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15. Supplementary Notes

FHWA Contract Manager: F. J. Daniels, III, HRS-41

This study was part of a joint effort between NHTSA and FHWA.

16. Abstract

The objective of this study was to collect and analyze data on freeway pedestrian accidents. Data on 236 accidents involving pedestrians struck on limited-access highways were collected. The data included behavioral sequence items, site characteristic items, identification items, pedestrian factors, driver factors and vehicle factors. The accident investigations were intended to identify the precipitating and predisposing factors in each accident. The data reduction and data analysis phase resulted in the identification of a number of characteristic accident situations or accident types. Although 14 different accident types were identified, the most frequent types accounted for nearly 60% of the accidents. Countermeasures intended to impact on each of the accident types are discussed. The relatively infrequent occurrences (less than 1,000 nationwide annually) and the varied causal factors involved (suicide, alcohol, poor weather, disabled vehicles) suggest that countermeasure implementation be very carefully considered on a site-by-site basis. This report is the first in a series. The others in the series are:

Vol. No.	FHWA No.	Short title
II	FHWA-RD-78-170	Final Report
III	FHWA-RD-78-171	Appendixes

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PREFACE

This document constitutes the final report of a joint effort between the National Highway Traffic Safety Administration and the Federal Highway Administration under Contract DOT-HS-355-3-718, performed by BioTechnology, Inc.

Phases I and II of this study covered pedestrian accidents in rural and suburban areas and was documented in the report "Countermeasures for Rural and Suburban Pedestrian Accidents: Accident Data Collection and Analysis," DOT-HS-802-266, March 1977. This report covers Phases III and IV which investigated pedestrian accidents occurring on freeways.

Further research under this contract is being conducted to determine when pedestrian pathways should be provided. From this research, a users manual will be developed.

ACKNOWLEDGMENTS

Many individuals were involved in this project and contributed to its success. Since this study involved such a large-scale data collection effort, it involved the cooperation of a number of Government officials, city officials, and even the accident victims who often provided the information that was needed. Hopefully, the contribution of the accident victims will be at least partly repaid by an eventual reduction of the pedestrian accident problem through this and subsequent efforts.

BioTechnology, Inc. would especially like to thank the officers and men in the various state police departments who assisted by providing the accident reports for the sample of pedestrian accidents. The officers in each of the police departments who coordinated our project efforts were:

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The continued assistance and support of the Department of Transportation and its personnel deserve special note:

Federal Highway Administration
F. J. Daniels, III

A number of BioTechnology personnel made important contributions to the project; we would especially like to thank each of the local field investigators for their assistance in collecting the accident data. A listing of individuals is contained in Volume III, Appendix E.

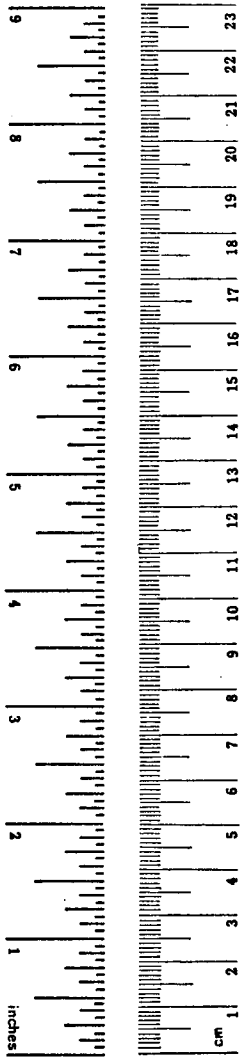
TABLE OF CONTENTS

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

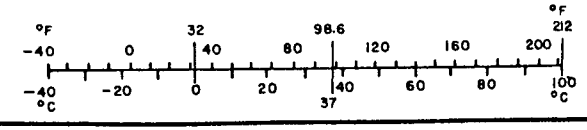
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



T.A.

I. EXECUTIVE SUMMARY

Introduction

Pedestrian accidents account for 20% of all motor vehicle fatalities nationwide. Approximately 300,000 pedestrians are struck and 9,000 are fatally injured.* Prior research efforts have focused on urban** and rural*** pedestrian accidents, yet some of the most frequently fatal and apparently senseless pedestrian accidents occur on freeways or limited-access highways. This report describes research aimed at determining the nature and extent of the freeway pedestrian accident problem.

The objectives of this study are: (1) to develop the necessary data collection rationales and techniques for investigating an adequate sample of freeway pedestrian accidents; (2) to collect and analyze data for identifying the causal factors of freeway pedestrian accidents; (3) to identify countermeasures directly relevant to the accident situation; and (4) to evaluate countermeasures by means of a behavioral (operational) evaluation of pedestrians and traffic. This document describes the research directed toward achieving the first three project objectives.

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*National Safety Council, Accident Facts, 1975.

**Snyder, M. and Knoblauch, R. Pedestrian safety, The identification of precipitating factors and possible countermeasures. Operations Research, Inc., Contract No. FH-11-7312, 1971.

***Knoblauch, R.L. Causative factors and countermeasures for rural and suburban pedestrian accidents: Accident data collection and analysis. BioTechnology, Inc., Phase I and II Report, Contract No. DOT-HS-355-3-718, National Highway Traffic Safety Administration and Federal Highway Administration, Washington, D.C., March 1976.

A freeway is a limited-access highway in which vehicular egress and exit is possible only at grade-separated interchanges. Reliable data on the number of pedestrian accidents occurring nationwide on freeways are not available. However, a number of extrapolations indicate that between 957 and 1,068 pedestrian accidents occur annually on freeways.

