

AN INVESTIGATION OF FALL PROTECTION SYSTEMS
IN THE ROOFING INDUSTRY

by

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Abstract of Thesis

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Occupational and Environmental Safety and Health

An Investigation of Fall Protection Systems in the Roofing Industry

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Abstract

Construction is one of most dangerous industries in the United States. One of the most hazardous areas within the construction industry is roofing. Concern for safety in roofing construction has continued to spread, as a result of falls that make up the greatest rate of fatalities in the construction industry. Previous research has found that falls have been one of the leading categories under type of occupational death and that fall protection systems are not consistently used to prevent fall accidents in the roofing industry. Research is needed in order to analyze falls and other potential hazards in roofing. The main goal for this study is to analyze commercial and residential roofers' behaviors, attitudes, and beliefs on the fall protection systems. A survey was distributed to commercial and residential roofers in the Midwest. Information collected from roofers was compared and analyzed to find differences between residential and commercial roofers. A total of 129 roofing contractors participated in this study. The results of the survey showed that while most of commercial roofers did use fall protection devices, a significant number of residential roofers did not comply with fall protection regulations and guidelines. Two main reasons of noncompliance with fall protection regulations and guidelines in roofing construction were found: (1) fall protection devices decrease productivity; (2) fall protection equipment makes roofers uncomfortable. Results from this study revealed that personal fall arrest system (PFAS) was the most prevalent fall

protection device used among residential and commercial roofers. PFAS was also the most preferred fall protection equipment among the two groups of roofers. For both residential and commercial roofing, there is a significant ($p = 0.05$ and $p = 0.01$) negative relationship between enforcing roofers to wear or install fall protection devices and having falls from roofs. In both residential and commercial roofing, there is a very significant ($p = 0.001$ and $p = 0.001$) positive relationship between the enforcement and the actual usage of fall protection equipment. This thesis presents the results of the investigation of fall protection systems in roofing construction and recommendations that ultimately would reduce fall accidents.

CHAPTER I

INTRODUCTION

Construction remains one of the largest industries in the United States, historically constituting about 10 percent of the nation's gross national product and employing about 6.7 million workers (Nunnally, 2001; Bureau of Labor Statistics [BLS], 2004). Workers in the industry frequently work with potentially dangerous tools or building materials at great heights. Consequently, they are the most susceptible to work-related injuries (BLS, 2004). Especially, fatalities are a serious problem in the construction industry. Findley et al. (2004) stated that construction is the most dangerous of all industries based on the total number of on-the-job fatalities. According to BLS (2002), construction employers continued to report the largest rate of fatal work injuries of all U.S. industries. Fatalities increased 6 percent in 2001 to their highest level since the fatality census began in 1992. In 2003, 1,126 fatal occupational injuries occurred in construction (BLS, 2004).

Occupational Safety and Health Administration (OSHA, 2005) reported that every year falls constitute the greatest number of fatalities in the construction industry. Ellis (2001) mentioned that falls frequently cause occupational fatalities in the United States. According to BLS (2002), falls resulting in fatalities increased to 808 in 2001, a rise of 10 percent when compared with 2000 levels and this was the worst case total since the fatality census was first conducted in 1992. A total of 408 fatal falls to lower levels in the construction industry were reported in 2001 while 367 cases occurred in 2000.

Cases of nonfatal falls in the construction industry are also notorious. Webster

(2000) reported that falls are one of the leading causes of nonfatal cases involving days away from work. According to BLS (2005), the leading types of events or exposures were contact with objects or equipment, overexertion, fall, and struck by an object (Figure 1.1). Together, these 4 groups accounted for more than two-thirds of all injuries to construction workers during the last 10 years. Figure 1.1 also shows other types of incidents or exposures. Falls were the third frequent type of nonfatal cases selected characteristics by detailed events or exposures among the category.

