

PEDESTRIAN FATALITIES

in the Construction Industry

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This study examined pedestrian fatalities that involved construction workers. Data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries were used to describe the construction-related events that resulted in the greatest frequency of such fatalities.

From 1992 to 1998, approximately 659 occupational fatalities occurred in the construction industry as the result of a worker being struck by a moving vehicle. Heavy construction trades accounted for the greatest percentage of pedestrian fatalities with approximately 70 percent. Various work activities in the construction industry place workers near moving traffic.

Approximately 24 percent of the industry's pedestrian fatalities were the result of workers being struck by a moving vehicle; in most cases, the incident occurred while the workers were walking in or near the roadway.

Preventive measures detailed include flagger training; following established safety standards while engaged in roadwork; and following proper barricading and signage methods to reduce driver errors.

Transportation accidents lead to major loss of life in several industries and occupations. Each year, more than 2,500 occupational fatalities involving motor vehicles occur in the U.S., accounting for nearly 42 percent of all such fatalities (BLS 41; 64; 49).

The overall impact of these fatalities varies among industries. For example, in 1997, the transportation industry accounted for the greatest number of fatalities, reporting 27 percent of all transportation-related fatalities (BLS 49). This industry was followed by agriculture, forestry and fishing (16 percent) and the service industry (11 percent) (BLS 49).

The construction industry is not immune to occupational fatalities involving motor vehicles. In 1997, it ranked fourth, accounting for 11 percent of all transportation-related incidents with 283 fatalities (BLS 49). Typically, such fatalities involve cranes, tractors, loaders and excavating machinery (Pratt, et al 70+; Ore and Stout 832+; Pollack, et al 325+).

The construction industry can be further subdivided into building construction, heavy construction and special trades construction. Transportation-related fatalities accounted for approximately 18.8 percent of all deaths in special trades industries; 24.2 percent in general building contractor trades; and 43.7 percent of all fatalities in the heavy construction industry (BLS 41). Over a 12-year period from 1980 to 1992, pedestrians were victims in approximately 40 percent of all fatal accidents involving motor vehicles

(Ore and Fosbroke 613+). In fact, the construction industry has the highest frequency of pedestrian fatalities—accounting for 23 percent of the overall total (BLS 41).

The construction industry also has the highest frequency of pedestrian fatalities in which a worker was struck by moving equipment in the roadway (27.3 percent); the highest percentage of workers killed as a result of being struck by moving equipment along the side of a roadway (27.3 percent); and the highest percentage of fatalities due to workers being struck by equipment in a parking lot or non-road area (21.2 percent) (BLS 49).

This high number of fatalities may be due, in part, to the type of exposure present on a construction site, particularly if it involves working on a roadway with moving traffic, directing vehicles and serving as a flagger. The last two duties are known to increase a construction laborer's risk for occupational fatality because they place the worker in close proximity to passing motorists. From 1980 through 1992, nearly 80 percent of the fatal injuries involving pedestrians were coded as "motor vehicle accident involving collision with a pedestrian" (Ore and Fosbroke 613+).

As these statistics reveal, transportation-related accidents clearly contribute to the number of fatalities in the construction industry. In some construction trades, the type of tasks performed place workers in close proximity to moving traffic (e.g., working alongside moving traffic lanes, working close to moving vehicles operated by co-workers). This study was

TABLE 1 Pedestrian Fatalities by Industry Group

Trade Group	Total Deaths	Pedestrian Deaths	Percent of Total Deaths	Percent of Pedestrian Deaths
Heavy Construction	1,998	465	23.3	70.6
Special Trades	4,134	161	3.9	24.4
General Building Contractors	1,195	33	2.8	5.0
Total	7,327	659		100.0

designed to identify the activities that place workers at a greater risk for being victims of pedestrian-related accidents. Pedestrian fatalities were examined by trade group and by victim characteristics. The risk for being involved in an occupational fatality was quantified and preventive strategies identified.

STUDY METHODS

Data

Data from the BLS Census of Fatal Occupational Injuries (CFOI) were used. CFOI is an official, systematic, verifiable count of fatal occupational injuries that occur during the year. Fatalities involving those employed in the construction industry from Jan. 1, 1992, to Dec. 31, 1998, were analyzed. To ensure that fatalities are work-related, cases are substantiated with two or more source documents or a source document and a follow-up questionnaire. Work-related deaths are classified as such if an event or exposure resulted in a fatal injury or illness of a person on the employer's premises or off the premises to perform work-related duties (BLS "Census of Fatal").

For each case, the industrial classification, date of event and narrative description were analyzed. Cases involving standard industrial classification group 1500 to 1799 were included. Classification methodology followed was that outlined in *Standard Industrial Classification Manual* (Office of Management and Budget).

Descriptive Analysis

A descriptive analysis was conducted to detail the characteristics of situations that most-frequently resulted in a pedestrian fatality to a construction worker. To be included in this review, the victim had to be a pedestrian or nonoccupant who was hit by a vehicle or other type of mobile equipment—be it on the highway, street, road or off-road. The four major classes of such events are 1) struck by a vehicle or mobile equipment in an unspecified location; 2) struck on the side of the road; 3) struck in the roadway; and 4) struck in a parking lot or nonroadway area. Events that led to fatalities were identified for each case as was the source of the accident.

