

AN ANALYSIS OF FATAL EVENTS IN THE CONSTRUCTION INDUSTRY 2011

**Prepared for: Office of Statistical Analysis
Occupational Safety and Health Administration
U. S. Department of Labor**

**Prepared by: Construction Industry Research and Policy Center
University of Tennessee, Knoxville**

March 14, 2013

This report is based upon OSHA-inspected fatal events in construction during calendar 2011. The data analyzed were provided by Dave Schmidt, Director, Office of Statistical Analysis, Occupational Safety and Health Administration. John Wagner, M.S., Research Associate III conducted the study and prepared this report. This research was supported by contract No. J089F26523 with the United States Department of Labor, Occupational Safety and Health Administration. The author thanks Dr. John R. Moore and Thomas E. Cressler II for their critique and suggestions which added measurably to the report. The author is solely responsible for all interpretations, conclusions and any errors found in the report.

Executive Summary

The Occupational Safety and Health Administration (OSHA) inspected 406 fatal construction incidents (excluding non-work related causes), involving 420 fatalities, in calendar year 2011. Eight of the 31 proximal causes classified in this report accounted for 235 (57.9 percent) of the fatal events investigated. They were: (1) “fall from/through roof”: 59 events (14.5 percent); (2) “crushed/run-over of non-operator by operating construction equipment”: 34 events (8.4 percent); (3) “crushed/run-over/trapped of operator of construction equipment”: 30 events (7.4 percent); (4) “fall from/with structure (other than roof)”: 28 events (6.9 percent); and (5) “crushed/run-over by highway vehicle”: 24 events (5.9 percent). The sixth, seventh, and eighth most frequent events each had the same number of events, 20 (4.9 percent). They were “fall from/with ladder”, “fall from/with scaffold” and “struck by falling object/projectile (including tip-over)”.

A comparison of the year-to-year ranks of the proximal causes during the 1991-2011 period shows that they are highly and significantly correlated, i.e., the individual ranks of the causes vary little from year-to-year.

Most of the fatal events involved a single victim, but 13 (3.2 percent) of the events were multi-fatality events which accounted for an additional 14 (3.3 percent) of the fatalities.

Other findings included:

- **Initiation.** In 243 (59.8 percent) of the fatal events the victim was judged to be the primary initiator of the cause; in 114 events (28.1 percent) the victim was judged to be simply in the wrong place at the wrong time; in 33 events (8.1 percent) another employee was judged to be the primary initiator of the cause; 15 events (3.7 percent)

could not be classified; and in 1 event (0.2 percent) the victim and another employee were judged to be primary initiator of the cause.

- Task. In 396 of the events (97.5 percent) the victim was judged to be performing work at the task site when injured; in 5 events (1.2 percent) the victim was going to or from work or not working when injured; and in 5 events (1.2 percent) no classification was possible.
- Timing. More fatal events happened on Tuesday and Thursday with 79 events each (19.5 percent) occurring that day of the week, followed by Monday with 75 events (18.5 percent) and Wednesday with 73 events (18.0 percent) occurring on these days; and more fatal events happened between the 10 and 11 hours with 52 events (12.8 percent) occurring during this time interval.

A special study examined the causes of fatalities occurring during highway/road construction, undertaken because of its unique exposure to external hazards, vehicular traffic, found that the leading cause of these 56 fatal events was “crushed/run-over by highway vehicle” accounting for 23 events (41.1 percent). The leading contributing cause of these 23 events was “highway vehicle lost control and entered well-identified work zone” accounting for 6 events (26.1 percent).

Table of Contents

Section	Page #
I. Introduction	1
II. Data	1
III. Analysis of Fatal Events by Cause	3
IV. Analysis by Victim’s Situation.....	12
V. Analysis of Fatal Events by Day of Week and Time.....	13
VI. Highway/Road Construction Fatalities.....	15

List of Tables in Text

Table 1. Construction Fatality Event Causes, 2011.....	4
Table 2. A Comparison of Ranks of Causes of Fatal Events in 1991 – 2010 with 2011.....	9
Table 3. Distribution of Fatal Construction Events by Day of Week, 2011.....	14
Table 4. Distribution of Fatal Construction Events by Hour, 2011.....	15
Table 5. Frequency of Fatality Causes in Highway/Road Construction, 2011.....	16
Table 6. Construction Fatalities Caused by “Crushed/Run-Over by Highway Vehicle” by Time of Day, 2011.....	18
Table 7. Frequency of Sub-Categories of “Crushed/Run-Over by Highway Vehicle”, 2011.....	20

List of Figures in Text

Figure 1. Fatal Events per 100,000 Construction Establishment Employees, 1991-2011.....	11
Figure 2. Highway Construction Fatality Cause Comparison, 2011.....	17

Appendices

Appendix A: Definitions of Fatality Causes.....	22
Appendix B: Figure B1. Comparison of Construction Fatal Events, 1995-2010 with 2011.....	25
Figure B2. Comparison of Construction Fatal Events, 2011.....	26
Figure B3. Comparison of Construction Fatal Events, 1995–2010.....	27
Figure B4. Comparison of Construction Fatal Events, 1995-2010 with 2011.....	28

Appendix C:	Table C1. Construction Fatal Events by End-Use Type, 2011	30
	Table C2. Construction Fatal Events by Type of Project, 2011	31
	Table C3. Construction Fatal Events by Four-Digit SIC, 2011	32
	Table C4. Construction Fatal Events by Project Value, 2011.....	33
	Table C5. Construction Fatalities by Construction Operation, 2011	34

I. Introduction

This report focuses on the direct causes of fatal events that occurred in the calendar year 2011 in the construction industry. Eighteen earlier studies¹ by the Construction Industry Research and Policy Center (CIRPC) analyzed the causes of fatal events in this industry in 1991-1992, 1993-1994 and for each of the years 1995 through 2010.

II. Data

The data analyzed in this report, provided by OSHA, consist of fatality case file narratives and coded data of the 406 fatal events inspected by OSHA which accounted for 420 fatalities in construction during calendar year 2011. In this report, as in earlier reports, analysis includes all OSHA-inspected fatal construction events under both Federal and State jurisdiction. The Occupational Safety and Health Act of 1970 provide States with the option of administrating the Act themselves or accepting Federal administration of the Act. Twenty-nine States, District of Columbia, and the Virgin Islands chose administration under the Federal System, and the remaining twenty-one States and one Territory chose self-administration under State Plans².

As in the earlier studies, the analysis excluded non-accidental fatalities on construction sites or contractor yards (such as deaths from non-work related heart attacks, strokes, seizures,

¹ An Analysis of Fatal Events in the Construction Industry, 1991-1992 (1993), An Analysis of Fatal Events in the Construction Industry, 1993-1994 (1995), An Analysis of Fatal Events in the Construction Industry, 1995 (1996), An Analysis of Fatal Events in the Construction Industry, 1996 (1997), An Analysis of Fatal Events in the Construction Industry, 1997 (1999), An Analysis of Fatal Events in the Construction Industry, 1998 (2000), An Analysis of Fatal Events in the Construction Industry, 1999 (2001), An Analysis of Fatal Events in the Construction Industry, 2000 (2002), An Analysis of Fatal Events in the Construction Industry, 2001 (2003), An Analysis of Fatal Events in the Construction Industry, 2002 (2004), An Analysis of Fatal Events in the Construction Industry, 2003, (2005), An Analysis of Fatal Events in the Construction Industry, 2004 (2006), An Analysis of Fatal Events in the Construction Industry, 2005 (2007), An Analysis of Fatal Events in the Construction Industry, 2006 (2008), An Analysis of Fatal Events in the Construction Industry, 2007 (2009), An Analysis of Fatal Events in the Construction Industry, 2008 (2010), An Analysis of Fatal Events in the Construction Industry, 2009 (2011), and An Analysis of Fatal Events in the Construction Industry, 2010 (2012). Construction Industry Research and Policy Center, University of Tennessee, Knoxville.

