

Fall-Related Construction Fatalities: An Analysis of Fatalities Investigations Report

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Falling from height is one of the fatal four in construction industry in the US and the leading cause of deaths due to construction accidents. In 2014, 349 out of 874 (39.9%) of the total deaths in construction sector came from falls. There are very limited previous researches focused on qualitative safety data such as Fatality Assessment and Control Evaluation (FACE) reports. Filling this research gap by exploring hidden information from 302 fall fatalities investigation reports and understanding the common features of fall fatality accidents including the comprehensive recommendations that have been provided through hundreds of fall fatality accident reports would be very helpful in understanding how to prevent accidents and deaths due to similar causes in the future. Results reveal the features of fall fatalities in construction and disclose some common fall safety patterns on construction sites. By analyzing all the recommendations that appear on these standard fatality reports this research has listed the most frequently cited recommendations for five different categories of fall related accidents that account for more than 75% of all fall fatality FACE reports compiled from 1982 to 2014.

Keywords: Safety, Fall, Accident Reports, FACE, OSHA

Introduction

The construction sector is one of the major economic sectors in the United States since the industry shared about 3.5% of the total gross domestic product (GDP) in 2010 (The Construction Chart Book, 2013). According to Occupational Safety and Health Administration (OSHA) statistical data, 874 of 4,251 (20.5%) worker fatalities in private industry in calendar year 2014 were in construction. The leading causes of fatal accidents in construction represented more than half, 58.1%, of construction worker deaths are falls, electrocution, struck by object, and caught-in/between. *Eliminating the Fatal Four would save 508 workers' lives in America every year*, (OSHA). In calendar year 2014, falls in construction were responsible for 39.9% or 349 out of 874 total deaths. According to the Construction Chart Book (2013), falling from height continues to be the major problem contributing to nearly one-third of the fatal accidents in the U.S. construction industry.

While there are numerous researches focused on quantitative data available on OSHA website there is very limited amount of research utilizing the vast amount of qualitative data such as those present in fatality investigation reports compiled by National Institute for Occupational Safety and Health (NIOSH) through the Fatality Assessment and Control Evaluation (FACE) program. Learning from accidents in the past is the most important strategy to prevent accidents. With this assertion this research explores the full text of hundreds of fall related fatality investigation reports with an aim to extract invaluable information

from construction accident reports which otherwise would remain buried and unexplored. Relying on quantitative and statistical data regarding accidents alone is not sufficient to be able to decode the underlying causes of these accidents. This research is based on the premise that analyzing text entries in addition to coded data provides far more information than looking at coded data alone. On the same note, construction accident reports can be exploited to provide much more information than they currently are relied upon. Exploring hidden information from fall fatalities investigations reports and understanding the common features of fall fatality accidents from a standard format reports as well as the comprehensive recommendations that have been provided through hundreds of fall fatality accident reports would be very helpful to prevent similar future accidents and deaths.

The Fatality Assessment and Control Evaluation (FACE) program is a research program designed to identify and study fatal occupational injuries. This program falls under the National Institute for Occupational Safety (NIOSH). By identifying and investigating work situations at high risk for injury and then formulating and disseminating prevention strategies to those who can intervene in the workplace, the FACE program looks to reach its goal of preventing occupational fatalities across the nation. FACE program consists of two components. The first component, NIOSH FACE which began in 1982, takes voluntary data from participating states resulting from targeted causes of death. The causes of these deaths have included confined spaces, electrocutions, machine-related, falls from elevation, working youth, and logging. State FACE is the second component that began in 1989. Currently, seven health or labor departments have cooperative agreements with NIOSH for conducting surveillance, targeted investigations, and prevention activities at the state level using the Face model. State FACE targets additional related fatalities in addition to the targeted fatalities of NIOSH FACE.

