

# **AN ANALYSIS OF FATAL EVENTS IN THE CONSTRUCTION INDUSTRY 2013**

**Prepared for:** Office of Statistical Analysis  
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*This report is based upon OSHA-inspected fatal events in construction during calendar year 2013. 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. 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 416 fatal construction incidents (excluding non-work related causes), involving 425 fatalities, in calendar year 2013. Seven of the 31 proximal causes classified in this report accounted for 230 (55.3 percent) of the fatal events investigated and 232 (54.6 percent) of the fatalities. They were: (1) “fall from/through roof”: 52 events (12.5 percent); (2) “fall from/with structure (other than roof)”: 36 events (8.6 percent); (3) “crushed/run-over/trapped of operator of construction equipment”: 34 events (8.2 percent); (4) “struck by falling object/projectile (including tip-over)”: 32 events (7.7 percent); (5) “crushed/run-over of non-operator by operating construction equipment”: 29 events (7.0 percent); (6) “electric shock from equipment installation/tool use”: 24 events (5.8 percent); and (7) “fall from/with ladder”: 23 events (5.5 percent).

A comparison of the year-to-year ranks of the proximal causes during the 1991-2013 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 9 (2.2 percent) of the events were multi-fatality events which accounted for an additional 9 (2.1 percent) fatalities.

Other findings included:

- **Initiation.** In 269 (64.7 percent) of the fatal events, the victim was judged to be the primary initiator of the cause; in 112 events (26.9 percent), the victim was judged to be simply in the wrong place at the wrong time; in 28 events (6.7 percent), another employee was judged to be the primary initiator of the cause; in 3 events (0.7 percent), the victim and another employee were judged to be primary initiators of the cause; and 4 events (1.0 percent) could not be classified.

- Task. In 412 of the events (99.0 percent), the victim was judged to be performing work at the task site when injured and in 4 events (1.0 percent), the victim was going to or from work or not working when injured.
- Timing. During the work week, the most fatal events happened on Monday with 90 events (21.6 percent), followed by Thursday with 82 events (19.7 percent), Tuesday with 75 events (18.0 percent), Wednesday with 73 events (17.5 percent), and Friday with 55 events (13.3 percent); and the most fatal events happened between the 10<sup>th</sup> and 11<sup>th</sup> hour with 52 events (12.5 percent) followed by fatal events happening between the 8<sup>th</sup> and 9<sup>th</sup> hour and the 11<sup>th</sup> and 12<sup>th</sup> hour, each with 40 events (9.6 percent).

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 35 fatal events was “crushed/run-over by highway vehicle” accounting for 13 events (37.1 percent). The leading contributing causes of these 13 events was “highway vehicle lost control and entered well-identified work zone”, “highway vehicle struck victim installing signs or traffic signals in unprotected work zone” and “highway vehicle struck victim who walked into traffic zone”, each with 3 events (25.0 percent).

## Table of Contents

<b>Section</b>		<b>Page #</b>
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 Fatal Event Causes, 2013 .....	4
Table 2.	A Comparison of Ranks of Causes of Fatal Events in 1991 – 2012 with 2013 .....	9
Table 3.	Distribution of Fatal Construction Events by Day of Week, 2013.....	14
Table 4.	Distribution of Fatal Construction Events by Hour, 2013 .....	15
Table 5.	Frequency of Fatal Event Causes in Highway/Road Construction, 2013.....	16
Table 6.	Construction Fatalities Caused by “Crushed/Run-Over by Highway Vehicle” by Time of Day, 2013.....	18
Table 7.	Frequency of Sub-Categories of “Crushed/Run-Over by Highway Vehicle”, 2013 .....	19

### List of Figures in Text

Figure 1.	Fatal Events per 100,000 Construction Establishment Employees (1991-2013) .....	11
Figure 2.	Highway Construction Fatality Cause Comparison (2013).....	17

### Appendices

Appendix A:	Definitions of Fatal Event Causes .....	22
Appendix B:	Figure B1. Comparison of Construction Fatal Events (1995-2012 with 2013).....	25
	Figure B2. Comparison of Construction Fatal Events (2013) .....	26
	Figure B3. Comparison of Construction Fatal Events (1995–2012) .....	27
	Figure B4. Comparison of Grouped Construction Fatal Events (1995-2012 with 2013).....	28

Appendix C:	Table C1. Construction Fatal Events by End-Use Type, 2013 .....	30
	Table C2. Construction Fatal Events by Type of Project, 2013.....	30
	Table C3. Construction Fatal Events by Six-Digit NAICS, 2013.....	31
	Table C4. Construction Fatal Events by Project Value, 2013.....	32
	Table C5. Construction Fatal Events by Construction Operation, 2013.....	33

## **I. Introduction**

This report focuses on the direct causes of fatal events that occurred in the calendar year 2013 in the construction industry. Twenty earlier studies<sup>1</sup> 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 2012.

## **II. Data**

The data analyzed in this report, provided by OSHA, consist of fatality case file narratives and coded data of the 416 fatal events inspected by OSHA which accounted for 425 fatalities in construction during calendar year 2013. 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 for Private Industry, and the remaining twenty-one States and Puerto Rico chose self-administration under State Plans<sup>2</sup>.

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<sup>1</sup> 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), An Analysis of Fatal Events in the Construction Industry, 2010 (2012), An Analysis of Fatal Events in the Construction Industry, 2011 (2013) and An Analysis of Fatal Events in the Construction Industry, 2012 (2014). Construction Industry Research and Policy Center, University of Tennessee, Knoxville.

<sup>2</sup> States in the Federal System for private industry 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.

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, etc.) as well as fatalities of construction workers killed off-site in traffic accidents; in 1991-2012 these fatalities accounted for about 4.3 percent of OSHA-inspected fatal construction events but about 5.4 percent in 2013. 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, not all fatalities on construction sites are 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 2013, the relative frequency of each cause and the number of victims killed.<sup>3</sup> It can be seen that “fall from/through roof” led all other causes in number of fatal events (52 or 12.5 percent of total events), followed by “fall from/with structure (other than roof)” (36 or 8.7 percent of total events). The third leading cause was “crushed/run-over/trapped of operator of construction equipment” (34 or 8.2 percent of total events); the fourth leading cause was “struck by falling object/projectile (including tip-over)” (32 or 7.7 percent of total events); the fifth leading cause was “crushed/run-over of non-operator by operating construction equipment” (29 or 7.0 percent of total events); the sixth leading cause “electric shock from equipment installation/tool use” (24 or 5.8 percent of total events); and the seventh leading cause was “fall from/with ladder” (23 or 5.5 percent of total events). The number and relative frequencies of the remaining causes of the 416 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.)

