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Quarterly DATA REPORT
SECOND QUARTER 2017

Struck-by Injuries and Prevention in the Construction Industry

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Struck-by hazards are a leading cause of fatal and nonfatal injuries in construction, and have been defined as one of the Focus Four hazards identified by the U.S. Occupational Safety and Health Administration (OSHA) (the other hazards are falls, caught-in-between, and electrocution; OSHA 2011). Struck-by injuries can occur in many different ways. To prevent construction workers from struck-by injuries, specific hazards and working environments should be taken into account for safety and health intervention programs. This Quarterly Data Report includes data on deaths and injuries from being struck by vehicles, objects, and equipment. Primary sources of struck-by injuries and vulnerable worker groups for such injuries were also analyzed and are presented in the report. Numbers of fatal and nonfatal injuries were obtained from the Census of Fatal Occupational Injuries (CFOI) and the Survey of Occupational Injuries and Illnesses (SOII), respectively. Both the CFOI and SOII are data collections of the U.S. Bureau of Labor Statistics (BLS). In addition to the BLS data, this report introduces solutions to prevent struck-by injuries selected from a variety of sources, including OSHA, the National Institute for Occupational Safety and Health (NIOSH), and CPWR.

KEY FINDINGS

- From 2011 to 2015, 804 construction workers died from struck-by injuries, more than any other major industry; 52% were struck by an object or equipment, and the rest were struck by a vehicle.
- More than half (51%) of fatalities involving being struck by an object or equipment were caused by falling objects or equipment.
- The majority (57%) of struck-by vehicle deaths in construction occurred in work zones.
- Most (96%) nonfatal struck-by injuries were from being struck by an object or equipment.
- The risk of nonfatal struck-by injuries in construction is nearly double the risk of all industries combined.
- Highway maintenance workers had the highest rate of struck-by fatalities, while helpers had the highest rate of nonfatal struck-by injuries.
- Construction workers 65 years or older experienced the highest rate of struck-by fatalities, whereas workers under 20 years had the highest rate of nonfatal struck-by injuries.

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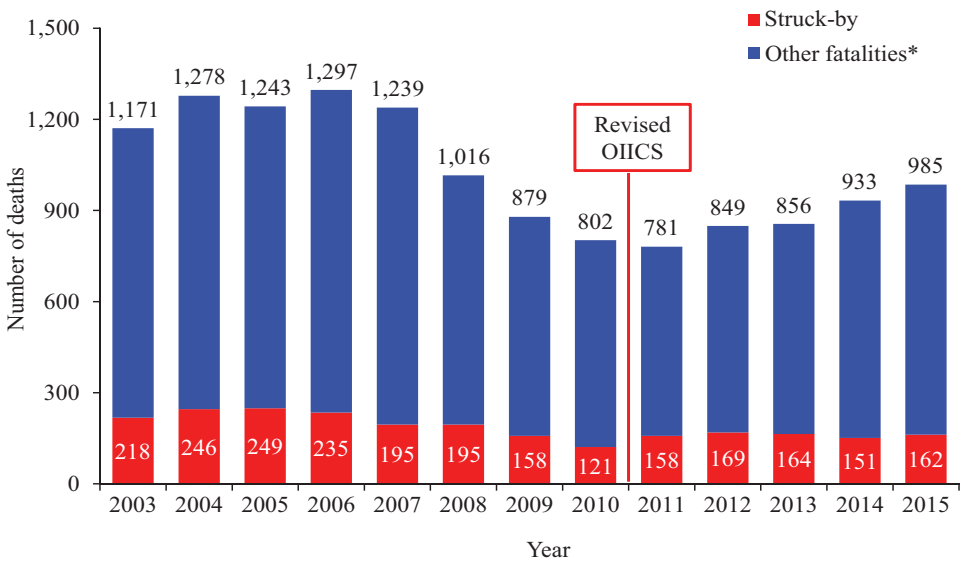
Second Quarter 2017

SECTION 1: TRENDS OF FATAL STRUCK-BY INJURIES IN CONSTRUCTION

The general trends of struck-by fatalities[1] followed the overall fatality trend in construction (Dong et al., 2017), falling during the recession and increasing afterwards. In 2015, 162 construction workers died from struck-by injuries, a 2.5% (4 deaths) increase from 2011 and 34% higher than the low point (121 deaths) in 2010 (chart 1). Although the number of struck-by fatalities slightly increased from 2011 to 2015, its share of the overall fatal injuries in construction dropped from 20% to 16% during this time period. On average, nearly one in five (18%) construction workers who died did so as a result of being struck by an object/equipment or a vehicle.

1. Number of fatalities in construction, struck-by and other fatalities*, 2003-2015



[1]Struck-by fatalities in this study include struck by object or equipment (Event codes 62xxxx in OIICS 2.01 and Event codes 02xxxx in OIICS 1.01) and struck by a vehicle (Event codes 24xxxx in OIICS 2.01 and Event codes 43xxxx in OIICS 1.01).

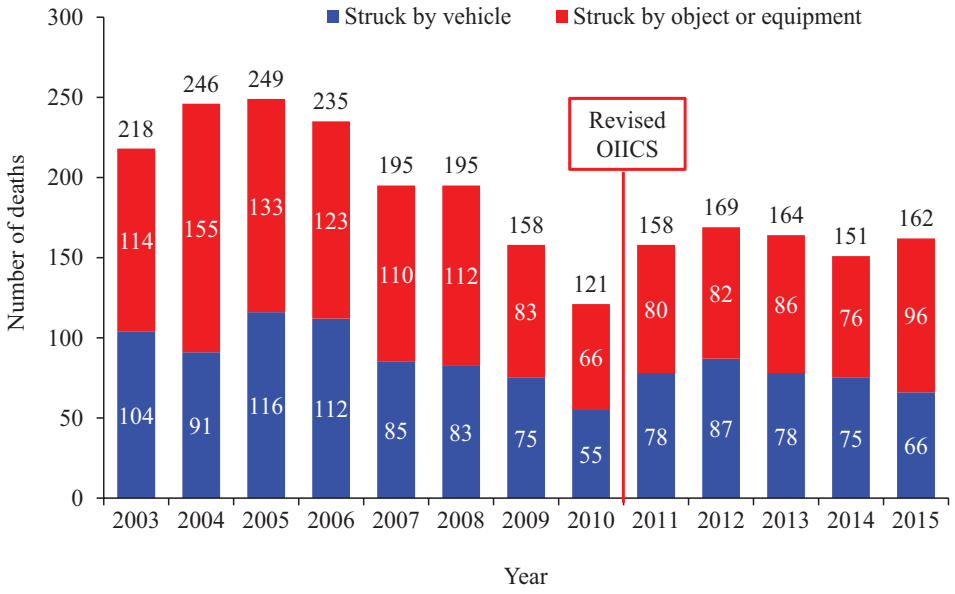
* Other fatalities are fatalities from all causes except struck-by.

Note: In 2011, the injury coding was switched from OIICS version 1.01 to OIICS version 2.01, therefore the numbers before and after 2011 are not directly comparable.

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

When stratified into more detailed categories, more than half (52.2%) of struck-by fatalities that occurred from 2011 to 2015 were due to being struck by an object or equipment (chart 2). The number of deaths due to being struck by an object or equipment increased 20%, from 80 in 2011 to 96 in 2015[2], while deaths due to being struck by a vehicle fell 15% during the same period.