² States in the Federal System are: AL, AR, CO, CT, DE, DC, FL, GA, ID, IL, KS, LA, ME, MA, MS, MO, MT, NE, NH, NJ, NY, ND, OH, OK, PA, RI, SD, TX, VI, WV and WI. States and Territories under State Plans are: AK, AZ, CA, HI, IN, IA, KY, MD, MI, MN, NV, NM, NC, OR, PR, SC, TN, UT, VT, VA, WA and WY.

etc.) as well as fatalities of construction workers killed off-site in traffic accidents; in 1991-2010 these fatalities accounted for about 4.1 percent of OSHA-inspected fatal construction events but about 6.4 percent in 2011. Although the Occupational Safety and Health Act of 1970 requires employers to report fatalities to OSHA within eight hours of the occurrence of the event, all fatalities on construction sites are not inspected by OSHA; for example, OSHA does not inspect fatal construction events involving independent contractors with no employees. Therefore, the results reported here do not provide a year-to-year analysis of changes in the absolute number of fatal events or individuals killed on construction sites.

Each narrative record typically consists of a brief description of the event leading to the fatality. The narratives were analyzed and classified into one of 31 cause categories, using the collective judgment of the investigators. However, where the narrative description was omitted, inconclusive, or completely unclear; the event cause was coded “unknown cause or other”.

CIRPC’s review of over 1200 case files of fatal construction events occurring in 1997, 1998 and 1999 revealed that coded data for an event sometimes did not comport with corresponding narrative descriptions and the narrative descriptions were sometimes internally inconsistent. Later reviews of fatality files for other special studies lead us to believe these inconsistencies continue although at a lower rate. Consequently, the data analyzed in this report are restricted to the direct causes of the fatal events where the authors were able, in most cases, to classify the events with relative certainty according to 31 types of causes. Essentially the same causes as were used in CIRPC’s previous fatality studies. For those who are interested, the original coded data from the files are included in Appendix C for the following classifications: (1) end-use of structure; (2) type of project; (3) victim by contractor type(s); (4) contract value of the construction project; and (5) construction operation associated with the fatality.

In classifying the events a rule of primacy was followed for multiple-cause fatalities the first cause in the chain of causes was recorded as the cause of the fatal event. Definitions of the causes are shown in Appendix A.

III. Analysis of Fatal Events by Cause

Table 1 shows the cause classification system, the number of times each cause represented a fatal event in 2011, the relative frequency of each cause and the number of victims killed.³ It can be seen that “fall from/through roof” led all other causes in number of fatal events (59 or 14.5 percent of total events), followed by “crushed/run-over of non-operator of operating construction equipment” (34 or 8.4 percent). The third leading cause was “crushed/run-over/trapped of operator of construction equipment” (30 or 7.4 percent); the fourth leading cause was “fall from/with structure (other than roof)” (28 or 6.9 percent); the fifth leading cause was “crushed/run-over/trapped by highway vehicle” (24 or 5.9 percent). The sixth, seventh, and eighth most frequent events each had the same number of events, 20 (4.9 percent). They were “fall from/with ladder”, “fall from/with scaffold” and “struck by falling object/projectile (including tip-over). The number and relative frequencies of the remaining causes of the 406 fatal events analyzed may be read directly from Table 1. (Comparative and aggregated frequencies for earlier years are shown in Figures B1 through B4 in Appendix B.)

³ Each event included at least one person killed and in several events additional workers were killed or injured.

Table 1. Construction Fatality Event Causes, 2011

Event Causes	Description	Number of Events and Victims		Percent of Events
		Events	Victims	
1.	asphyxiation/inhalation of toxic vapor	10	11	2.5
2.	caught in/struck by stationary equipment	4	4	1.0
3.	crushed from collapse of structure	18	19	4.4
4.	crushed/run-over of non-operator by operating construction equipment	34	34	8.4
5.	crushed/run-over/trapped of operator by operating construction equipment	30	30	7.4
6.	crushed/run-over by construction equipment during maintenance/modification	3	3	0.7
7.	crushed/run-over by highway vehicle/non-construction equipment	24	25	5.9
8.	drown, non-lethal fall	3	3	0.7
9.	electric shock by touching exposed wire	15	16	3.7
10.	electric shock by equipment contacting power source	15	18	3.7
		<u>Event</u>	<u>Percent</u>	
a.	ladder	4	1.0	
b.	scaffold	2	0.5	
c.	crane/lifting equipment/boom/dump truck	5	1.2	
d.	contact while handling materials such as gutters, iron rods, etc.	4	1.0	
11.	electric shock from equipment installation/tool use	17	17	4.2
12.	electric shock, other	1	1	0.2
13.	elevator (struck/crushed by elevator or counter weights)	3	3	0.7
14.	fall from/with ladder: includes collapse/fall of ladder	20	20	4.9
15.	fall from/through roof	59	59	14.5
		<u>Event</u>	<u>Percent</u>	
a.	fall off of roof	39	9.6	
b.	fall through roof other than skylight	6	1.5	
c.	fall through skylight or other opening	14	3.4	
16.	fall from highway vehicle/construction equipment	2	2	0.5
17.	fall from/with scaffold	20	20	4.9
18.	fall from/with bucket (aerial lift/basket)	9	11	2.2
19.	fall from/with structure (other than roof)	28	29	6.9
		<u>Event</u>	<u>Percent</u>	
a.	fall with collapse of structure	9	2.2	
20.	fall from/with platform or catwalk	2	2	0.5
21.	fall through opening (other than roof)	4	4	1.0

Table 1. Construction Fatality Event Causes, 2011 (continued)

<u>Event Causes</u>	<u>Description</u>	<u>Number of Events and Victims</u>		<u>Percent of Events</u>
		<u>Events</u>	<u>Victims</u>	
22.	fall, other or unknown	5	5	1.2
23.	fire/explosion/scalding	9	11	2.2
24.	hyperthermia/hypothermia	10	10	2.5
25.	hit, crushed, fall during lifting operations	13	14	3.2
26.	struck by falling object/projectile (including tip-over)	20	20	4.9
27.	crushed/suffocation from trench collapse	15	16	3.7
28.	crushed while unloading-loading equipment/material (except by crane)	4	4	1.0
29.	shock/burn from lightning	1	1	0.2
30.	crushed other	1	1	0.2
31.	unknown cause or other	7	7	1.7
		<u>Event</u>	<u>Percent</u>	
a.	Other	4	1.0	
Total		406	420	100.0

At the risk of misleading the reader by over generalizing, it may be informative to describe examples of frequently occurring specific situations leading to the 8 most frequent causes of fatal events as listed in Table 1.

Fall from/through Roof. An inattentive roofer or laborer without fall protection walks backward and off the roof or steps into a skylight opening or onto a covered skylight opening.

Crushed, Run-over, Non-operator. A laborer guiding trucks while backing up, a grade checker or a laborer performing site clean-up in proximity of excavating machinery is run-over after getting out of the line-of-sight of an operator/driver.

Crushed/Run-over...Operator. Mobile construction equipment, such as a dozer or fork lift, goes over an embankment and rolls over or turns over when encountering uneven terrain, resulting in the crushing of the operator. (The operator may be crushed inside the equipment or crushed by the equipment while trying to escape.)

Fall from/with Structure. An ironworker without fall protection slips or loses balance while erecting steel frame and falls or a carpenter or an ironworker falls as a result of a collapsing structure or structural component.

Crushed/Run-over by Highway Vehicle. A worker working in a work zone is struck by an out-of-control highway vehicle.

Fall from/with Ladder. Worker falls from or with a ladder because he/she overreaches or fails to secure the ladder or missteps or slips or simply loses balance.

Fall from/with scaffold. A worker slips/trips and falls from a scaffold; a worker overloads a scaffold causing the scaffold to collapse with him on it; a worker assembling/dis-assembling a scaffold falls from the scaffold.

Struck by falling object/projectile. A worker is working on a high pressure line when a break causes a part to fly off striking the worker; a tow line breaks striking the worker.

The number of victims killed by each cause is also shown in Table 1 where it can be seen that in most events only one worker was killed per event. There were 21 fatality causes where no event had multiple fatalities; only 10 fatality causes included events with multiple fatalities. The fatality causes with the most victims per event were “fire/explosion/scalding” and “fall from/with

bucket (aerial lift/basket)", each had 9 events and 11 victims and "electric shock by equipment contacting power source: with 15 events and 18 victims. Each of these fatality causes had 1.2 victims per event. The fatality cause, fire/explosion/scalding had the largest multiple loss of life in a single event, 3 victims.

