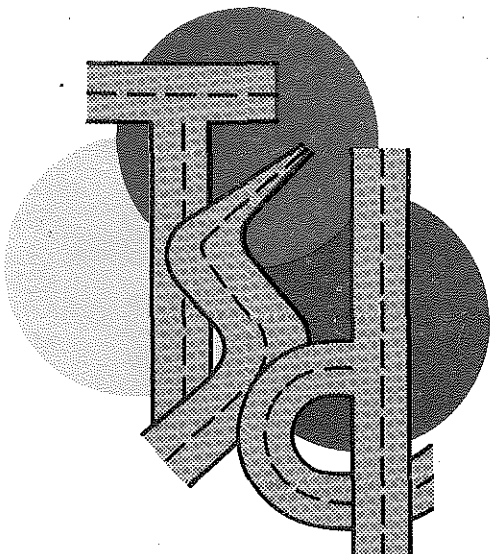


ANALYSES OF  
INTERSTATE ACCIDENTS IN MICHIGAN

TSD-248-74



**TRAFFIC and  
SAFETY  
DIVISION**

**DEPARTMENT OF STATE HIGHWAYS  
STATE OF MICHIGAN**

72-73

MICHIGAN DEPARTMENT  
OF  
STATE HIGHWAYS AND TRANSPORTATION

ANALYSES OF  
INTERSTATE ACCIDENTS IN MICHIGAN

TSD-248-74

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"The opinions, findings and conclusions expressed in this publication are those of the author and not necessarily those of the U.S. Department of Transportation, Federal Highway Administration."

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## INTRODUCTION

This study is an attempt to investigate the nature of motor vehicle accidents taking place on the 1,020 miles of Interstate highways in Michigan in 1972 and 1973. Emphasis has been placed upon comparisons of the frequency of accidents and the severity of injuries due to various vehicle types, highway types, surface conditions, accident types and lighting conditions in order to comprehend the characteristics of accidents under numerous circumstances. Subsequently, proper countermeasures may be taken to improve the safety of roads.

The last part of 1973 was the time in which a nationwide fuel shortage occurred to the degree that motorists had difficulty purchasing fuel for their vehicles. Shortages of most materials and the inflation ratio increase slowed down the economy. Such economical impacts were assumed to be significant in affecting the traffic accident patterns. With growing numbers of people using the gas-saving compact vehicles, this study is also directed to inquire into the features of small vehicle involved accidents on the freeways and in turn to gain some possible improvements there.

Accident data were obtained from a computer program which tabulates the appropriate accidents from the Michigan Accident Master File in the computer library of the Department

of State Highways and Transportation. A statistical Chi-square method, at a 95% confidence level, has been used to assure the accuracy of the data analyses in the study.



## ANALYSIS OF DATA

### 1. Data Collection

Accident frequency tabulations for the compact vehicle involved, full-size vehicle involved and semi-truck involved were acquired through computer program Q24155 for calendar years 1972 and 1973. The program tabulates accidents in severity categories which include fatal, injury and property damages as follows:

- (1) Day of week
- (2) Time of day
- (3) Month of year
- (4) Highway type
- (5) Surface conditions
- (6) Weather
- (7) Accident type
- (8) Lighting conditions

Each part will be arranged into the special forms and figures to be presented with the analysis. Hereafter, in the report, compact vehicles involved, full-size vehicle involved and semi-truck involved accidents will be referred to as compact vehicle, full-size vehicle, and truck accidents, respectively.

## 2. Distribution of Injury and Fatal Accidents

Table 1 shows that the percentage of injury accidents which is the quotient of the injury accidents divided by the total accidents, decreased substantially for the passenger vehicle during the two years 1972 to 1973 - it dropped 3.3% for the compact and 1.5% for the full-size. The figure for the truck stayed the same.

The average number of injury accidents over the two-year period discloses that the compact was 4.9% higher than the full-size. Statistical tests show that the difference is significant at the 95% confidence level. There was only 1.6% different between the full-size and the truck. Apparently compact vehicles which normally weigh under 3000 pounds have less capability to protect the passengers from being injured during the collisions. This may logically be contributed to the lighter body weight.

## 3. Monthly, Daily, Hourly Accident Distributions

Figure 1A and Figure 1B show that full-size and compact vehicle accidents followed the same trend that had higher proportions of accidents during Friday to Sunday, in the range of 14% to 20%, with the peak occurring on Friday, and had lower proportions of accidents during the middle

Table 1 - Accident Severity Distribution

1972 Accident Data						
ACC. TYPE \ VEH. TYPE	COMPACT		FULL-SIZE		TRUCK	
	# OF ACC.	PERCENT	# OF ACC.	PERCENT	# OF ACC.	PERCENT
FATAL	39	1.6	78	1.0	20	1.4
INJURY	934	37.2	2587	32.0	422	29.4
PROPERTY DAMAGE	1538	61.2	5407	67.0	994	69.2
TOTAL	2511	100.0	8072	100.0	1436	100.0

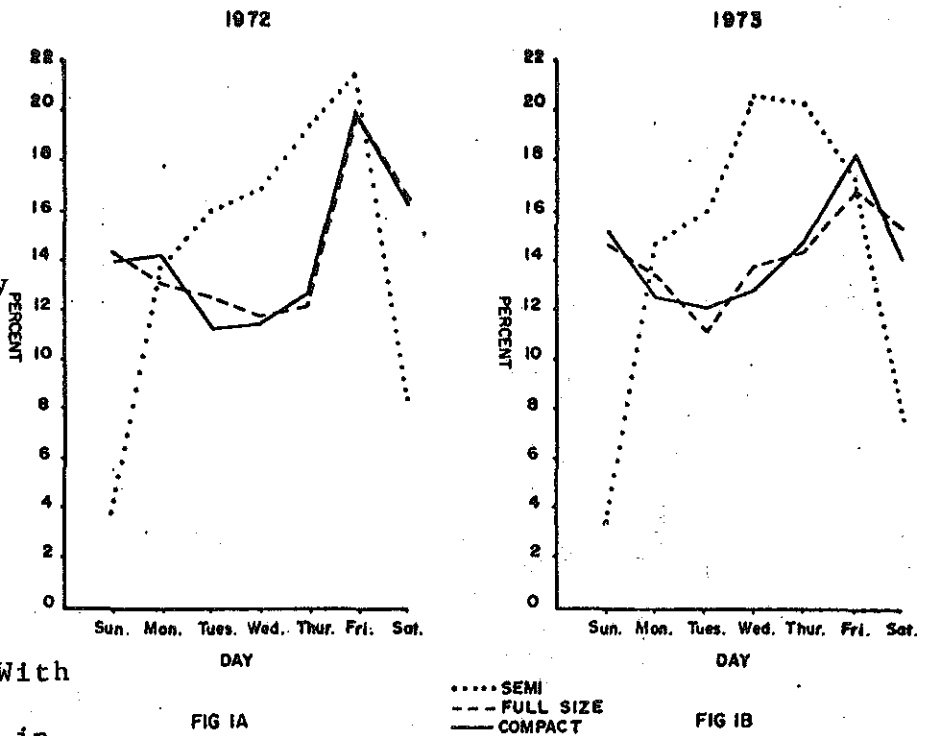
1973 Accident Data						
ACC. TYPE \ VEH. TYPE	COMPACT		FULL-SIZE		TRUCK	
	# OF ACC.	PERCENT	# OF ACC.	PERCENT	# OF ACC.	PERCENT
FATAL	24	1.0	78	1.1	30	1.9
INJURY	832	34.5	2190	30.4	461	28.6
PROPERTY DAMAGE	1558	64.5	4925	68.5	1118	69.5
TOTAL	2414	100.0	7193	100.0	1609	100.0

of the week, with an average of 12%.