2. Number of fatal struck-by injuries in construction, 2003-2015



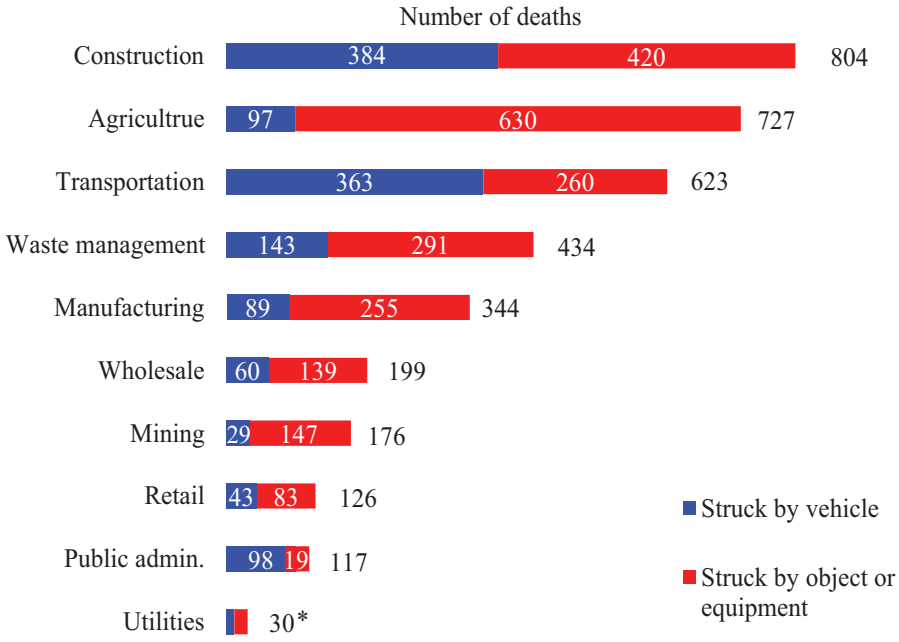
[2]In 2011, the injury coding was switched from OIICS version 1.01 to OIICS version 2.01, therefore the numbers before and after 2011 are not directly comparable.

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

Section 1: Trends of Fatal Struck-by Injuries in Construction Second Quarter 2017

From 2011 to 2015, 804 construction workers died from struck-by injuries, more than any other major industry (chart 3). Specifically, the construction industry had the highest number of fatalities due to being struck by a vehicle and the second highest number of deaths due to being struck by an object or equipment among all major industries.

3. Number of fatal struck-by injuries, by major industry, sum of 2011-2015 (All employment)

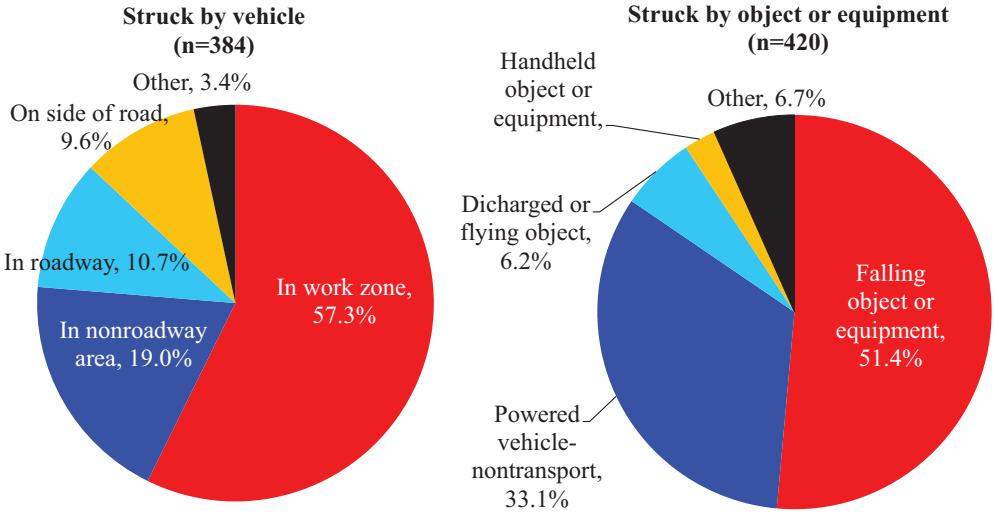


*Eleven deaths were from being struck by vehicle, and 19 deaths were from being struck by object or equipment.
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

Section 1: Trends of Fatal Struck-by Injuries in Construction Second Quarter 2017

Among construction workers who died from being struck by an object or equipment, more than half (51%, or 216) were struck by falling objects or equipment, followed by nontransport vehicles[3] (33%; chart 4). The majority (57%, or 220) of struck by vehicle deaths in construction occurred in work zones[4], and another 19% or 73 deaths happened in nonroadway areas[5]. Overall, 57% (217 deaths) of struck by vehicle fatalities were due to being struck by forward-moving vehicles, and another 26% (101 deaths) were struck by backing-up vehicles.

4. Fatal struck-by injuries in construction, struck by vehicle versus struck by object or equipment, sum of 2011-2015

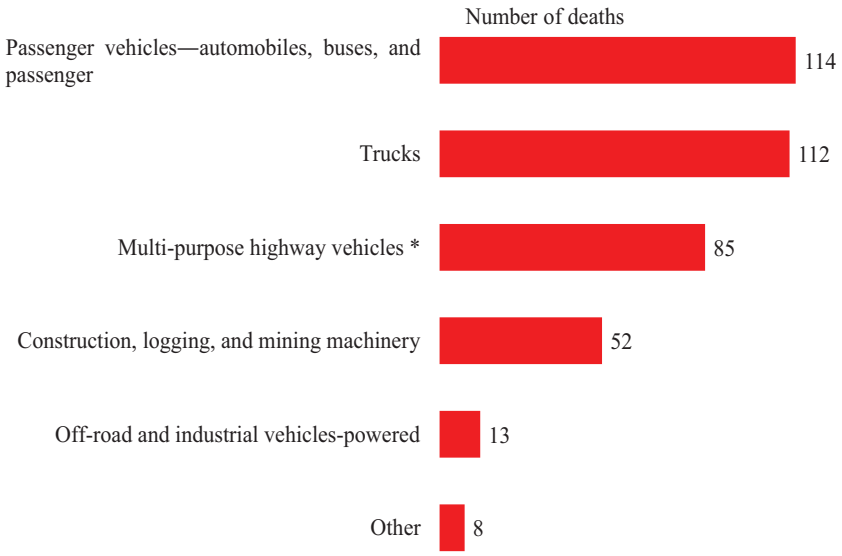


[3]This category includes being struck or run over by vehicle or mobile equipment in nontransport-related incidents.
[4]"Work zones" includes the vicinity of road construction, maintenance, or utility work or within an area marked by signs, barricades, or other devices.
[5]"Nonroadway areas" or "nonhighway" includes industrial, commercial, residential, and farm premises; parking lots; and logging roads.
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