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

**Table 1. Construction Fatal Event Causes, 2013**

Event Causes	Description	Number of Events and Victims		Percent of Events
		Events	Victims	
1.	asphyxiation/inhalation of toxic vapor	7	7	1.7
2.	caught in/struck by stationary equipment	5	5	1.2
3.	crushed from collapse of structure	17	18	4.1
4.	crushed/run-over of non-operator by operating construction equipment	29	29	7.0
5.	crushed/run-over/trapped of operator by operating construction equipment	34	34	8.2
6.	crushed/run-over by construction equipment during maintenance/modification	9	9	2.2
7.	crushed/run-over by highway vehicle/non-construction equipment	17	17	4.1
8.	drown, non-lethal fall	6	6	1.4
9.	electric shock by touching exposed wire	7	7	1.7
10.	electric shock by equipment contacting power source	13	13	3.1
		<u>Event</u>	<u>Percent</u>	
a.	ladder	2	0.5	
b.	scaffold	0	0.0	
c.	crane/lifting equipment/boom/dump truck	8	1.9	
d.	contact while handling materials such as gutters, iron rods, etc.	3	0.7	
11.	electric shock from equipment installation/tool use	24	24	5.8
12.	electric shock, other	1	1	0.2
13.	elevator (struck/crushed by elevator or counter weights)	1	1	0.2
14.	fall from/with ladder: includes collapse/fall of ladder	23	23	5.5
15.	fall from/through roof	52	52	12.5
		<u>Event</u>	<u>Percent</u>	
a.	fall off of roof	33	7.9	
b.	fall through roof other than skylight	6	1.4	
c.	fall through skylight or other opening	13	3.1	
16.	fall from highway vehicle/construction equipment	2	2	0.5
17.	fall from/with scaffold	17	17	4.1
18.	fall from/with bucket (aerial lift/basket)	7	7	1.7
19.	fall from/with structure (other than roof)	36	37	8.7
		<u>Event</u>	<u>Percent</u>	
a.	fall with collapse of structure	8	1.9	
20.	fall from/with platform or catwalk	2	2	0.5
21.	fall through opening (other than roof)	9	9	2.2

**Table 1. Construction Fatal Event Causes, 2013 (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	4	4	1.0
23.	fire/explosion/scalding	7	9	1.7
24.	hyperthermia/hypothermia	6	6	1.4
25.	hit, crushed, fall during lifting operations	18	21	4.3
26.	struck by falling object/projectile (including tip-over)	32	33	7.7
27.	crushed/suffocation from trench collapse	20	21	4.8
28.	crushed while unloading-loading equipment/material (except by crane)	8	8	1.9
29.	shock/burn from lightning	1	1	0.2
30.	crushed other	0	0	0.0
31.	unknown cause or other	2	2	0.5
		<u>Event</u>	<u>Percent</u>	
a.	Other	0	0.0	
<b>Total</b>		<u>416</u>	<u>425</u>	<u>100.0</u>

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 seven most frequent causes of fatal events as listed in Table 1.

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.
2. 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.
3. 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.)
4. Struck by falling Object/projectile. A worker walking near a building under construction was struck by a brick that fell from an upper level. An operating tool kicked back striking the employee in the head.
5. Crushed/Run-over of non-operator by construction equipment. A worker was not visible in a work area and was backed over by construction equipment.
6. Electric shock from equipment installation/tool use. An electrician working with live wires is electrocuted while replacing a light fixture or while trouble shooting a HVAC unit.
7. Fall from/with Ladder. Worker falls from or with a ladder because he/she over-reaches or fails to secure the ladder or missteps or slips or simply loses balance.

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 25 fatality causes where no event had multiple fatalities; only 6 fatality causes included events with multiple fatalities. The fatality cause with the most victims per event was “fire/explosion/scalding” with 7 events and 9 victims or 1.3 victims per event and the largest loss in a single event was 2. All multiple fatality events had only two victims per event.

The data for construction fatalities in 2013 showed that 9 of the fatal events (2.2 percent) involved multiple fatalities. The multiple-fatality events averaged 2.0 fatalities per event and accounted for an additional 9 fatalities (2.1 percent) and a total of 18 fatalities (4.2 percent) of the 425 individuals killed in 2013.

These results, with lower rates, 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.<sup>4</sup> It should be noted that the BLS data included homicides, and they accounted for 19 percent of their multi-fatality incidents. There were no homicides in the 2013 OSHA data. If homicides had been reported they would have been excluded from the analysis as they have been in prior years.

Table 2 compares the ranks of the causes in 2013 with the average rank of the causes of fatal events during the period 1991-2012. It can be seen that the overall rank pattern of the causes in 2013 is very similar to the rank pattern in 1991-2012. An overall statistical comparison of the correlation of the rank in 2013 with the average rank in 1991-2012 was calculated using a Spearman rank correlation procedure.<sup>5</sup> The correlation obtained was + 0.91,  $p < 0.001$ , indicating that the ranks of the causes in the two time periods are highly and positively correlated, i.e., did not change significantly between 1991-2012 and 2013<sup>6</sup>. The Spearman rank-

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

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

<sup>6</sup>Five 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.

order correlation between 2012 and 2013 causes was calculated and found to be + 0.90,  $p < 0.001$ , indicating also that the pattern changed very little between 2012 and 2013.

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 36.5 percent of 2013 construction fatal events and, for the 1991-2012 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 bears watching. These fatal events were 20.2 (2009), 20.6 (2010), 22.4 (2011), 20.6 (2012), and 21.4 (2013) percent of fatal construction events and for the 1991-2012 period, 19.3 percent.

**Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2012 with 2013**

<u>Event</u>	<u>1991 - 2012 Average</u>			<u>2013</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	8.1	1.3	22	7	1.7	17
2. caught in/struck by stationary equipment	5.5	0.9	25	5	1.2	23
3. crushed from collapse of structure	25.1	4.0	12	17	4.1	11
4. crushed/run-over of non-operator by operating construction equipment	47.3	7.5	3	29	7.0	5
5. crushed/run-over/trapped of operator by operating construction equipment	34.0	5.4	5	34	8.2	3
6. crushed/run-over by construction equipment during maintenance/modification	12.5	2.0	21	9	2.2	14
7. crushed/run-over by highway vehicle	25.4	4.0	11	17	4.1	11
8. drown, non-lethal fall	5.1	0.9	26	6	1.4	21
9. electric shock by touching exposed wire	19.6	3.1	14	7	1.7	18
10. electric shock by equipment contacting power source	38.3	6.1	4	13	3.1	13
11. electric shock from equipment installation/tool use	32.1	5.1	6	24	5.8	6
12. electric shock, other	3.3	0.6	28	1	0.2	28
13. elevator (struck/crushed by elevator or counter weights)	2.5	0.5	29	1	0.2	28
14. fall from/with ladder: includes collapse/fall of ladder	28.3	4.5	8	23	5.5	7
15. fall from/through roof	73.4	11.6	1	52	12.5	1
16. fall from highway vehicle/construction equipment	4.5	0.8	27	2	0.5	26
17. fall from/with scaffold	23.2	3.8	13	17	4.1	11
18. fall from/with bucket (aerial lift/basket)	13.6	2.3	17	7	1.7	18
19. fall from/with structure (other than roof)	52.4	8.4	2	36	8.7	2