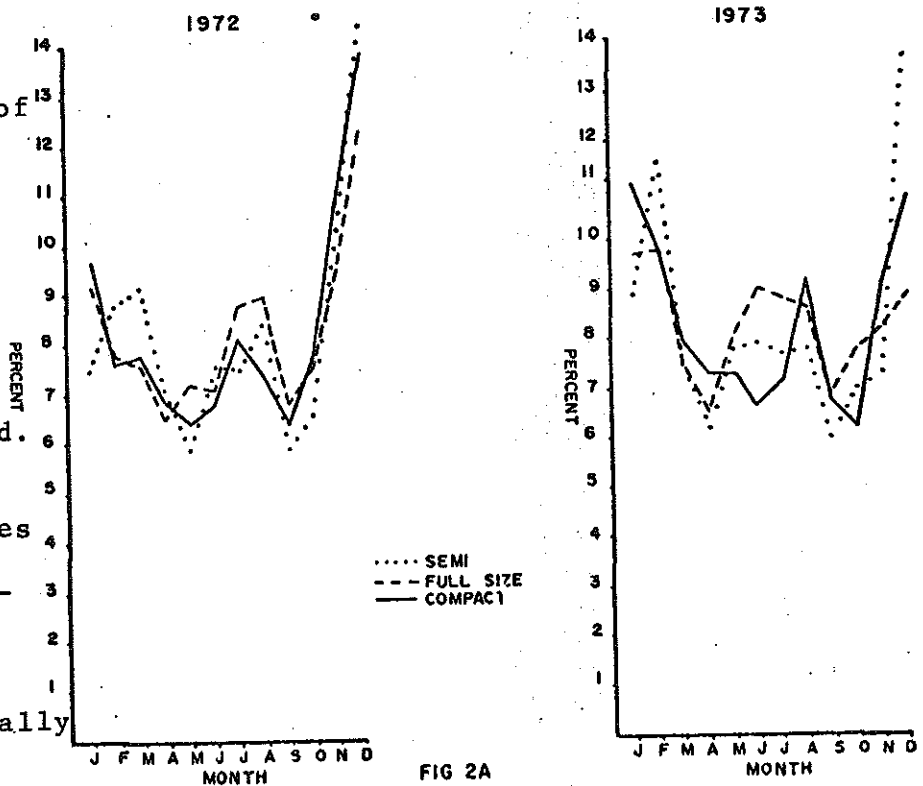
Semi-truck accidents had their unique pattern in both years, which indicate that they took place during business days from Monday through Friday, in the range of 14% to 22%, and dropped substantially to about 8% on Saturday and less than 4% on Sunday.

In Figure 2A, all three types of vehicles had similar monthly accident distributions in 1972. Accidents occurred relatively higher during the summer and winter seasons with an average of about 8.5% in August and 13% in December. With thousands of lakes in Michigan, summer is the season for most outdoor activities. Subsequently, level of service decreased on the interstate highways and congestion, hence accidents occurred. Figure 2B indicates that full-size vehicle accidents decreased drastically

DAILY ACCIDENT DISTRIBUTIONS OF THE WEEK



MONTHLY ACCIDENT DISTRIBUTIONS OF THE YEAR

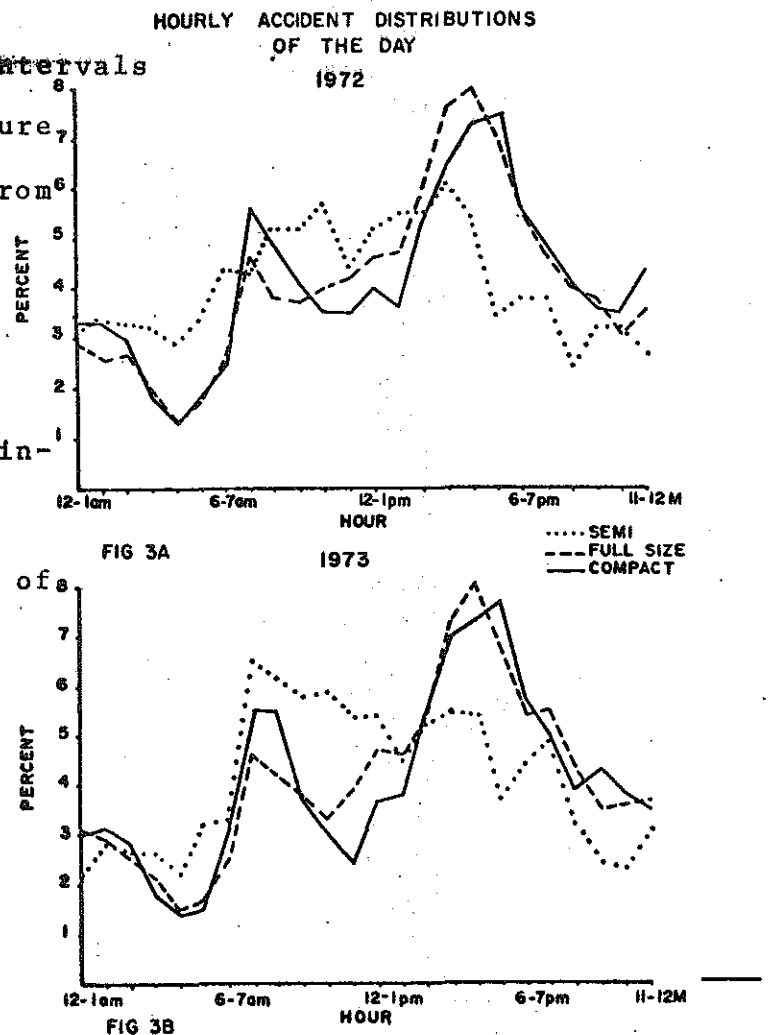


in the last few months of 1973. In December alone, full-size vehicle accidents dropped from 12.3% in 1972 to 8.9% in 1973, while compact vehicle accidents dropped from 13.8% to 10.9% and semi-truck accidents decreased slightly. It is assumed that reduced non-commercial driving and a lower speed limit due to the fuel shortage have contributed to the changes. Nevertheless, in both years, the monthly compact vehicle accidents varied much sharper than those of full-size vehicle accidents.

Figures 3A and 3B indicate the hourly distributions of the accidents.

In general there are two intervals in the truck accident picture. During the daytime hours from 7:30 a.m. to 6:30 p.m. it fluctuated in the neighborhood of 4% to 6%, and then it dropped to the vicinity of 3% the remainder of the time, with no evidence of an afternoon peak hour.

Full-size and compact vehicle accidents followed the same trend. Starting at the lowest point



with 1.2% at 4:30 a.m., it rose to 5% by the 7:30 a.m. peak, then dropped slightly to 4% until 1:30 p.m. It again increased sharply to 8% by the 4:30 p.m. peak and dropped steadily to 1.2% by 4:30 a.m. The high passenger vehicle accidents coincide with the high traffic volumes in the morning and afternoon peaks.

#### 4. Highway Type Accident Distribution

Table 4.1 lists the accident distributions based upon the highway types which basically divided into interchanges and mainlines. It appears that the compact and full-size vehicles had the same proportions of the interchange and the mainline accidents in both years; approximately 50% of them were the interchanges in 1972 and 52.5% in 1973. Trucks had a slightly lower percentage of interchange accidents - they were 42.5% in 1972 and 47.5% in 1973. Interchanges, functioning to interconnect roadways in conjunction with one or more grade separations have their independent geometric configurations and traffic characteristics that play important roles in the highway accident pattern.

Hence, comparisons of the percentages of injury and fatal accidents at the interchanges and on the mainlines are computed in Table 4.2 and Table 4.3. Table 4.2 indicates that the percentages of injury accidents at the interchanges

Table 4-1 Highway Type Accident Distribution

1972 Accident Data						
Hwy. Type \ Veh. Type	Compact		Full-Size		Truck	
	Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Interchange	1265	50.4	4001	49.6	610	42.5
Mainline	1246	49.6	4071	50.4	826	57.5
TOTAL	2511	100.0	8072	100.0	1436	100.0

1973 Accident Data						
Hwy. Type \ Veh. Type	Compact		Full-Size		Truck	
	Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Interchange	1269	52.6	3771	52.4	764	47.5
Mainline	1145	47.4	3422	47.6	845	52.5
TOTAL	2414	100.0	7193	100.0	1609	100.0

and on the mainlines are fairly close in all the vehicle types in 1972 and 1973. Such similarity is conformable with the statewide accident statistics. Table 4.3 lists the percentages of fatal accidents at the interchanges and on the mainlines in various vehicle types and the Chi-square test for the difference of the percentages of fatal accidents between them. It shows that the compact vehicles had significantly higher percentages of fatal accidents in both years.