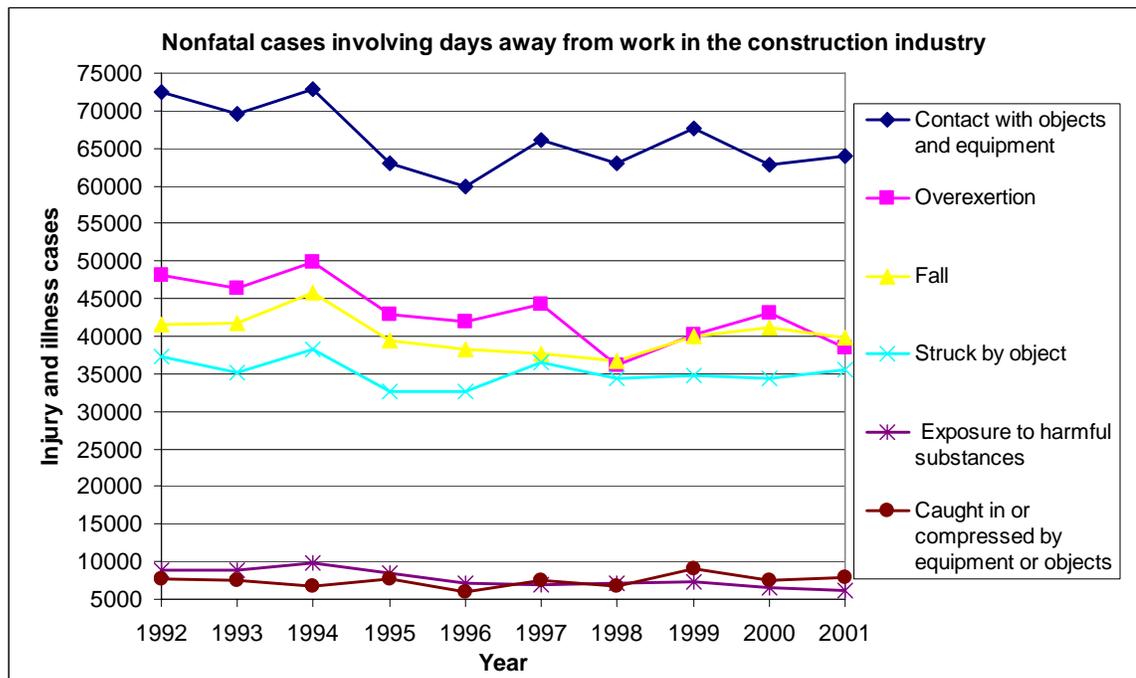


Figure 1.1: Nonfatal cases involving days away from work in the construction industry from 1992 to 2001 in the USA (Bureau of Labor Statistics)

One of the most hazardous sectors in the construction industry is roofing.

According to BLS (2004), roofing is strenuous and dangerous work and it demands heavy lifting, climbing, bending, and kneeling. Roofers are at greater risk of slipping or falling

from scaffolds, ladders, or roofs. Hinze et al. (2002) reported that the rate of falls has increased for the time period from January 1990 through October 2001. Janicak (1998) reported that miscellaneous trades comprised the largest number of fatal work-related falls with 21.4%, followed by roofing 19.3% and non-residential building with 12.0%. The results from the study showed that about 20% of all fatal falls occurred from work heights of 12 feet or less. As shown in Figure 1.2, the fatal injury cases of roofers have been higher than those of any other workers, such as truck drivers, janitors, welders, cutters, and nurses.

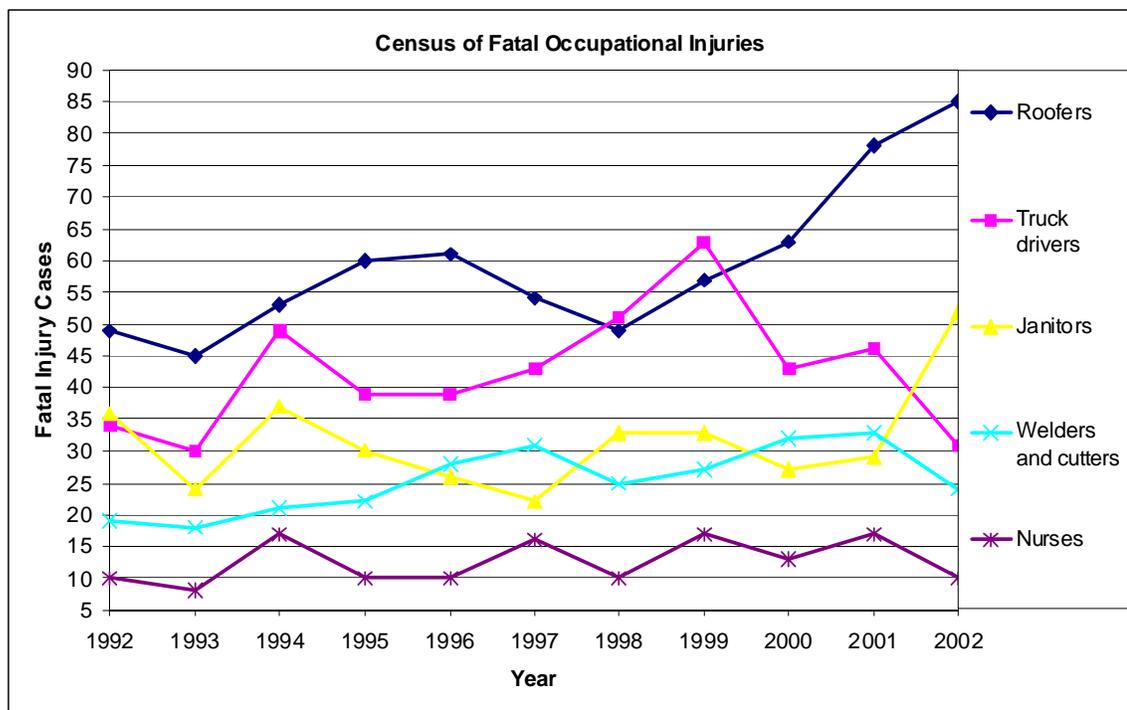


Figure 1.2: Total fatal occupational injuries from 1992 to 2002 for Roofers, Truck drivers, Janitors, Welders and cutters, and Nurses in the USA (BLS)

According to OSHA (2005), events surrounding fall types of accidents are

related to a number of factors, including unstable working surfaces, incomplete or improper use of fall protection devices, and human error. Hinze et al. (2002) discussed some situations that cause falls from roofs. The situations are that work is performed by roofers who are not tied-off and personal fall arrest system (PFAS) (Figure 1.3) are unhooked to facilitate movement on roofs. They concluded that adequate provision and proper use of fall protection devices are necessary to prevent deaths and injuries that result from falls.