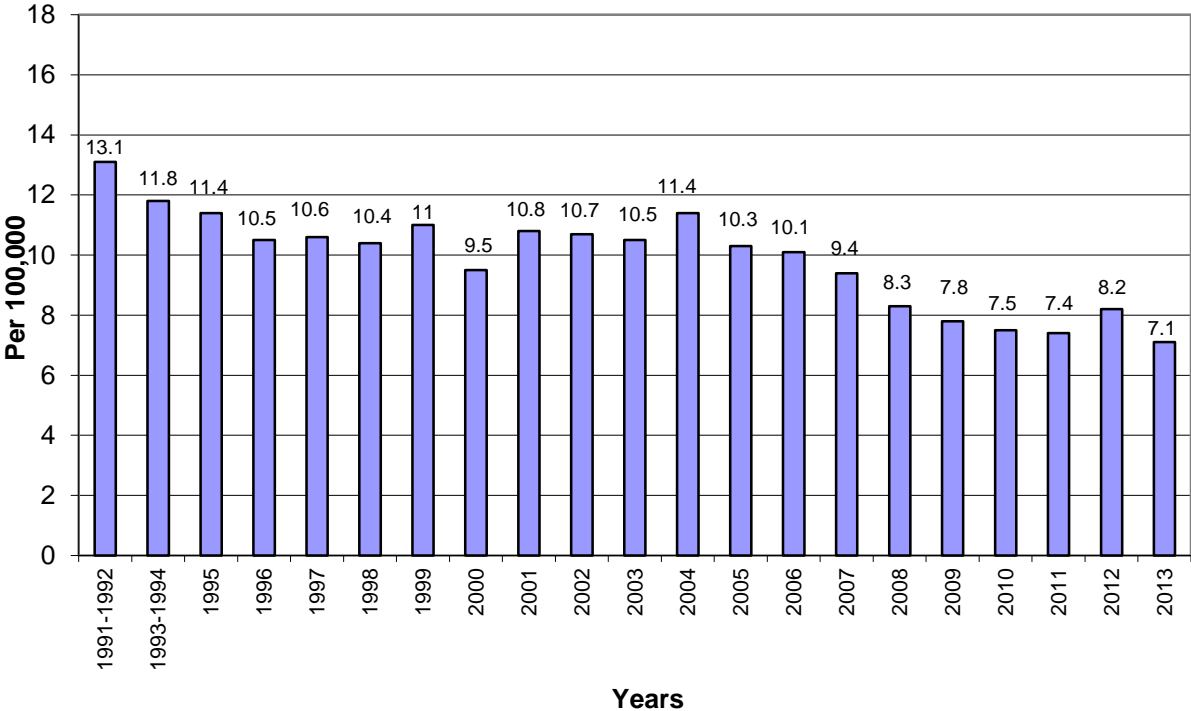
**Table 2. Comparison of Ranks of Causes of Fatal Events in 1991 - 2012 with 2013 (continued)**

<u>Event</u>	<u>1991 – 2012 Average</u>			<u>2013</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	13.4	2.3	18	2	0.5	26
21. fall through opening (other than roof)	15.8	2.6	15	9	2.2	14
22. fall, other or unknown	5.0	0.9	24	4	1.0	24
23. fire/explosion/scalding	12.3	2.1	19	7	1.7	18
24. hyperthermia/hypothermia	5.7	1.1	23	6	1.4	21
25. hit, crushed, fall during lifting operations	31.4	5.1	7	18	4.3	9
26. struck by falling object/projectile (including tip-over)	26.9	4.4	10	32	7.7	4
27. crushed/suffocation from trench collapse	27.2	4.5	9	20	4.8	8
28. crushed while unloading-loading equipment/material (except by crane)	11.5	2.0	20	8	1.9	16
29. shock/burn from lightning, other	13.1	2.3	16	3	0.7	25
<b>Total</b>	<b>616.5</b>	<b>100.0</b>		<b>416</b>	<b>100.0</b>	



The number of OSHA-inspected fatal construction events has varied over the years since 1991 as has employment in construction establishments.<sup>7</sup> 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 (1991-2013)**



The number of fatal events per 100,000 construction establishment employees had been declining for seven years before increasing to 8.2 in 2012, about the same as 2008. The previous trend of declining fatalities per 100,000 construction employees may be resuming. The number of fatal events per 100,000 construction establishment employees decreased from 8.2 in 2012 to 7.1 in 2013.

<sup>7</sup> Bureau of Labor Statistics, National Employment, Hours, and Earnings, CES, Table B-1 [www.bls.gov/ces/cesbtabs.htm](http://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 416 events: (1) victim primary initiator of event: 269 events (64.7 percent); (2) victim and another employee primary initiator: 3 events

(0.7 percent); (3) person other than victim primary initiator: 28 events (6.7 percent); (4) wrong place at wrong time: 112 events (26.9 percent); and (5) unknown: 4 events (1.0 percent).

An additional classification of the 416 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: 412 (99.0 percent) of the fatal events involved workers performing work at their task site and 4 (1.0 percent) of the events involved workers going to or from work or not working.

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. The largest number of fatalities occurred on Mondays with 90 events (21.6 percent) and contrary to popular conception Fridays had the fewest fatalities of the normal workdays with 55 events (13.2 percent). Thursday had the second largest number of events, 82 (19.7 percent) followed by Tuesday with 75 events (18.0 percent), and Wednesday with 73 events (17.5 percent). 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, 2013**

<b><u>Day</u></b>	<b><u>Number of Events</u></b>	<b><u>Percent</u></b>
Monday	90	21.6
Tuesday	75	18.0
Wednesday	73	17.5
Thursday	82	19.7
Friday	55	13.2
Saturday	28	6.7
Sunday	13	3.1
<b>Total</b>	<b>416</b>	<b>100.0</b>

Table 4 shows the distribution of fatal events by hour (military) of the day. The following percentages represent recorded event times. Few, if any, event times were not recorded until 2012. Event times were missing for 11.0 percent of 2012 events and 4.6 percent of 2013 events. We assume the events with missing time were similarly distributed.

It can be seen that the 10-11 hour period contained the most fatal events, 52 (13.1 percent). 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 168 (42.3 percent) of the fatal events occurred in the 8-12 hour period and 129 (32.5 percent) occurred in the 13-17 hour period is a little surprising. In prior years with the exception of 2012, 2011 and 2004, the number of fatal events has been approximately equal for each four hour period.

Three-fourths (74.8 percent) of the fatal events occurred during 8-12 hour period and the 13-17 hour period. In the previous 10 years, the percent of fatal events occurring during these eight hours has ranged from 72.9 to 78.2 percent with a median of 75.6 percent.