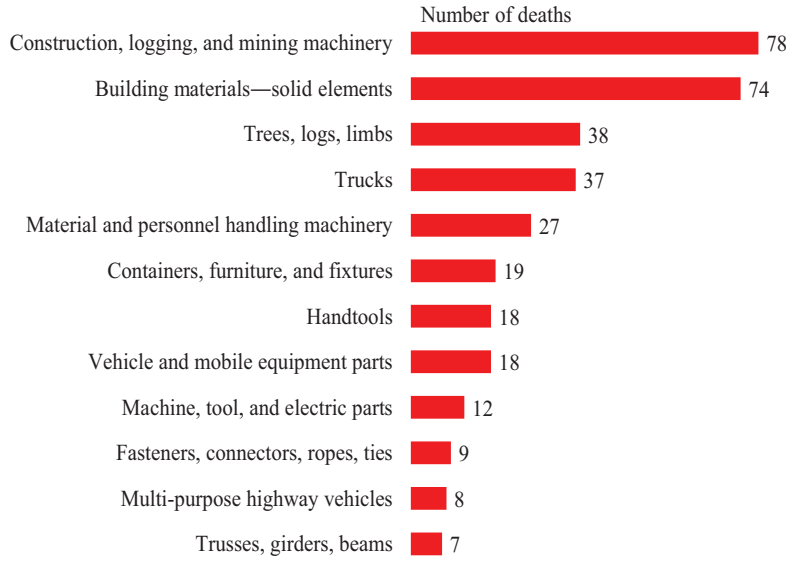
Section 1: Trends of Fatal Struck-by Injuries in Construction Second Quarter 2017

From 2011 to 2015, among construction workers who died from being struck by vehicles, 114 (30%) were struck by passenger vehicles, and another 29% (112) were struck by trucks[6] (chart 5a). Together these two sources caused 59% of struck-by vehicle deaths in construction during these years. Among workers who died of being struck by an object or equipment, 19% (78) were struck by construction, logging, and mining machinery, and another 18% (74) were struck by solid building materials (chart 5b).

5a. Number of fatal injuries from being struck by vehicle in construction, by primary source, sum of 2011-2015



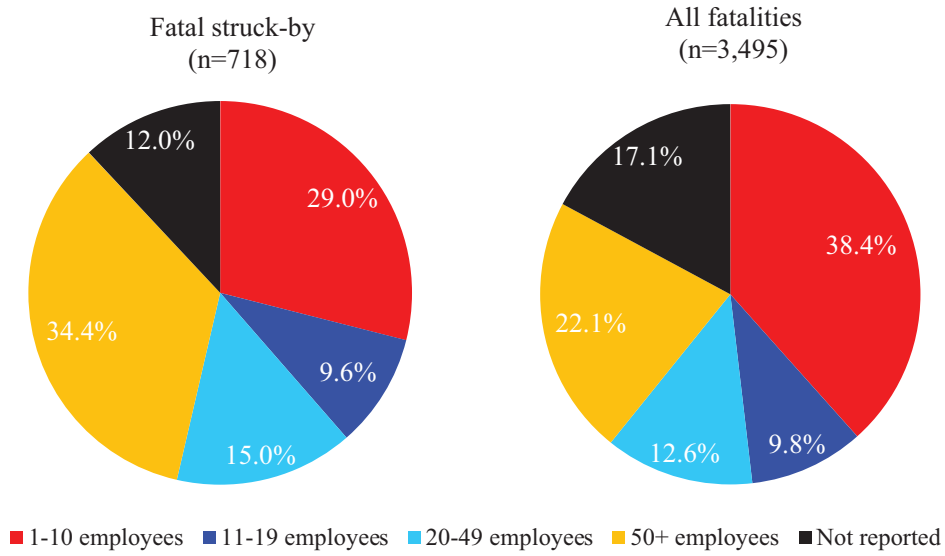
5b. Number of fatal injuries from being struck by object or equipment in construction, selected primary source, sum of 2011-2015



[6]Forty-four out of 112 were dump trucks.
*This source category includes vehicles that can be used either for transport of passengers or of goods and materials as their primary function.
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

Struck-by fatalities were more likely to occur among larger establishments. From 2011 to 2015, 34.4% of struck-by fatalities occurred in establishments with 50 or more employees, compared to 22.1% for all construction fatalities (chart 6).

6. Fatal injuries in construction, by establishment size, sum of 2011-2015 (Wage-and-salary workers)



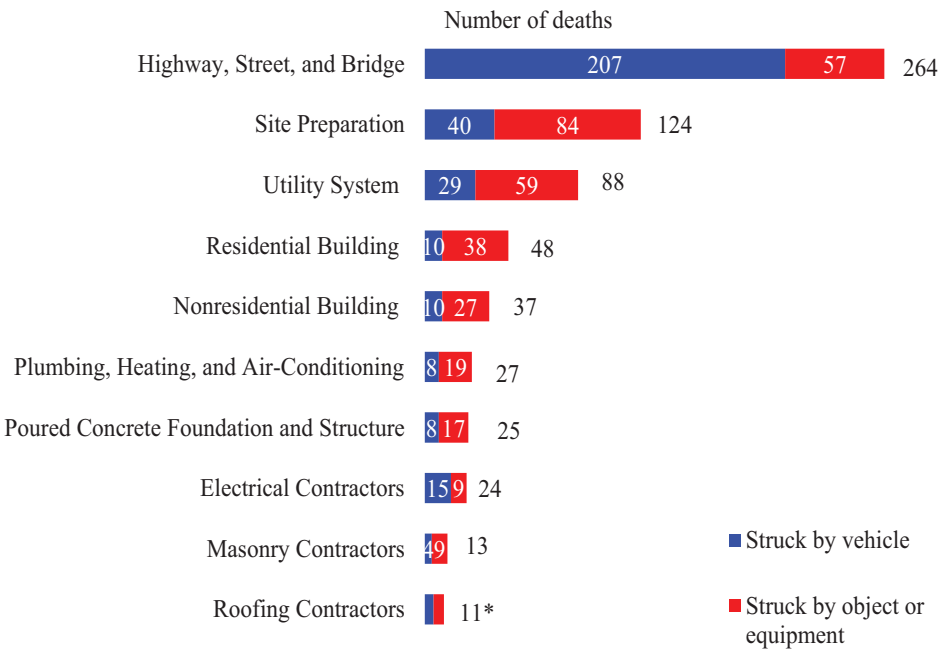
Note: Self-employed workers were excluded.
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

Second Quarter 2017

SECTION 2: FATAL STRUCK-BY INJURIES AMONG CONSTRUCTION SUBGROUPS

Of the construction subsectors, the highway, street, and bridge construction sector had the highest number of struck-by fatalities from 2011 to 2015; the majority of these fatalities were due to being struck by a vehicle on the job (chart 7). However, more site preparation construction workers died of being struck by an object or equipment than did workers in other subsectors.