The data for construction fatalities in 2011 showed that 13 of the fatal events (3.2 percent) involved multiple fatalities. The multiple-fatality events averaged 2.1 fatalities per event and accounted for an additional 14 fatalities (3.3 percent) and a total of 27 fatalities (6.4 percent) of the 420 individuals killed in 2011.

These results parallel those reported by the Bureau of Labor Statistics (BLS). During 1995-1999, 4 percent of all fatal work-related events involved multiple fatalities, and these multiple-fatality events accounted for 10 percent of the workers killed during the period. They averaged three fatalities per incident.⁴ It should be noted that the BLS data included homicides, and they accounted for 19 percent of their multi-fatality incidents. There was one homicide in the 2011 OSHA data. As in prior years, homicides have been excluded from the analysis.

Table 2 compares the ranks of the causes in 2011 with the average rank of the causes of fatal events during the period 1991 - 2010. It can be seen that the overall rank pattern of the causes in 2011 is very similar to the rank pattern in 1991 - 2010. An overall statistical comparison of the correlation of the rank in 2011 with the average rank in 1991-2010 was calculated using a Spearman rank correlation procedure.⁵ The correlation obtained was + 0.83, $p < 0.001$, indicating that the ranks of the causes in the two time periods are highly and positively

⁴ Drudi, Dino and Mark Zak, "Work-Related Multi-Fatality Incidents," *Monthly Labor Review*, Vol. 127, No. 10, October 2004.

⁵ Sidney Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York: McGraw-Hill Book Co., Inc., 1956), p. 219.

correlated, i.e., did not change significantly between 1991 – 2010 and 2011⁶. The Spearman rank-order correlation between 2010 and 2011 causes was calculated and found to be + 0.91, $p < 0.001$, indicating also that the pattern changed very little between 2010 and 2011.

The correlation result is not surprising given that the general composition of construction output, and therefore the mix of construction operations required to produce the output, was probably very similar during the time periods examined. This interpretation implies that the rank of a cause is a function of the magnitude of exposure to the cause and/or the inherent danger associated with the cause.

Falls continues to be the leading fatality cause. Falls represent 36.7 percent of 2011 construction fatal events and for the 1991-2010 period 37.2 percent of construction fatal events. Crushed/run-over by construction equipment and highway vehicles is a major cause of construction fatalities that may be trending upward. These fatal events were 20.2 (2009), 20.6 (2010), and 22.4 (2011) percent of fatal construction events and for the 1991-2010 period 19.2 percent.

⁶Five of the 719 fatal events in 2002 and 17 of 719 fatal events in 2001 had either no narrative or a narrative too incomplete to classify the cause of fatality. These records were coded as “unknown” cause; this was not done in prior years. They were omitted from the calculation of the Spearman Rank correlation in order to avoid data distortion.

Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2010 with 2011

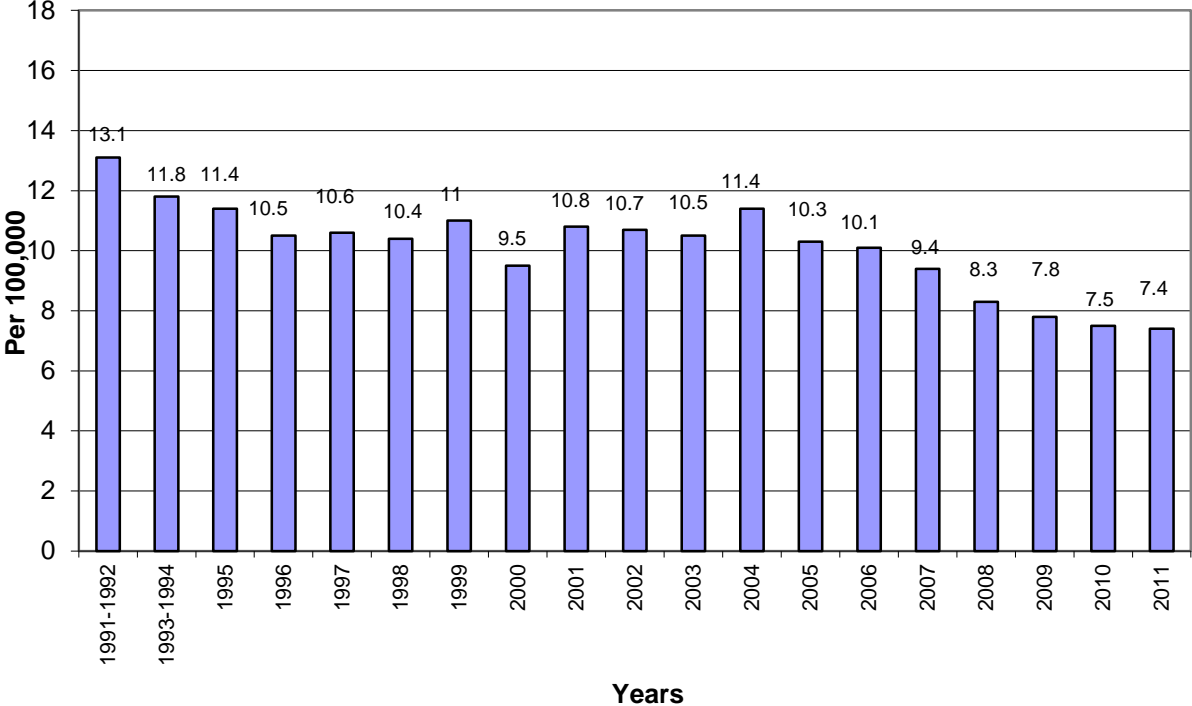
<u>Event</u>	<u>1991 - 2010 Average</u>			<u>2011</u>		
	<u>Number</u>	<u>Percent</u>	<u>Rank</u>	<u>Number</u>	<u>Percent</u>	<u>Rank</u>
1. asphyxiation/inhalation of toxic vapor	8.2	1.3	22	10	2.5	15
2. caught in/struck by stationary equipment	5.7	0.9	23	4	1.0	22
3. crushed from collapse of structure	25.8	4.1	11	18	4.4	9
4. crushed/run-over of non-operator by operating construction equipment	49.3	7.8	3	34	8.4	2
5. crushed/run-over/trapped of operator by operating construction equipment	34.7	5.5	5	30	7.4	3
6. crushed/run-over by construction equipment during maintenance/modification	13.3	2.1	19	3	0.7	25
7. crushed/run-over by highway vehicle	24.7	3.9	12	24	5.9	5
8. drown, non-lethal fall	5.4	0.9	24	3	0.7	25
9. electric shock by touching exposed wire	20.4	3.2	14	15	3.7	12
10. electric shock by equipment contacting power source	40.2	6.3	4	15	3.7	12
11. electric shock from equipment installation/tool use	33.1	5.2	6	17	4.2	10
12. electric shock, other	3.5	0.6	28	1	0.2	29
13. elevator (struck/crushed by elevator or counter weights)	2.6	0.4	29	3	0.7	25
14. fall from/with ladder: includes collapse/fall of ladder	28.5	4.5	9	20	4.9	7
15. fall from/through roof	74.8	11.8	1	59	14.5	1
16. fall from highway vehicle/construction equipment	4.8	0.7	27	2	0.5	27
17. fall from/with scaffold	23.7	3.7	13	20	4.9	7
18. fall from/with bucket (aerial lift/basket)	14.0	2.2	17	9	2.2	18
19. fall from/with structure (other than roof)	54.4	8.6	2	28	6.9	4

Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2010 with 2011 (continued)

<u>Event</u>	<u>1991 - 2010 Average</u>			<u>2011</u>		
	<u>Number</u>	<u>Percent</u>	<u>Rank</u>	<u>Number</u>	<u>Percent</u>	<u>Rank</u>
20. fall from/with platform or catwalk	14.4	2.3	16	2	0.5	27
21. fall through opening (other than roof)	16.7	2.6	15	4	1.0	22
22. fall, other or unknown	5.2	0.8	25	5	1.2	20
23. fire/explosion/scalding	12.7	2.0	20	9	2.2	18
24. hyperthermia/hypothermia	5.1	0.8	26	10	2.5	15
25. hit, crushed, fall during lifting operations	32.7	5.1	7	13	3.2	14
26. struck by falling object/projectile (including tip-over)	27.4	4.3	10	20	4.9	7
27. crushed/suffocation from trench collapse	28.6	4.5	8	15	3.7	12
28. crushed while unloading-loading equipment/material (except by crane)	12.1	1.9	21	4	1.0	22
29. shock/burn from lightning, other	13.7	2.2	18	9	2.2	18
Total	634.8	100.0		406	100.0	

The number of OSHA-inspected fatal construction events has varied over the years since 1991 as has employment in construction establishments.⁷ The trend of these fatal events per 100,000 construction establishment employees is shown in Figure 1.