**Table 4. Distribution of Fatal Construction Events by Hour, 2013**

<b><u>Hour</u></b>	<b><u>Number of Events</u></b>	<b><u>All Events Percent</u></b>	<b><u>Events with recorded Times Percent</u></b>
0-1	1	0.2	0.3
1-2	0	0.0	0.0
2-3	0	0.0	0.0
3-4	0	0.0	0.0
4-5	2	0.5	0.5
5-6	4	1.0	1.0
6-7	10	2.4	2.5
7-8	13	3.1	3.3
8-9	40	9.6	10.1
9-10	36	8.7	9.1
10-11	52	12.5	13.1
11-12	40	9.6	10.1
12-13	30	7.2	7.6
13-14	37	8.9	9.3
14-15	36	8.7	9.1
15-16	34	8.2	8.6
16-17	22	5.3	5.5
17-18	16	3.8	4.0
18-19	8	1.9	2.0
19-20	8	1.9	2.0
20-21	1	0.2	0.3
21-22	1	0.2	0.3
22-23	5	1.2	1.3
23-24	1	0.2	0.3
Unknown	19	4.6	
<b>Total</b>	<b>416</b>	<b>100.0</b>	<b>100.0</b>

**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 2013, 36 workers were killed in 35 events while working on highway/road projects (8.4 percent of the total fatal events). On-site operating construction equipment was involved in 14 fatal events (3.4 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” 13 events (37.1 percent), followed by “crushed/run-over of non-operator by operating construction equipment” 9 events (25.7 percent) and “crushed/run-over of operator by operating construction equipment” 5 events (14.3 percent) and “struck by falling object/projectile” 3 events (8.6 percent). Other event causes are shown in Table 5.

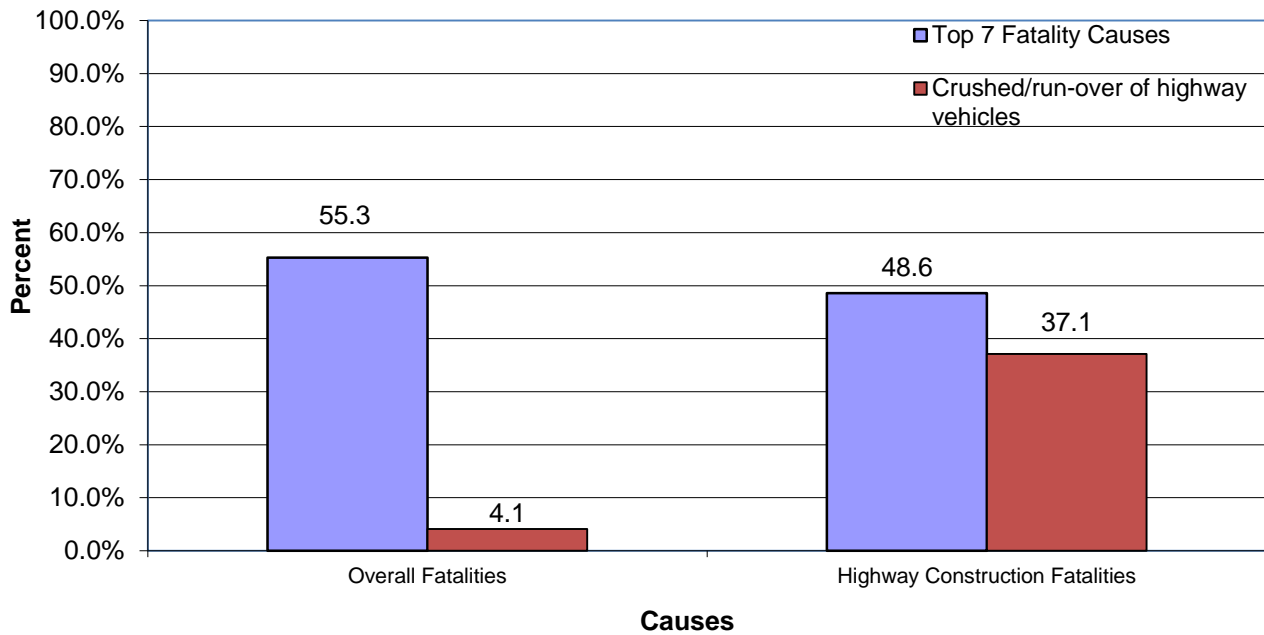
**Table 5. Distribution of Fatal Event Causes in Highway/Road Construction, 2013**

<u>Cause</u>	<u>Number of Events</u>	<u>Percent</u>
Crushed/run-over by highway vehicle	13	37.1
Crushed/run-over of non-operator by operating construction equipment	9	25.7
Crushed/run-over of operator by operating construction equipment	5	14.3
Struck by falling object/projectile	3	8.6
Caught in/struck by stationary equipment	2	5.7
Hit/crushed/fall during lifting operation	1	2.9
Crushed/suffocation from trench collapse	1	2.9
Crushed while unloading-loading equipment/material	1	2.9
<b>Total</b>	<b>35</b>	<b>100.0</b>

Figure 2 compares the top 7 fatality causes with “crushed/run-over by highway vehicle” for highway/road construction. The top 7 fatality causes (identified in Table 1) had 230 events (55.3 percent) of the total 416 events compared with only 17 events (4.1 percent) for “crushed/run-over by highway vehicle.” For highway/road construction fatal events, the top 7 fatality causes (shown in Table 5) had 34 events (97.1 percent) and “crushed/run-over by highway vehicle” had 13 events (37.1 percent) of the 35 fatal events. It should be noted that the top 7 fatal event causes which

accounted for over 55.3 percent of the total events also accounted for 48.6 percent of the highway/road work construction fatal events. However, the “crushed/run-over by highway vehicle” cause increased significantly from 4.1 percent overall to over 37.1 percent for highway/road construction.

**Figure 2. Highway Construction Fatality Cause Comparison (2013)**



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 seven years, 2006 through 2012, a majority of these events occurred from mid-morning through late-afternoon (8-17 hour period) and ranged from 47 percent to 80 percent with a median 60 percent. In 2013, 23 events (65.7 percent) occurred during the 8-17 hour period.

This year, 2013, 5.7 percent of the fatal events occurred in the early morning (0-5 hour period) and none in the late night (20-24 hour period). For the previous seven years, 2006 to 2012, the late night and early morning periods, fatalities rose from 7 percent in 2006 to 40 percent in 2010 and fell back to 37 percent in 2012.

It seems clear that road work practices are changing to avoid traffic congestion when possible. This shift should result in a greater proportion of fatalities during early morning and late evening work hours. Whether the change in the proportion of 2013 fatalities occurring during the early morning and late night times represents a change from the trend of prior years remains to be determined. Regardless, it is not possible to calculate fatality rates for these time-of-day periods without knowing the hours worked in each period. More information about conditions which contribute to fatalities in highway/roadway construction would seem to an area worthy of further investigation.

**Table 6. Construction Fatalities Caused by “Crushed/Run-Over by Highway Vehicle” by Time of Day, 2013**

<u>Time</u>	<u>Frequency</u>	<u>Percent</u>
Early Morning: 00:00 - 5:00	2	5.7
Dawn: 5:00 - 8:00	6	17.1
Mid-Morning: 8:00 - 11:00	4	11.4
Mid-Day: 11:00 - 14:00	9	25.7
Late-Afternoon: 14:00 - 17:00	10	28.6
Evening: 17:00 - 20:00	4	11.4
Late Night: 20:00 - 24:00	0	0.0
Unknown	<u>0</u>	<u>0.0</u>
<b>Total</b>	<b>35</b>	<b>100.0</b>

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 five sub-categories of “crushed/run-over by highway vehicle”. Table 7 shows these sub-categories and their frequency.