7. Number of fatal struck-by injuries, selected construction subsectors, sum of 2011-2015

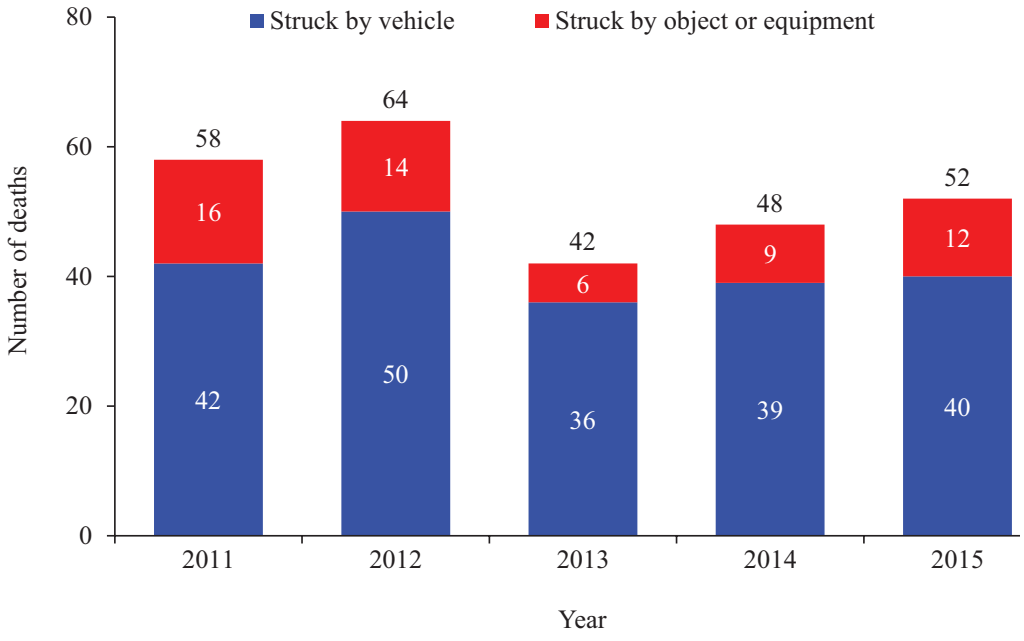


* Five deaths were from being struck by vehicle and six deaths were from being struck by object or equipment.
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

Section 2: Fatal Struck-by Injuries among Construction Subgroups Second Quarter 2017

The number of deaths due to struck-by injuries in the highway, street, and bridge construction subsector dipped in 2013 and increased afterwards (chart 8). Despite the increasing trend, the number of struck-by fatalities in this subsector in 2015 was still lower than that in 2011. On average during this time period, 41 deaths due to being struck by a vehicle and 11 deaths due to being struck by an object or equipment occurred yearly in this subsector.

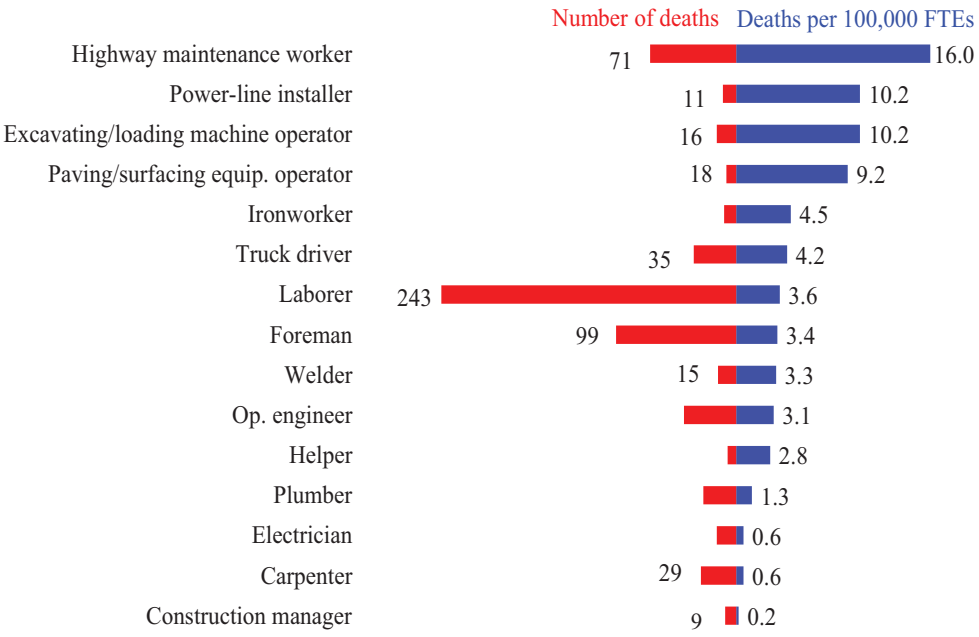
8. Number of fatal stuck-by injuries in Highway, Street, and Bridge Construction subsector, 2011-2015



Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

By occupation, construction laborers, the largest trade in construction, had the highest number of fatal struck-by injuries among all construction occupations between 2011 and 2015 (243 deaths; chart 9). However, highway maintenance workers had the highest rate of fatalities due to struck-by injuries, with 16 deaths per 100,000 *full-time equivalent workers* (FTEs). Power-line installers and excavating/loading machine operators also had high risk of struck-by fatalities, each with 10.2 deaths per 100,000 FTEs.

9. Number and rate of fatal struck-by injuries in construction, selected occupations, sum of 2011-2015

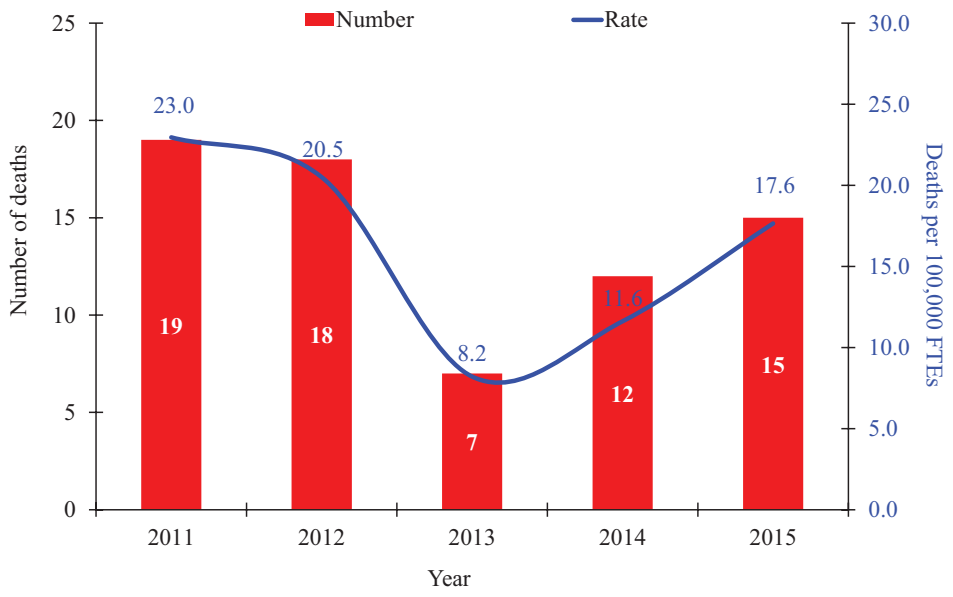


Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

Section 2: Fatal Struck-by Injuries among Construction Subgroups Second Quarter 2017

Highway maintenance workers (SOC 47-4051) are at high risk of being struck by motorists as they perform their work alongside highways exposed to traffic. The majority of workers in this construction trade are employed with local or state governments (BLS, 2017). Correspondingly, most victims of fatal struck-by injuries in this trade were public employees in Highway, Street, and Bridge Construction (NAICS 23731). While the number and rate of struck-by deaths dipped in 2013, they increased for the following two years, though remaining below the 2011 level (chart 10). In 2015, both the number and rate of struck-by fatalities more than doubled from 2013. In addition to data fluctuations year to year due to relatively small death numbers, increased traffic volume (U.S. Department of Transportation, 2016) and distracted driving (StateFarm, 2015) could be partially responsible for the increased death numbers in recent years. On average, about 14 highway maintenance workers died of struck-by injuries per year during this time period.