Figure 1. Fatal Events per 100,000 Construction Establishment Employees, 1991-2011



The number of fatal events per 100,000 construction establishment employees continues to decline.

⁷ Bureau of Labor Statistics, National Employment, Hours, and Earnings, CES, Table B-1
www.bls.gov/ces/cesbtabs.htm

IV. Analysis by Victim's Situation

Fatal events were analyzed to determine the role of the 'victim' in each event. The analysis classified the role of the victim by four general categories: (1) victim(s) was (were) the primary, immediate contributor to the event; (2) a combination of victim(s) and another employee was (were) the primary (3) person(s) other than victim(s) was (were) the primary, immediate contributor to the event; (4) no individual directly contributed to the event, i.e., the victim(s) was at the wrong place at the wrong time; and (5) unknown.

The first category includes, for example, most falls, crushed/run-over of operators, electrocutions other than those occurring during lifting operations, asphyxiations and hypothermia. The second category includes, for example, most crushed/run-over of non-operators, lifting operations, loading/unloading of equipment/materials, struck by highway vehicles, fall from/with aerial lift, and electrocutions from crane boom/tackle contacting overhead power lines. The third category includes, for example, most structure and trench collapses, struck by projectile/falling objects, and lightning.

It should be understood that these classifications do not indicate fault or preventability of the fatality. For example, while falls are generally classified as "victim was the primary contributor to the event", many fall fatalities would have been prevented with compliance with OSHA's fall protection standards. Similarly, trench collapses classified as "being in the wrong place at the wrong time" are preventable with compliance with OSHA's trenching standard.

Although the classifications were often subjective due to a lack of precise information or conflicting information, following are the results for the 406 events: (1) victim primary initiator of event: 243 events (59.8 percent); (2) victim and another employee primary initiator: 1 event (0.2

percent); (3) person other than victim primary initiator: 33 events (8.1 percent); (4) wrong place at wrong time: 114 events (28.1 percent); and (5) unknown: 15 events (3.7 percent).

An additional classification of the 406 fatal events was also analyzed to estimate the distribution of events by work status of the victim. As with the previously discussed classification of who initiated the event, the work status classifications were also subjective. Nevertheless, it may be useful in understanding, in a general sense, the situations in which construction fatalities occur. It was found that: (1) 396 (97.5 percent) of the fatal events involved workers performing work at their task site; (2) 5 (1.2 percent) of the events involved workers going to or from work or not working; and (3) 5 (1.2 percent) of the events could not be classified.

The first category includes, for example, many roofing fatalities, fatalities resulting from structure and trench collapses, events involving crushed/run-over of operators, electrocutions while installing electrical equipment, workers caught in stationary equipment, workers falling from/with aerial lifts and scaffolds and workers climbing/relocating on structures.

V. Analysis of Fatal Events by Day of Week and Time

The fatality data reported from the narratives includes the date and time of day of most fatal events. Table 3 shows the distribution of fatal events by day of the week. Contrary to the popular conception that most fatalities occur on Mondays and Fridays, it can be seen that Tuesday and Thursday had the largest number of events, 79, each followed by Monday with 75 events, Wednesday with 73 events and finally Friday with 60 fatal events. Note, however, that without knowing the total number of construction hours worked each day, it is not possible to be certain that any one day is more or less hazardous than another.

Table 3. Distribution of Fatal Construction Events by Day of Week, 2011

<u>Day</u>	<u>Number of Events</u>	<u>Percent</u>
Monday	75	18.5
Tuesday	79	19.5
Wednesday	73	18.0
Thursday	79	19.5
Friday	60	14.8
Saturday	28	6.9
Sunday	12	3.0
Total	406	100.0

Table 4 shows the distribution of fatal events by hour (military) of the day. It can be seen that the 10-11 hour period contained the most fatal events, 52. As pointed out previously, without knowing the total hours worked in construction each hour, it is not possible to calculate hourly event rates. However, it may be reasonably assumed that the total construction hours worked each hour during the 8-12 hour period and the 13-17 hour period are approximately equal. If so, the results showing that 178 of the fatal events occurred in the 8-12 hour period and 127 occurred in the 13-17 hour period is a little surprising. In prior years the number of fatal events has been approximately equal for each four hour period. Three-fourths (75.1 percent) of the fatal events occurred during these eight hours.

Table 4. Distribution of Fatal Construction Events by Hour, 2011

<u>Hour</u>	<u>Number of Events</u>	<u>Percent</u>
0-1	3	0.7
1-2	2	0.5
2-3	1	0.2
3-4	3	0.7
4-5	1	0.2
5-6	0	0.0
6-7	1	0.2
7-8	14	3.4
8-9	37	9.1
9-10	46	11.3
10-11	52	12.8
11-12	43	10.6
12-13	37	9.1
13-14	38	9.4
14-15	44	10.8
15-16	22	5.4
16-17	23	5.7
17-18	14	3.4
18-19	6	1.5
19-20	5	1.2
20-21	3	0.7
21-22	1	0.2
22-23	0	0.0
23-24	3	0.7
Unknown	7	1.7
Total	406	100.0

VI. Highway/Road Construction Fatalities

One might think that highway/road construction would be relatively safe, since most work activity at these sites occurs at or near ground level. Falls from elevations, the leading direct cause of construction fatalities, would have a low potential. However, in 2011, 57 workers were killed in 56 events while working on highway/road projects (13.9 percent of the total fatal events). On-site operating construction equipment was involved in 19 fatal events (33.9 percent).

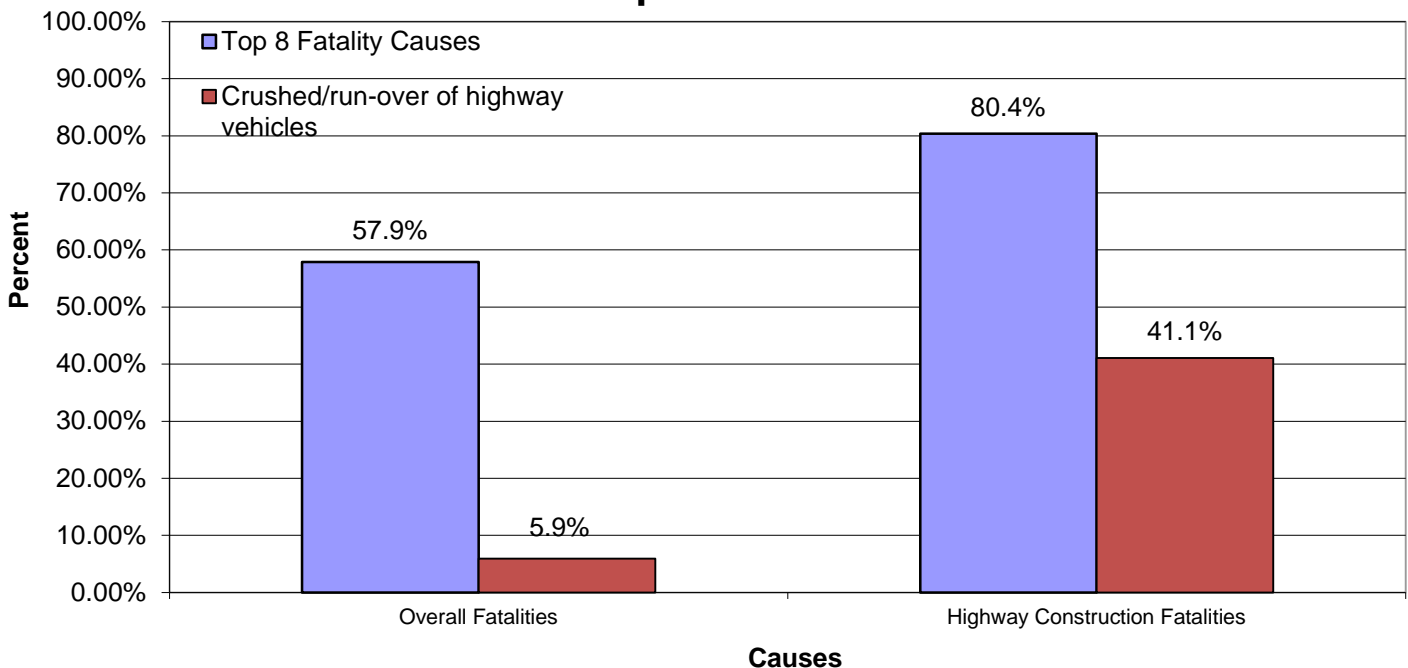
Table 5 ranks the direct causes of the fatal events by their frequency. The table shows that the leading causes were “crushed/run-over by highway vehicle” 23 events (41.1 percent), followed by “crushed/run-over of non-operator by operating construction equipment” 16 events (28.6 percent), and “crushed/run-over of operator by operating construction equipment” and “struck by falling object/projectile” each with 3 events (5.4 percent). Other event causes are shown in Table 5.