This executive summary provides an abbreviated discussion of the major sections of the final report including:

- Introduction
- Procedures
- Results
  - General Sample Characteristics
  - Collision Narrative
  - Accident Type Development
  - Accident Group Development
- Countermeasure Identification

Procedures

The accident sample included all the freeway pedestrian accidents from five geographically distributed states--California, Michigan, Missouri, North Carolina and Pennsylvania. The total number of freeway pedestrian accidents in the sample was 236, which represents approximately one-fifth of the annual national total.

The required data items were determined by considering the information needed to identify causal factors in freeway pedestrian accidents and the information needed for countermeasure development. The following types of data items were developed:

- Identification Items
- Trip Characteristics and Pedestrian, Driver and Vehicle Descriptive Items
- Site Characteristic Items
- Collision Narrative
- Field Investigator (FI) Conclusion Items.

The data collection procedure used carefully trained experienced local field investigators (FI's) in each of the five states to collect site-specific and participant data to supplement the regular police accident report. The accident sample was obtained from an appropriate state agency. In most cases the accidents that ultimately constituted the freeway accident sample were selected by reviewing reports from a larger subsample (i.e., all limited- and controlled-access highways). The accident sample included all 1974 freeway pedestrian accidents and the data collection was conducted during 1974 and early 1975. The police accident reports were reviewed by project personnel to determine the data items to be collected by the FI's. The FI visited the accident site and interviewed the pedestrian, the driver, any witness and the investigating officer if necessary to collect the required items. When the FI completed this report, a project staff member carefully reviewed each response prior to keypunching. The staff member then coded appropriate data items, including the accident typology, based on information provided in the collision narrative. The data form was keypunched and verified prior to actual data analysis. The data analysis process was aimed at developing additional accident typologies, descriptive information and ultimately accident preventive countermeasures.

Results

The results of the data collection and analysis effort are divided into three separate subsections. The first describes the general characteristics of the entire accident data base. The second is a discussion of selected subsamples of accident types. The final subsection details the procedures and results of a sophisticated analysis technique that was used to develop countermeasure-oriented accident groups.

General Sample Characteristics

This entire section is a discussion of the distributions, cross-tabulations, and other data found in Appendix A of this report. Each time a particular data item is called out in the text, the citation is followed by a number in parentheses. This number refers to the variable field for the particular data item in Appendix A.

Descriptive Factors. The 236 accidents were distributed among the five states as shown below in Table 1 (Field 2). When compared with each state's distribution of fatal and nonfatal interstate accidents and interstate vehicle miles, it is apparent that the distribution of freeway pedestrian accidents most closely follows the distribution of fatal interstate accidents.

TABLE 1

ACCIDENT DISTRIBUTION PERCENTAGE NATIONWIDE

STATE	FREEWAY PEDESTRIAN ACCIDENTS	FATAL ACCIDENTS (INTERSTATE)	NONFATAL ACCIDENTS (INTERSTATE)	VEHICLE MILES (INTERSTATE)
CALIFORNIA	9.9	8.8	8.1	11.2
MICHIGAN	3.7	3.7	5.4	4.2
MISSOURI	3.5	4.0	2.2	3.2
N. CAROLINA	2.0	2.0	1.3	1.5
PENNSYLVANIA	4.0	3.6	5.1	4.1
SAMPLE TOTAL	23.3	22.1	22.2	24.3

The distributions of month (Field 5) and day of week (Field 6) are relatively flat although the winter months and the weekends had somewhat more accidents. The time of day (Field 9) distribution shows that most of the accidents occur in the evening and early morning hours. Figure 1 shows that nearly two-thirds (66.1%) of the accidents occur between 6 p.m. and 6 a.m.

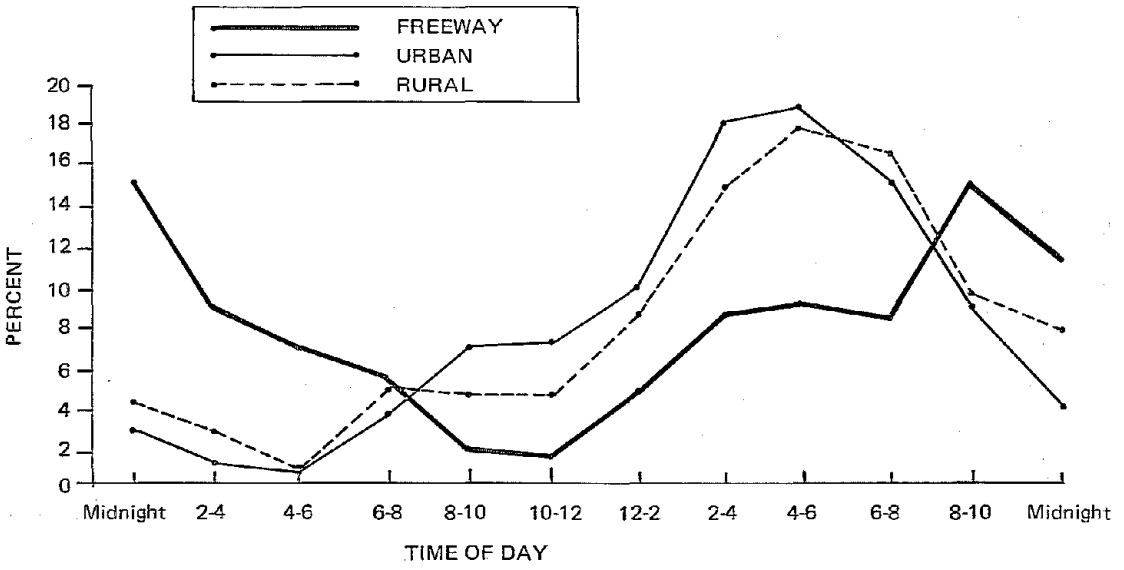

Figure 1. Time of occurrence.