Figure 1.3: Personal Fall Arrest System (Acro Building Systems)

Pilla and Vidal (2002) stated that falls in the workplace can be preventable. Previous studies (Johnson et al., 1988; Personick, 1990; Suruda et al., 1995, OSHA, 2005) have shown that the proper use of guardrails (Figure 1.4), PFAS, and safety nets (Figure 1.5) can prevent many fatalities and injuries from falls. In this study, data on fall protection systems were gathered and hazardous factors in the roofing industry were

analyzed.



Figure 1.4: Guardrail (Acro Building Systems and OSHA)



Figure 1.5: Safety net (ABC Supply and South West Safety Nets)

CHAPTER II

REVIEW OF LITERATURE

Analysis of Data in the Construction Industry

Nunnally (2001) mentioned that construction is inherently a dangerous work and the construction industry has been at the greatest risk of accidents among all industries. Molenaar et al. (2002) pointed out that although great efforts have been made toward a safe working environment in the construction industry, many companies' safety plans have not been effective. Kines (2002) researched construction workers' falls through roofs. He stated that construction is a tough and hazardous industry and it is both unique and arduous to study. Findley et al. (2004) stated that construction workers experience the highest number of injuries with days away from work of all U.S. industries.

Analysis of Data in the Roofing Industry

Personick (1990) stated that workers in the roofing industry are at the greatest risk of occupational injuries. However, roofers work at heights without adequate fall protection devices. This risky work practice explains why falls are the main cause of injury in roofing. Derr et al. (2001) reported that 6660 construction fatalities were analyzed from all OSHA investigated events from 1990 to 1999. Thirty-five percent of the construction fatalities were categorized as either "Fall (Same Level)" or "Fall (From Elevation)." Of these, roofing, siding, and sheet metal workers had the highest number of fatalities. The authors pointed out that although OSHA reported that 22 fewer fatalities per year (roughly 10%) for all construction would occur due to the 1995 Subpart M

standard-Fall Protection, a noticeable decrease that the implementation of the new standard would bring about was not seen with regression analysis.

Falls from roofs

Personick (1990) stated that falls from rooftops are an important cause of accidents, consisting of 30% of the cases recorded in roofing. Suruda et al. (1995) researched fatal work-related falls from roofs. They reported that annually over 500 workers died from falls and about 20% of these falls are from roofs. Construction workers suffered 232 of the 288 fatal falls (80%). The authors found that falls from roofs are the leading category under type of accident or exposure. Janicak (1998) indicated that the majority of the falls in the construction industry occur from roofs, ladders, or scaffolds.

Fall-related deaths and injuries

Lin et al. (1995) studied slip and fall accident prevention. They indicated that falls have been the second main reason of accidental deaths, since the early 19th century. Janicak (1998) researched fall-related deaths in the construction industry. He indicated that the deaths resulting from falls continue to be a major concern. Helmkamp and Lundstrom (2000) researched work-related deaths in West Virginia from July 1996 to June 1999. Their study showed that work-related fatal injuries occurred consistently in the transportation and public utilities, manufacturing, construction, and mining sectors. They identified leading categories under type of work-related deaths as motor vehicle

crash, struck by object, machinery-related, and falls from an elevation.

Ellis (2001) mentioned that elevated falls frequently result in serious or fatal injuries. Halperin and McCann (2004) stated that falls from heights are a major cause of death for workers at construction sites. Hinze et al. (2002) reported that falls represented 34.6% of the injuries from January 1990 through October 2001 from a total of 7,543 OSHA-investigated accidents. Lipscomb et al. (2004) stated that falls resulting in severe injuries to workers at construction sites make up a disproportionate share of costs and lost work time compared with other types of injuries. According to OSHA (2005), in 1995, 1,048 deaths occurred in construction and falls accounted for 32% or 335 cases. Annually, falls consistently have the greatest frequency of fatalities in the construction industry, and are always a main concern in other industries.

Injury Costs in the Construction Industry

The literature shows that the costs of construction accidents are considerable. Levitt (1987) noted that in 1981 in the USA the annual cost of Worker's Compensation Insurance premiums exceeded 6 billion dollars, which represented about \$2,000 per worker employed. Other direct and indirect costs, such as time taken by supervisors to report the accidents, damage or loss of material and equipment, reduction in productivity in crew during and after the accident, and so forth, average about four times the amount of compensation paid to workers. These costs combined with insurance premiums exceed a total of twenty billion dollars per year or about 6% of total construction costs. Since the profit margin in construction may vary between 1-5% of gross revenues, the cost of

accidents exceeds the gross profit (Helander, 1991). There are similar estimates from Sweden and Finland (Niskanen & Saarsalmi, 1983) and in Canada it has been estimated that the average premium for Workmen's Compensation is Canadian \$3,350 with a range of variation from \$1,342 - \$7,370, without considering indirect costs (Randerson, 1987).