Table 5. Distribution of Fatality Causes in Highway/Road Construction, 2011

<u>Cause</u>	<u>Number of Events</u>	<u>Percent</u>
Crushed/run-over by highway vehicle	23	41.1
Crushed/run-over of non-operator by operating construction equipment	16	28.6
Crushed/run-over of operator by operating construction equipment	3	5.4
Struck by falling object/projectile	3	5.4
Fall from highway vehicle/construction equipment	2	3.6
Hyperthermia/Hypothermia	2	3.6
Asphyxiation/inhalation of toxic vapor	1	1.8
Caught in/struck by stationary equipment	1	1.8
Crushed from collapse of structure	1	1.8
Crushed/run-over by construction equipment during main/mod.	1	1.8
Electric shock by equipment contacting power source	1	1.8
Hit/crushed/fall during lifting operation	1	1.8
Crushed/suffocation from trench collapse	1	1.8
Total	56	100.0

Figure 2 compares the top 8 fatality causes with “crushed/run-over by highway vehicle” for highway/road construction. The top 8 fatality causes (identified in Table 1) had 235 events (57.9 percent) of the total 406 events compared with only 21 events (5.2 percent) for “crushed/run-over by highway vehicle.” For highway/road construction fatal events, the top 7 fatality causes (shown in Table 5) had 50 events (89.3 percent) and “crushed/run-over by highway vehicle” had 23 events (41.1 percent) of the 56 fatal events. It should be noted that the top 8 fatal event causes which accounted for over 57.9 percent of the total events also accounted for 80.4 percent of the highway/road work construction fatal events. However, the “crushed/run-over by highway vehicle” cause increased significantly from 5.9 percent overall to over 41 percent for highway/road construction.

Figure 2. Highway Construction Fatality Cause Comparison 2011



Since traffic on many or most highway/road varies by time of day, and most construction on highway/road occurs during the day, one might expect that most “crushed/run-over by highway

vehicles” fatalities would occur during morning and afternoon commuting periods when traffic loads peak. Table 6 shows fatal events caused by victim being crushed/run-over by highway vehicles by time of day (1- 24 hours). For the previous five years, 2006 through 2010, a majority, ranging from 47 percent to 80 percent, of the construction fatalities caused by “crushed/run-over by highway vehicle” have occurred from mid-morning through late-afternoon (8 – 17 hour period). This year 67 percent of the fatalities occurred during these hours and 29 percent of the fatalities occurred between late night (20-24 hour period) and early morning (24 – 5 hour period).

It is not possible to calculate fatality rates for these time-of-day periods without knowing the hours worked in each period. However, as mentioned earlier the morning and evening commuting periods would seem to be the times when these events are most likely to occur. With shifting road work practices, road work done at night to avoid traffic congestion, the historical and expected periods of fatal events may be changing. More information about conditions which contribute to fatalities in highway/roadway construction would seem to be an area worthy of further investigation.

Table 6. Construction Fatalities Caused by “Crushed/Run-Over by Highway Vehicle” by Time of Day, 2011

<u>Time</u>	<u>Frequency</u>	<u>Percent</u>
Early Morning: 24:00 - 5:00	5	23.8
Dawn: 5:00 - 8:00	0	0.0
Mid-Morning: 8:00 - 11:00	6	28.6
Mid-Day: 11:00 - 14:00	5	23.8
Late-Afternoon: 14:00 - 17:00	3	14.3
Evening: 17:00 - 20:00	1	4.8
Late Night: 20:00 - 24:00	1	4.8
Total	21	100.0

Since “crushed/run-over by highway vehicle” was the leading direct cause of fatal events occurring in highway/road construction, it may be helpful in protecting workers engaged in highway/road construction to look for specific situations in which these fatalities occurred. The often brief narratives of highway construction fatalities provided little or no information on speed limits, pavement conditions, visibility, protective barriers, work zone markings or potential impairments of vehicle operators involved in the fatalities. However, it was still possible to identify six sub-categories of “crushed/run-over by highway vehicle”. Table 7 shows these sub-categories and their frequency.

This table shows that the largest numbers of fatal events occurred when highway vehicles lost control and swerved into work zones striking workers, accounting for 6 (28.6 percent) of the fatal events. This sub-category was followed by a situation where a highway vehicle struck a flagger signaling traffic at the beginning of a marked work zone accounting for 3 (14.3 percent) of the fatal events. A highway vehicle struck worker installing work signs or traffic signals and a highway vehicle struck a shadow vehicle protecting a worker each had 2 events (9.5 percent). The remaining sub-categories each had 1 event (4.8 percent). Five of the event descriptions (23.8 percent) were inadequate for classification, indicating only that the worker had been run-over by a highway vehicle. Last year only one event description was inadequate for classification purposes.

Table 7. Frequency of Sub-Categories of “Crushed/Run-Over by Highway Vehicle”, 2011

<u>Sub-Category</u>	<u>Frequency</u>	<u>Percent</u>
Highway vehicle lost control and entered (by swerving or inadvertently entering) well-identified work zone, striking victim	6	28.6
Highway vehicle struck victim (flagger) signaling traffic at beginning of marked work zone	3	14.3
Highway vehicle struck victim installing signals in unprotected work zone.	2	9.5
Highway vehicle struck shadow vehicle protecting moving vehicle from which victim was performing work, crushing victim	2	9.5
Highway vehicle struck victim working (paving) in unprotected work zone	1	4.8
Highway vehicle struck victim who walked into traffic zone	1	4.8
Highway vehicle struck victim by entering inadequately marked and protected work zone	1	4.8
unknown	5	23.8
Total	21	100.0

APPENDIX A

Definitions of Fatality Causes

1. asphyxiation/inhalation of toxic vapor: lack of oxygen and/or inhalation of toxic gas, (excluding asphyxiation resulting from fire/explosion)
2. caught in/struck by stationary equipment: body or clothing caught pulling worker into equipment
3. collapse of structure: building or other structure falling on worker, not including falling ladder, scaffold, aerial lift/ basket, platform, with a structure, trench collapse, or wall (earthen) collapse
4. crushed/run-over of non-operator by operating construction equipment: non-operator run-over or crushed between equipment and ground or another object by an operator controlled piece of construction equipment
5. crushed/run-over/trapped of operator by operating construction equipment: includes rollover and catching of body in equipment or between equipment and ground or other object while operating the equipment*
6. crushed/run-over by construction equipment during maintenance/ modification: includes equipment/parts falling on worker while assembling or disassembling equipment
7. crushed/run-over by highway vehicle: any run-over by non-construction equipment, including trains
8. drown, non-lethal fall: non-lethal falls into water and flooding of container, trenches, etc.
9. electrocution by touching exposed wire/source: body part contacting the wire/source except when installing equipment or using a tool
10. electrocution by equipment contacting wire
 - a. ladder
 - b. scaffold
 - c. crane/lifting equipment/boom/dump truck
 - d. other: contact while handling materials, e.g. gutters, iron rods, painting equipment, etc.
11. electrocution from equipment installation/tool use: includes failure to de-energize equipment, inappropriate energizing, contacting energized part with tool or body, and inadequately grounded tools or exposed tool wires
12. electric shock, other and unknown cause
13. elevator (struck/crushed by elevator or counter-weights)
14. fall from/with ladder: includes collapse/fall of ladder

*Includes fatalities resulting from asphyxiation/fire/explosion/drowning of trapped operators.