10. Number and rate of fatal struck-by injuries among highway maintenance workers, 2011-2015

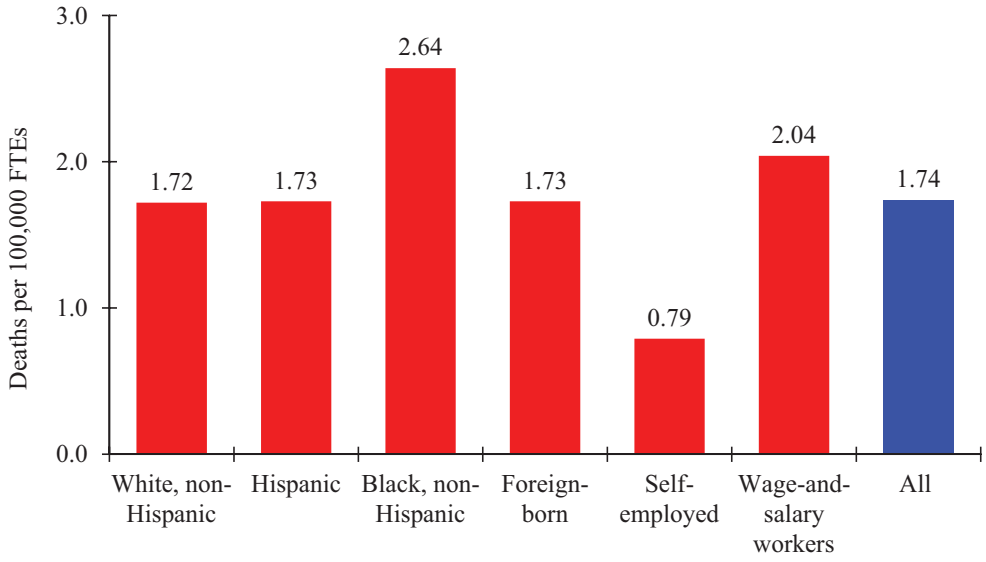


Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

Section 2: Fatal Struck-by Injuries among Construction Subgroups Second Quarter 2017

The rate of fatal struck-by injuries in construction varies among subgroups. On average from 2011 to 2015, black non-Hispanic workers experienced a much higher rate of fatal struck-by injuries (2.64 deaths per 100,000 FTEs; chart 11) than any other worker group. Wage-and-salary construction workers also had a higher rate of such deaths (2.04 deaths per 100,000 FTEs).

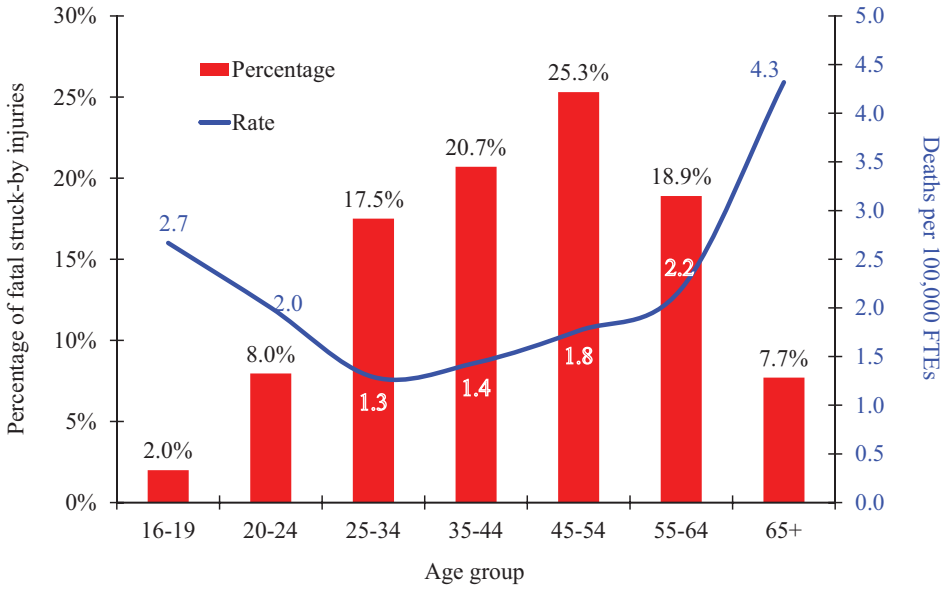
11. Rate of fatal struck-by injuries in construction, selected worker characteristics, average of 2011-2015



Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

By age, about a quarter (25.3%) of struck-by decedents were 45 to 54 years old, the largest proportion among all age groups (chart 12). While less than 8% of struck-by decedents were 65 years or older, this age bracket experienced the highest rate of struck-by fatalities of any age bracket, at 4.3 deaths per 100,000 FTEs, more than three times the rate for those ages 25-34. In addition, the youngest age group had an elevated risk of struck-by fatalities.

12. Percentage and rate of fatal struck-by injuries in construction, by age group, average of 2011-2015



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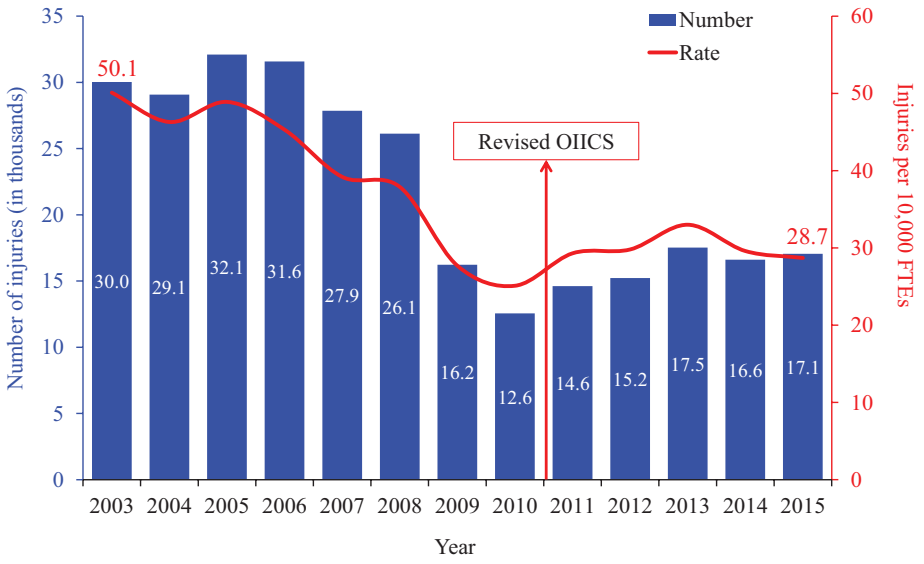
Second Quarter 2017

SECTION 3: TRENDS OF NONFATAL STRUCK-BY INJURIES IN CONSTRUCTION

Coinciding with the fatal struck-by injury trend, both the number and rate of struck-by injuries resulting in days away from work (DAFW) in construction hit a low in 2010 and increased afterward. In 2015, 17,050 struck-by injuries occurred in construction, 2,430 more than in 2011[7], about a 17% increase (chart 13). The rate however slightly decreased, from 29.3 in 2011 to 28.7 injuries per 10,000 FTEs in 2015. All nonfatal injury numbers in this report refer to those resulting in DAFW.