Hinze et al. (2002) mentioned that the average penalty on fall injuries is higher than on the total of any other accident among all construction accidents. They reported that the average and median values of the imposed penalty for fall-related accidents were \$8,917 and \$2,250 respectively and comparing to \$7,757 and \$1,800 for all accidents. They also found that "there are more serious violations in fall inspections than in overall inspections." According to BLS (2005), falls account for the most citations to Construction Special Trade Contractors. Findley et al. (2004) reported that the costs of fatalities and serious injuries result in both human suffering and economic losses in construction. Choi et al. (2003) reviewed costs of injuries in the roofing industry. They stated that injuries within the roofing industry bring about a major concern for health and safety. Additional difficulties of these injuries are the costs they invoke on many employers and insurers.

Literature has indicated that falls have continued to be a serious issue in the construction industry and roofers who are not protected from falls have over twice as many accidents as roofers who are protected (Johnson et al., 1988; Personick, 1990; Suruda et al., 1995). There is a tremendous amount of evidence in the literature that fall protection systems can prevent falls (Johnson et al., 1988; Personick, 1990; Suruda et al., 1995; OSHA, 2005; Pilla & Vidal, 2002). No current article contradicts the fact that falls

from roofs have been a significant issue to roofers and that the best way to prevent falls is to use fall protection systems.

OSHA Standards and Roofing Safety

Most of the information concerning current safety procedures was found through review of the OSHA Fall Protection Standards (OSHA, 2005). This information goes over proper safety precautions and discusses systems and procedures designed to prevent employees from falling off, onto, or through working levels. Title 29 CFR 1926.500 sets standards and fall protection policies for workers. Subparts L, M, R, X provide rules for roofers to reduce injury and fatalities. These rules cover various areas or activities where fall protection becomes necessary. OSHA's fall protection standard recognized an elevation of 1.8 m (6 ft) above ground level as a critical elevation that requires the use of fall protection instrumentation.

Fall Protection Systems

The OSHA (1998) suggested several methods to control fall hazards. These methods include the elimination or substitution of the operation that can lead to falls, the use of engineering controls, informing/reminding workers-at-risk to avoid fall hazards (through warnings and administrative controls such as training and inspection), and the appropriate use of personal protective equipment (PPE). According to the revised OSHA (1998) regulations (Title 29 CFR 1926.501(b)(10)), each employee engaged in roofing activities on low-slope roofs (i.e., a rise to run slope less than 4 inches (10.16 cm) per 12

inches (30.48 cm) (18°)) with unprotected sides and edges 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, or personal fall arrest systems. This also could be a combination of a warning line system and guardrail system, warning line system and safety net system and safety monitoring system. On roofs 50 feet (15.25 m) or less in width, the use of a safety monitoring system without a warning line system is permitted. In the revised OSHA (1998) regulations (Title 29 CFR 1926.501 (b)(11)), each employee on a steep roof (i.e., a slope greater than 4 inches (10.16 cm) per 12 inches (30.48 cm)) with unprotected sides and edges, 6 feet (1.8 m) or more above lower levels, shall be protected by either guardrail systems with toeboards, a safety net system, or a personal fall arrest system.

Guardrail Systems

A guardrail system is a “barrier erected to prevent employees from falling to lower levels” (OSHA, 1998). Guardrails systems should be present on construction sites where workers are called to work on elevations of 6 feet (1.8 m) or more above ground level. OSHA regulated guardrails are constructed from 2 inches (5 cm) x 4 inches (15 cm) lumbars and can range between 39 inches (1 m) and 45 inches (1.14 m) above the working level. There are various ways of setting them up: counterweighing, mounting on the roof as joists or attaching to the wall or roof of the building (Scharff, 1996).

Safety Net Systems

A safety net system is a meshed netted structure located under the surface where

employees are working, which prevents them from making contact with the surfaces at lower levels during a fall. OSHA provides various regulations on safety net systems in order to ensure that they perform safely and accurately. When working on high elevations, the systems should be installed no more than 9.1 m (30 ft) below the working surface and should have sufficient clearance to avoid contact with surfaces at lower levels on lower elevations. Mesh sizes are limited to 15 cm (6 in) by 15 cm (6 in) and should be properly secured to prevent enlargement of mesh openings during a fall (OSHA, 1998).

Personal Fall Arrest and Fall Restraint Systems

A personal fall arrest system is described by OSHA as a “system including but not limited to an anchorage, connectors, and a body harness used to arrest an employee in a fall from a working level” (OSHA, 1998). These are used to protect employees under situations where falls can be potentially very harmful and will prevent the employee from making contact with a potentially dangerous surface below through deceleration.

Personal fall arrest systems should be carefully inspected for wear damage and other types of deterioration before being used by employees.

Fall restraint systems “prevent [workers] from reaching or going over the unprotected edge of a walking or working surface” (OSHA, 1998). Although these systems are not addressed by OSHA’s Fall Protection Standards, certain states make it a requirement for fall protection. The system consists of a body harness attached to a tether, which is then attached to one, or multiple anchor points. When working on pitches less

than 4 inches (10.16 cm) per 12 inches (30.48 cm), the system should prevent a worker from going over an unprotected edge and on pitches from 4 inches (10.16 cm) per 12 inches (30.48 cm) (18°) to 8 inches (20.32 cm) per 12 inches (30.48 cm) (34°), it should prevent the employee from sliding more than two feet (OSHA, 1998).

Warning Line Systems

A warning line system is “a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge and which designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net systems” (OSHA, 1998). Warning line systems are composed of stanchions and rope or wire, rigged and supported so as to comply with OSHA regulations. The systems are usually used on flat roof work (Scharff, 1996). OSHA regulates that warning line systems be erected no less than 6 feet (1.8 meters) from the roof edge to prevent falls (OSHA 1998).