There are four primary activities of the FACE program. These activities include: (1) conducting surveillance to identify occupational fatalities, (2) performing investigations of specific types of events to identify injury risks, (3) developing recommendations designed to control or eliminate identified risks, and (4) making injury prevention information available to workers, employers, and safety and health professionals. At times FACE will conduct on-site investigations which is essential for sites where fatalities have occurred and for gathering facts and data from company officials, witnesses, and co-workers. The facts and data are collected by the investigators on what was happening just before, at the time of, and right after the fatal injury. A few facts and data that are collected during on-site investigations are: (1) type of industry involved, (2) number of employees in the company, (3) company safety program, (4) the victim's age, sex occupation, (5) the working environment, (6) the tasks the victim was performing, (7) the tools or equipment the victim was using, (8) the energy exchange resulting in fatal injury, and (9) the role of the management in controlling how these factors interact. The FACE program is important for various reasons but, with an average of 16 workers dying each day as a result of a traumatic injury on the job, FACE program investigations will allow the identification of factors that contribute to fatal occupational injuries. Once information is developed, it will help to create comprehensive recommendations for preventing similar deaths.

One major characteristic of FACE reports is text narrative in nature. McKenzie et al. (2010) believed that the narrative text have added value when compared to coded surveillance data because of three aspects : (a) the identification of cases through alternative classification schema; (b) the identification of sequential chain-of-event information; and (c) the identification of system errors. Higgins et al. (2001) also believed

that FACE reports have contributed to the formulation and dissemination of diverse strategies for Occupational and Safety Health (OSH) injury control. FACE reports, as a secondary data source, were beneficial for OSH research based on three strengths: (a) FACE reports represented a high level of accuracy based on NIOSH investigators' expertise and professionalism; (b) national-scale data across historical periods of time enable researchers to reflect the entire industry's trends over time; (c) accident data collection is extremely difficult since an accident cannot be designed or manipulated in a laboratory, requiring continuous inputs led by a national organization such as NIOSH. As a result Smith et al. (2006) focused on narrative text data pertaining to occupational safety and health in construction while Bentley et al. (2005), Fordyce et al. (2007) and Lincoln et al. (2004) studied narrative text data in regards to occupational safety and health in others industries. Cohen et al. (2006) investigated FACE reports and presented accidents characteristics and strategies to protect workers. Zhao et al. (2014) also analyzed electrocution reports and listed the top-cited NIOSH recommendations for electrocution prevention. Bunn et al. (2008) mentioned that each FACE investigation report contains non-routinely-analyzed elements in its report that allows for identification of factors that contribute to a fatal accident. Kunadharaju et al. (2011) investigated NIOSH recommendations from firefighter fatality investigations reports and provided accident causes and corrective actions. Effective protection strategies for firefighters were also reported after analyzing FACE reports (Kunadharaju et al., 2011).

Methodology

The scope of data collection for this research was confined to the FACE investigations with the cause of falls in construction from 1982 through 2014. As mentioned in literature review there are two types of FACE investigations reports which are NIOSH FACE and State FACE. While NIOSH FACE is conducted by NIOSH and State FACE is conducted by NIOSH's cooperative state partners the format and content of these FACE investigations reports from these two different sources follow the same pattern. Both NIOSH and State FACE investigation reports normally provide a complete description of the incident including events leading to the incidents, causal factors, event date, industry, victim information, and recommendations from investigators and safety experts. Both NIOSH and State FACE investigations reports were filtered by industry (construction), causes of deaths (fall). The data preparation was manually done on the 308 fatalities investigations reports that were retrieved from the publicly accessible FACE website, <http://www.cdc.gov/niosh/face/default.html>. After reviewing these investigations reports, 308 of qualified FACE investigations reports were selected for analysis. The author decided to investigate falls accident patterns by exploring month and weekday of fall occurrence, victim's occupation and age, height of fall in order to get a broader picture of fall related fatalities in construction. Since this study mainly emphasizes on the recommendations part of the FACE reports frequencies of similar recommendations provided by FACE investigators and safety experts are categorized and analysed.

Results and Discussion

After collecting and reviewing 308 fatalities investigations reports, the author found that there were 312 individual victims from different times of occurrence from various types of projects across the United States. There are 3 different focus points in the results. The first part focuses on time of the fall occurrence. The second part focuses on victims' demographic characteristics. The third part focuses on the circumstances behind the accidents. In order to provide better understanding and preventions in fall accidents, the recommendations from different scenes of fall fatality accidents based on FACE reports will be discussed as well.