Pedestrian Factors. The pedestrians involved in freeway accidents tend to be considerably older (Field 23) than those involved in either urban or rural pedestrian accidents (see Figure 2. The mean pedestrian age was 34.1 years (S.D. = 16.1). Most (83.1%) of the pedestrians were male (Field 25).

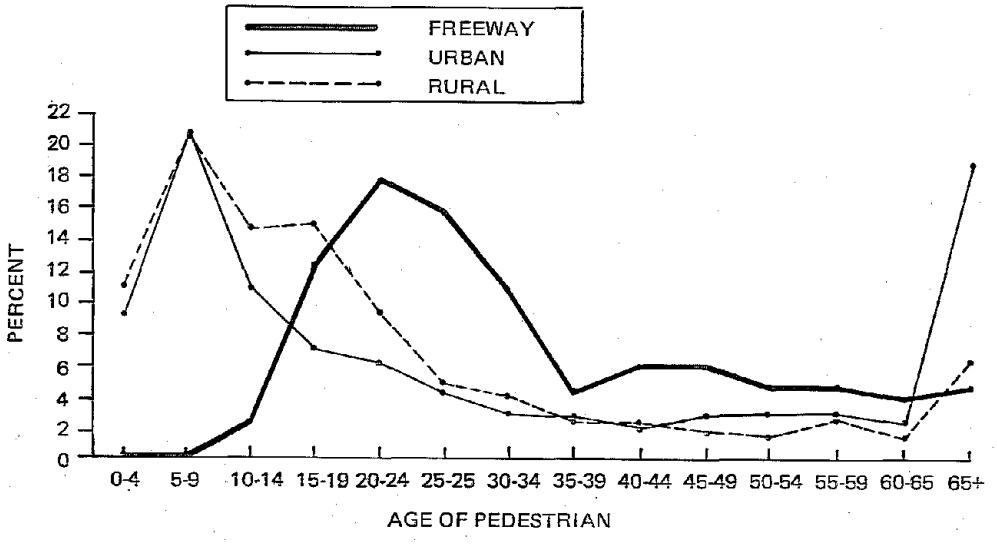

Figure 2. Pedestrian age.

Pedestrians struck on limited-access highways tended to be seriously or fatally injured (Field 47). Seventy-three percent of the freeway pedestrians were either seriously injured or killed. Only 48% of the rural pedestrians and 38% of the urban pedestrians were seriously or fatally injured.

Driver Factors. The ages of the drivers involved (Field 24) are quite similar to those of the pedestrians struck. The mean driver age was 35.8 years (S.D. = 13.5) versus 34.1 years (S.D. = 16.1) for the pedestrians. Since 17% of the cases involved hit-and-run drivers, it was not possible to determine the driver's sex in those cases. However, only 11% of the drivers were known to be female (Field 26).

Vehicle Factors. The legal speed at most (84.8%) of the sites was 55 mph (Field 41, $\bar{X}$ = 53.5, S.D. = 6.4); however, the estimated preinvolvement speed was slightly lower (Field 42, $\bar{X}$ = 47.4, S.D. = 14.1%) while the estimated impact speed was even lower (Field 43, $\bar{X}$ = 39.8, S.D. = 16.5). Although most of the vehicles were regular full-sized cars (30.5%) (Field 45), there were relatively large percentages of large trucks (13.1%) and small trucks (13.1%). The interaction between vehicle size and injury severity was statistically examined but no significant differences were found (Z-test, 0.01 level). Vehicle defects were noted by the investigating officer in only 1.7% of the cases (Field 35).

Environmental Factors. Although 15% of the accidents occurred during rain, snow or conditions of reduced visibility (Field 36) and 17% occurred on wet or icy roads (Field 37), the most striking characteristic of these accidents is that 66% occurred during dark or twilight conditions (Field 39). Two-thirds of these (42% of the sample) occurred at night with no roadway lighting (see Table 2).

TABLE 2

WEATHER, ROAD SURFACE AND LIGHTING CONDITIONS

	RURAL, %	URBAN, %	FREEWAY, %
WEATHER			
Clear or cloudy	92	88	85
Rain	4	9	8
Snow	2	1	3
Reduced visibility, fog, etc.	2	1	4
ROAD SURFACE			
Dry	86	84	81
Wet	10	12	11
Snow or ice	3	1	6
LIGHTING CONDITIONS			
Daylight	60	67	30
Twilight	6	5	4
Dark	31	27	62

Pedestrian and Driver Trip Factors. Most of the pedestrians were found to have come from disabled vehicles (45.5%) (Field 54). The majority were mechanically disabled; only 4.7% had run out of gas (Field 34). Most of the pedestrians (52.1%) were within one mile of their trip origin when struck, although the distance was unknown in 39.8% of the sample (Field 38). The pedestrians were also close to their destinations with 38.6% within one mile; 49.2% were an unknown distance (Field 60).

The drivers were also fairly close to their trip origins; 25% were within 10 miles and only 6.4% were more than 99 miles. The distance was unknown in 55.1% (Field 59). The drivers' destinations were comparably close: 23.3% within 10 miles, 8.1% more than 99 miles and 49.6% unknown (Field 61).

The pedestrians were reasonably close to home when struck: 42.8% were within 10 miles and only 13.4% were more than 99 miles. The distance was unknown in 31.4% (Field 62). The drivers were also close to home: 33.9% within 10 miles, 14.4% more than 99 miles. The distance was unknown in 28.8% (Field 63).