Table 4-2 Percentage of Injury (Injury Accident/Total Accident)  
of the Two Highway Type Accidents

	1972 Accident Data			1973 Accident Data		
	Compact	Full-Size	Truck	Compact	Full-Size	Truck
Inter-change	35.3%	31.3%	29.0%	33.5%	29.8%	27.5%
Mainline	39.1%	32.8%	29.7%	33.5%	31.2%	29.8%

Table 4-3 Percentage of FataIs  $\left( \frac{\text{Fatal Accident}}{\text{Injury Accident} + \text{Fatal Accident}} \right)$   
of the Two Highway Type Accidents

	1972 Accident Data			1973 Accident Data		
	Compact	Full-Size	Truck	Compact	Full-Size	Truck
Inter-change	2.62%	2.94%	4.32%	1.85%	2.43%	5.43%
Mainline	5.24%	2.91%	4.67%	3.78%	4.47%	6.66%
*Chi-Square Test	S	N-S	N-S	S	S	N-S

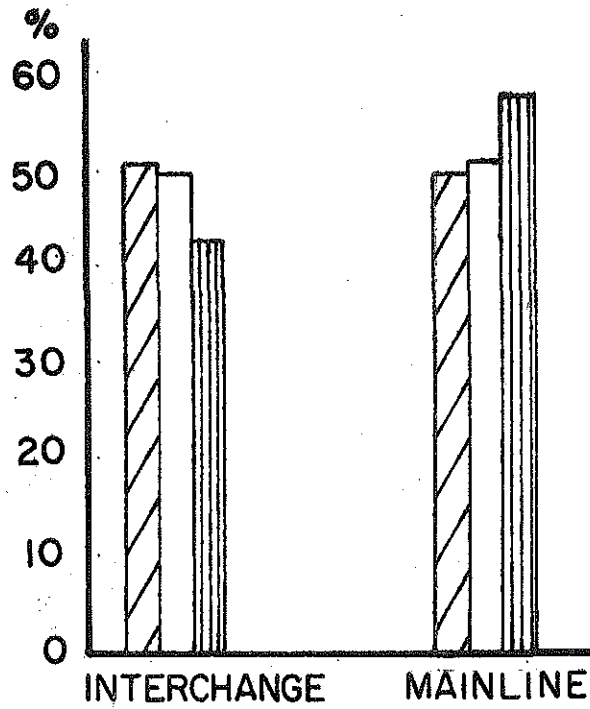
\*95% confidence level is used.

S = Statistically significant lower fatal rate in the interchanges

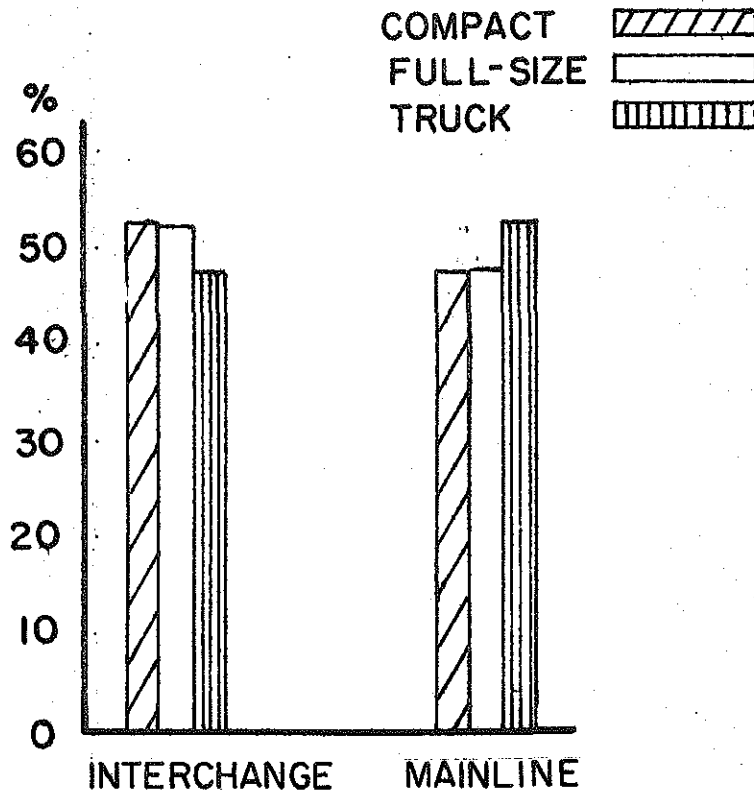
N-S = Not significant



# HIGHWAY TYPE ACCIDENT DISTRIBUTION



1972  
FIG. 4A



1973  
FIG. 4B

The full-size vehicles had no difference in 1972 and they were higher on the mainlines in 1973. The percentage of truck fatal accidents stayed the same in both years although they were higher than the passenger vehicles. The weight of truck, generating greater momentum during an impact with the other vehicles or a nearby fixed object, causes more severe damage to the vehicles involved in the accident and reduces the efficiency of the roadside safety features such as guardrails, guard cables, protective crash cushions, etc.

5. Accident Distributions on the Different Surface Conditions

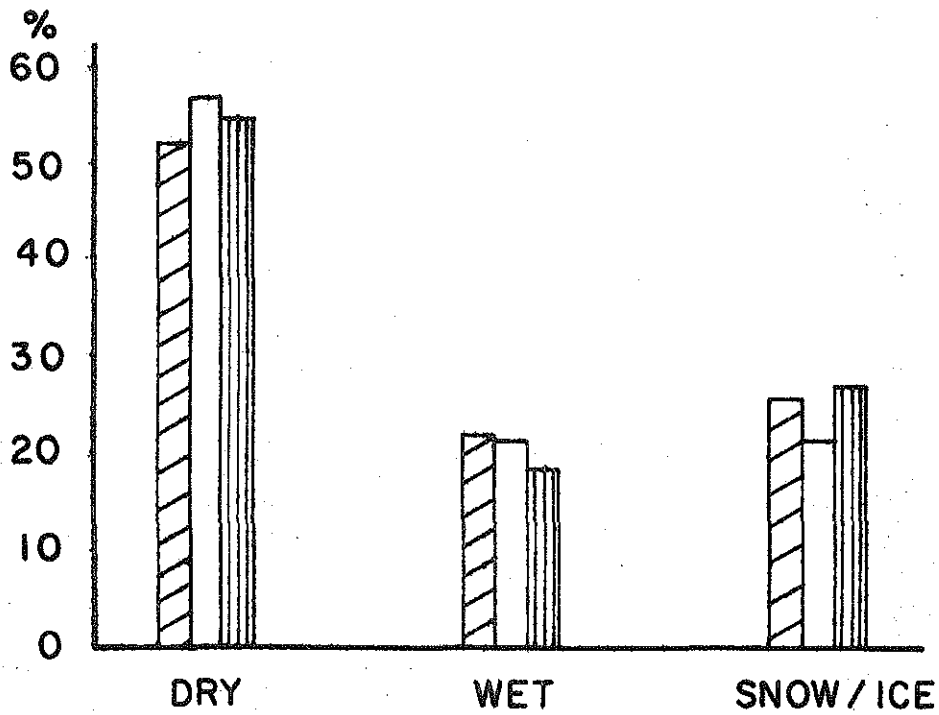
Table 5.1 reveals that the proportions of the motor vehicle accidents taking place on the snow/ice pavements were higher in 1972 than those in 1973; they were 3.3% higher for the compact, 4.5% for the full-size and 2.2% for the truck. On the wet pavements, passenger vehicle accidents remained in the same general direction with 3.9% and 2.1% higher in 1972 for the compact and full-size, respectively. However, the truck accidents were 2.4% lower in 1972.

To have an in-depth look at the occurrences of the accidents on the snow/ice pavements, the Chi-square test is to be used to detect the differences of the accident frequencies, and the percentages of injury accident as

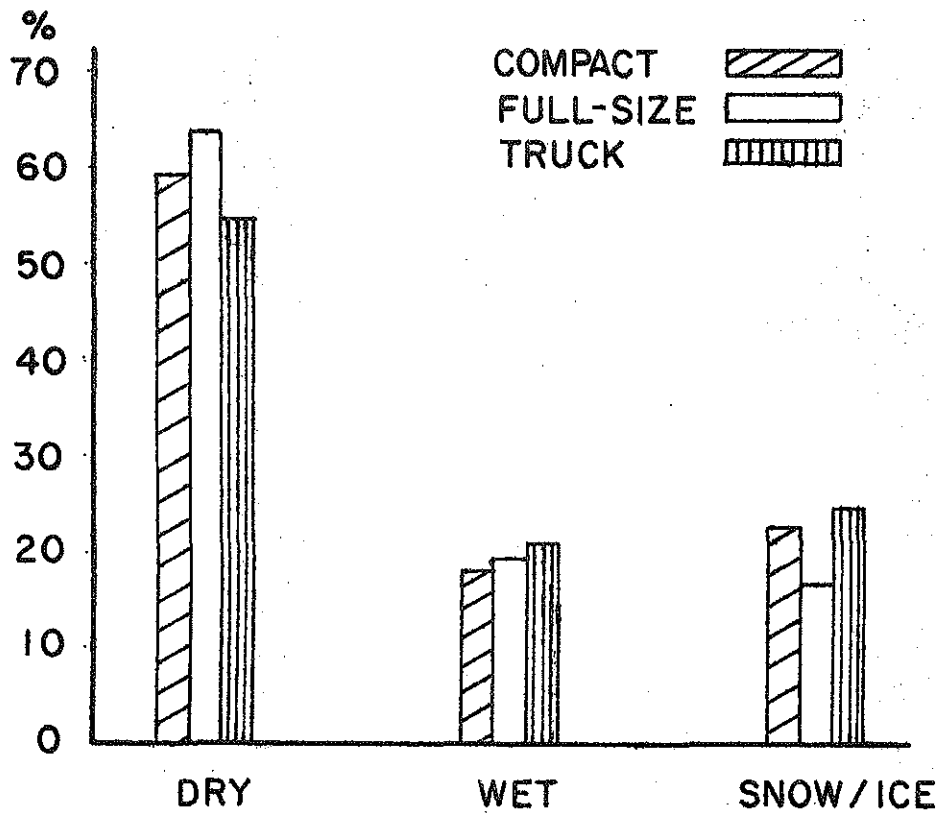
Table 5-1 Accident Distributions on  
the Different Surface Conditions