Time of Fall Occurrence

Based on data analysis, the frequencies of fall fatality accidents occurring by year, month and weekday it was found that the fatal accidents due to fall in construction peaked in 1993 at 30 out of the 308 which makes up 10% of the total fatalities. The annual trend revealed that accidents related to fall started to go down after 2000. Also, the number of fall deaths in construction peaked in September at 11.69% and bottomed in December at 4.87%. Highest fall fatality accidents occurred on Monday at 58 out of 308 cases or 18.83%.

Fall Fatality Accidents by Construction Types, Scene of Occurrence and Height of Occurrence

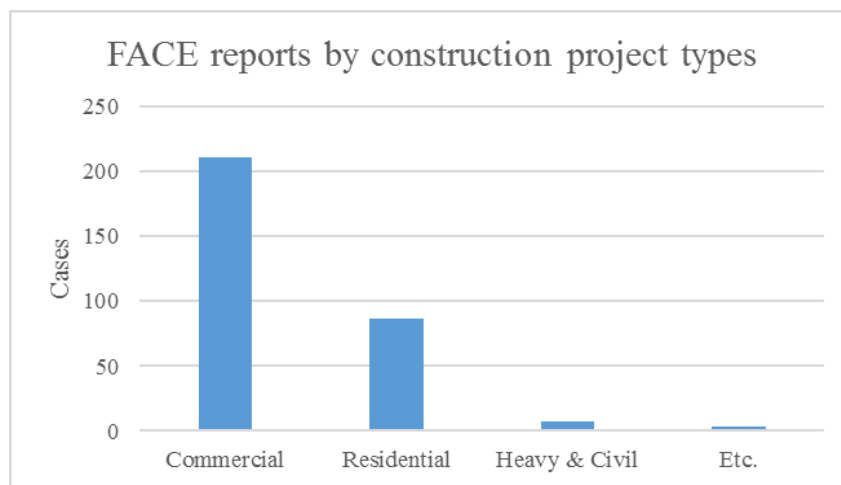


Figure 1: Project types of fatal fall occurrence

Figure 1 indicates that almost 70% or 211 out of 308 cases of fall fatality accidents based on FACE reports came from commercial construction sector while residential construction accounted only 28% of all accidents and very few from heavy or civil construction projects.

According to Figure 2, more than 75% of fall fatality occurrence came from five major scenes which are falls from roofs, scaffolds or platforms, openings, ladders, and structures under construction.