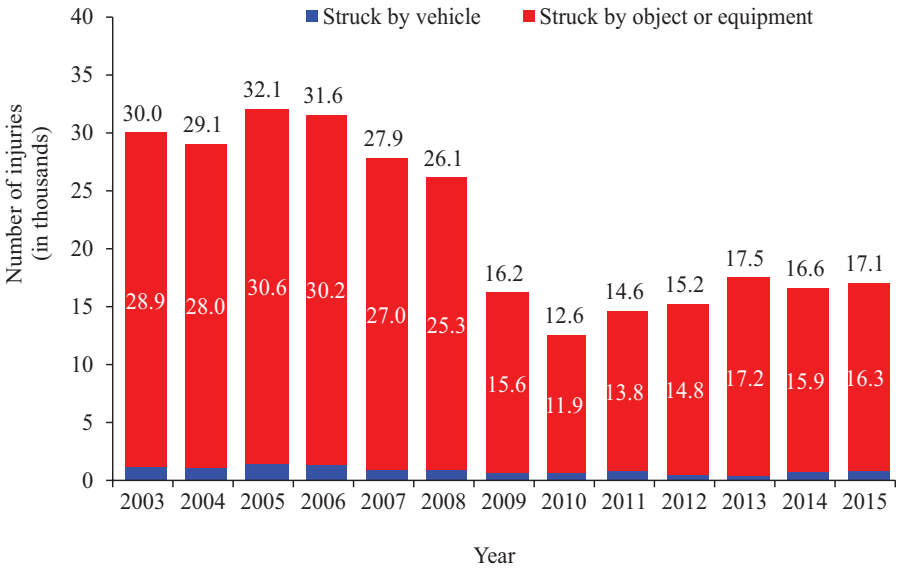
13. Number and rate of nonfatal struck-by injuries in construction, 2003-2015 (Private wage-and-salary workers)



[7]In 2011, the injury coding was switched from OIICS version 1.01 to OIICS version 2.01, therefore the numbers before and after 2011 are not directly comparable.
Source: 2003-2015 Survey of Occupational Injuries and Illnesses.

By more detailed categories, about 96% of all nonfatal struck-by injuries in construction from 2011 to 2015 were caused by an object or equipment (chart 14). The increase (2,430) between 2011 and 2015 can be attributed to such equipment and object injuries, given that the number of struck-by vehicle injuries was approximately the same in both 2011 and 2015.

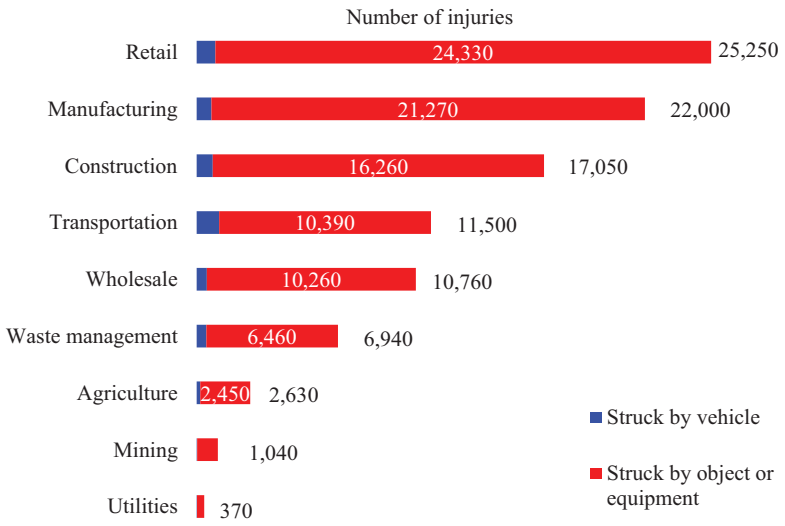
14. Number of nonfatal struck-by injuries in construction, by vehicle versus by object or equipment, 2003-2015 (Private wage-and-salary workers)



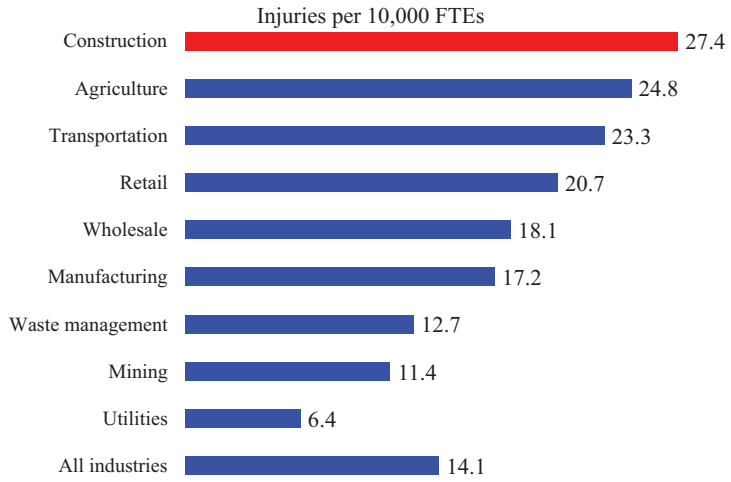
Note: In 2011, the injury coding was switched from OIICS version 1.01 to OIICS version 2.01, therefore the numbers before and after 2011 are not directly comparable.
Source: 2003-2015 Survey of Occupational Injuries and Illnesses.

In 2015, construction had the third-highest number of overall struck-by injuries after manufacturing and retail (chart 15a). Construction was also ranked third in injuries due to being struck by a vehicle, after transportation and retail. Moreover, construction had the highest risk of being struck by an object or equipment among all industries, at 27.4 injuries per 10,000 FTES, nearly twice the risk of all industries combined (chart 15b).

15a. Number of nonfatal struck-by injuries, by major industry, 2015 (Private wage-and-salary workers)

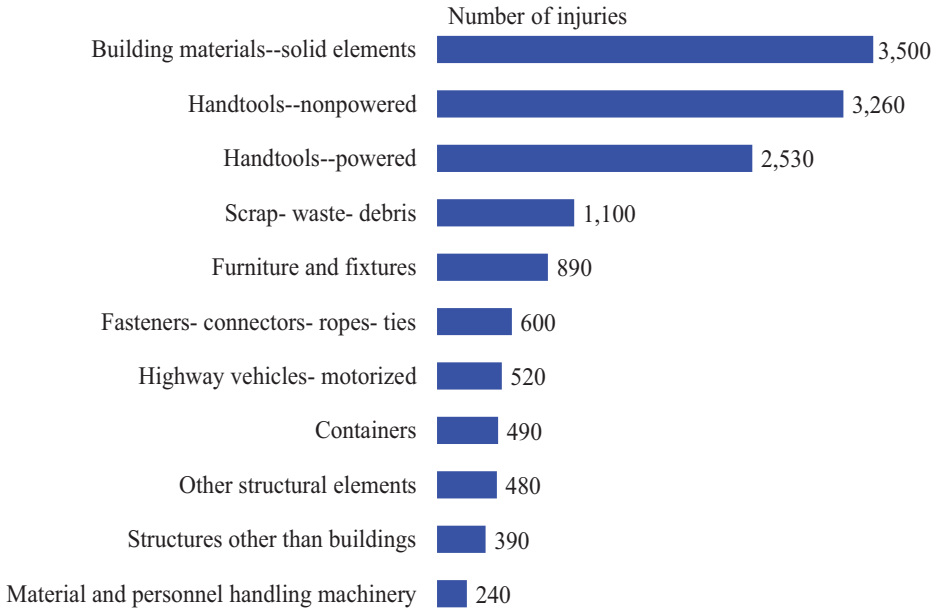


15b. Rate of nonfatal injuries from being struck by object or equipment, by major industry, 2015 (Private wage-and-salary workers)



Solid building materials were the most common source of nonfatal struck-by injuries in 2015, accounting for about 3,500 injuries (chart 16). Other common sources were hand tools (both nonpowered and powered), and scraps, waste, and debris. Together these four sources caused 64% of nonfatal struck-by object injuries.