15. fall from roof; fall through roof: skylight or other opening
 - a. fall off of roof
 - b. fall through roof other than skylight
 - c. fall through skylight or other opening
16. fall from vehicle (vehicle/construction equipment): falls from vehicle or equipment while in motion or at rest.
17. fall from/with scaffold: includes collapse/fall of scaffold
18. fall from/with bucket (aerial lift/basket): includes collapse/fall of bucket
19. fall from/with structure (other than roof): fall through opening in the side or through the floor (not opening in the floor) and with the structure in a collapse
 - a. fall with collapse of structure
20. fall from/with platform or catwalk (attached to structure: includes collapse/fall of platform)
21. fall through opening (other than roof): falls through stairwells, equipment openings, or other openings in a floor
22. fall, other or unknown
23. fire/explosion/scalding, excluding electrical burns/explosions
24. heat/hypothermia
25. lifting operations: failure of equipment, inappropriate lifting, and all loading and unloading by crane operations except electrocution. (Includes objects falling and striking victim during lifting operation)
26. struck by falling object/projectile (including tip-over): does not include collapse of structure, trench, earthen wall, or lifting operations
27. trench collapse: includes earthen wall
28. unloading-loading equipment/material (except by crane): includes slipping and tipping over of construction equipment/material while loading and unloading
29. lightning
30. crushed
31. unknown cause or other
 - a. other