The pedestrians were just starting their walking trip as 22.5% were walking for one minute or less, 18.6% were walking for two to ten minutes. Only 3.4% were walking for more than one hour (Field 64). Only 11% of the drivers had been driving for more than one hour (Field 65). Both drivers and pedestrians were relatively familiar with the accident site; most of the pedestrians (51.7%) and most of the drivers (62.8%) had been at the site more than 99 times in the past year (Fields 66 and 67).

Site Factors. The freeway pedestrian accidents tended to occur in open areas as opposed to residential or commercial areas, and in urban as opposed to suburban and country locations (Field 75). However, the single most common site characteristic involved open areas in country locations, 31.8% (see Table 3).

TABLE 3
ACCIDENT SITE CHARACTERISTICS

LAND USE	TYPE OF AREA			
	CITY OR TOWN	SUBURBAN	COUNTRY	ROW TOTAL, %
RESIDENTIAL	9	2	1	12
COMMERCIAL	18	5	6	29
OPEN AREA	10	8	32	50
INDUSTRIAL	6	1	1	9
COLUMN TOTAL, %	44	16	40	100

A number of other accident site factors were of interest:

- 22.4% occurred on upgrades and 17.4% occurred on downgrades (Field 77).
- Mean interchange frequency in the 10 miles preceding the site was 5.9 (S.D. = 2.92) (Field 79).
- Mean interchange frequency in the 10 miles following the site was 6.3 (S.D. = 2.88) (Field 81).
- 42% of the accidents occurred at interchanges; 49.5% of these were full diamond interchanges (Field 87).
- 78% of the sites had a highway guide sign and 30% a speed limit sign in the area one mile prior to the POI (Field 92).

- Sight distance defects were found infrequently. Factors which did reduce an approaching driver's view of the POI to less than 500 feet included vertical curvature (3.4%), horizontal curvature (25%) and overpasses or underpasses (2.1%) (Field 93).
- Estimates indicate that there are high vehicle volumes at the accident site at the time of day and day of week of the accident. One-half of the sites had estimated vehicle volumes greater than 480 vehicles per hour. Only 12% of the sites had less than 60 vehicles per hour (Field 72).
- In spite of the high vehicle volumes the collision vehicle was a lone vehicle in half of the cases, the lead vehicle in a platoon in 30% of the cases, and the last vehicle in a platoon in 18% of the cases (Field 74).

Roadway Factors. During their site visit, the field investigators made various measurements of the roadway, surface and pavement markings:

- The mean number of lanes was 2.5 (Field 108); mean traveled way width was 33.8 (Field 109); and the traveled way was concrete in 82% of the accidents (Field 111).
- Pavement lane markings were typically dashed white (53%), although pavement delineators and Botz dots were found in 30% (Field 106). Median edge markings were typically solid yellow (35%) (Field 107). Right edge markings were usually solid white (83%), although 13% of the sites had no outside edge markings (Field 112).

Collision Narrative. The field investigators provided a detailed narrative of the collision dynamics in each accident. These narratives were reviewed and the information coded on the pedestrian's and driver's preinvolvement location, collision course activity, and evasive action behavior.

Most of the pedestrians were on the traveled way prior to being struck by the collision vehicle (Field 118). Only 18% were on the shoulder of the through road and 3% on the shoulder of an exit or entrance ramp. Although 49% were in the traveled way, a total of 31% were either in the outside lane (19%) or on the outside edge of the traveled way (12%) (see Table 4).

TABLE 4

PEDESTRIAN LOCATION

Traveled Way	49%
Outside lane	19%
Center lane(s)	14%
Median lane	14%
Edge of Traveled Way	17%
Outside edge	12%
Median edge	4%
Shoulder	18%
Outside shoulder	15.7%
Median shoulder	2.1%
Ramp	10%
Traveled way	7%
Shoulder	3%
Other or Unknown	6%
Total	100%

The pedestrians were involved in a variety of preinvolvement activities (Field 119). The most common activity was crossing the roadway (34.2%) either walking or running. Many of the pedestrians were standing next to (11%) or working on (10%) a disabled vehicle. Note that 4.7% were flagging a vehicle and 1.3% were working on the roadway. Of the pedestrians who were walking along the roadway, more were walking with traffic (7.6%) than against traffic (1.7%) (see Table 5).

Although half (51%) of the drivers were going straight ahead and/or sustaining speed (Field 122), a relatively large percentage (15%) were either out of control or driving off the traveled way. Distracting maneuvers such as merging, passing, and changing lanes were infrequently encountered (see Table 6).

Nearly one-third (30%) of the impacts occurred along the shoulder or the edge of the traveled way (Field 52). Most of the remainder (63%) occurred on the traveled way (see Table 7).

TABLE 5

PEDESTRIAN ACTIVITY

21%	Crossing, running
11%	Standing next to a disabled vehicle
10%	Crossing, walking
10%	Working on a vehicle
10%	Other
8%	Walking, with traffic
6%	Standing
5%	Flagging vehicle
4%	Crossing, not further specified
3%	Entering or exiting vehicle
3%	Pushing vehicle
3%	Unknown
2%	Sitting or lying down
2%	Walking against traffic
1%	Working on roadway

TABLE 6

DRIVER ACTIVITY

51%	Going straight and/or sustaining speed
15%	Driving off traveled way or out of control
9%	Decelerating
8%	Unknown
4%	Other
3%	Changing lanes
3%	Speeding
3%	Negotiating curve
1%	Starting from stopped position
1%	Backing up
1%	Passing
1%	Merging

TABLE 7

IMPACT LOCATION

30%	Along the shoulder or edge of the traveled way
7%	Just as the pedestrian entered the traveled way
16%	During the first quarter of the traveled way entered
17%	During the second quarter of the traveled way entered
9%	During the third quarter of the traveled way entered
14%	During the last quarter of the traveled way entered
2%	On the median
3%	Other
2%	Unknown

That many of the drivers and pedestrians were not aware of the impending collision is clearly demonstrated by the evasive action factors (Fields 120 and 123). Three-quarters of the pedestrians and one-third of the drivers did not attempt evasive action (see Table 8).