Slide guard



Figure 2.1: Slide guard (Roofer 911).

Barricading Roof Openings

Because a considerable amount of falls occurs through openings in roofs as well as over the edges of roofs, it is important to provide procedures to prevent those types of falls by properly guarding rooftop openings. There are various barricade options for guarding floor openings. These include:

- Hinged covers, constantly attended whenever the cover is open
 - Portable railings should be placed on all exposed sides except at entrances to stairways
 - Railing should be placed around temporary floor openings
- (Scharff, 1996).

Toeboards can also be used to guard roof openings. Not only do toeboards protect workers at elevated levels, it also protects the workers below by preventing tools and equipment from falling through openings. OSHA describes a toeboard as “a low protective barrier that prevents material and equipment from falling to lower levels and protects personnel from falling (OSHA, 1998). Toeboards are used in addition to barricades and are erected on all exposed sides of the opening. They are usually made of strips of wood or metal, and are three to six inches in height (Scharff, 1996).

Safety Monitoring Systems

A safety monitoring system is described by OSHA as a “safety system in which a competent person is responsible for recognizing and warning employees of fall hazards” (OSHA, 1998). Safety monitoring systems are usually used in the absence of other protective measures. Employers designate safety monitors by ensuring that the monitor is able to perform the following tasks: (1) clearly recognize fall hazards; (2) warn workers of fall hazard dangers and unsafe work practices; (3) operate on the same surface of the other employees in order to have a clear view of them; and (4) work within a reasonable distance to efficiently communicate with workers and not be distracted.

Fall Protection Guidelines for Residential Construction

Fall protection requirements for residential construction are set out in Title 29 CFR 1926.501(b) (13). In general, that provision requires conventional fall protection for

work at or over 6 feet (1.8 m). However, OSHA Instruction STD 3.1 (OSHA, 1999) modifies those requirements. It permits employers engaged in certain residential construction activities to routinely use alternative procedures instead of conventional fall protection. A fall protection plan is required but it does not have to be written nor does it have to be specific to the jobsite. Different alternative procedures are specified for different activities. The definition of residential construction is: (1) An employer is engaged in residential construction where the working environment, materials, methods and procedures are essentially the same as those used in building a typical single-family home or townhouse; (2) Materials with wood framing (not steel or concrete) and wooden floor joists and roof structures while requiring traditional wood frame construction techniques; (3) The construction of a discrete part of a large commercial building (not the entire building), such as a wood frame, shingled entranceway to a mall, may fit within the definition of residential construction.

There are four groups of residential construction activities for which alternative fall protection plans are available. The groups are: (1) Installation of floor joists, floor sheathing, and roof sheathing, erecting exterior walls, setting and bracing roof trusses and rafters; (2) Working on concrete and block foundation walls and related formwork; (3) Installing drywall, insulation, Heating, Ventilation, and Air-Conditioning (HVAC) systems, electrical systems (including alarms, telephone lines, and cable TV), plumbing and carpentry; and (4) Roofing work (removal, repair, or installation of weatherproofing roofing materials such as shingles, tile and tar paper), which will be described in detail.

Roofing Work

The alternative procedures in OSHA Instruction STD 3.1 (OSHA, 1999) may only be used for roofing work where: (a) the roof slope is 8 inches (20.32 cm) per 12 inches (30.48 cm) (34°) or less; (b) the fall distance, measured from the eave to the ground level, is 25 feet (7.6 m) or less. The general requirements for the alternative procedures are described as follows:

- **Trained Workers Only** – Only workers who have been trained to be proficient in the alternative methods of fall protection shall be allowed onto the roof. In addition, each affected employee shall be trained to ensure specific awareness of the fall hazards associated with work on roofs with rake edges ("rake edges" are inclined roof edges, such as those on the gable end of a building).
- **Slip Hazards** – The roof surfaces shall be inspected for slipping hazards. The employer shall either eliminate any such hazards or take effective measures to have workers avoid them. The employer shall have workers wear appropriate footwear to reduce the potential for slipping.
- **Bad Weather** – When adverse weather (such as high winds, rain, snow, or sleet) creates a hazardous condition, roofing operations shall be suspended until the hazardous condition no longer exists.
- **Roof holes/openings** – The employer shall have any damaged portions of the roof deck repaired as soon as practicable. Any holes (including skylight openings) or other areas where employees would not have safe footing shall be covered or surrounded by guardrails.

- Ladders/Scaffolds – If ladders or scaffolds are used, they shall be erected and maintained in accordance with the requirements of OSHA's construction standards (OSHA, 1998).
- Access to Roof – Employers shall not allow workers to ascend or descend the roof's slope within 6 ft (1.8 m) of the rake edge except where that limitation would prevent the performance of work.
- Location of Materials – Supplies and materials shall not be stored within 6 ft (1.8 m) of the rake edge, or 3 ft (0.9 m) (where tile roof systems are being installed).
- Impalement Hazards – The area below the eaves and rakes shall be kept clear of materials and other objects that could pose impalement or other hazards, or properly guarded.

Tables 1 and 2 present specific requirements of different roof slope, eave height, and roof types.