1972 Accident Data							
Surface	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Dry		1307	52.0	4577	56.7	783	54.5
Wet		549	21.9	1727	21.4	263	18.3
Snow/Ice		643	25.6	1709	21.2	382	26.6
Unk		12	0.5	59	0.7	8	0.6
Total		2511	100.0	8072	100.0	1436	100.0
1973 Accident Data							
Surface	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Dry		1425	59.0	4548	63.2	875	54.4
Wet		435	18.0	1391	19.3	333	20.7
Snow/Ice		537	22.3	1197	16.7	393	24.4
Unk		17	0.7	57	0.8	8	0.5
Total		2414	100.0	7193	100.0	1609	100.0

# ACCIDENT DISTRIBUTION ON THE DIFFERENT SURFACE CONDITIONS



1972  
FIG 5A



1973  
FIG 5B

Table 5-2 Chi-square Test for the Proportions of Snow/Ice Accidents in the Compact and Full-Size Vehicle Accidents

1972 Accident Data			
	Compact	Full-Size	$\chi^2$ Test Result
Snow/ice	643	1709	There were significantly higher proportions of the compact vehicle accidents than those of the full-size vehicle accidents on the snow/ice pavements.
Non-snow/ice	1868	6363	
1973 Accident Data			
	Compact	Full-Size	$\chi^2$ Test Result
Snow/ice	537	1197	Same result as 1972
Non-snow/ice	1977	5996	

well as severities between the compact and full-size vehicle accidents.

Table 5.2 indicates that the compact vehicle accidents occurring on the snow/ice pavements were disproportionately high within the passenger vehicles. Lower skid resistance, due to lighter body weight of the vehicle, may be associated with the accidents. Truck accidents which occurred on the snow/ice pavements constituted about 25% of all the truck involved accidents - they were more numerous than the compact. Since the volume of commercial traffic is not reduced as much as the passenger vehicle traffic which

Table 5-3 Chi-square Tests for the Comparisons of the Percentage of Injury and Fatal Accidents of the Compact and Full-size Vehicle Accidents on the Snow/Ice Pavements

1972 Snow/Ice Accident Data			
	Compact	Full-size	X <sup>2</sup> Test Result
Fatal & Injury	201	481	There was no significant difference in the percentage of injury between the compact and full-size vehicle accidents on the snow/ice pavements.
Property Damage	442	1228	
Fatal	3	10	There was no significant difference in the proportions of the fatalities in the injury accidents between the compact and full-size vehicle accidents on the snow/ice pavements.
Non-Fatal Injury	198	471	
1973 Snow/Ice Accident Data			
	Compact	Full-size	X <sup>2</sup> Test Result
Fatal & Injury	156	308	Same result as 1972 test
Property Damage	381	889	
Fatal	1	9	Same results as 1972 test
Non-Fatal Injury	155	299	

may exclude pleasure trips under the adverse weather that generates the snow/ice pavements, trucks are exposed a good deal more on the hazardous pavements than the passenger vehicles. Such highway exposure definitely correlates with accident proneness.

Table 5.3 shows that the percentages of injury and fatal accidents between the compact and the full-size were not significantly different. The percentages of injury accidents on the snow/ice pavements constitute 31.3% and 29.5% for the compact in 1972 and 1973; 29.2% and 25.7% for the full-size, which are about 7% and 5.5% lower than the percentage of overall injury accidents for the compact and full-size, respectively. Such reductions demonstrate that the passenger vehicle accidents taking place on the snow/ice roads suffer fewer injuries. Motorists tend to drive slower than the usual speed on the snow/ice roads, which in turn diminishes the severity.

#### 6. Weather Effect on the Accidents

Table 6 indicates that the passenger vehicle accidents which occurred in the snow dropped substantially in 1973; they were 3.4% lower for the compact and 4.5% lower for the full-size. The truck accidents dropped only 1.3%. The fact of lowering the speed limits on the freeways and curtailing the non-commercial driving in the second half of 1973 as shown in Figure 2 would logically account for the reductions.

It is not surprising that Table 6 is linearly related to Table 5; rainy days cause wet surfaces and snow creates snow/ice roads. Therefore, we have the following comparable results. Rainy weather accidents in

Table 6 Weather Effect on Accidents

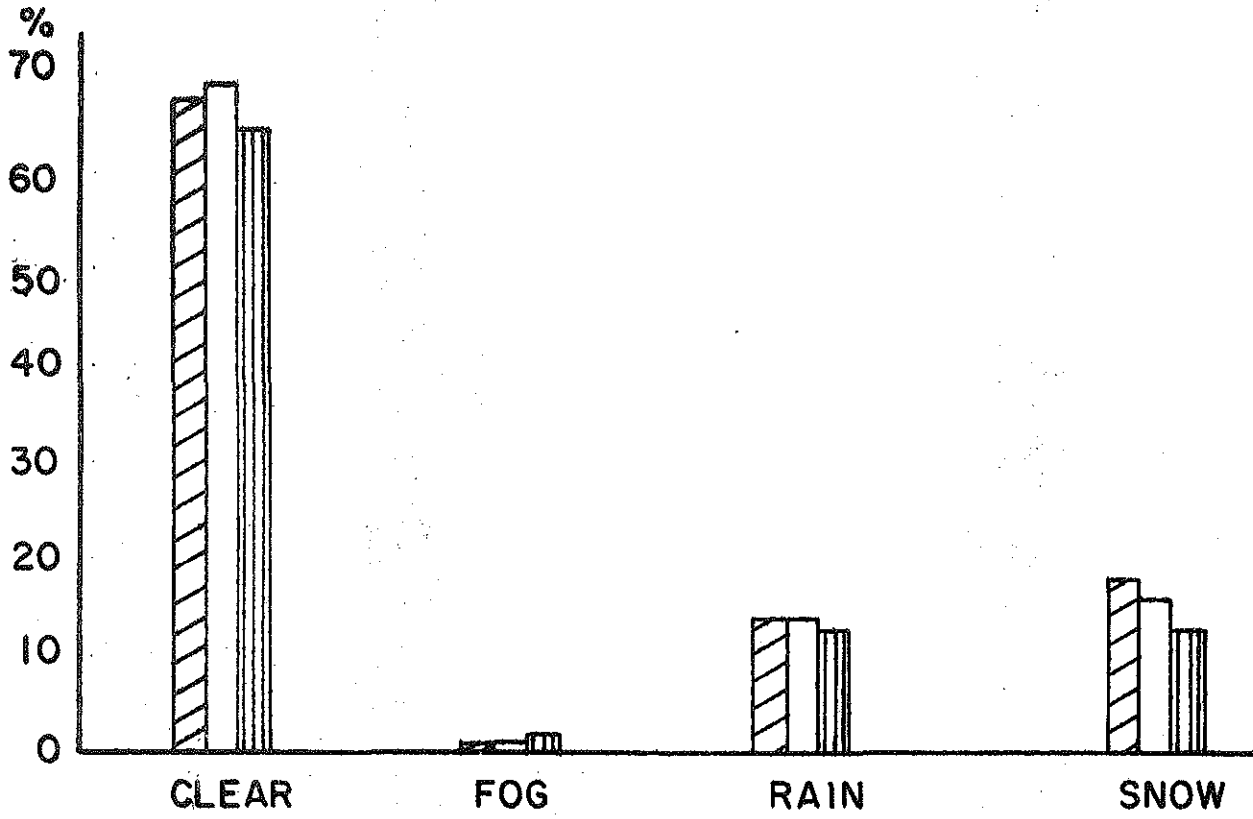
1972 Accident Data							
Weather Cond.	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Clear		1690	67.3	5576	69.1	928	64.6
Fog		22	0.9	74	0.9	28	1.9
Rain		351	14.0	1128	14.0	178	12.4
Snow		446	17.7	1265	15.7	301	21.0
Unk		2	0.1	29	0.3	1	0.1
Total		2511	100.0	8072	100.0	1436	100.0