TABLE 8

EVASIVE ACTION FACTORS

Evasive Activity	Pedestrian	Driver
None made, not futher specified	25%	7%
None made, unaware of need	35%	15%
None made, insufficient time	6%	15%
None made, ped walked or ran into vehicle	12%	—
Total - No Evasive Action	78%	37%
Jump, lunge, or dodge vehicle	4%	
Continued running across road	2%	
Other	6%	
Unknown	11%	
Attempted to stop		13%
Attempted to swerve		17%
Attempted to stop and swerve		14%
Other		8%
Unknown		11%
Total - Attempted Evasive Action	22%	63%

Causal Conclusions

The behavioral factors that combined to precipitate the accident are indicated as causal conclusions. Three main categories of causal factors are summarized: pedestrian causal factors, driver causal factors, and environmental causal factors.

Nearly all (97%) of the accidents had at least one pedestrian causal factor indicated (Fields 127 and 129) (see Table 9). Pedestrian course risk-taking was the most frequently coded (30%) factor. This indicates the pedestrian did something intrinsically dangerous, i.e., pushing a vehicle in the roadway, lying in the roadway, etc. Short-time exposure, when the pedestrian appeared suddenly in the path of the vehicle, occurred in 28%. Misdirected or inadequate search and detection was found in a total of 47%

of the cases. The condition of the pedestrian as influenced by alcohol or drugs was found to be a causal factor in 18%.

TABLE 9

PEDESTRIAN CAUSAL FACTORS

Factor	% of Accidents
No contributory pedestrian factors	3
Pedestrian course, risk-taking	30
Short-time exposure	28
Misdirected search and detection	26
Inadequate search and detection	21
Condition of pedestrian (alcohol, drugs)	18
Running on or into the roadway	12
Distraction	9
Other	6
Misinterpretation of driver's intent	5

In nearly one-third (31%) of the cases, there were no contributing driver causal factors found (Fields 131 and 133) (see Table 10). However, nearly one-fourth (22%) of the cases were caused by the driver either driving off the traveled way, being under the influence of alcohol or drugs, or proceeding at an excessive speed.

TABLE 10

DRIVER CAUSAL FACTORS

Factor	% of Accidents
No contributory driver factors	31
Misdirected search	15
Misinterpretation of pedestrian's intent	10
Ran off traveled way	9
Condition of driver (alcohol, drugs)	7
Inadequate search and detection	7
Other	7
Vehicle speed	6

As was the case for driver causal factors, no environmental causal factors were indicated in 31% of the cases (Fields 135 and 137). Darkness-related factors were considered causal in 32% of the cases. Poor weather factors combined to be causal factors in 23% of the cases (see Table 11).

TABLE 11

ENVIRONMENTAL CAUSAL FACTORS

Factor	% of Accidents
No contributory environmental factors	31
No roadway lighting	23
Condition of roadway, other	10
Inadequate roadway lighting	9
Roadway curvature	8
Condition of roadway, ice/snow	8
Driver and/or pedestrian vision impaired by weather	5

Accident Type Development

In order to better understand the problem and to identify appropriate countermeasures, a number of accident types were identified. The entire sample was divided into situations that shared certain common elements or critical descriptors and different accident situations were conceptualized. The accident data were then examined to determine if the conceptualized accident situation occurred with sufficient frequency to create an "accident type." A total of 22 accident situations were found; of these, 14 accounted for at least 3% of the sample.

In order to classify a situation as a particular accident type, certain characteristics or "critical descriptors" were necessary. The critical descriptors for each of the types were:

ACCIDENT TYPE	CRITICAL DESCRIPTORS
Disabled Vehicle Related	Pedestrian struck while working on or standing next to a disabled vehicle.
Result of Auto Crash	Pedestrian struck by vehicle(s) as a direct result of an auto-auto or solo-auto accident.
Weird	Very unusual circumstances, not believed to be countermeasure corrective.
Hitchhiking	Pedestrian struck while hitchhiking.
Interchange Dash	Pedestrian struck while crossing at an interchange; pedestrian appeared suddenly or ran into the path of the vehicle (short-time exposure).
Walking to or from Disabled Vehicle	Pedestrian struck while walking to or from a disabled vehicle.
Other	Unusual circumstances, believed to be countermeasure corrective, at least on a one-by-one basis.
Dart-out and Dash	Pedestrian struck while crossing not at interchange. Pedestrian was either running or appeared suddenly in the path of the vehicle (short-time exposure).
Walking in the Traveled Way	The pedestrian was standing, walking, stumbling, falling, running with or against traffic in traveled way before being struck.
Limited Information	Not able to specify accident type because of inadequate information.
Result of Vehicle Going Out of Control	Pedestrian struck by vehicle that had lost control prior to becoming involved with the pedestrian.
Emergency/Police Vehicle Related	Pedestrian struck while in the vicinity of an emergency or police vehicle.

ACCIDENT TYPE	CRITICAL DESCRIPTORS
Interchange Walk	Pedestrian struck while walking across the freeway at an interchange.
Working in the Roadway	Pedestrian, a construction worker, struck while working on the roadway or shoulder.

Table 12 lists 14 different accident types in order of frequency, and shows the percentage of the sample represented by each type.