Table 1

Safety Monitors and Slide Guards for Roofs with An Eave Height of Up to and Including 7.6 m (OSHA, 1999)

Roof Slope	Eave Height	Roof Type	Requirement
Up to 18°	Up to 7.6 m	Any Roof Type	Safety Monitoring System or Roofing Slide Guards
18° to 34°	Up to 7.6 m	Except Tile or Metal	Roofing Slide Guards
Up to 34°	Up to 7.6 m	Tile or Metal Roofs	Safety Monitoring System
Over 34°	Up to 7.6 m	Any Roof Type	Not Available
Any Slope	Over 7.6 m	Any Roof Type	Not Available

Table 2

Slide Guards Requirements for Materials, Configuration, and Installation
(OSHA, 1999)

Roof Slope	Material	Installation	Configuration
26° or less	5 cm×15 cm (nominal) stock	<ul style="list-style-type: none"> No more than three rows of roofing materials shall be installed before installing the slide guards The roof jacks shall be installed using nails long enough to withstand an employee sliding into the guard 	<ul style="list-style-type: none"> The face of the slide guard must be perpendicular (about 90 degrees) to the surface of the roof There must be continuous slide guards along the eave
26° to 34°	5 cm×15 cm stock	<ul style="list-style-type: none"> Continuous slide guards shall be installed along the eave Additional slide guards shall be installed below each work area at intervals not to exceed eight feet While standing on the slide guard below, secures the roof jacks for the next slide guard with nails and then installs the planks The employee then climbs up to the new slide guard to continue the roofing work 	<ul style="list-style-type: none"> The continuous slide guards at the eave must be at about 90 degrees to the roof surface Additional slide guards need not be continuous, but they must be long enough to protect the work area The additional slide guards do not have to be at 90 degrees to the roof surface

Johnson et al. (1998) examined PFAS, roof jack systems, warning line systems, scaffolds, and guardrail systems. They stated that fall protection devices must be economical, flexible, feasible, simple, and protective. The results of the research showed

that only PFAS are quite feasible, moderately simple, protective, flexible and economical. They concluded that any fall protection system that was able to completely meet all of the criteria was not found. Hsiao and Simeonov (2001) discussed fall protection systems in a critical review of preventing falls from roofs. They stated that conventional fall protection systems are guardrail systems, safety net systems, and PFAS. Warning-line systems and safety-monitoring systems are often used in combination with conventional fall protection systems. They pointed out that roofers have to use PFAS in roof-work environments. Hinze et al. (2002) mentioned that the provision of proper fall protection devices on roofs is necessary to prevent falls.

Janicak (1998) pointed out that 4 major prevention areas should be emphasized as a means of preventing fatal work-related falls in construction. Employee training, the enforcement of the use of fall protection systems, and inspection and testing of the fall protection systems in use are included in the major prevention areas. Kines (2003) stated that the prevention of falls from heights is a common concern for workers, employers, the health sector, health and safety professionals, and insurance companies. The study focused on 26 semi structured personal interviews and on-site investigations with male workers who had falls from heights. He pointed out that all 26 hazards were not only detectable but also preventable.

CHAPTER III

RATIONALE AND OBJECTIVES

Construction has been one of the largest industries and one of the most dangerous ones in the United States (Nunnally 2001, BLS 2002, Findley et al. 2004). Kisner and Fosbroke (1994) found that construction has continued to report high occupational injuries and fatalities. Although the construction industry remains the sixth largest employer, fatal injuries and lost workday injuries occur more frequently when compared to all industries in the United States. Derr et al. (2001) reported that construction consisted of 19.8% of the 6023 occupational fatalities in the United States during 1999. The proportion of the fatalities is far greater than that of fatalities in any other major industrial classification. In addition, falls made up 31.8% of the 1190 fatalities in construction in 1999. Lipscomb (2004) reported that analyses of death certificates between 1980 and 1989 showed that in construction, occupational falls comprised 2798 deaths, recording nearly half (49.6%) of fatal occupational falls in all U.S. industries. OSHA (2005) reported that occupational fatalities that result from falls are a serious public health problem in the United States.

Hinze et al. (2002) reviewed fall accidents in construction. Results of the study showed that fall accidents are the main cause of many serious injuries. Incomplete or improper use of fall protection, and inoperative safety equipment accounted for more than 30% of the falls. They concluded that workers can be protected by PFAS after they have falls from an elevation and more lives might be saved by more flexible PFAS. Janicak (1998) reported causes of fatal work-related deaths in the construction industry.

No fall protection consisted of the greatest percentage with 35.3% of all deaths from falls, followed by structural collapse with 22.6% and fall protection not attached with 6.4%.

Hinze et al. (2002) found falls from roofs remain the most frequent accidents in commercial buildings and single family or duplex dwelling projects and many falls result from roofs, from/with structures, from/with scaffolds, from/with ladders, and through openings.

Studies (Johnson et al., 1998; Derr et al., 2001) showed that the unsafe situations in the roofing industry have not been substantially changed after 1996, when the OSHA regulations on personal protection equipment were noticeably changed.

It is evident that many fall hazards still exist and that the unsafe situations have not changed. Therefore, it is essential that fall protection systems and other hazardous factors that cause falls be investigated to change the unsafe situations in commercial and residential roofing. The main goal for this study is to analyze and compare commercial and residential roofers' behaviors, thoughts, opinions, and beliefs on the fall protection systems.