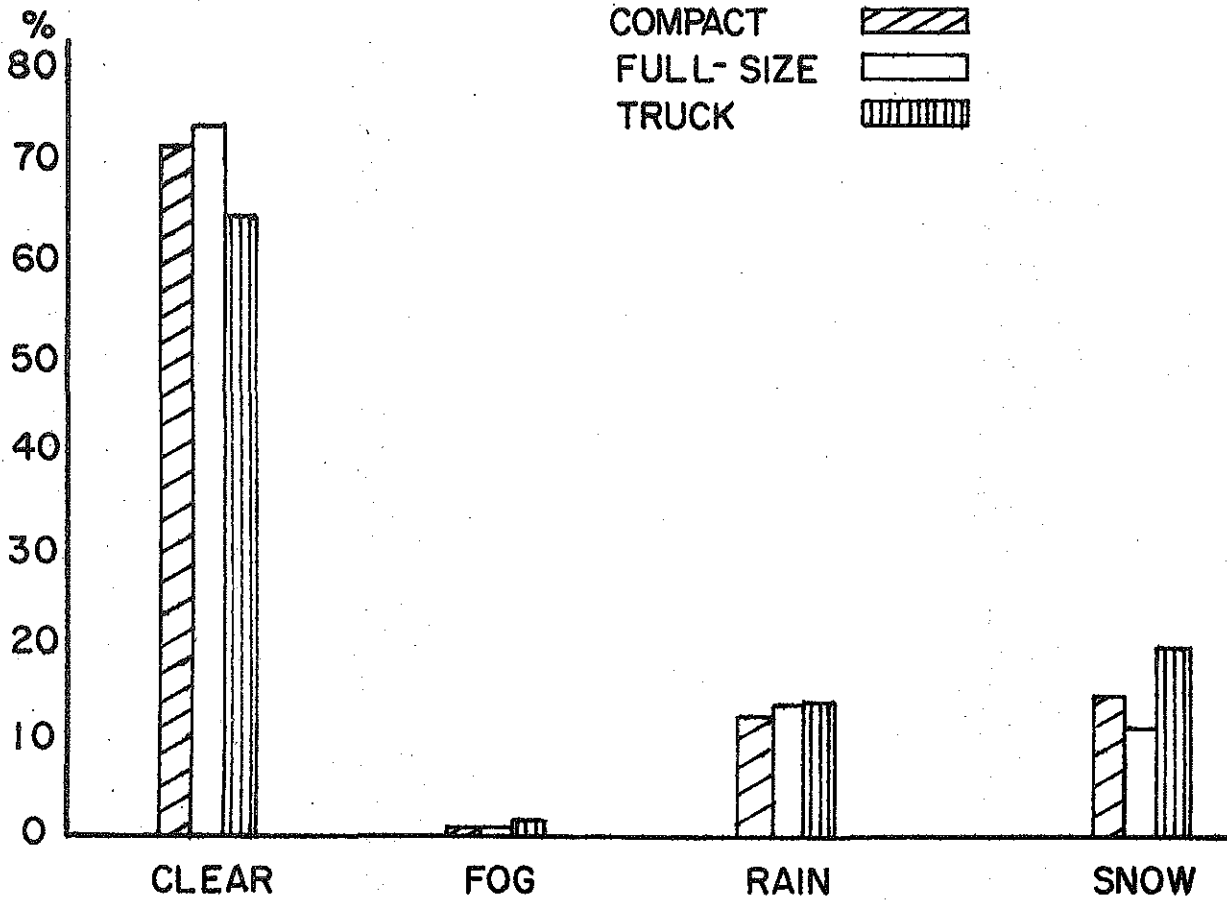
1973 Accident Data							
Weather Cond.	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Clear		1736	71.9	5312	73.8	1040	64.6
Fog		25	1.0	74	1.0	27	1.7
Rain		302	12.5	982	13.7	224	13.9
Snow		344	14.3	803	11.2	316	19.7
Unk		7	0.3	22	0.3	2	0.1
Total		2414	100.0	7193	100.0	1609	100.0



# WEATHER EFFECT ON THE ACCIDENTS



1972  
FIG 6A



1973  
FIG 6B

both years contributed to 13% of the total accidents for all types of vehicles. The compact was 2.6% higher than the full-size, while the truck was 6.9% higher than the full-size in the snowy weather over the two-year period.

#### 7. The Distribution of the Accident Type

There were a few types of accidents having the consistent changes regardless of various types of vehicles involved from 1972 to 1973: sideswipe at the same direction accidents increased 1.7% for the compact vehicles, 0.8% for the full-size and 1.4% for the truck accidents. Angle accidents increased 1.5%, 0.4% and 1.1% for the compact, full-size and truck accidents respectively - so were the animal accidents, their figures were increased 0.8%, 1.4% and 0.8%. The other types of accidents were very similar on the yearly basis except a 5.3% drop for the truck rear-end accidents and a 2.6% drop for the compact vehicle fixed accidents. The percentages of head-on, right-turn, rear-end and parking accidents stayed very close for all types of vehicles, which were approximately 1.5%, 1%, 40% and 3% respectively. Sideswipe at the same direction, angle, left-turn and fixed object accidents virtually divided into two groups - passenger vehicles and trucks; they

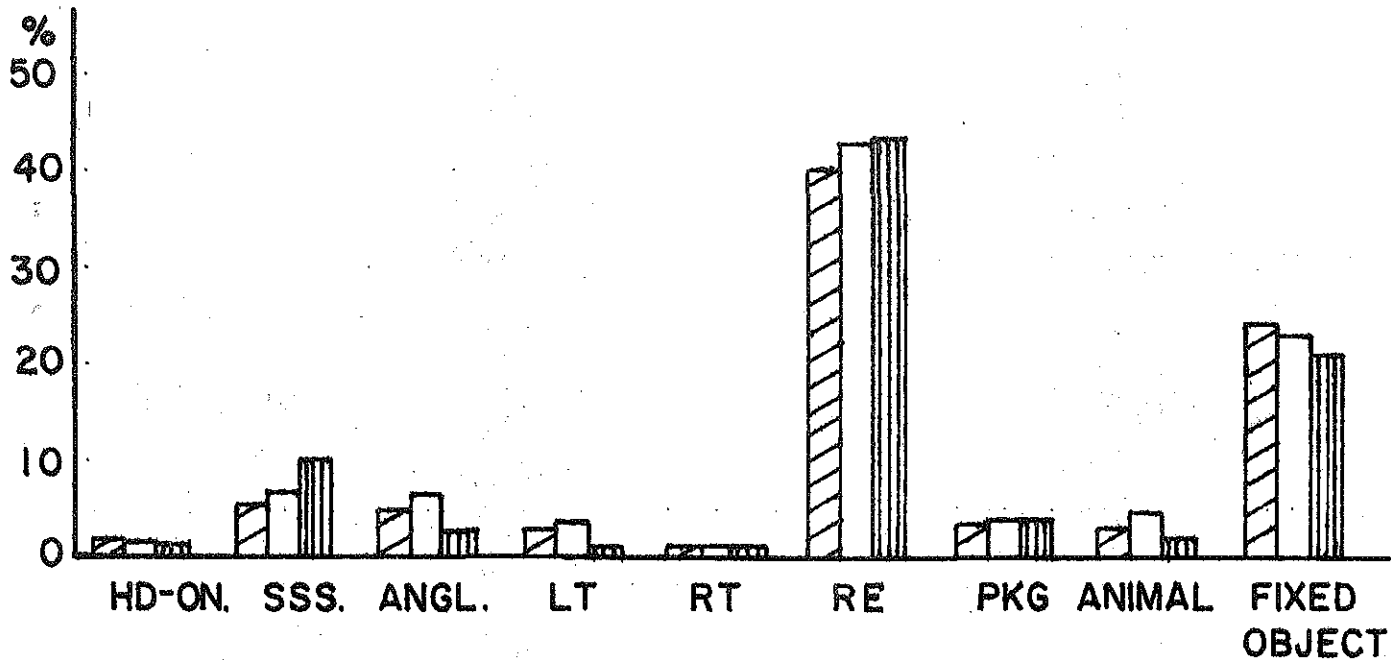
Table 7 Accident Distribution of Vehicle Types