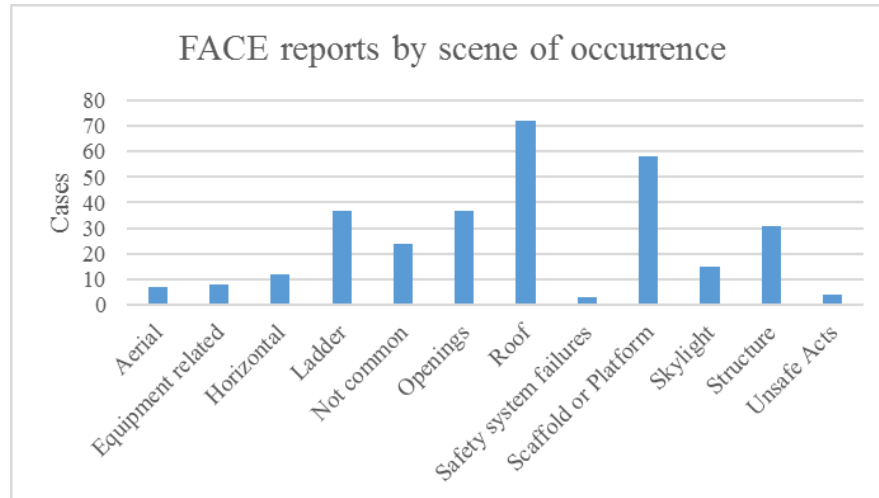


Figure 2: Scene of Fatal Fall Occurrence

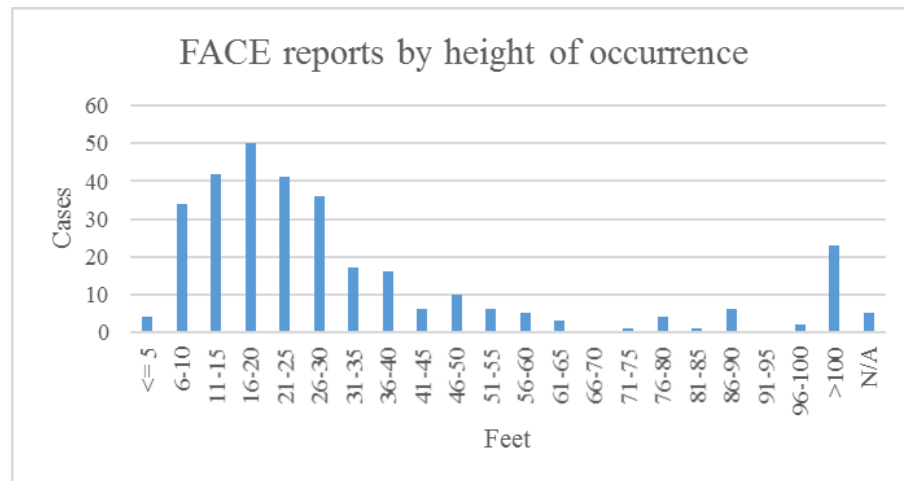


Figure 3: Height of Fatal Fall Occurrence

According to fall fatality accidents based only on the FACE reports from 1982-2014 as shown in Figure 3, more than 65% of the victims fell from 6-30 feet while more than 15% of them fell from 16-20 feet. There was a case of a fatality recorded where the victim fell from the chair while trying to change a light bulb which was only 2-3 feet tall.

Victims' Demographic Characteristics

There were 310 male victim out of 312 total victims from fall fatality during 1982-2014. According to Figure 4, more than 50% of the victims are 26-45 years old and average age of the 312 victims is only 40 years old. The minimum age of the victims is only 13 years old while the maximum age of the victim is 73 years old.

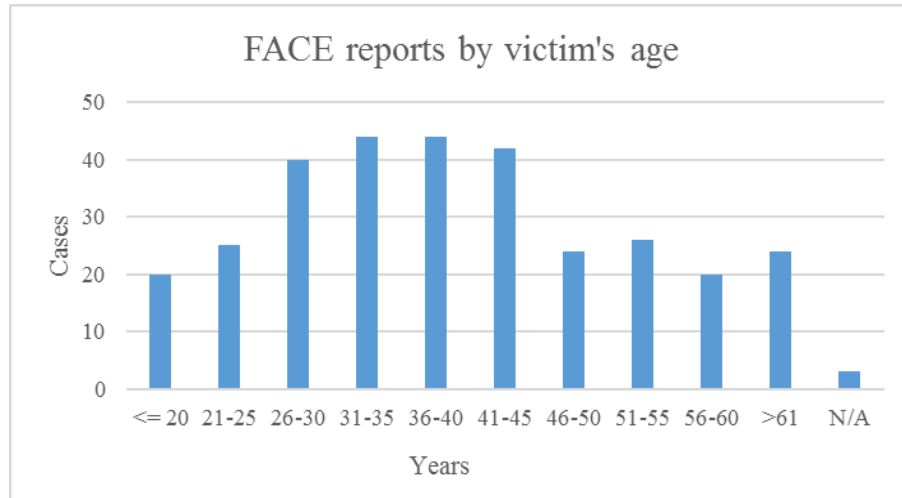


Figure 4: Fatal Fall Victim's Age

Figure 5 represents victims' occupations. More than 80% of the victims came from top 10 occupations which are laborer, roofer, carpenter, ironworker, painter, electrical related, company owner including president, mason worker, and sheet metal worker. Laborers were the most frequent victims with 73 of 312 fatalities.