**Table 7. Frequency of Sub-Categories of “Crushed/Run-Over by Highway Vehicle”, 2013**

<b><u>Sub-Category</u></b>	<b><u>Frequency</u></b>	<b><u>Percent</u></b>
Highway vehicle lost control and entered (by swerving or inadvertently entering) well-identified work zone, striking victim	3	25.0
Highway vehicle struck victim installing signals in unprotected work zone.	3	25.0
Highway vehicle struck victim who walked into traffic zone	3	25.0
Highway vehicle struck victim (flagger) signaling traffic at beginning of marked work zone	2	16.7
Highway vehicle struck victim working (paving) in unprotected work zone	<u>1</u>	<u>8.3</u>
<b>Total</b>	<b>12</b>	<b>100.0</b>

Unlike most years there is no predominate fatal event sub-category for the “crushed/run-over by highway vehicle” category of fatal events. Seventy-five percent of the events were in three of the five sub-categories “highway vehicle lost control and entered well identified work zone, striking victim”, “highway vehicle struck victim installing signals in unprotected work zone” and “highway vehicle struck victim who walked into traffic zone” each with 3 events

(25 percent). One-third of the events (4 events) occurred in unprotected work zones and might have been avoided by marking the work zones. One-fourth of the events (3 events) occurred when the victim walked into a traffic zone.

### **Observation**

The quality of the descriptions and information about the 2013 fatal events has deteriorated compared to 2012 and earlier years. Previously we have commented about the descriptive statements often not including sufficient detail to clearly identify the root cause of a fatal event; in some cases only a one or two word comment, e.g. run-over, died, fell off building. Inadequate descriptions have become more frequent.

In 2013, the number of missing data elements has increased in some categories and decreased in others. The project value of the construction activity was missing in 37 percent of the fatal events compared to 29 percent in 2012; the construction operation being performed was missing in 11 percent of the fatal events compared to 25 percent in 2012; the end-use type of the construction project was missing in 9 percent of the fatal events compared to 16 percent in 2012; the type of project was missing in 10 percent of fatal events compared to 14 percent in 2012; and the time of day of the fatal events was missing in 5 percent of the fatal events compared to 11 percent in 2012. Twenty thirteen is the first year NAICS coding was used and 7 percent of the codes were missing compared to no missing SIC codes in 2012.

Road work seems to be shifting to times when there is less traffic, generally in the late evening and early morning hours. The hour of a fatal event is especially important in assessing the impact of this change in road work patterns. In 2013 all of the event times for road work fatalities were recorded, compared to 2012 where 10 percent were missing.

## **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

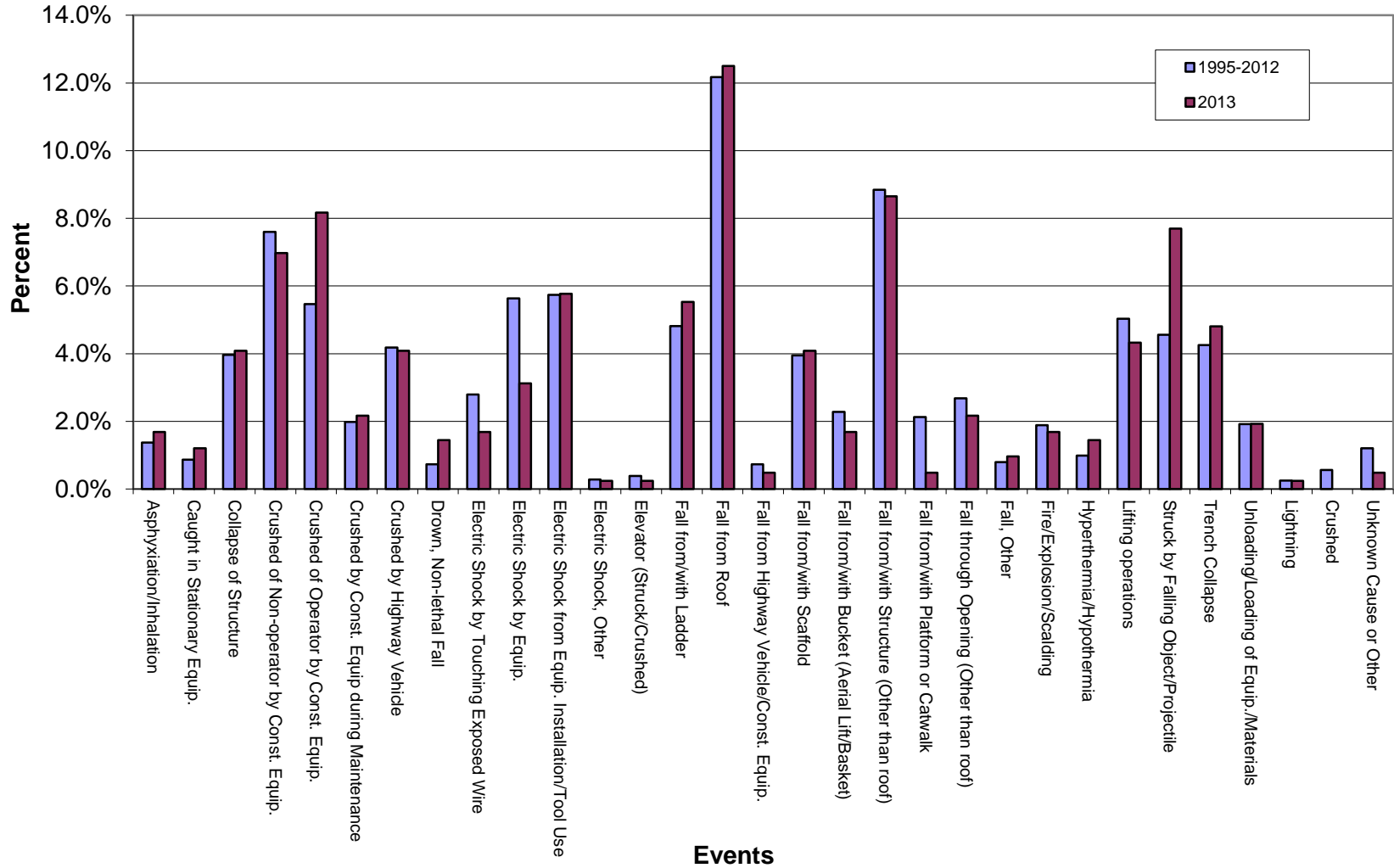
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\*Includes fatalities resulting from asphyxiation/fire/explosion/drowning of trapped operators.

