14	2		8
0	17		12
37	1		1
3	10		11
1	13		10
4	8		4
1	13		17
8	5		2
1	13		9
7	6		13
6	7		2

### Table VI.11 Comparison of Actual and Predicted values of Total accident frequency in RC-Group 1







Actual Values	Rank	Predicted Values	Rank
54 6 . 11 7 2 5 67 2	2 5 3 9 4 7 6 1 7	24.20 9.42 10.83 1.27 1.29 9.66 4.09 61.12 13.68	2 6 4 9 8 5 7 1 3

# Table VI.12 Comparison of Actual and Predicted values of Total accident frequency in RC-Group 3







Actual Values	Rank	Predicted Values	Rank
Actual Values 44 1 29	Rank 1 3 2	Predicted Values 29.59 -66.03 -60.81 82.68	Rank 2 4 3 1

# Table VI.13 Comparison of Actual and Predicted values of Total accident frequency in RC-Group 6







Actual Values	Rank	Predicted Values	Rank
Actual Values	4 3 2 1	9.08 19.72 13.96 30.76	Rank 2 3 1

### Table VI.14 Comparison of Actual and Predicted values of Total accident frequency in RC-Group 7

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Actual Values	Rank	Predicted Values	Rank
16 16 2 2 3 5 4	1 6 5 3 4	19.72 17.92 16.57 2.44 9.47 22.53 2.17	2 3 4 6 5 1 7

### Table VI.15 Comparison of Actual and Predicted values of Total accident frequency in RC-Group 9

,







Actual Values	Rank	Predicted Values	Rank
46	3	32.52	3
56	2	13.30	5
18	4	21.06	4
13	5	50.21	2
75	1	55.44	1

# Table VI.16 Comparison of Actual and Predicted values of Total accident frequency in FC-Group 2







Actual Values	Rank	Predicted Values	Rank
4 1 2 1 1 1	1 3 3 3 3	2.07 2.07 3.91 2.07 2.07 3.91	3 1 3 1 1

### Table VI.17 Comparison of Actual and Predicted values of Total accident frequency in UON-Group 2






Actual Values	Rank	Predicted Values	Rank
2 2 15 9 1 9	4 1 2 6 2	5.99 4.61 17.30 1.07 5.15 15.43	3 5 1 6 4 2

# Table VI.18 Comparison of Actual and Predicted values of Total accident frequency in UOF-Group 2







#### CHAPTER VII

#### SUMMARY and CONCLUSIONS

#### Summary

Freeway interchanges play a very important role in reducing the probability of vehicular conflicts during transfer from one road to another. However, the number of accidents on freeway interchanges is increasing with increased traffic on the freeway.

The purpose of this study was to identify the type of accidents that occurred on the elements of the interchanges, compare the accident rates with the results from J. A. Cirillo's study, and finally construct freeway interchange accident predictive models based on the elements which comprise an interchange.

The first step in constructing these models was to obtain geometric data, accident data and traffic data for interchanges located in the State of Michigan. The data obtained were:

- o Geometric data describing the elements of the freeway interchange geometry were obtained from the Michigan Department of Transportation's Highway Accident Master Data file.
- o Accident data from 1982 to 1984 were obtained from the



Michigan Department of Transportation's Highway Accident Master Data file.

 o Traffic Data describing the level of use of the freeway interchange elements were available from the Michigan Department of Transportation's TVM (Trunkline Vehicle Miles) Master Data file and Traffic Flow map.

These data files were merged to produce a master data file composed of geometric data, accident data and traffic data. This file was then stratified into 3 analysis units for constructing freeway interchange accident predictive models for each element of an interchange. These analysis units were:

o mainline unit

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o crossroad unit
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o ramp unit

During the study period 4464 out of 9534 accidents occurred on the mainline unit, 2536 accidents occurred on the crossroad unit and 2534 accidents occurred on the ramp unit, respectively.

Based upon the total number of accidents for each analysis unit, the first attempt was made to construct a linear regression model using all interchanges in one model. The multiple regression R coefficient for the mainline unit was 0.5624, indicating that less than 30 % of the variance in



accident frequency was explained by the independent variables used.