TABLE 12

ALL ACCIDENT TYPES

	%
DISABLED VEHICLE RELATED	20%
RESULT OF AUTO CRASH	10%
WEIRD	10%
HITCHHIKING	9%
INTERCHANGE DASH	8%
WALKING TO OR FROM DISABLED VEHICLE	8%
OTHER	6%
DART-OUT AND DASH	5%
WALKING IN THE TRAVELED WAY	5%
LIMITED INFORMATION	5%
RESULT OF VEHICLE GOING OUT OF CONTROL	4%
EMERGENCY/POLICE VEHICLE RELATED	4%
INTERCHANGE WALK	3%
WORKING IN THE ROADWAY	3%
TOTAL	100%

The remaining discussion in this section involves these 14 types.

Disabled Vehicle Related (20%). This type involves a pedestrian standing next to or working on a disabled vehicle at night on freeways passing through open areas in city or country locations. The collision most frequently occurs on the shoulder or the edge of the traveled way, although the vehicle occasionally runs off the road striking the pedestrian. The pedestrian is basically not attending to oncoming traffic, but working on, looking at, or standing next to the disabled vehicle.

- 33% of the vehicles disabled at night did not have flashers on to warn oncoming traffic.
- 58% of the disabled vehicles were mechanically disabled.
- 75% of the accidents occurred on the open freeway and 25% occurred at an interchange.
- 38% of the pedestrians were working on the vehicle.
- 27% of the pedestrians were standing near a disabled vehicle.
- Only 2% of the pedestrians were known to have taken evasive action.

Result of Auto-Auto Crash (10%). This type involves a pedestrian who is struck as a result of an auto-auto accident on the freeway. Almost all of the accidents occurred at night and nearly half of the freeways were rain- or snow-covered. Pedestrian activities were distributed almost equally among standing, not moving, running across the freeway, sitting or lying in the roadway, directing traffic, entering or exiting vehicles and flagging vehicles. Many times the pedestrian was unaware that he should have taken evasive action.

Weird (10%). This type of accident occurs under unusual circumstances and is not believed to be countermeasure corrective. The "weird" category includes cases that were especially unusual or unique in the predisposing and precipitating factors. Since it is unlikely that the same set of circumstances would occur again, the accidents in this category were not considered correctable by countermeasures.

Hitchhiking (9%). This type involves pedestrians who are struck while hitchhiking on the freeways in a country or suburban open area. They occur at nighttime with very little lighting; the weather and road surface conditions are excellent. Half of the hitchhikers were struck while attempting to cross the freeway and one-quarter were involved with alcohol.

- Only 27% of the hitchhikers were struck on the shoulder or edge of traveled way.
- Many hitchhikers were wearing dark clothes at night.
- 64% of the accidents occurred at interchanges.
- 18% of the hitchhikers did attempt evasive action.
- Only 46% of the drivers attempted evasive action.

Interchange Dash (8%). The interchange dash had a pedestrian running across the freeway at an interchange in a city or suburban commercial location. Nighttime conditions and dark clothing on the pedestrian contributed to drivers' visual recognition problems. Although running and short-time exposure were primary pedestrian causal factors, the driver was frequently aware of, but misinterpreted, the pedestrian's intentions. The driver is typically going straight and sustaining speed at the interchange.

- All of the impacts occurred on the traveled way.
- 80% of the pedestrians were running across the roadway.
- 40% of the pedestrians made no attempt at evasive action and 30% ran into the vehicle.

Walking to or from a Disabled Vehicle (8%). This type involves a pedestrian walking to or from a disabled vehicle in a city or country open area, mainly at night on the freeways. Half of the pedestrians struck while walking to or from a disabled vehicle were actively crossing the freeway. The primary pedestrian causal factor was short-time exposure; one-quarter of the pedestrians were wearing dark clothes. Almost three-fourths of the pedestrians did not take any evasive action and almost half of the drivers did not take evasive action either.

- 25% of the vehicles did not have activated flashers.
- 39% occurred at an interchange.
- 33% of the pedestrians were struck while running across the freeway.

Others (6%). This type includes other unusual accident situations which were not one of the more specific accident types, but are countermeasure corrective on a one-to-one basis. Since they are not grouped by conceptual similarities, a detailed discussion of their combined attributes is not appropriate.

Dart-out and Dash (5%). The dart-out and dash accidents have a pedestrian running across the freeway, not at an interchange, in a suburban or country residential area. The driver of the impacting vehicle is usually going straight and sustaining speed. An important condition is that the pedestrian appears suddenly in the vehicle's path and the driver is unable to avoid the pedestrian. Usually the accident site was dark with no lighting, and half of the pedestrians were wearing dark clothes.

- All of the pedestrians were struck in the traveled way.
- 42% of the pedestrians were running.
- The pedestrian causal factors identified included: 50% short-time exposure; alcohol in 25% of the cases; 50% of the accident sites had no lighting.

Walking in the Traveled Way (5%). This accident type involves a pedestrian walking in the traveled surface of the freeway either with or against traffic at night in a country or city open area with no lighting. Short-time exposure was frequently the main pedestrian causal factor with only half of the drivers aware of the need for evasive action. Often the driver's vision was obscured by moving traffic which shielded the pedestrian until the collision was imminent and unavoidable.

- 42% of the pedestrians were wearing dark clothes.
- Only 25% occurred at interchanges.
- 58% of the pedestrians were walking with traffic, and 17% were walking against traffic.
- 91% of the pedestrians made no evasive action.

Limited Information (5%). This category contains cases with insufficient information. These include hit-and-run cases in which virtually nothing was known. It was not possible to determine which accident type is appropriate.

Out of Control (4%). This type involves a pedestrian being struck by a vehicle that had lost control before striking the pedestrian, who is on the shoulder or the edge of the traveled way

of a freeway in a city or country open area. Half of the accidents occurred on rain- or snow-covered freeways, but were equally distributed as to time of day and lighting conditions. None of the predestrians made any attempt at evasive action which indicates that they were unaware of the collision vehicle.