1972 Accident Data						
ACC. TYPE \ VEH. TYPE	Compact		Full-Size		Truck	
	Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Head On	43	1.7	124	1.5	21	1.5
Sideswipe Same Direction	133	5.3	544	6.8	143	10.0
Sideswipe Opposite Direction	2	0.1	18	0.2	3	0.2
Angle	114	4.5	503	6.2	35	2.4
Left Turn	72	2.9	256	3.2	15	1.0
Right Turn	22	0.9	63	0.8	11	0.8
Rear-End	1005	40.0	3463	42.9	621	43.2
Backing	3	0.1	25	0.3	3	0.2
Parking	78	3.1	298	3.6	54	3.8
Pedestrian	9	0.4	29	0.4	6	0.4
Animal	72	2.9	361	4.5	28	1.9
Fixed Object	603	24.0	1834	22.7	298	20.8
Train	0	0	0	0	0	0
Bicycle	0	0	5	0.1	0	0
Others	355	14.1	549	6.8	198	13.8
Total	2511	100.0	8072	100.0	1436	100.0


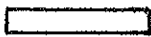

  

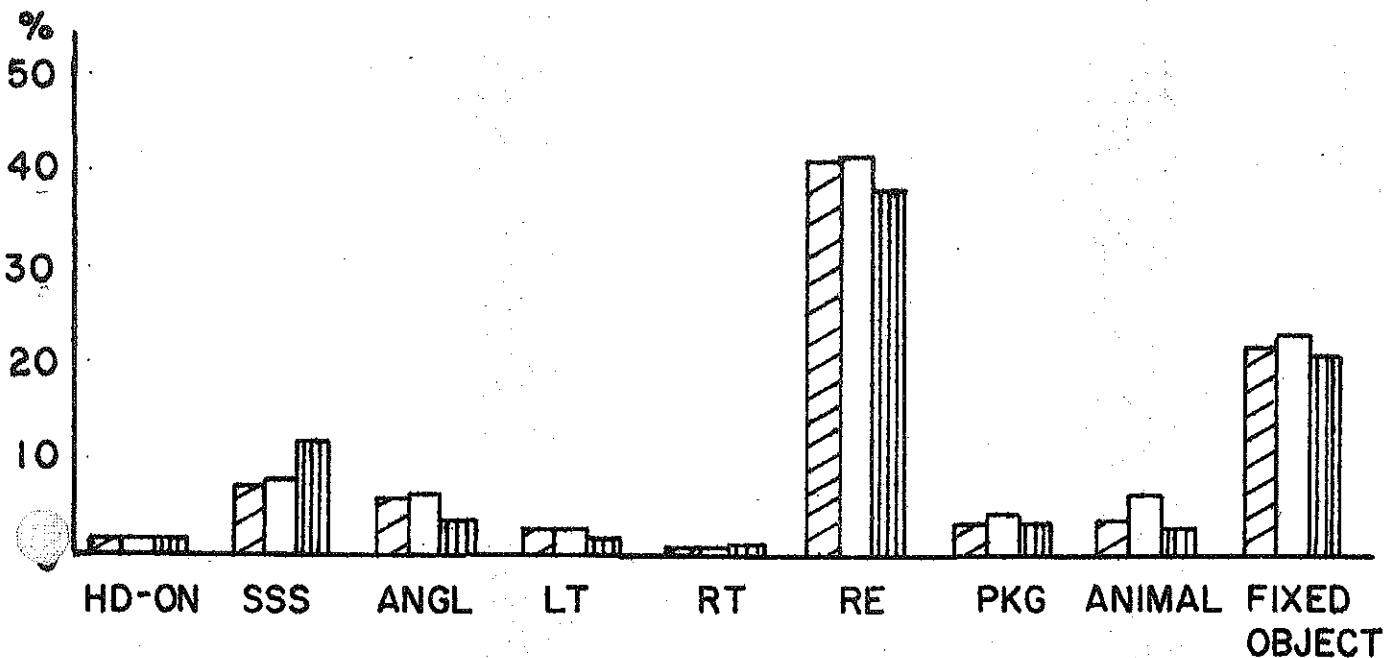
1973 Accident Data						
ACC. TYPE \ VEH. TYPE	Compact		Full-Size		Truck	
	Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Head On	32	1.3	103	1.4	25	1.6
Sideswipe Same Direction	169	7.0	550	7.6	184	11.4
Sideswipe Opposite Direction	3	0.1	13	0.2	3	0.2
Angle	145	6.0	471	6.6	57	3.5
Left Turn	63	2.6	205	2.9	27	1.7
Right Turn	15	0.6	52	0.7	17	1.0
Rear-End	980	40.6	2957	41.1	611	38.0
Backing	11	0.5	29	0.4	7	0.4
Parking	73	3.0	284	3.9	50	3.1
Pedestrian	3	0.1	20	0.3	6	0.4
Animal	89	3.7	425	5.9	43	2.7
Fixed Object	516	21.4	1619	22.5	333	20.7
Train	0	0	0	0	0	0
Bicycle	2	0.1	5	0.1	0	0
Others	313	13.0	460	6.4	246	15.3
Total	2414	100.0	7193	100.0	1609	100.0

# DISTRIBUTION OF THE ACCIDENT TYPES



1972  
FIG 7A

COMPACT   
 FULL-SIZE   
 TRUCK 



1973  
FIG 7B

were 7% sideswipe at the same direction for the passenger vehicles, 11% for the truck accidents, 6% and 3% for the angle, 3% and 1.2% for the left-turn, and 22.5% and 20.5% for the fixed object. The percentages of the sideswipe at the same direction, backing, pedestrian, train and bicycle accidents can be neglected owing to their insufficient sample size.

Pedestrians are not allowed to wander the freeway areas unless for emergencies such as a stranded motorist seeking assistance; but hitchhikers facing the oncoming traffic, walking along the freeway shoulders with their arms outstretched are a common occurrence on our highway system. There were a total of 44 pedestrian accidents for the three types of vehicles in 1972, 11 of which were fatal. The figure for 1973 was equally high - 11 fatalities out of 29 accidents.

#### 8. Accident Distribution in Different Light Conditions

Table 8.1 shows that the percentages of accidents in various light conditions in 1973 had little deviation from those in 1972 for all types of vehicles; they are about 60% for the daylight, 5% for the dawn/dusk, and 31% for the dark, with the exception that the passenger vehicle accidents had about 4.5% and truck accidents only 2% occurring in the dark with street lights. The fact that