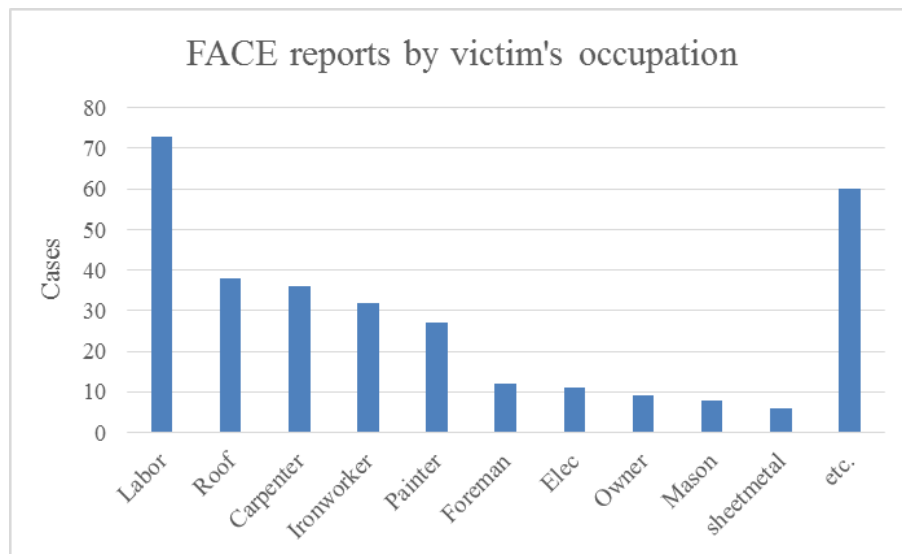


Figure 5: Fatal Fall Victim's Occupation

Top-Ranked NIOSH Recommendations

All fall fatality FACE reports were grouped into different categories based on the scenes of fall fatalities accidents in order to investigate and discuss about the recommendations that were provided at the end of each FACE report. The author divided fall fatalities FACE reports into twelve groups according to the

scenes of fall fatalities accidents. They are equipment related fall accidents, falls from horizontal construction activities such as bridge, falls from ladder, falls from aerial scaffolds or moving devices, falls from openings, falls from roofs, falls from scaffolds, falls from skylights, falls while building structure was under construction, falls from uncommon construction projects, falls from safety system failures, and falls from unsafe acts of the workers. However, only recommendations related to falls from ladder, opening, roof, scaffold or platform, and structure that is under construction has been presented in this paper since these five major scenes accounted for more than 75% of fall fatality FACE reports during 1982-2014.

NIOSH Recommendations for Falls from Ladder

A total of 37 out of 308 (12.01%) of all fall fatality accidents were related with falling from ladder in construction industry. Falls from ladder is one of the top three fall fatality accidents based on FACE reports during 1982-2014. After reviewing all 37 falls from ladder accident reports, there were 29 recommendations provided at the end of the reports while 14 of them were cited from many reports. Of these recommendations, about 45.6% (n=17) suggested a need to develop, implement, and enforce a comprehensive written safety program that included adequate safety training in fall hazard recognition and the use of fall protection devices complying OSHA regulations. Ensuring supervisory positions that are knowledgeable regarding safe work practices and able to recognize whether employees are effectively protected was the second most frequently appearing recommendation at 29.7% or n = 11 in these reports.

NIOSH Recommendations for Falls from Openings

There were also 37 out of 308 (12.01%) fall fatality accidents related to falling from openings in construction industry. Falling from openings is one of the top three fall fatality accidents based on FACE reports during 1982-2014. There were 17 recommendations that were provided at the end of the report while 13 of them were cited from many reports. Within the examined 37 falls from opening fatality reports, 94.6% (n=35) suggested a need for secured guardrails and toe boards that can only be removed by a competent person and use fall arrest systems when guardrails are removed as well as placing signs or placards showing that workers should not step on an opening. Developing, implementing, and enforcing a comprehensive written safety program that included adequate safety training in fall hazard recognition and the use of fall protection devices according to OSHA regulations were the second most frequently appeared recommendation at 54.1% or n = 20.