APPENDIX B

Figure B1. Comparison of Construction Fatality Events, 1995-2010 with 2011

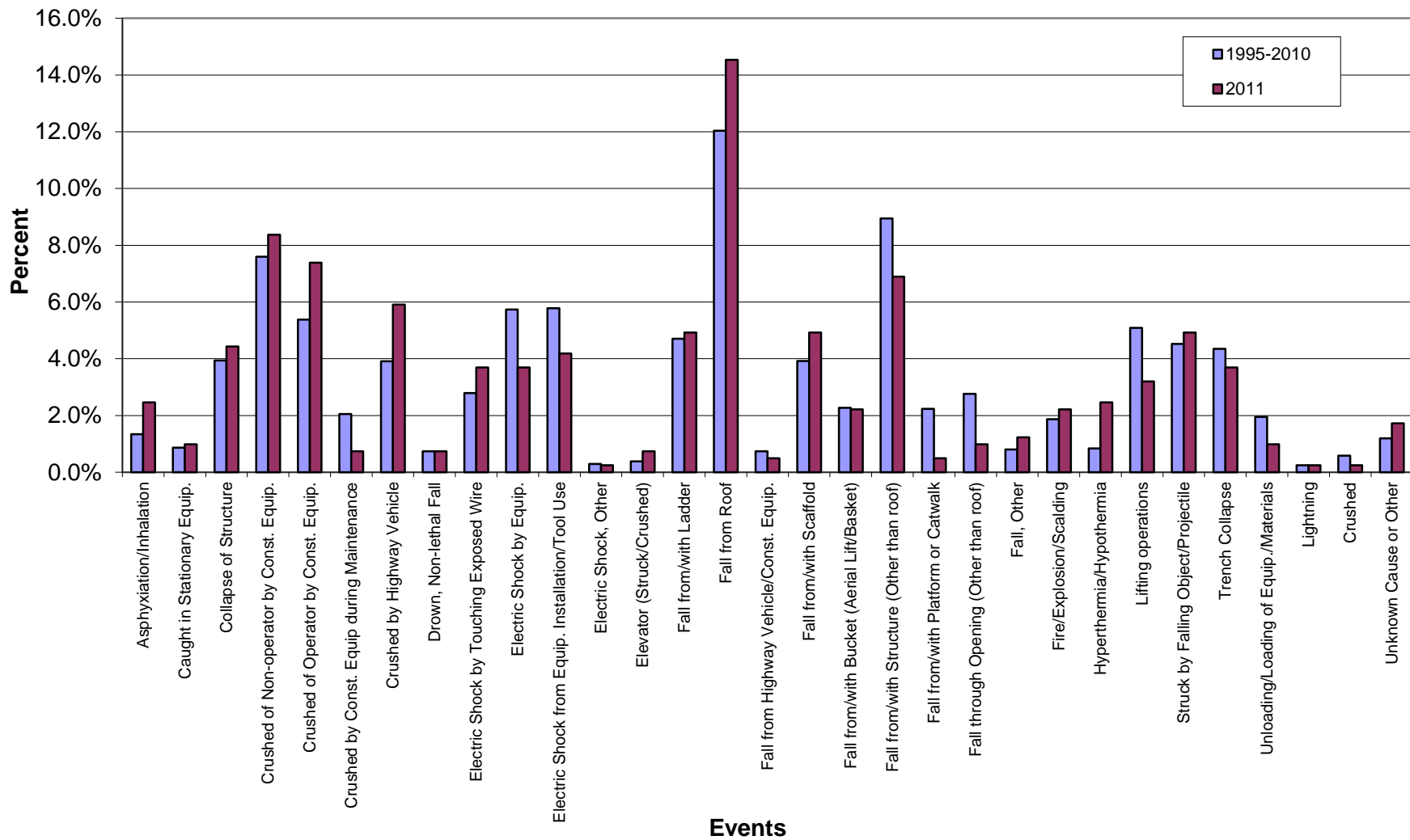


Figure B2. Comparison of Construction Fatality Events, 2011

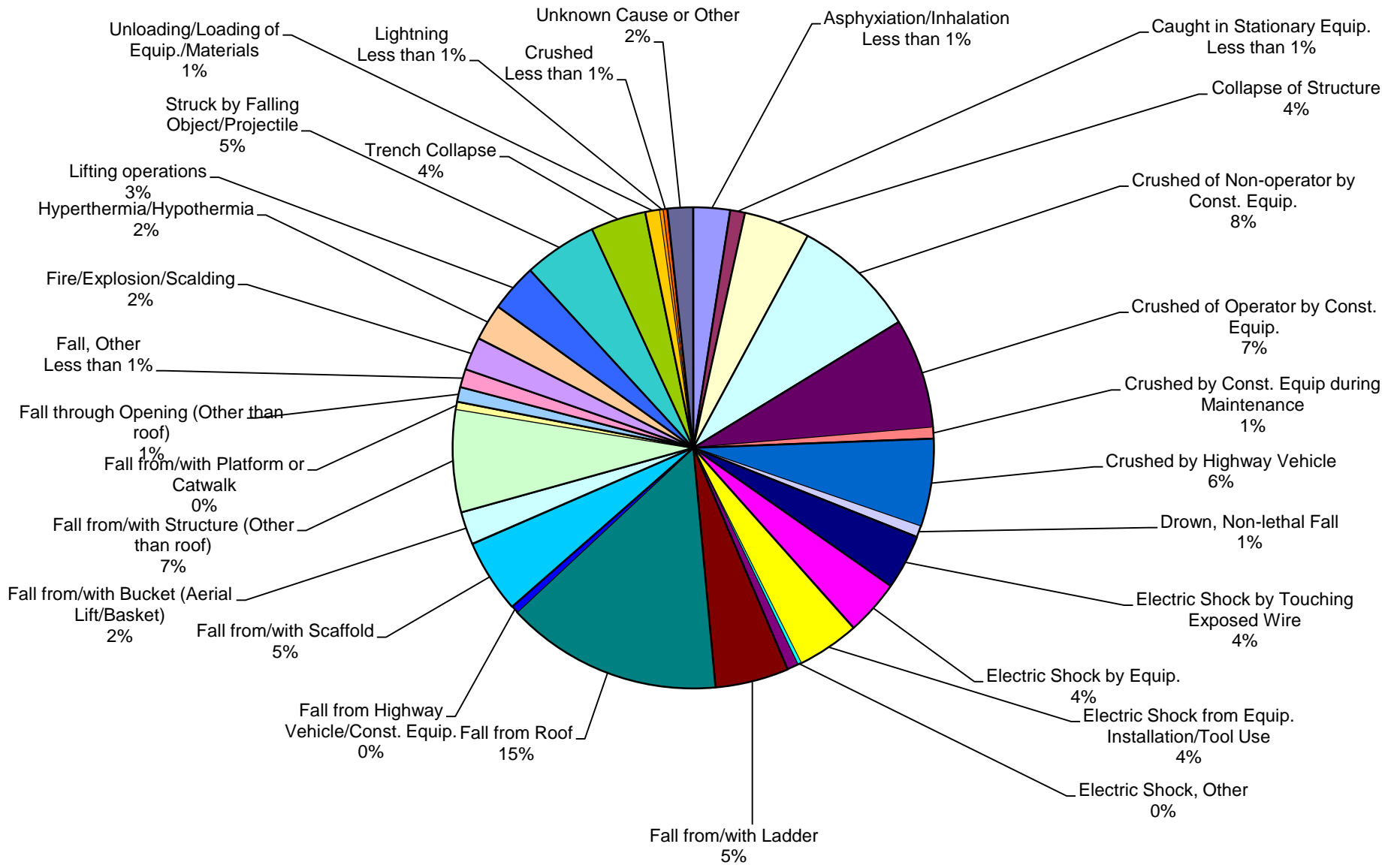


Figure B3. Comparison of Construction Fatality Events, 1995-2010

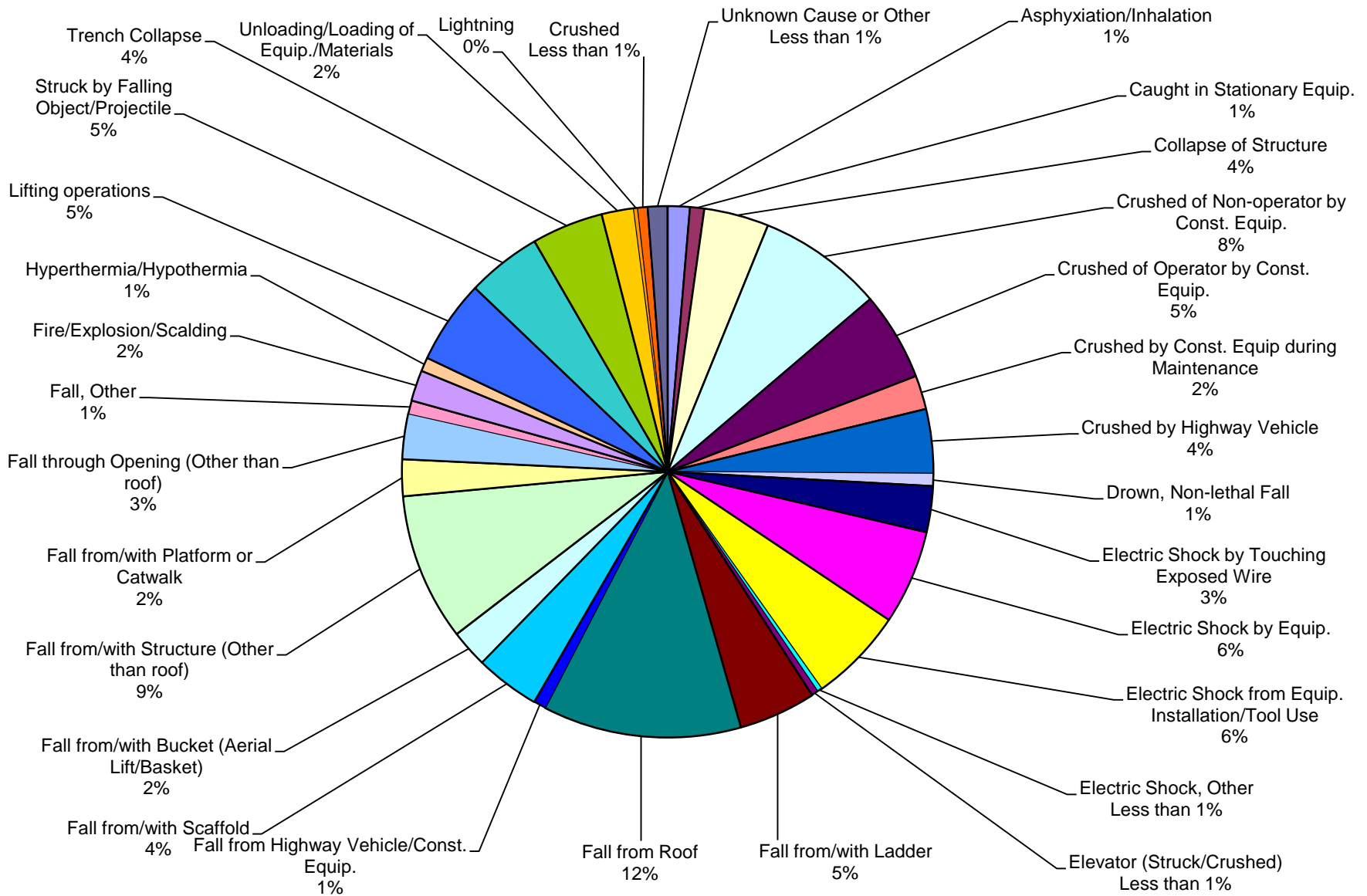
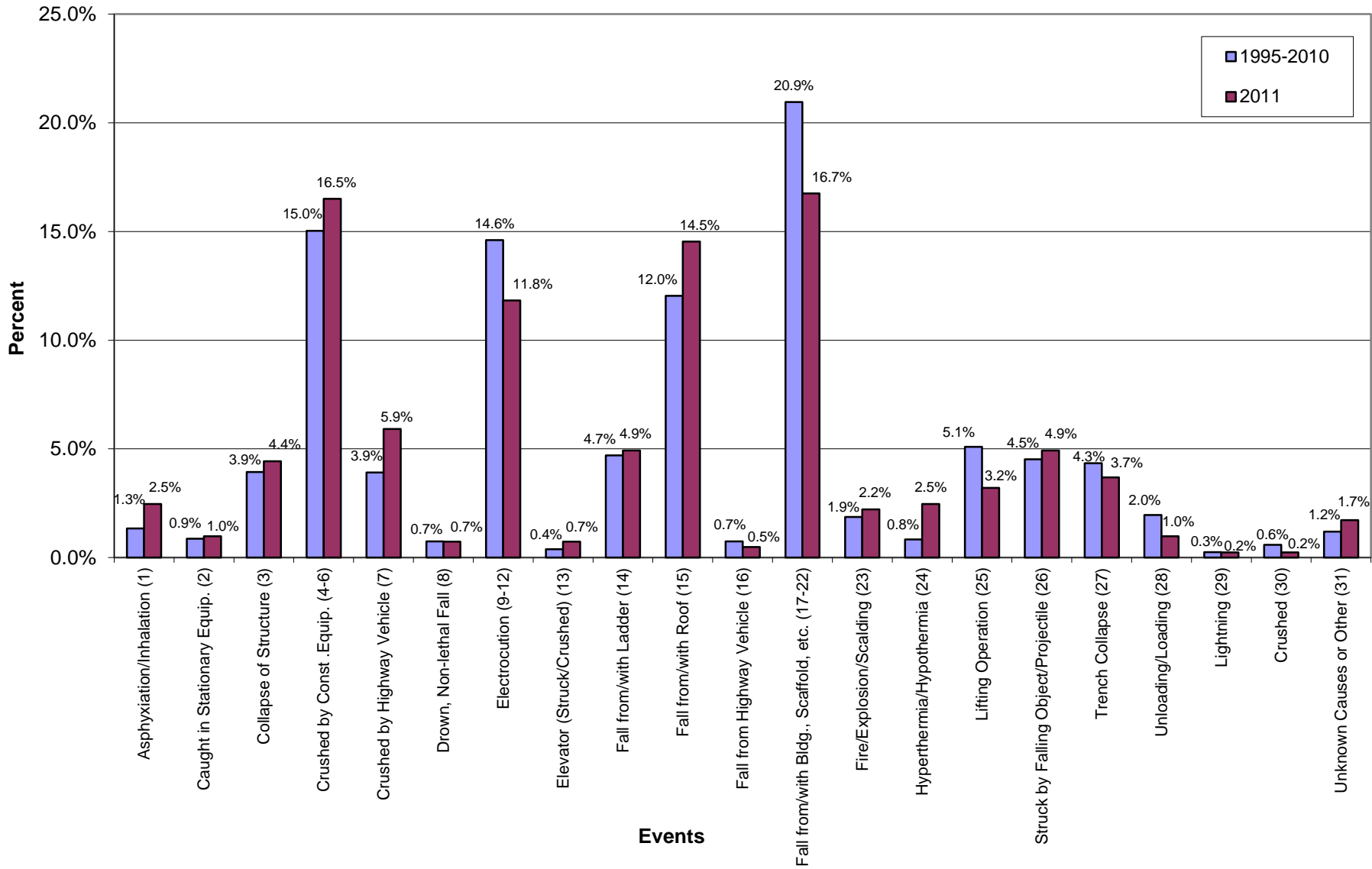