16. Number of nonfatal injuries from being struck by object or equipment in construction, selected primary sources, 2015 (Private wage-and-salary workers)



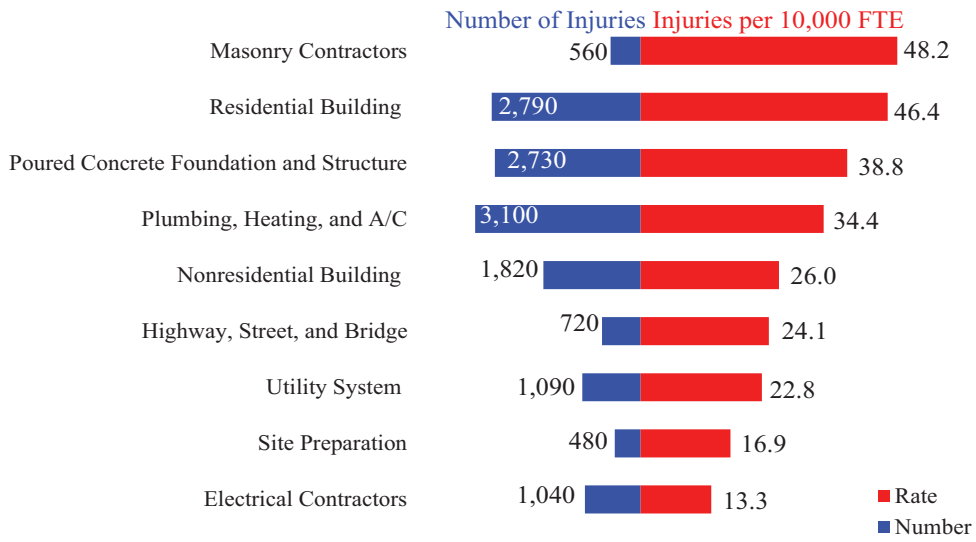
Source: Numbers were obtained from the BLS through special requests. The views expressed here do not necessarily reflect the views of the BLS.

Second Quarter 2017

SECTION 4: NONFATAL STRUCK-BY INJURIES AMONG CONSTRUCTION SUBGROUP

The plumbing, heating, and air conditioning construction subsector had a higher number of struck-by object injuries than other subsectors, with 3,100 workers suffering such injures in 2015 (chart 17). However, the masonry contractor subsector experienced the highest rate of struck-by object injuries, with 48.2 injuries per 10,000 FTEs in 2015.The residential building subsector experienced the second highest number of injuries and the second highest rate.

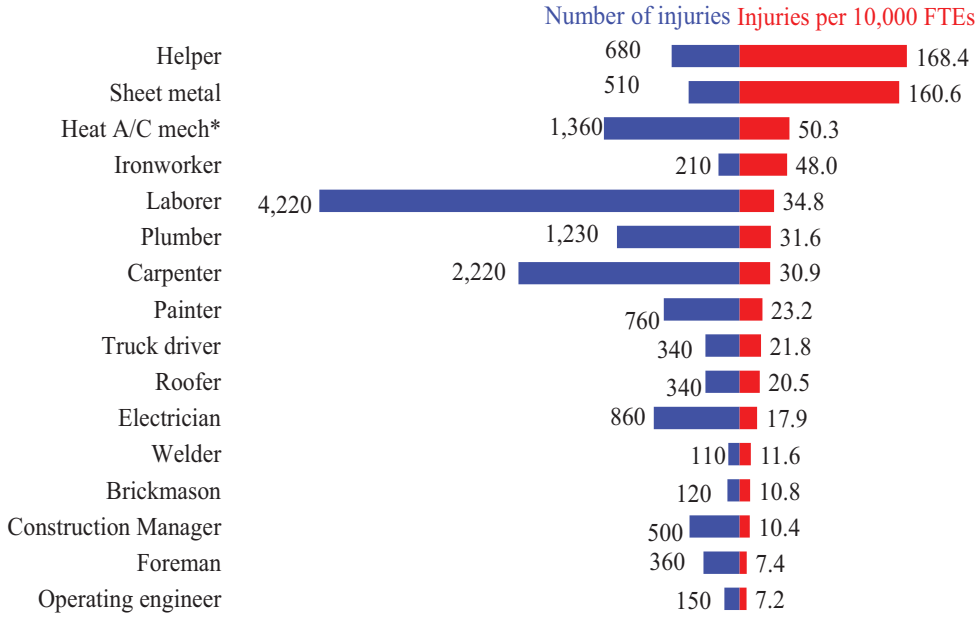
17. Number and rate of nonfatal injuries from being struck by object or equipment, selected construction subsectors, 2015 (Private wage-and-salary workers)



Source: 2015 Survey of Occupational Injuries and Illnesses

By occupation, construction laborers had more DAFW injuries due to being struck by an object than other occupations, with 4,220 laborers taking work off due to struck-by injuries in 2015 (chart 18). Carpenters, the second largest trade in construction, had the second-highest number of nonfatal struck-by injuries in construction (2,220 injures). Together, these two occupations accounted for 40% of nonfatal struck-by injuries in construction. Construction helpers had the highest rate of struck-by injuries (168.4 injuries per 10,000 FTEs), more than seven times the rate of all construction occupations combined (22.5 injuries per 10,000 FTEs).

18. Number and rate of nonfatal injuries from being struck by object or equipment, selected construction occupations, 2015 (Private wage-and-salary workers)