NIOSH Recommendations for Falls from Roof

Falling from roof constituted 72 out of 308 (23.38%) of all fall fatality accidents which is the major cause of deaths based on FACE reports. There were 25 recommendations that were provided at the end of the reports while 13 of them were cited from many reports. In a majority of these accident reports, that is 68% (n=49), suggested a need to ensure that employees use appropriate fall protection system if the potential for a serious of fatal fall exists. Developing, implementing, and enforcing a comprehensive written safety program that included adequate safety training in fall hazard recognition and the use of fall protection devices complying OSHA regulations was the second most frequently appeared recommendation at 51.4% or n = 37.

NIOSH Recommendations for Falls from Scaffold or Platform

Falling from scaffolds or platforms was reported to be the second major cause of accidents in construction. There were 58 out of 308 or 18.8% of fall fatality accidents related with falling from scaffolds/platforms. After reviewing all 58 falls from scaffold or platform accident reports, it was found that there were 31 recommendations that were provided at the end of the reports while 20 of them were cited from many reports.

Of all the 58 fatalities resulting from scaffold or platform, 53.4% (n=31) suggested a need for the employer to provide appropriate fall protection system as well as personal protective equipment for all workers who may be exposed to a fall hazard. Developing, implementing, and enforcing a comprehensive written safety program that included adequate safety training in fall hazard recognition and the use of fall protection devices complying OSHA regulations was the second most frequently appeared recommendation at 51.7% or n = 30.

NIOSH Recommendations for Falls from Structure that was Under Construction

Of all the 308 fall related deaths, 38 (12.3%) were related with falling from structure that was under construction. A total of 25 recommendations were provided at the end of the reports while 12 of them were cited from many reports for this category of fatal accident. Within the examined 38 fall related fatalities from structure that was under construction, 44.7% (n=17) suggested a need for employer to insure that fall protection was appropriately used along with fall arrest systems. Developing, implementing, and enforcing a comprehensive written safety program that included adequate safety training in fall hazard recognition and the use of fall protection devices complying OSHA regulations was the second most frequently appearing recommendation at 44.7% or n = 17.

Conclusion

According to OSHA, falling from height is one of the fatal four in the United States construction. The author explored Fatality Assessment and Control Evaluation (FACE) reports that are provided by the National Institute for Safety and Health (NIOSH) with a conviction that learning from previous failures would be very useful in understanding and devising effective prevention plans. Literature review along with the cases of deaths from 308 fall fatality accidents reports from FACE program were studied and analyzed. A majority of the published literatures are focused on accident contributory factors such as society, organization, work group, site condition, individual factors, contractor, supervision, and project management while there were very few studies focusing on freely accessible safety reports from safety organization such as NIOSH. After reviewing 308 fall fatality accidents reports the author found that number of fall accidents in construction has been decreasing from 1990's but fall is still one of the fatal four in the United States construction sector. Based only on these reports it was found that September had the highest cases of fall fatalities while December had the lowest number.

Most of the fall fatality accidents based on FACE reports were in commercial construction. Falling from roof, scaffold, ladder, opening, and structure that was under construction were the top rank scenes of the fatality accidents, and more than 65% of the victims fell from 6-30 feet.

Almost hundred percent of the victims are male and more than 50% of the victims are between the ages of 26 and 45 while average age of the victim is only 40 years old. Laborer, roofer, carpenter, ironworker, and painter represent more than 65 percent of all the victims based on occupations.

After exploring all recommendations at the end of every FACE reports, the author found that the safety experts recommend all construction employers to develop, implement, and enforce a comprehensive written safety program complying OSHA regulations, provide adequate training and fall protection system as well as personal protection equipment. The recommendations also cover job hazard analysis, safety inspections, and emphasize more on safety aspect during planning phase of the projects.

While the research paper presented textual information in statistical form, the ultimate intention of the research is to conduct a factor analysis not only for the causes and features of fall related accidents but also for recommendations that are a major and useful component of these FACE reports. Accident prediction along with preventive strategies can then be modeled more accurately when causal factors and their prevention methods are accurately deciphered from the past cases.

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