Table 8-1 Accident Distribution  
in Different Light Conditions

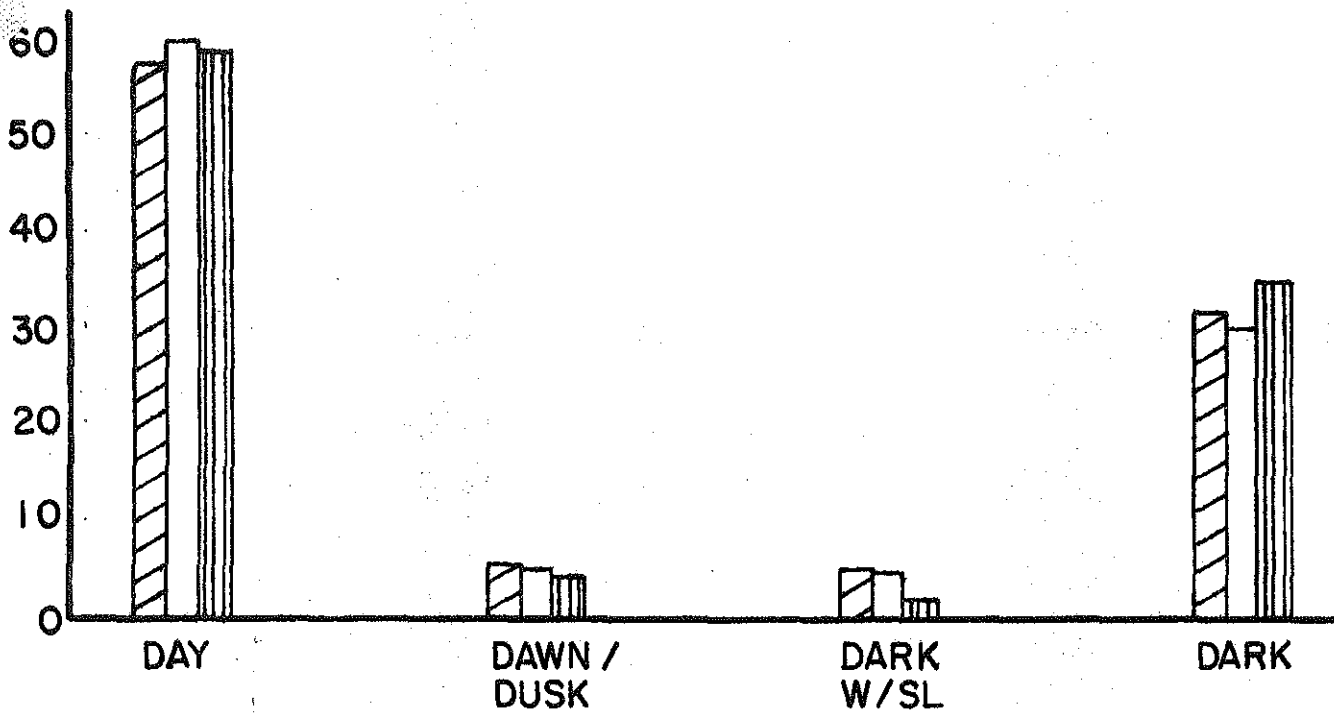
1972 Accident Data							
Light Cond.	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Day		1441	57.4	4816	59.7	844	58.8
Dawn/Dusk		144	5.7	416	5.1	63	4.4
Dark W. SL.		130	5.2	399	4.9	28	1.9
Dark		792	31.5	2419	30.0	500	34.8
Unk		4	0.2	22	0.3	1	0.1
Total		2511	100.0	8072	100.0	1436	100.0
1973 Accident Data							
Light Cond.	Veh. Type	Compact		Full-Size		Truck	
		Total Acc.	Percent	Total Acc.	Percent	Total Acc.	Percent
Day		1404	58.2	4343	60.4	996	61.9
Dawn/Dusk		108	4.5	343	4.8	79	4.9
Dark W. SL.		114	4.7	298	4.1	30	1.9
Dark		781	32.3	2188	30.4	501	31.1
Unk		7	0.3	21	0.3	3	0.2
Total		2414	100.0	7193	100.0	1609	100.0

the passenger vehicles are mostly used for transportation within the cities where the majority of the street lights were set up, while trucks are primarily utilized on the inter-city routes, can be the main cause for the difference.

Fatality rates for the daylight accidents appear to be about

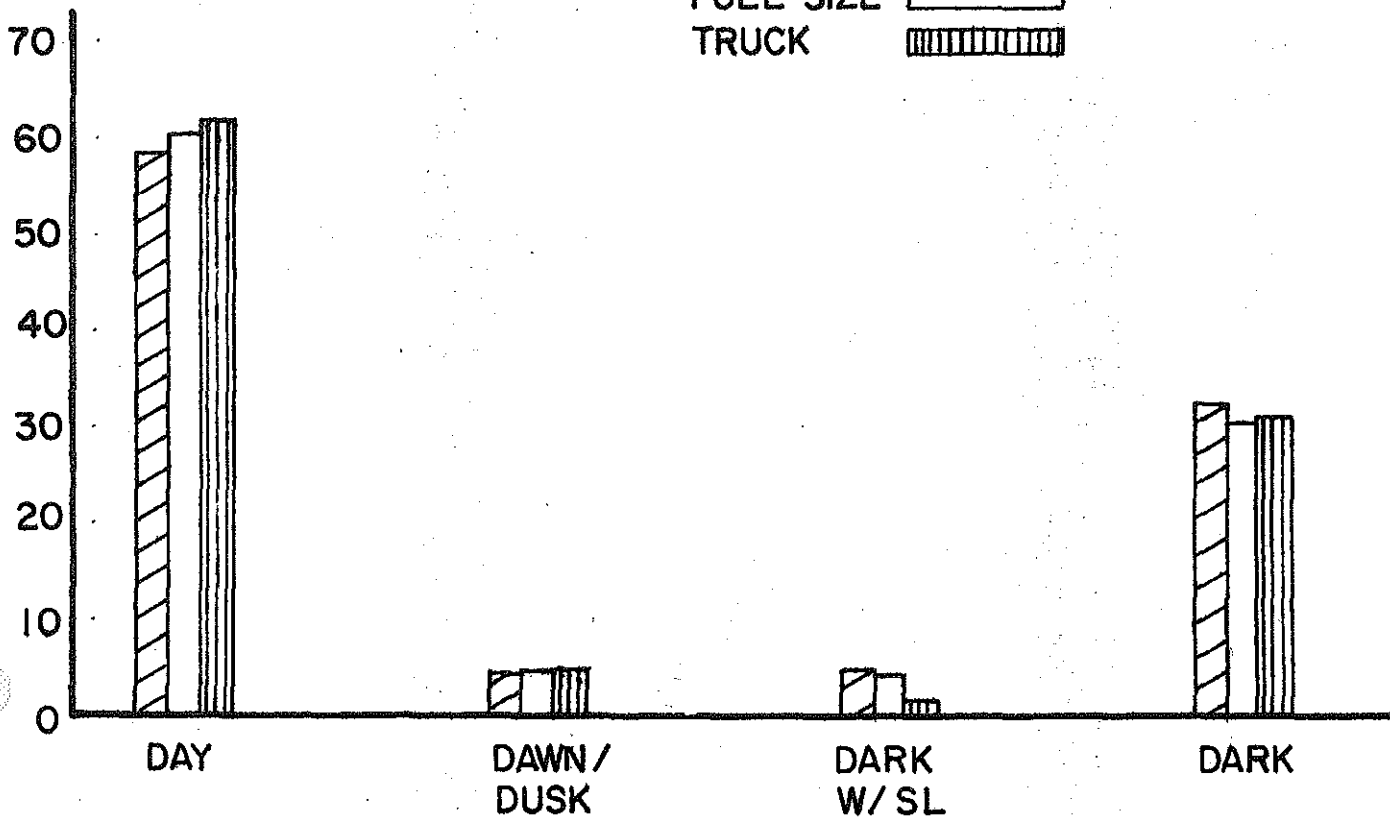
one-half that of the dark hours. Table 8.2 consists of the results of Chi-square tests for the distinctions. It indicates that five out of the six cases had higher proportions of the fatal accidents during the dawn/dusk or dark. The dangerous drinking drivers usually appearing on the roads during the night, the wrong-way motorists who often enter the wrong ramps of the freeway interchanges because of the poor visibility in the dark, can be the causes behind such higher fatalities.

# ACCIDENT DISTRIBUTION IN DIFFERENT LIGHT CONDITIONS



1972  
FIG 8A

COMPACT   
 FULL-SIZE   
 TRUCK



1973  
FIG 8B



Table 8-2 Chi-square Tests for the Comparison of the Proportion of Daylight Fatal Accidents Against Those of the Others

1972 Accidents

		Fatal	Non-Fatal	X <sup>2</sup> Test*
Compact	Daylight	15	1426	S
	Dawn/dusk or dark	24	1046	
Full-Size	Daylight	27	4789	S
	Dawn/dusk or dark	51	3205	
Truck	Daylight	7	837	S
	Dawn/dusk or dark	13	579	

1973 Accidents

		Fatal	Non-Fatal	X <sup>2</sup> Test
Compact	Daylight	10	1394	N-S
	Dawn/dusk or dark	14	996	
Full-Size	Daylight	28	4315	S
	Dawn/dusk or dark	50	2800	
Truck	Daylight	12	984	S
	Dawn/dusk or dark	18	595	

\* S = there was significantly higher proportion of dawn/dusk or dark fatal accidents than those of the daylight at the 95% confidence level

N-S = no significant difference

## FINDINGS

1. Passenger vehicle and truck accidents had different patterns with respect to day of week, hour of day and month of year.
2. Passenger vehicle accidents dropped substantially in the summer and winter of 1973 compared with the same period of 1972, while truck accidents stayed the same.
3. Compact vehicles had higher proportions of injuries than those of the other sizes.
4. Injury at the interchanges and on the mainlines were similar in magnitude. However the percentage of fatal accidents for the passenger vehicle was higher on the mainlines.
5. There were higher proportions of the snow/ice pavement accidents for the compact than for the full-size vehicles.
6. The percentages of pedestrian fatal accidents were extremely high.
7. The percentage of fatal accidents occurring in the dawn/dusk or dark was higher than those occurring in the daylight.