Thus, the objectives of this research are to:

1. Assess the current status of compliance with fall protection regulations and guidelines in commercial and residential roof constructions,
2. Analyze the sources of noncompliance with fall protection regulations and guidelines in roofing construction,
3. Compare residential and commercial roofers in terms of fall protection equipment usage and preference,

4. Examine existing methods of fall protection for commercial and residential roof constructions for their ability to meet those requirements,
5. Incorporate the results of the investigation into specific cautions and other actions for regulatory agency implementation.

CHAPTER IV

METHODS AND PROCEDURES

In order to find roofers' thoughts, a written survey was developed as one research method in this study. The primary focus of this chapter was to present specific information about participants, research design, procedures of the survey, and the development of the questionnaire.

The survey was designed to gather information from 4 major sections. It begins by collecting brief background information about roofers. It is followed by questions concerning injuries, the use of fall protection devices and work conditions.

The survey was sent along with an application to the University of Wisconsin-Whitewater Institutional Review Board (UW-W IRB - Appendix A) to gain legal permission to conduct the survey. After the UW-W IRB approval, 1 residential roofing and 1 commercial roofing site were visited in Wisconsin region to conduct an initial survey. A total of 3 residential roofers and 3 commercial roofers participated in this initial survey. The participants were asked if any of the questions that were included in the questionnaires were confusing. Since no vague questions were found by the participants of the survey instrument, the survey was used at other roofing sites in the Midwest (Wisconsin, Illinois, Michigan, Indiana, and Iowa). Data on the investigation of fall protection systems in the roofing industry was measured along with demographic information and the self-reported data on work-related injuries. A copy of the final survey is found in Appendix B.

Scope of the study

In order to achieve the project objectives, a survey was designed. Participants were contacted at roofing sites in WI, IL, MI, IN, and IA from May to June 2005. Approximately 35 different residential roofing sites and about 15 commercial roofing sites were visited in the Midwest. The survey was aimed at gathering information that helped determine specific factors that contribute to injuries in the roofing industry, finding the reasons why roofers use or do not use fall protection systems, and examining existing methods of fall protection in residential and commercial roofing.

- Participants were residential and commercial roofers.
- The participants were 129 roofers in the Midwest (WI, IL, MI, IN, and IA).
- Duration of this research was from September 2004 to September 2005.

Procedural description

The first step was to determine research area (states) within the Midwest to conduct the survey. WI, IL, MI, IN, and IA were selected in the Midwest. The second step was to select cities which were around Whitewater, Wisconsin. In total, 25 cities were selected within the 5 states. The third step was to find and visit roofing sites in the 25 cities from May to June 2005. The fourth step was to meet employers, safety managers, or foremen at the jobsites. The fifth step was to explain the purpose of this study to them and gain permission to meet roofers. After their approval, roofers were contacted at safe places around the roofing sites. The last step was to explain the purpose of the study again to the roofers and ask for participation in the survey. Participants were

workers who wanted to participate voluntarily in the survey. Then, surveys were distributed by the researcher to the participants. After completing the surveys, the participants returned the surveys to the researcher. By July 2005, the results of the survey were analyzed and recorded.

Description of the instrument (Appendix B)

The basic information for questionnaires was collected from the BLS online database and analyzed to find what types of injuries occurred in roof construction and how those injuries happened.

There were 3 types of questions included in the survey. The first type of question required participants to place a checkmark on one or all the applicable choices from a given list. The second type asked them to record a written response. The third type asked for participants to allot percentages among choices in a given list in order to designate common walking conditions and common ranges of pitch on roofs (see Appendix B for the survey instrument).

The survey instrument asked how the current status of compliance with fall protection regulations and guidelines in commercial and residential roof constructions is, what sources of noncompliance with fall protection regulations and guidelines in the roofing industry are, and what existing methods of fall protection in residential and commercial roofing are. One of the survey instrument concerns was to find any different working conditions between residential and commercial roofers. In order to uncover certain differences, some questions were designed to elicit additional information on

walking surfaces, common heights, and common pitches on which roofers commonly spent work time. In order to do correlation analysis (Pearson correlation) between having fall protection training programs and having falls from roofs, the enforcement of the use of fall protection devices and experiencing falls, and providing roofers with fall protection devices and experiencing falls, these 3 questions regarding the concerns listed above were included in the survey.

CHAPTER V

RESULTS

The objectives of this study were to: (1) assess the current status of compliance with fall protection regulations and guidelines in commercial and residential roof construction, (2) analyze the sources of any noncompliance with fall protection regulations and guidelines in roof construction, (3) compare residential and commercial roofers in terms of fall protection equipment usage and preference, (4) examine existing methods of fall protection for commercial and residential roof constructions for their ability to meet those requirements, and (5) incorporate the results of the investigation into specific cautions and other actions for regulatory agency implementation.