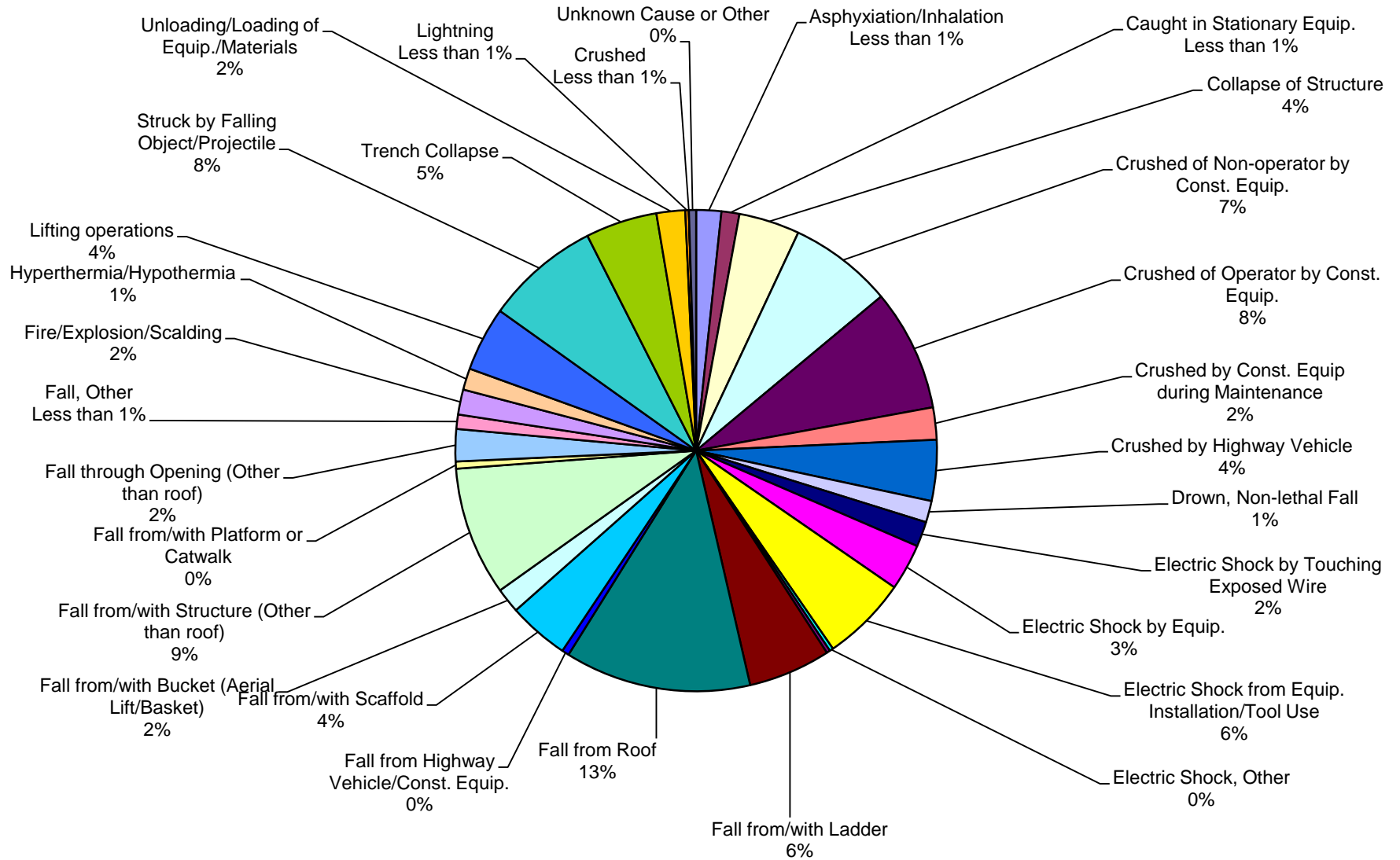
15. fall from roof; fall through roof: skylight or other opening
  - a. fall off of roof
  - b. fall through roof other than skylight
  - c. fall through skylight or other opening
16. fall from vehicle (vehicle/construction equipment): falls from vehicle or equipment while in motion or at rest.
17. fall 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. hyperthermia/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 Fatal Events (1995-2012 with 2013)**