## RECOMMENDATIONS

1. Lowering speed limit to 55 MPH, which assisted in the reduction of the accidents in 1973, should be promulgated broadly through a drive for public support. The reduced speed limit should be extended.
2. Research and development of improved anti-skid pavements should be encouraged to enhance the safety of light-weight compact vehicles traveling under the snow/ice condition.
3. Law and enforcement of anti-hitchhiking measures along the freeways should be established to reduce pedestrian accidents that frequently cause fatalities or severe injuries.
4. With the high number of fatal accidents in the dark, it is suggested this finding warrants further detailed investigation. The vehicles with erroneous aiming headlights, freeways with improper signing and lighting systems, and drivers under the influence of alcohol, fatigue or in hypnotic condition all can be the critical factors related to the accidents.

**APPENDIX 1**

**A Sample of Q24155 Output**

## 1972 SEMIS INVOLVED ON INTERSTATE

ARAJ 4-25-74

		STATEWIDE				
HWY TYPE	FATAL	INJURY	P DAMG	# ACC	PERCENT	
ITRCHG	8	172	413	593	41.2	
ITRSCN	0	5	12	17	1.1	
OTHER	12	245	569	826	57.5	
NON-TRAF	0	0	0	0	.0	
TOTAL	20	422	994	1436	99.8	
DAY						
SUN	0	15	41	56	3.8	
MON	4	63	130	197	13.7	
TUES	4	60	168	232	16.1	
WED	4	75	164	243	16.9	
THUR	3	63	214	280	19.4	
FRI	3	110	195	308	21.4	
SAT	2	36	82	120	8.3	
UNK	0	0	0	0	.0	
TOTAL	20	422	994	1436	99.6	
TIME						
12- 1AM	0	14	31	45	3.1	
1- 2	1	18	30	49	3.4	
2- 3	0	11	37	48	3.3	
3- 4	1	17	28	46	3.2	
4- 5	2	11	30	43	2.9	
5- 6	1	19	30	50	3.4	
6- 7	2	24	38	64	4.4	
7- 8	1	19	43	63	4.3	
8- 9	2	23	51	76	5.2	
9-10	0	24	51	75	5.2	
10-11	0	23	60	83	5.7	
11-12N	0	16	48	64	4.4	
12-1PM	1	21	54	76	5.2	
1- 2	1	21	57	79	5.5	
2- 3	2	26	51	79	5.5	
3- 4	0	28	60	88	6.1	
4- 5	1	18	59	78	5.4	
5- 6	0	14	35	49	3.4	
6- 7	1	15	39	55	3.8	
7- 8	3	14	39	56	3.8	
8- 9	0	10	25	35	2.4	
9-10	0	11	36	47	3.2	
10-11	1	10	35	46	3.2	
11-12M	0	15	25	40	2.7	
UNK	0	0	2	2	.1	
TOTAL	20	422	994	1436	98.8	
WEATHER						
CLEAR	11	280	637	928	64.6	
FOG	1	10	17	28	1.9	
RAIN	2	52	124	178	12.3	
SNOW	6	80	215	301	20.9	
UNK	0	0	1	1	.0	
TOTAL	20	422	994	1436	99.7	

1972 SEMIS INVOLVED ON INTERSTATE

ARAU 4-25-74

		STATEWIDE			B ACC	PERCENT
		FATAL	INJURY	P DAMG		
<b>LIGHT</b>						
	DAY	7	246	591	844	58.7
	DAWN/DUSK	1	21	41	63	4.3
	DARK W SL	1	12	15	28	1.9
	DARK	11	143	346	500	34.8
	UNK	0	0	1	1	.0
	<b>TOTAL</b>	<b>20</b>	<b>422</b>	<b>994</b>	<b>1436</b>	<b>99.7</b>
<b>SURFACE</b>						
	DRY	11	239	533	783	54.5
	WET	2	70	191	263	18.3
	SNOW/ICE	7	113	262	382	26.6
	UNK	0	0	8	8	.5
	<b>TOTAL</b>	<b>20</b>	<b>422</b>	<b>994</b>	<b>1436</b>	<b>99.9</b>
<b>CONDITION</b>						
	ENGR	0	2	5	7	.4
	CONSTR ZONE	0	22	61	83	5.7
	OTHER	20	398	928	1346	93.7
	<b>TOTAL</b>	<b>20</b>	<b>422</b>	<b>994</b>	<b>1436</b>	<b>99.8</b>
<b>DEFECT</b>						
	NONE	20	405	941	1366	95.1
	RASTRN	0	0	2	2	.1
	LOOSE MAT	0	2	2	4	.2
	HOLE RUT RP	0	0	3	3	.2
	LOW S SHOUL	0	1	3	4	.2
	DRTG SNOW	0	5	8	13	.9
	FROSTY BRDG	0	2	3	5	.3
	SLIP WH WET	0	4	11	15	1.0
	OTHER/UNK	0	3	21	24	1.6
	<b>TOTAL</b>	<b>20</b>	<b>422</b>	<b>994</b>	<b>1436</b>	<b>99.6</b>
<b>ACCIDENT TYPE</b>						
	HO-ON	3	10	8	21	1.4
	SSS	0	25	118	143	9.9
	SSO	0	0	3	3	.2
	ANGL	0	10	25	35	2.4
	LT	0	5	10	15	1.0
	RT	0	4	7	11	.7
	RE	10	228	383	621	43.2
	RKG	0	0	3	3	.2
	PKG	1	14	39	54	3.7
	PON	1	5	0	6	.4
	ANIMAL	0	1	27	28	1.9
	FIXED OBJ	2	70	226	298	20.7
	TRAIN	0	0	0	0	.0
	BIKE	0	0	0	0	.0
	OTHER	3	50	145	198	13.7
	<b>TOTAL</b>	<b>20</b>	<b>422</b>	<b>994</b>	<b>1436</b>	<b>99.4</b>

1972 SEMIS INVOLVED ON INTERSTATE

ARAU 4-25-74

## STATEWIDE

ROAD TYPE	FATAL	INJURY	P. DAMG	# ACC	PERCENT
2 WAY UNDIV	0	0	0	0	.0
ONE WAY	0	0	0	0	.0
DIVIDED	0	0	0	0	.0
LIMITED ACC	0	0	0	0	.0
UNK	20	422	994	1436	100.0
TOTAL	20	422	994	1436	100.0
TOTAL LANES					
2	0	0	0	0	.0
3	0	0	0	0	.0
4	0	0	0	0	.0
5	0	0	0	0	.0
6	0	0	0	0	.0
7	0	0	0	0	.0
8	0	0	0	0	.0
9	0	0	0	0	.0
MORE/UNK	20	422	994	1436	100.0
TOTAL	20	422	994	1436	100.0
ALNMT HORZ					
STRT	18	380	876	1274	88.7
CRV LESS 2X	1	39	106	146	10.1
CRV GTR 2X	1	3	11	15	1.0
N P ZONE	0	0	1	1	.0
UNK	0	0	0	0	.0
TOTAL	20	422	994	1436	99.8

## ACCIDENT TABULATIONS

1972 SEMIS INVOLVED ON INTERSTATE

ARAU 4-25-74

		STATEWIDE				
MONTHLY	DISTR	FATAL	INJURY	P DAMG	# ACC	PERCENT
	JANUARY	3	30	76	109	7.5
	FEBRUARY	4	39	84	127	8.8
	MARCH	1	40	92	133	9.2
	APRIL	1	30	72	103	7.1
	MAY	0	18	68	86	5.9
	JUNE	1	31	78	110	7.6
	JULY	1	38	69	108	7.5
	AUGUST	2	37	82	121	8.4
	SEPTEMBER	1	28	57	86	5.9
	OCTOBER	2	28	66	96	6.4
	NOVEMBER	0	39	110	149	10.3
	DECEMBER	4	64	140	208	14.4
	UNK	0	0	0	0	.0
TOTAL		20	422	994	1436	99.2



**APPENDIX 2**

**2 x 2 Chi-square Technique**

## Statistical Method Used in the Report

### 2 x 2 Chi-square Test

Data

	Class 1	Class 2
Population 1	$A_{11}$	$A_{12}$
Population 2	$A_{21}$	$A_{22}$

Assumptions:

1. Each sample is a random sample.
2. The two samples are mutually independent.
3. Each observation may be categorized either into Class 1 or Class 2.

Hypotheses: Let the probability that a randomly selected element will be in Class 1 be denoted by  $P_1$  in Population 1 and  $P_2$  in Population 2.

$$H_0 : P_1 \leq P_2$$

$$H_1 : P_1 > P_2$$

Test Statistics

$$T = \frac{(A_{11}A_{22} - A_{12}A_{21})^2 (A_{11} + A_{12} + A_{21} + A_{22})}{(A_{11} + A_{12}) (A_{21} + A_{22}) (A_{11} + A_{22}) (A_{12} + A_{21})}$$

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