Proportionate Mortality Ratios

Proportionate mortality ratios (PMRs) were calculated for pedestrian fatalities by industry. These ratios compared fatal-

TABLE 2 Events Leading to Fatality

Event	Frequency	Percent
Struck by vehicle, mobile equipment in the roadway	299	45.4
Struck by vehicle, mobile equipment in nonroadway or parking lot	190	28.8
Struck by vehicle, mobile equipment on side of road	123	18.7
Struck by vehicle, mobile equipment (unspecified)	47	7.1
Total	659	100.0

TABLE 3 Activity at Time of Incident

Activity	Frequency	Percent
Walking in or near roadway	154	23.4
Construction, assembling	114	17.3
Walking, standing, running, etc.	86	13.1
Directing traffic, flagging	76	11.5
Repair maintenance	45	6.8
Resurfacing, blacktopping	24	3.6
Inspecting, checking	20	3.0
Constructing, repairing, cleaning	16	2.4
Construction, NOC	10	1.5
Other	114	17.4
TOTAL	659	100.0

ities due to pedestrian accidents to deaths due to all other causes in the industry. Mantel-Haenszel Chi-square tests of significance were performed to determine whether the observed deaths differed significantly from what could be expected (Mantel and Haenszel 719+). Utilizing procedures described by Spiegelman, Wang and Wegman, PMRs and tests of significance were used to determine whether workers in certain construction trade groups experienced a significantly higher-than-expected proportion of fatalities due to pedestrian accidents (599+).

RESEARCH RESULTS

Descriptive Analysis

From Jan. 1, 1992, to Dec. 31, 1998, some 7,498 fatalities occurred in the construction industry; of these, 659 involved a victim who was considered a pedestrian. As noted, more than 70 percent of all pedestrian fatalities occurred in the heavy construction trade group. Pedestrian fatalities also accounted for the most deaths within this group (nearly 23

percent). Table 1 provides a summary of pedestrian fatalities by industry group.

Table 2 lists events that led to fatalities as well as the source of the accident. Of the 659 pedestrian fatalities, "employee being struck by a vehicle in the roadway" was the most-frequent cited cause—accounting for 45 percent of the deaths.

At the time of the incident, 23 percent of the victims were walking in or alongside the roadway (Table 3). Narratives from these accidents indicate that in some cases, the worker was attempting to cross lanes of traffic when struck; in other cases, a moving vehicle struck the worker as s/he was standing alongside the road. Specific information regarding whether the lanes were barricaded or properly marked was not available for all cases.

Approximately 17 percent of all pedestrian fatalities occurred when employees were struck by a vehicle while engaged in construction work. Cases identified as walking, standing and running activities occurred while the victim was engaged in such activity away from a roadway/road-

TABLE 4 Proportionate Mortality Ratios

Industry	Pedestrian Deaths	Total Deaths	Deaths (Other)	Expected	Variance	X ²	PMR
General Contractors – Residential	12	604	592	54.24	45.31	40.32	22.12
Operative Builders	0	10	10	0.90	0.82	2.39	0.00
General Contractors – Non-residential	20	581	561	52.18	43.73	24.42	38.33
Heavy Construction – Highway and Streets Construction	340	854	514	76.69	61.68	1,119.80*	443.32
Heavy Construction (except highways and streets)	125	1,144	1,019	102.74	78.92	6.00*	121.67
Plumbing, Heating, AC	10	425	415	38.17	32.73	25.11	26.20
Painting, Paper Hanging	15	291	276	26.13	22.84	5.92	57.40
Electrical Work	24	585	561	52.54	44.01	19.16	45.68
Masonry and Stonework	11	340	329	30.53	26.51	15.14	36.03
Carpentry and Floor Work	5	268	263	24.07	21.11	18.14	20.77
Roofing, Siding and Sheet Metal	8	644	636	57.83	48.02	52.75	13.83
Concrete Work	23	197	174	17.69	15.67	1.48	130.01
Water Well Drilling	3	56	53	5.03	4.54	1.41	59.65
Miscellaneous Special Trades	63	1,328	1,266	119.26	88.89	37.53	51.99
TOTAL	659	7,327	6,669				

*p<.05

side. Examples included workers who were struck by non-road moving vehicles on a jobsite (e.g., worker hit by a moving dump truck).

In 11 percent of the cases, the victim was directing and flagging traffic, making it the fourth-leading activity leading to an occupational pedestrian fatality. An example would be a worker struck by a moving vehicle while serving as a flagger.

Proportionate Mortality Ratios

As noted, PMRs were calculated for each construction trade. Two trades were found to have a significantly higher proportion of pedestrian-related occupational fatalities than expected (Table 4): 1) highway and street construction, except elevated highways (SIC 161) and 2) heavy construction, except highway and street (SIC 162).