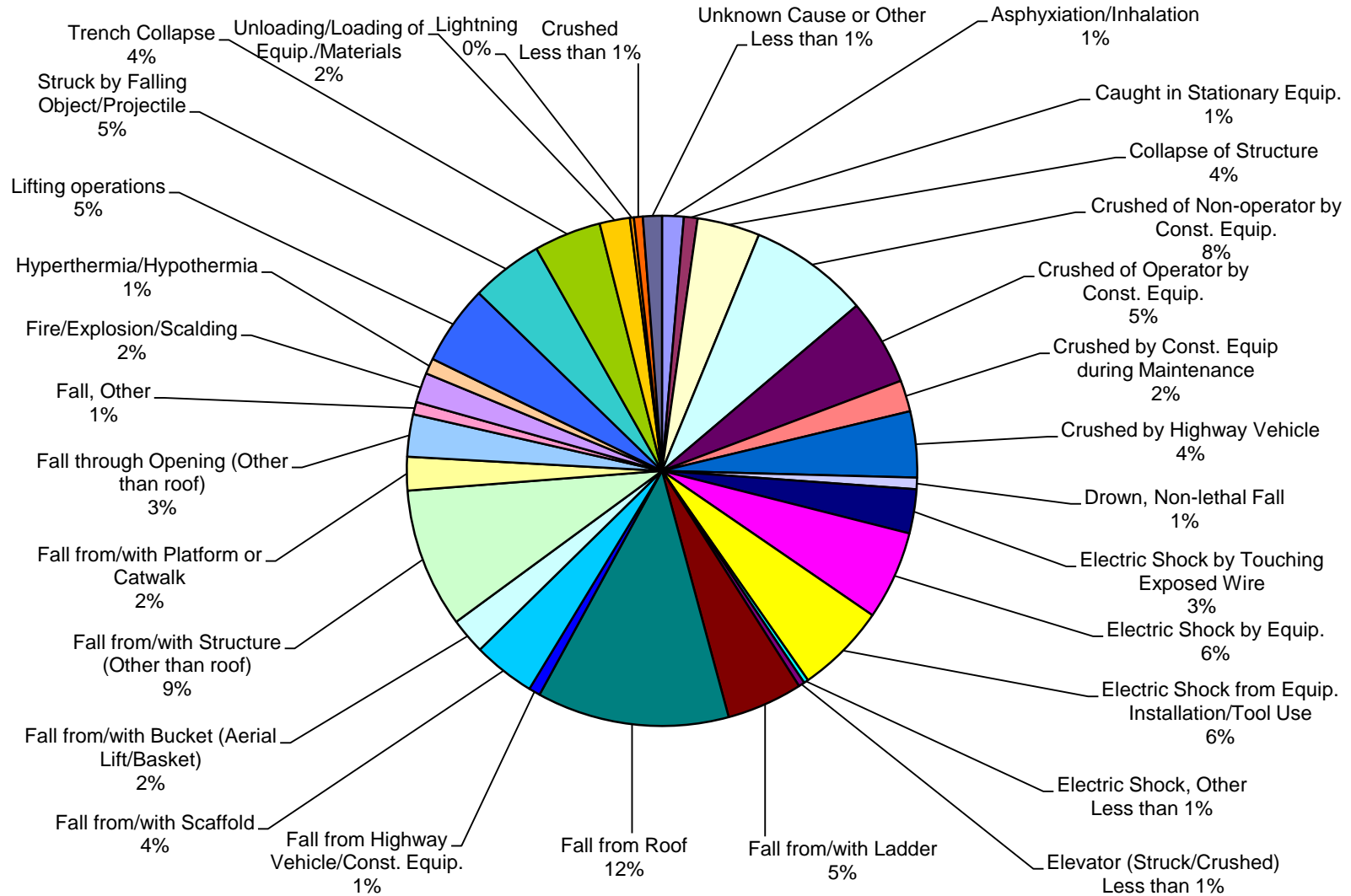


**Figure B2. Comparison of Construction Fatal Events (2013)**

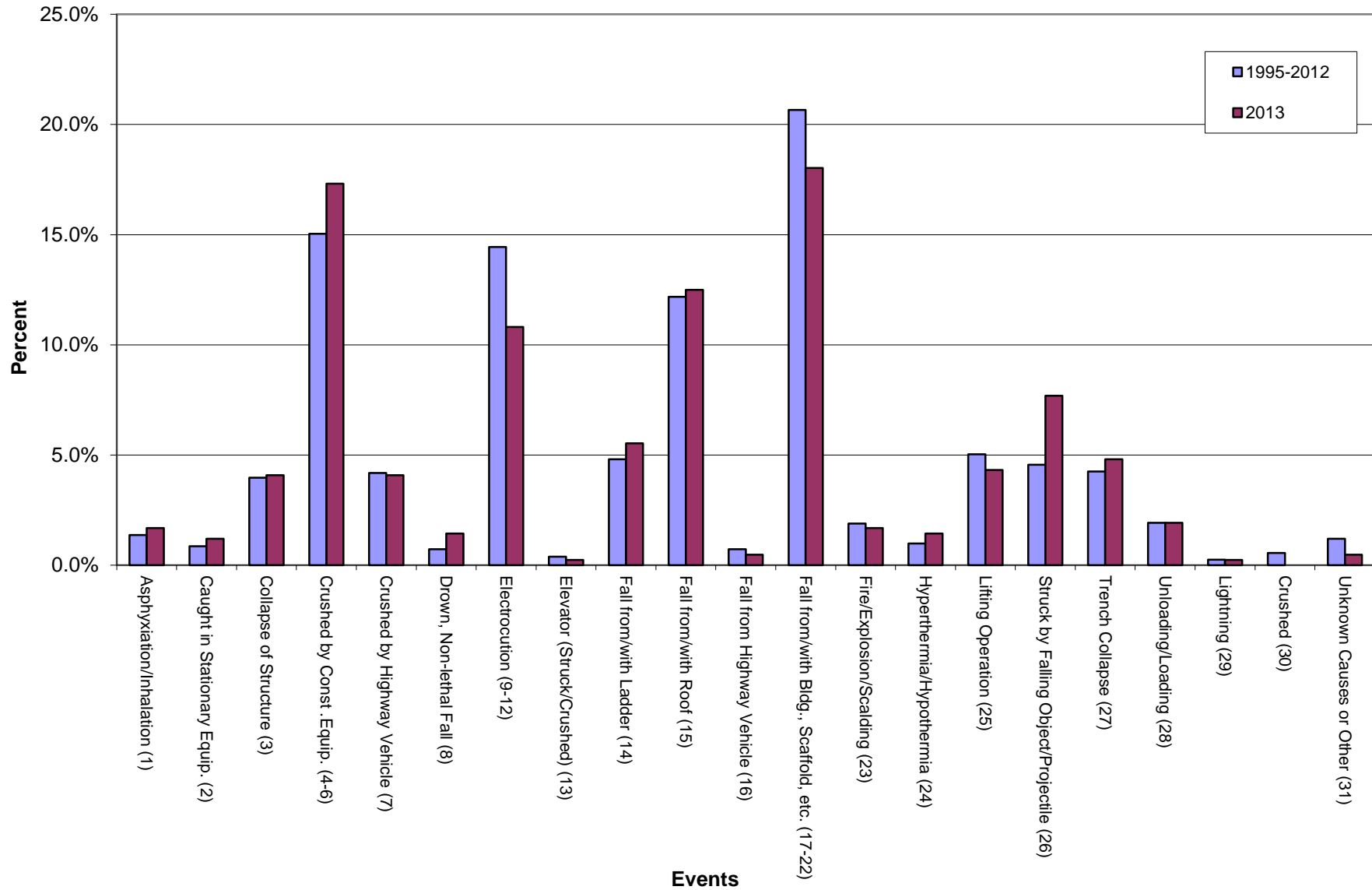




**Figure B3. Comparison of Construction Fatal Events (1995-2012)**



**Figure B4. Comparison of Grouped Construction Fatal Events (1995-2012 and 2013)**



## **APPENDIX C**

**Table C1. Construction Fatal Events by End-Use Type, 2013**

<b><u>End Use Type</u></b>	<b><u>Description</u></b>	<b><u>Number of Events</u></b>	<b><u>All Events Percent</u></b>	<b><u>Events with Recorded End-Use Percent</u></b>
1	Single Family or Duplex	78	18.8	20.5
2	Multi-family	24	5.8	6.3
3	Commercial	78	18.8	20.5
4	Manufacturing	11	2.6	2.9
5	Refinery	0	0.0	0.0
6	Power plant	5	1.2	1.3
7	Sewer or Water Plant	15	3.6	3.9
8	Other Building	50	12.0	13.2
9	Highway/Road Work	35	8.4	9.2
10	Bridge	10	2.4	2.6
11	Tower, Tank, Storage Elevator	12	2.9	3.2
12	Shoreline, Dam, Reservoir	1	0.2	0.3
13	Pipeline	21	5.0	5.5
14	Excavation, Landfill	3	0.7	0.8
15	Power line, Transmission Line	10	2.4	2.6
16	Other Heavy Construction	19	4.6	5.0
17	Contractors Yard	8	1.9	2.1
18	Unknown	<u>36</u>	<u>8.7</u>	<u>    </u>
<b>Total</b>		<b>416</b>	<b>100.0</b>	<b>100.0</b>

**Table C2. Construction Fatal Events by Type of Project, 2013**

<b><u>Project Type</u></b>	<b><u>Description</u></b>	<b><u>Number of Events</u></b>	<b><u>All Events Percent</u></b>	<b><u>Events with Recorded Type of Project Percent</u></b>
1	New, Addition and Alteration	239	57.5	63.9
2	Maintenance, Repair and Demolition	109	26.2	29.1
3	Other	26	6.3	7.0
4	Missing	<u>42</u>	<u>10.1</u>	<u>    </u>
<b>Total</b>		<b>416</b>	<b>100.0</b>	<b>100.0</b>