Emergency/Police Vehicle Related (4%). This type involves pedestrians who were struck while in the vicinity of emergency or police vehicles on the freeways. All of the pedestrians were law officers at work, usually at night. Less than half the drivers attempted evasive action. The primary pedestrian causal factors were stimulus overload, misinterpretation of the driver's intent, and poor path prediction. Primary driver causal factors were driver's search not directed at the pedestrian and poor path prediction.

Interchange Walk (3%). The interchange walk involves a pedestrian walking across the freeway at at interchange in a city, commercial or country open area. The pedestrians did not exhibit short-time exposure characteristics and were not running. Most drivers at these interchanges were aware of the pedestrians and took evasive action, even though the majority of the accidents occurred in non-daylight hours.

- 38% of the pedestrians involved were wearing dark clothes.
- 25% of the accidents occurred on exit ramps.
- 88% of the pedestrians made no evasive action; in fact, 50% actually walked into the impacting vehicle.
- 75% of the drivers took evasive action.
- 38% of the pedestrians were involved with alcohol.
- There were no driver causal factors indicated.

Working in Roadway (3%). This type includes pedestrians, usually construction workers or flagmen, struck while working on the freeway. They occurred in daylight, in good weather conditions, with good pedestrian visibility, and with one-quarter of the pedestrians wearing orange safety vests. The majority of the pedestrians were not paying attention to the collision vehicle,

but rather to their work activity. Over half of the drivers were unaware of the need for any evasive action.

- 57% occurred at interchanges.
- 71% of the pedestrians failed to take any evasive action.
- The primary driver causal factors had 60% inadequate search failures; 20% of the drivers ran off the traveled way.

Accident Group Development

A new set of accident groups was developed to incorporate both the theoretical and empirical aspects of particular accidents into clusters not considered before data analysis began. Procedures utilized to accomplish this included correlation analysis, cluster analysis, and tests of significance between groups.

The data base was divided into several general kinds of accidents. Because of inherent differences between certain accidents, pooled analysis can be misleading and unproductive. We first looked individually at accidents:

- Occurring at interchanges (47%);
- With pedestrians attempting to cross the road (45%);
- With pedestrians at or near vehicles (40%); and
- With pedestrians not attempting to cross the road (55%).

For each general type, correlation analyses were run using a wide range of descriptive variables, such as site characteristics, environmental factors and causal factors. These analyses helped identify independent descriptors of characteristics which might best cluster observations.

Finally, only pedestrians crossing the road and pedestrians at or near disabled vehicles were retained for further analysis. These two general types were analyzed using a clustering technique called profile analysis. Several analysis runs were made, resulting in approximately 58% of the sample being assigned to accident groups. Several accident types were redefined into groups; these original types were left intact because of the previous specificity of their definition. Sixteen final accident groups were identified.

Group characteristics were found by statistically testing differences between groups over a range of variables. The major groups are discussed in the following paragraphs:

1. Pedestrian Crossing Entrance or Exit Ramp (5%). Ramp accidents often involved hitchhikers inattentive to vehicle conflicts. Sites were usually well lit. Injury severity was lower than other crossing accidents.

2. Pedestrian Crossing At or Near a Disabled Vehicle (7%). Most pedestrians had previously been involved in an auto accident and were crossing for aid. These accidents often occurred at night. The drivers frequently attempted to evade, but hit the distracted pedestrian, often causing fatal injuries.

3. Pedestrian Crossing Overpass (5%). Overpass accidents often involved local residents crossing freeways. The collision vehicle was in traffic and failed to see the pedestrian in time. These accidents often occurred at night.

4. Pedestrian Crossing Underpass (9%). Underpass accidents often occurred in heavy traffic in urban areas. Pedestrians were hitchhikers or local residents who were often under the influence of alcohol. High impact speeds led to severe injuries.

5. Pedestrian Crossing Open Road (9%). Open road accidents often occurred in dark places at night. Pedestrians were often under the influence of alcohol, and few took evasive action. Impact speeds were high, and most accidents were fatal.

6. Pedestrian Near Vehicle - Collision Vehicle Ran Off Traveled Way (7%). The pedestrian, near the edge of the traveled way, was hit by a vehicle which drifted off the road. Drivers were often inattentive or under the influence of alcohol.

7. Pedestrian Near Vehicle - In Traveled Way with Visibility (11%). These accidents often occurred in bad weather, with a disabled vehicle partially in the traveled way. Both the pedestrian and the driver were at fault.

8. Pedestrian Near Vehicle - In Traveled Way But Not Visible (5%). These accidents often occurred on the through road, not near interchanges. Drivers failed to see the pedestrian who was often under the influence of alcohol.

9. Pedestrian Walking Along Traveled Way (4%). The pedestrian, a hitchhiker or ex-motorist was hit while on the shoulder. Fewer edge markings were present. A distracted driver drifted off the traveled way.

10. Pedestrian Walking in Traveled Way (7%). These most often occurred at night with no street lighting. Shoulders were adequate, and pavement edge markings were present. These accidents are probably not countermeasure corrective.

11. Miscellaneous (12%). This group included vehicles backing up, vehicles out of control, pedestrian working in the traveled way, and emergency/police vehicle related.

Countermeasure Identification

A major purpose of the accident data collection effort was to identify the causal factors involved in freeway pedestrian accidents so that potential countermeasures could be identified. With about 1,000 such accidents occurring nationwide on a freeway system of approximately 40,000 roadway miles, clearly any realistic countermeasure identification and development effort must consider the expense of implementing countermeasures on even a small part of such a system.