The master data file was then stratified into 3 area types of activity density (urban, rural and fringe). The master data file was further classified into groups of interchange configurations with similar accident rates. The interchange type with the lowest average accident rate (accidents per interchange per 3 years) was 0.91 for the Partial Diamond type interchanges and the highest value of the average accident rate was 14.29 for the Full Directional type interchanges. Interchange types that were similar to each other in the average accident rate and variance were grouped for further analysis. The interchanges were classified into 12 groups for each analysis unit:

- Group 1 Diamond
- . Group 2 Tight Diamond, Urban Diamond
- Group 3 Modified Diamond, Modified Tight Diamond, Parclo
  A 4 Quad
- . Group 4 Partial Diamond, Partial Tight Diamond, Trumpet A, Partial Directional Y
- . Group 5 Split Diamond, General Directional, Other
- . Group 6 Diamond plus 1 loop, Parclo B 4 Quad, Trumpet B, Directional Y
- . Group 7 Parclo AB, Partial Directional
- . Group 8 Cloverleaf, Cloverleaf with CD Roads, Cloverleaf



minus 1 loop, Directional with loops

- . Group 9 Parclo A, Parclo B, Parclo AB 4 Quad
- . Group 10 Full Directional, General
- . Group 11 SRI-A
- . Group 12 SRI-B

For the classified groups, group 4 had the lowest value of 1.25 acc./int./3 yrs. and group 10 had the highest value of 10.27 acc./int./3 yrs.

The most common accident types occurring on the urban interchanges were fixed object, rear-end and angle straight accidents. Group 2 had the highest percentage of fixed object, rear-end and angle straight accidents. The accident types on the rural interchanges were fixed object, rear-end and animal accidents. Group 1 had the highest percentage of fixed object and animal accidents, and group 3 had the highest percentage of rear-end accidents. The predominant accident types on the fringe interchanges were fixed object, rear-end and animal accidents. Group 3 had the highest percentage of fixed object and rear-end accidents, and group 1 had the highest percentage of animal accidents.

Based on the total number of accidents per interchange for each analysis unit (considering only groups with more than 10 interchanges), rural group 4 and urban group 10 had the lowest value of 4.84 acc./int. and highest value of 13.75 acc./int., respectively on the mainline unit. On the crossroad



unit rural group 4 had the lowest value of 1.03 acc./int., and urban groups 7 and 10 had the highest value of 6.5 acc./int. On the on-ramp unit rural group 2 had the lowest value of 0.60 acc./int., and urban group 6 had the highest value of 3.50 acc./int. On the off-ramp unit rural group 4 had the lowest value of 0.54 acc./int., and urban group 3 had the highest value of 4.82 acc./int.

From the classified groups, only groups with more than 10 interchanges were selected for constructing linear regression models. Three fourth of the stratified data in each cell were used to construct the model and the remaining 25 % of the data were used for calibrating the model. Variables used to construct the models were population (in 1000's) of the county, lane mileage (0.01 mile units) of the analysis unit, number of on-ramps, number of off-ramps, average daily traffic (ADT) for the independent variables and the total number of accidents for the dependent variable. Models with greater than 0.7 in multiple R coefficient were tested against the remainder of the stratified data.

The last step in constructing linear regression models for predicting accidents on freeway interchanges was to compare predicted and actual accident frequencies for the acceptable models.

### <u>Conclusions</u>

The following conclusions concerning modeling accidents on freeway interchanges were drawn:

- 1. The data support the literature which found that the accident rate on ramp units is higher than on mainline and crossroad units.
- 2. Models with all interchanges in one model are not reliable, because there is too much variance to be explained by the variables used in the study. The type of interchange (configuration) is the most important variable, with accident rates ranging between 0.91 acc./int. and 14.29 acc./int.
- 3. Out of the variables used for constructing accident predictive models, the average daily traffic (ADT) was found to be the most significant in modeling freeway interchange accidents. The number of accidents on the mainline and crossroad units increased with increased traffic. However, the number of accidents on the ramp units tended to decrease with increased traffic.
- 4. It is possible to obtain reasonable predictions of the accident frequency on the elements of some interchange classes (see R values in Table V.3).
- 5. Some of the other variables tested (over or under, lighting, and ramp control) might improve the model



prediction power, but the data base was not large enough to make these additional stratifications.



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