**Table C3. Construction Fatal Events by Six-Digit NAICS, 2013**

<b><u>Description</u></b>	<b><u>NAICS</u></b>	<b><u>Number of Events</u></b>	<b><u>All Events Percent</u></b>	<b><u>Events with Recorded NAICS Percent</u></b>
New Single-Family Housing Construction	236115	12	2.9	3.1
New Multifamily Housing Construction	236116	3	0.7	0.8
New Housing For-Sale Builders	236117	1	0.2	0.3
Residential Remodelers	236118	3	0.7	0.8
Land Subdivision	236210	4	1.0	1.0
Commercial and Institutional Building Construction	236220	16	3.8	4.1
Water and Sewer Line and Related Structures Construction	237110	26	6.3	6.7
Oil and Gas Pipeline and Related Structures Construction	237120	9	2.2	2.3
Power and Communication Line and Related Structures Construction	237130	14	3.4	3.6
Land Subdivision	237210	2	0.5	0.5
Highway, Street, and Bridge Construction	237310	39	9.4	10.1
Other Heavy and Civil Engineering Construction	237990	9	2.2	2.3
Poured Concrete Foundation and Structure Contractors	238110	12	2.9	3.1
Structural Steel and Precast Concrete Contractors	238120	16	3.8	4.1
Framing Contractors	238130	19	4.6	4.9
Masonry Contractors	238140	7	1.7	1.8
Glass and Glazing Contractors	238150	1	0.2	0.3
Roofing Contractors	238160	41	9.9	10.6
Siding Contractors	238170	2	0.5	0.5
Electrical Contractors	238210	28	6.7	7.2
Plumbing, Heating, and Air-Conditioning Contractors	238220	27	6.5	7.0
Other Building Equipment Contractors	238290	9	2.2	2.3
Drywall and Insulation Contractors	238310	7	1.7	1.8
Painting and Wall Covering Contractors	238320	19	4.6	4.9
Flooring Contractors	238330	1	0.2	0.3
Tile and Terrazzo Contractors	238340	1	0.2	0.3
Finish Carpentry Contractors	238350	2	0.5	0.5
Site Preparation Contractors	238910	29	7.0	7.5
All Other Specialty Trade Contractors	238990	29	7.0	7.5
Unknown		<u>28</u>	<u>6.7</u>	<u>7.2</u>
<b>Total</b>		<b>416</b>	<b>100.0</b>	<b>100.0</b>

**Table C4. Construction Fatal Events by Project Value, 2013**

<b><u>Project Value Code</u></b>	<b><u>Cost</u></b>	<b><u>Number of Events</u></b>	<b><u>All Events Percent</u></b>	<b><u>Events with Recorded Project Value Percent</u></b>
1	Under \$50,000	89	21.4	34.0
2	\$50,000-\$250,000	50	12.0	19.1
3	\$250,000-\$500,000	29	7.0	11.1
4	\$500,000-\$1,000,000	26	6.3	9.9
5	\$1,000,000-\$5,000,000	37	8.9	14.1
6	\$5,000,000-\$20,000,000	15	3.6	5.7
7	\$20,000,000 and over	16	3.8	6.1
8	Unknown	<u>154</u>	<u>37.0</u>	—
	<b>Total</b>	<b>416</b>	<b>100.0</b>	<b>100.0</b>

**Table C5. Construction Fatal Events by Construction Operation, 2013**

<b><u>Code Description</u></b>	<b><u>Number of Fatalities</u></b>	<b><u>Percent of All Fatalities</u></b>	<b><u>Fatal Events with Recorded Construction Operation Percent</u></b>
01 Backfilling and compacting	3	0.7	0.8
02 Bituminous concrete placement	2	0.5	0.5
03 Construction of playing fields, tennis courts	1	0.2	0.3
04 Cutting concrete pavement	2	0.5	0.5
05 Demolition	24	5.8	6.5
06 Dredging	1	0.2	0.3
07 Elevator, escalator installation	1	0.2	0.3
08 Emplacing reinforcing steel	2	0.5	0.5
09 Erecting structural steel	11	2.6	3.0
11 Excavation	10	2.4	2.7
12 Exterior masonry	2	0.5	0.5
13 Exterior cladding	2	0.5	0.5
14 Exterior carpentry	30	7.2	8.1
15 Exterior painting	16	3.8	4.3
16 Fencing, installing lights, signs, etc.	8	1.9	2.2
18 Forming	3	0.7	0.8
19 Forming for Piers or Pylons	1	0.2	0.3
20 Installing interior walls, ceilings, doors	1	0.2	0.3
22 Installing windows and doors, glazing	3	0.7	0.8
23 Installing culverts and incidental drainage	3	0.7	0.8
24 Installing equipment (HVAC and other)	25	6.0	6.7
25 Installing plumbing, lighting fixtures	11	2.6	3.0
26 Installing underground plumbing conduit	2	0.5	0.5
27 Interior Tile Work	1	0.2	0.3
28 Interior masonry	1	0.2	0.3
29 Interior plumbing, ducting, electrical work	6	1.4	1.6
30 Interior carpentry	12	2.9	3.2
31 Interior painting and decorating	10	2.4	2.7
32 Landscaping	3	0.7	0.8
34 Paving	24	5.8	6.5
35 Pile driving	1	0.2	0.3
37 Placing bridge girders and beams	3	0.7	0.8
38 Plastering	2	0.5	0.5
40 Pouring concrete floor at grade	2	0.5	0.5
42 Pouring concrete foundations and walls	6	1.4	1.6
43 Roofing	55	13.2	14.8
44 Seawall Construction, riprap placement	3	0.7	0.8

**Table C5. Construction Fatal Events by Construction Operation, 2013 (continued)**

<b><u>Code</u></b>	<b><u>Description</u></b>	<b><u>Number of Fatalities</u></b>	<b><u>Percent of All Fatalities</u></b>	<b><u>Fatal Events with Recorded Construction Operation Percent</u></b>
45	Site clearing and grubbing	8	1.9	2.2
46	Site grading and rock removal	5	1.2	1.3
48	Surveying	1	0.2	0.3
50	Temporary work (buildings, facilities)	24	5.8	6.5
51	Traffic protection	6	1.4	1.6
52	Trenching, installing pipe	27	6.5	7.3
53	Waterproofing	1	0.2	0.3
56	Steel Erection of Solid Web-Welding/Burning/Grinding	2	0.5	0.5
66	Installation of Decking-Initial Laying Deck (Including Layout & Safety)	1	0.2	0.3
69	Installation of Decking-Hoisting Bundles	1	0.2	0.3
71	Other Activities-Post Decking Detail Work	3	0.7	0.8
00	Unknown/Missing	<u>44</u>	<u>10.6</u>	<u>        </u>
	<b>Total</b>	<b>416</b>	<b>100.0</b>	<b>100.0</b>

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