Perhaps the most persuasive characteristic of all of the accidents investigated was that a large number appeared to be "unpreventable" with traditional pedestrian- or roadway-oriented countermeasures that are within the scope of this effort. For example, more than half (51.7%) of the accidents involved at least one of the following characteristics:

- Icy or snow-covered roadway.
- Vehicle out of control, excessive speed or driving off the traveled way.
- Inadequate or no roadway lighting.
- Pedestrian and/or driver under the influence of alcohol or drugs.
- Apparent pedestrian suicide.

Clearly, accidents involving these kinds of causal factors can be prevented only by more global roadway-, pedestrian- and driver-oriented efforts. However, a number of potential countermeasures were identified which might impact on some of the remaining freeway pedestrian accidents. The infrequent occurrence of "preventable" accidents, approximately 500 accidents annually on 40,000 miles of roadway, dictates that any countermeasure selection and implementation program be carefully considered, most likely on a site-specific basis.

Three different procedures were used to identify potential countermeasures (C/M's):

- C/M's suggested by field investigators
- C/M's identified by accident type development
- C/M's identified by accident group development.

C/M's Suggested by Field Investigators

The countermeasures identified by the local field investigators were considered on a case-by-case basis to be potentially effective ways to prevent a particular accident from recurring.

The most effective potential C/M identified involved providing pedestrian barriers, either median barriers or right-of-way fencing as a means of keeping pedestrians off the freeway or to prevent pedestrians from attempting to cross the freeway. Barriers were suggested as a potential C/M in 14% of the accidents. Other C/M's that were identified in more than 5% of the accidents are shown in Table 13.

Note that although 32% of the accidents had inadequate or no roadway lighting, only 10% might have been prevented with better roadway lighting. Although 18% of the accidents involved pedestrian alcohol, only 8% might not have occurred if the pedestrian had not been drinking.

TABLE 13

COUNTERMEASURES IDENTIFIED BY FI'S
I

Countermeasure	% of Accidents
Provide pedestrian barriers	14%
Provide roadway lighting	10%
Control drinking pedestrians	8%
Provide motorist aid system	8%
Enforce pedestrian regulations	7%
Provide advisory and/or warning signs	6%

Other countermeasures were indicated by the field investigators as potentially preventing between 1% and 5% of the accidents (see Table 14).

TABLE 14

COUNTERMEASURES IDENTIFIED BY FI'S
II

Improve vehicle flasher systems	5%
Control drinking drivers	5%
Control hitchhikers	5%
Reflectorized clothing	3%
Improve headlights	3%
Enforce existing vehicle regulations	3%
Increase driver's awareness of danger of fatigue	2%
Provide pedestrian overpass/tunnel	1%

The field investigators indicated that 5% of the accidents might not have occurred if the vehicle had an improved emergency flasher system. Interestingly, one-third of the disabled vehicles did not have their emergency flashers on.

C/M Suggested by Accident Type Development

Each accident type was analyzed to identify causal factors and countermeasure concepts were projected for each causal factor within each accident type. For example, the local residents crossing the freeway right-of-way who were involved in the dart-out and dash types could be kept off the freeway by improved right-of-

way fencing. A projected annual target computation was made to determine the number of accidents occurring annually that could be prevented by each countermeasure (see Table 15).

TABLE 15

COUNTERMEASURES IDENTIFIED BY ACCIDENT TYPE ANALYSIS

Countermeasure		Projected Annual Target
Median barriers	– at interchanges	112
	– between interchanges	48
Right of way fencing	– at interchanges	42
	– between interchanges	20
Motorist aid system		144
Hitchhiking regulations		88
Law enforcement personnel safety		36
Construction personnel safety		28
	Total	518

This projected number is the number that could actually be prevented only if the countermeasure was installed at all potential sites and was 100% effective in producing the desired effect.

C/M's Suggested by Accident Group Development

A similar procedure was used to identify countermeasures applicable to the various accident groups. Because of the different causal orientations of the various accident groups, somewhat different projected target populations were calculated; however, similar countermeasures were identified (see Table 16).

C/M Summary Considerations

Having determined the causal factors involved in freeway pedestrian accidents, a number of potential countermeasures were identified. Certain practical constraints must be considered before any countermeasure is implemented. Specifically, the nationwide limited-access highway system is a very large system

TABLE 16

COUNTERMEASURES IDENTIFIED BY ACCIDENT GROUP ANALYSIS

Countermeasure		Project Annual Target
Median barrier	— at interchanges	60
	— between interchanges	28
Right-of-way fencing	— at interchanges	52
	— between interchanges	20
Motorist aid systems		132
Hitchhiking regulations		64
Require vehicle warning flashers, flares, etc.		44
Pavement edge markings		16
Construction personnel safety		28
Barriers to keep vehicles on traveled way		16
Law enforcement personnel safety		36
Improve visibility while directing traffic		16
Approach stopped vehicles from right		20
Total		480

that has relatively few pedestrian accidents. Increasing the design standards for right-of-way fencing and providing standards for pedestrian-proof median barriers would clearly save some lives. Yet, just as clearly, these would not be cost-effective applications for limited highway safety budgets. The countermeasures identified in this research effort should be considered only as spot treatments for very site-specific areas.

Limited-access highways with pedestrian accident potential can be identified through accident records and by observations of unusually high pedestrian activities on the right-of-way. It is at these sites that the various countermeasures might effectively be installed. For example, if a number of pedestrians are known to cross a freeway section that passes between a suburban subdivision and a shopping center, then improved right-of-way fencing or possibly median barrier fencing might be effective at

that location. However, this does not mean that such barriers would be worthwhile any more than up to one interchange before and one interchange after the shopping center. The countermeasures identified should be considered for installation only at those sites where there is behavioral or accident history justification for their installation.

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