Figure B4. Comparison of Construction Fatal Events, 1995-2010 and 2011



APPENDIX C

Table C1. Construction Fatal Events by End-Use Type, 2011

<u>End Use</u> <u>Type</u>	<u>Description</u>	<u>Number of</u> <u>Events</u>	<u>Percent</u>
1	Single Family or Duplex	70	17.2
2	Multi-family	30	7.4
3	Commercial	88	21.7
4	Manufacturing	11	2.7
5	Refinery	4	1.0
6	Power plant	4	1.0
7	Sewer or Water Plant	8	2.0
8	Other Building	62	15.3
9	Highway/Road Work	56	13.8
10	Bridge	8	2.0
11	Tower, Tank, Storage Elevator	5	1.2
12	Shoreline, Dam, Reservoir	5	1.2
13	Pipeline	10	2.5
14	Excavation, Landfill	5	1.2
15	Power line, Transmission Line	9	2.2
16	Other Heavy Construction	14	3.4
17	Contractors Yard	4	1.0
18	Unknown	13	3.2
	Total	406	100.0

Table C2. Construction Fatal Events by Type of Project, 2011

<u>Project Type</u>	<u>Description</u>	<u>Number of Events</u>	<u>Percent</u>
1	New, Addition and Alteration	235	57.9
2	Maintenance, Repair and Demolition	128	31.5
3	Other	30	7.4
4	Missing	<u>13</u>	<u>3.2</u>
Total		406	100.0

Table C3. Construction Fatal Events by Four-Digit SIC, 2011

<u>Description</u>	<u>SIC</u>	<u>Number of Events</u>	<u>Percent</u>
General Contractors - Single Family Houses	1521	14	3.4
General Contractors - Residential Buildings Other than Single Family	1522	8	2.0
General Contractors – Operative Builders	1531	1	0.2
General Contractors - Industrial Building and Warehouses	1541	9	2.2
General Contractors - Non-residential Buildings, other than Industrial and Warehouses	1542	14	3.4
Highway and Street Construction, Except Elevated Highways	1611	49	12.1
Bridge, Tunnel, and Elevated Highway Construction	1622	9	2.2
Water, Sewer, Pipeline, and Communications and Power Line Construction	1623	25	6.2
Heavy Construction, Not Elsewhere Classified	1629	21	5.2
Plumbing, Heating and Air-Conditioning	1711	20	4.9
Painting and Paper Hanging	1721	15	3.7
Electrical Work	1731	28	6.9
Masonry, Stone Setting, and Other Stone Work	1741	21	5.2
Plastering, Drywall, Acoustical, and Insulation Work	1742	11	2.7
Carpentry Work	1751	12	3.0
Roofing, Siding, and Sheet Metal Work	1761	53	13.1
Concrete Work	1771	9	2.2
Water Well Drilling	1781	2	0.5
Structural Steel Erection	1791	17	4.2
Glass and Glazing Work	1793	2	0.5
Excavation Work	1794	9	2.2
Wrecking and Demolition Work	1795	14	3.4
Installation or Erection of Building Equipment, Not Elsewhere Classified	1796	4	1.0
Special Trade Contractors, Not Elsewhere Classified	1799	39	9.6
Total		406	100.0

Table C4. Construction Fatal Events by Project Value, 2011

<u>Project Value Code</u>	<u>Cost</u>	<u>Number of Events</u>	<u>Percent</u>
1	Under \$50,000	149	36.7
2	\$50,000-\$250,000	66	16.3
3	\$250,000-\$500,000	28	6.9
4	\$500,000-\$1,000,000	29	7.1
5	\$1,000,000-\$5,000,000	55	13.5
6	\$5,000,000-\$20,000,000	28	6.9
7	\$20,000,000 and over	24	5.9
8	Unknown	27	6.7
	Total	406	100.0

Table C5. Construction Fatalities by Construction Operation, 2011

<u>Code</u>	<u>Description</u>	<u>Number of Fatalities</u>	<u>Percent of Fatalities</u>
01	Backfilling and compacting	7	1.7
02	Bituminous concrete placement	1	0.2
03	Construction of playing fields, tennis courts	1	0.2
04	Cutting concrete pavement	1	0.2
05	Demolition	27	6.7
07	Elevator, escalator installation	2	0.5
08	Emplacing reinforcing steel	2	0.5
09	Erecting structural steel	14	3.4
10	Erection of coffer dams, caissons	2	0.5
11	Excavation	18	4.4
12	Exterior masonry	15	3.7
13	Exterior cladding	7	1.7
14	Exterior carpentry	14	3.4
15	Exterior painting	8	2.0
16	Fencing, installing lights, signs, etc.	6	1.5
17	Fireproofing	1	0.2
18	Forming	3	0.7
19	Forming for Piers or Pylons	1	0.2
20	Installing interior walls, ceilings, doors	8	2.0
21	Installing metal siding	4	1.0
22	Installing windows and doors, glazing	1	0.2
23	Installing culverts and incidental drainage	2	0.5
24	Installing equipment (HVAC and other)	15	3.7
25	Installing plumbing, lighting fixtures	6	1.5
26	Installing underground plumbing conduit	4	1.0
28	Interior masonry	3	0.7
29	Interior plumbing, ducting, electrical work	6	1.5
30	Interior carpentry	2	0.5
31	Interior painting and decorating	4	1.0
32	Landscaping	3	0.7
33	Loading dock forming and pouring	1	0.2
34	Paving	21	5.2
35	Pile driving	1	0.2
37	Placing bridge girders and beams	1	0.2
38	Plastering	3	0.7
39	Pouring or installing floor decks	2	0.5
40	Pouring concrete floor at grade	1	0.2
42	Pouring concrete foundations and walls	4	1.0
43	Roofing	50	12.3

Table C5. Construction Fatalities by Construction Operation, 2011 (continued)

<u>Code</u>	<u>Description</u>	<u>Number of Fatalities</u>	<u>Percent of Fatalities</u>
45	Site clearing and grubbing	7	1.7
46	Site grading and rock removal	7	1.7
47	Stripping and curing concrete	1	0.2
48	Surveying	1	0.2
50	Temporary work (buildings, facilities)	18	4.4
51	Traffic protection	10	2.5
52	Trenching, installing pipe	12	3.0
53	Waterproofing	5	1.2
60	Steel Erection of Open Web Steel Joist - Connecting	1	0.2
62	Steel Erection of Open Web Steel Joists-Welding	1	0.2
66	Installation of Decking-Initial Laying Deck (Including Layout & Safety)	4	1.0
67	Installation of Decking-Final Attachment Deck (Welding/Shear Studs/etc.)	2	0.5
70	Other Activities-Installing Ornamental and Architectural Steel	7	1.7
71	Other Activities-Post Decking Detail Work	3	0.7
00	Unknown/Missing	<u>55</u>	<u>13.5</u>
Total		406	100.0