SIC 161 includes general and special-trade contractors primarily engaged in the construction of roads, streets, alleys, public sidewalks, guardrails, parkways and airports. This group was found to have more than four times the number of expected pedestrian fatalities. Companies in SIC 162 engage in bridge, tunnel and elevated highway construction; water, sewer, pipeline, communications, power-line and heavy construction; this group had 1.2 times the number of expected pedestrian fatalities.

DISCUSSION

As these results indicate, occupational pedestrian fatalities are a concern for those who work in the heavy construction industry. As noted, from 1992 to 1998, some 659 pedestrian-related occupational fatalities occurred in the con-

struction industry—nearly nine percent of these deaths reported by the industry within this timeframe.

Because of the nature of their jobs, workers in the heavy construction trade group often find themselves working in close proximity to moving traffic. Consequently, they were most-frequently struck by a vehicle in the roadway while crossing the road, performing road maintenance or standing in the road.

PMRs confirm this increased risk for occupational pedestrian fatalities in the heavy construction industry. Both SIC 161 and 162 had significantly higher-than-expected proportions of fatalities than all other construction trade groups. SIC 161 had more than 4.4 times the expected proportion of fatalities (PMR=443.32 X²=1,119.80, p<.05). SIC 162 had approximately 1.2 times the expected proportion of fatalities (PMR=121.67 X²=6.00, p<.05).

Preventive Measures

Preventive measures should target workers engaged in street and highway construction. The fact that several fatalities occurred when workers tried to cross a busy road is of primary concern. Employee training and education must cover the basic principles of working around moving traffic.

Proper arrangement of the worksite is another effective preventive measure. Workers should be trained on proper signage, roadway markings and site layout. Such training should cover jobsite inspection procedures before work begins as well as acceptable materials to use for signage and roadway markings.

In addition to proper jobsite prepara-

tion, workers who flag or direct traffic must also be properly trained. In this study, 11 percent of all pedestrian fatalities involved a worker flagging or directing traffic. To help in this area, the American Traffic Safety Services Assn. (ATSSA) has developed a national flagger registration program that provides training for instructors and flaggers, and maintains a national database of certified flaggers (ATSSA). In some states, flaggers must attend an approved training program and complete a certification process; however, only 40 percent of the states currently require such training (Table 5).

In all cases, flagger training should be provided by a qualified, experienced instructor who has knowledge of pertinent government regulations and required equipment. The course should also cover different types of traffic patterns, approved flagging methods and appropriate personal protective equipment.

In 29 CFR 1926, OSHA has established requirements designed to protect workers who perform street construction activities. These requirements cover the use of traffic control devices and flaggers when signs and barricades do not provide adequate protection. The regulations also stipulate the color, design and size of flags, sign paddles and warning garments. In addition, according to the standards, flaggers must wear a red or orange warning garment while flagging; if worn at night, such garments must feature reflective material.

Use of standardized signaling directions (per ANSI D6.1-1971, *Manual on Uniform Traffic Control Devices for Streets and Highways*) also helps prevent accidents. The federal *Manual of Uniform Traffic Control Devices* (MUTCD) establishes a nationwide standard so drivers learn one set of rules that does not change from state to state. MUTCD is the highway industry standard for establishing criteria for signage wording, colors, size and barricade placement within a construction zone.

Some states have also passed laws regarding roadway barricades. Most publish a manual for a uniform system of traffic-control devices. In many cases, these state systems conform to the system set forth by the federal government.

TABLE 5 Flagger Requirements By State

Alaska		X	
Arizona		X	Certification is "strongly recommended."
Arkansas		X	
California		X	Maintenance trains its own flaggers.
Colorado	X		Every two years.
Connecticut		X	
Delaware	X		As of 6/17/97 on all construction projects.
Florida	X		
Georgia	X		
Hawaii		X	
Idaho	X		Every three years.
Illinois	X		Every two years.
Indiana		X	
Iowa		X	
Kansas		X	
Kentucky	X		Every two years.
Louisiana	X		
Maine		X	
Maryland	X		
Massachusetts		X	
Michigan		X	
Minnesota		X	
Mississippi	X		
Missouri		X	
Montana		X	
Nebraska	X		For contractors only, not DOT.
Nevada	X		
New Hampshire		X	
New Jersey		X	
New Mexico	X		
New York		X	
North Dakota		X	
Ohio		X	
Oklahoma		X	
Oregon	X		Every three years.
Pennsylvania		X	
Puerto Rico		X	
Rhode Island	X		Training provided by laborer's union.
South Carolina		X	
South Dakota		X	
Tennessee		X	State employees receive training from safety trainers.
Texas		X	
Utah	X		Training provided by community colleges.
Vermont	X		Every two years; police handle flagging.
Virginia	X		Every two years.
Washington	X		Every three years.
West Virginia	X		Every year.
Wisconsin		X	
Wyoming	X		

CONCLUSION

Certain construction industry trades face a greater risk for occupational pedestrian fatalities. As this study shows, workers engaged in street and highway construction face the greatest risk because they frequently work near traffic or must cross busy roadways. To combat these problems, preventive measures should include employee training in jobsite traffic control, lane markings, proper traffic flow, signage and flagger activities. ■

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