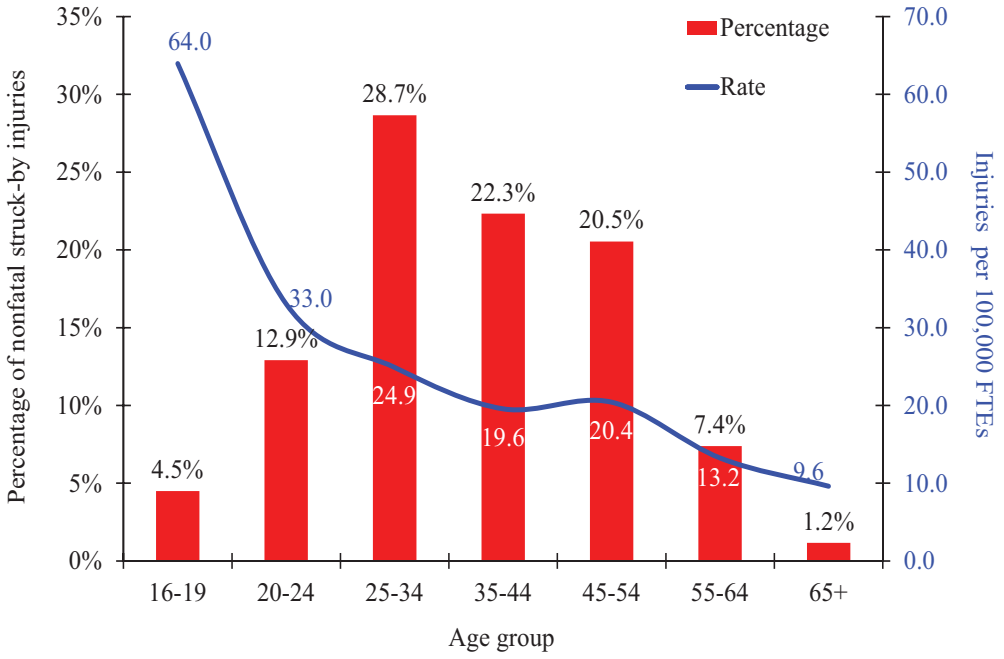


* This refers to the Heating and Air Conditioning Mechanics occupation.
Source: Number of nonfatal injuries were obtained from the BLS through special requests. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors.

Section 4: Nonfatal Struck-by Injuries among Construction Subgroup Second Quarter 2017

Unlike fatal struck-by injuries (see chart 12), younger construction workers had a higher risk of nonfatal struck-by injuries than their older counterparts. Construction workers under 20 years old had the highest rate of nonfatal struck-by injuries, with 64 injuries per 10,000 FTEs, while workers ages 65 years and older had the lowest rate of such injuries. Construction workers ages 25 to 34 years old had the largest proportion of struck-by object injuries (28.7%; chart 19). This age group had a higher injury rate than older ones and shared a larger proportion of construction employment as well.

19. Percentage and rate of nonfatal injuries from being struck by object or equipment in construction, by age group, 2015 (Private wage-and-salary workers)



Source: Numbers were obtained from the BLS through special requests. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors.

Second Quarter 2017

SECTION 5: PREVENTING STRUCK-BY INJURIES IN CONSTRUCTION

Struck-by injuries and deaths are preventable. Training (OSHA, 2011), personal protective equipment, engineering controls, safety protocols, and other solutions may be implemented to prevent struck-by injuries among construction workers. For example, many struck-by vehicle injuries can be prevented by back-up cameras, highly visible clothing, barriers and enforcement in road construction zones, and internal traffic control plans (Table 1). The implementation of safety solutions such as the ones listed in the table below can greatly reduce unnecessary deaths due to struck-by injuries.

Table 1: Solutions to Prevent Struck-By Injuries

Event	Hazard	Solution
Struck-by vehicles	Backover	• Back-up cameras[1a, 6a] • Back-up alarms radar systems[1a,6a] • Backover prevention standards [7, 10, 11] • Broad spectrum alarms[2] • Blind Spot Diagrams[6b] • Internal Traffic Control Plan[1b]
	Runover and backover during night work	• Hardhats with active illumination[3a] • Hardhat mounted mirrors [12] • High visibility clothing[4b,5a] • Work zone lighting systems[3b,5a]
	Work zone intrusions from passenger vehicles in highway maintenance and road construction	• Concrete/water filled barriers[5b,8c] • Mobile/Movable longitudinal barriers[1a,1d,3d] • Temporary-barriers[1c] • Intrusion alarms[1e] • Use of advance traffic signs[8e] • Gradual tapering of any lane closure[8e] • Police traffic enforcement in work zone [8e]
	Injuries among flaggers	Automated Flagging Assistant Devices (AFAD)[3c]
Struck-by falling objects	• Injuries from falling objects when working or walking below elevated work surfaces • Injuries from falling objects when materials are being moved overhead • Injuries from falling objects when carrying / lifting heavy loads	• Hand tools tethered to worker's belt by lanyard[9] • Hardhats[4c] • Pedestrian walkways[8c] or sidewalk sheds[8c] • Toe-boards, screens, debris nets, and guardrails on scaffolding[8a, 8e] • Workers remain a safe distance from suspended loads [8d] • Proper storage of materials [8d] • Workers don't exceed the equipment's load or lift capacity[8e] • Barricades for all dangerous areas and posted warning signs [8e]
Struck-by flying objects	• Injuries from flying objects created by power tools (such as pneumatic nail gun) and activities such as pushing, pulling, or prying • Injuries from flying objects caused by grinding or striking materials	• Workers trained on safe operation of power tools[8e] • All tools inspected before use[8e] • Sequential triggers for nail guns[8b] • Protective gear (Safety glasses[4c], Hardhats[4c], Face Shields [8d])
Struck-by swinging or slipping object	Injuries from swinging or slipping objects	• No one working under loads as they are being lifted [8d] • All loads secured and lifted evenly to prevent them from slipping.[8d]
Struck-by equipment	Injuries due to being struck by heavy equipment or machinery	• All equipment inspected before use[8e] • Operators trained and certified to operate equipment safely[8e] • Extreme caution used when approaching heavy equipment [8d] • A highly visible reflective vest [8d]

Source: For sources cited in the table, please see the attached supplement.

Conclusion

Struck-by hazards are a major cause of fatal and nonfatal injuries in construction. During the period of 2011 to 2015, 804 construction workers died from struck-by injuries, more than any other major industry. Construction also had the highest rate of nonfatal struck-by injuries among all industries.

Hazards leading to fatal and nonfatal struck-by injuries in construction were quite different. About half (52.2%) of struck-by fatalities were caused by an object or equipment, while about 96% of nonfatal struck-by injuries were due to the same cause. The risk of struck-by injuries varied by occupation. The highway maintenance worker, power-line installer, and excavating or loading machine operator occupations were the most dangerous in terms of struck-by fatalities, whereas helpers and sheet metal workers had the highest risk of nonfatal struck-by injuries. In general, older construction workers had a higher risk of struck-by fatalities, while younger workers had a higher risk of nonfatal struck-by injuries.

Struck-by injuries and fatalities are preventable. The select solutions presented in this report summarizes struck-by prevention methods in construction, including safety standards and regulations, engineering controls, proper personal protective equipment (PPE), and safety and health training. These methods may be applied separately or together based on specific circumstances in order to prevent construction workers from struck-by injuries.

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Second Quarter 2017

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About the CPWR Data Center

The CPWR Data Center is part of CPWR – The Center for Construction Research and Training. CPWR is a 501(c)(3) nonprofit research and training institution created by North America's Building Trades Unions, and serves as its research arm. CPWR has focused on construction safety and health research since 1990. The Quarterly Data Reports – a series of publications analyzing construction-related data, is part of our ongoing surveillance project funded by the National Institute for Occupational Safety and Health (NIOSH).

Please visit CPWR's other resources to help reduce construction safety and health hazards:

Construction Solutions http://www.cpwrconstructionsolutions.org/
Construction Solutions ROI Calculator http://www.safecalc.org/
The Electronic Library of Construction OSH http://www.elcosh.org/index.php
Falls Campaign http://stopconstructionfalls.com/
Hand Safety http://choosehandsafety.org/
Work Safely with Silica http://www.silica-safe.org/

CPWR is the research and training arm of North America's Building Trades Unions. Production of this document was supported by cooperative agreement OH 009762 from the National Institute for Occupational Safety and Health (NIOSH). The contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

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