As seen in Table 1, a total of 129 roofing contractors participated in the survey in WI, IL, MI, IN, and IA. The particular question designed to group roofers asked, “What is the type of work that you do?” 71 participants stated that they did residential roofing. 58 mentioned that they did commercial roofing. Among the 71 participants who stated that they did residential roofing, 39% (28 of 71) only did residential roofing. Twenty one percent (15 of 71) did 90% residential and 10% commercial and 27% (19 of 71) did 80% residential roofing and 20% commercial roofing. Eleven percent (8 of 71) did 70% residential roofing and 30% commercial roofing. Only 2% (1 of 71) did 60% residential and 40% commercial. Of the 58 participants who stated that they did commercial roofing, 66% (38 of 58) stated that they only did commercial roofing. Twelve percent (7 of 58) did 90% commercial and 10% residential and 21% (12 of 58) did 80% commercial and 20% residential. Only 2% (1 of 58) did 70% commercial roofing and 30% residential

roofing. If some participants did over 50% residential roofing or over 50% commercial roofing, they were considered residential roofers or commercial roofers. Totally 71 residential roofers and 58 commercial roofers completed the survey.

Table 3
Summary of the Participants

	Residential Roofer	Commercial Roofer	Total
WI	16	14	30
IL	19	16	35
MI	10	13	23
IN	16	2	18
IA	10	13	23
Total	71	58	129

Background

The first section of the survey was designed to collect background information such as gender and work experience. Only 1 roofer was a female.

Participants were asked to record their work experience as a roofer. They were able to record a written response. Work experience as a roofer was divided into 5 categories (Figure 5.1).

Zero to five years made up the majority of the work experience totaling 45% (32 of 71) and 11 to 20 years followed with 24% (17 of 71) in residential roofing. Six to ten years and 21 to 30 years comprised 18% (13 of 71) and 9% (6 of 71), respectively. More than 30 years constituted 4% (3 of 71). In commercial roofing, 0 to 5 years recorded 26% (15 of 58). Eleven to twenty years and 21 to 30 years each accounted for 24% (14 of 58),

respectively. Six to ten years made up 22% (13 of 58) and more than 30 years consisted of 3% (2 of 58).

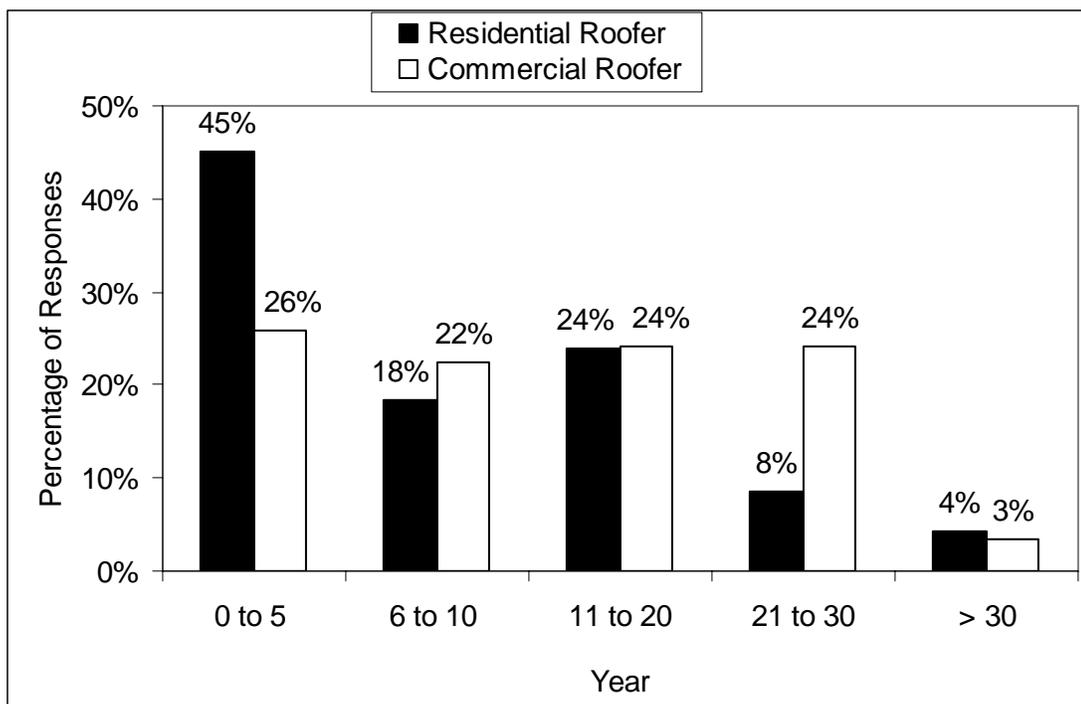


Figure 5.1: Work experience of the participants

As seen in Figure 5.2, the size of the participating roofers' companies was various with some employing as few as 0 workers (self-employed) and others as many as 600. The size of the roofing companies was divided into five categories. Participants could record a written response.

Fifty-six percent of residential roofers (40 of 71) reported that 1 to 10 workers were in their company. Twenty percent (14 of 71) employed 50 to 100 workers, and 18% (13 of 71) had 11 to 20 employees. Four percent (3 of 71) had 21 to 50 employees and 1% (1 of 71) employed more than 100 workers. One commercial roofer did not answer

this question. Thirty-three percent (19 of 57) reported having 50 to 100 workers. Thirty percent (17 of 57) had 11 to 20 employees, and 26% (15 of 57) had 21 to 50 workers. Seven percent (4 of 57) had 1 to 10 employees and 4% (2 of 57) had over 100 workers employed.

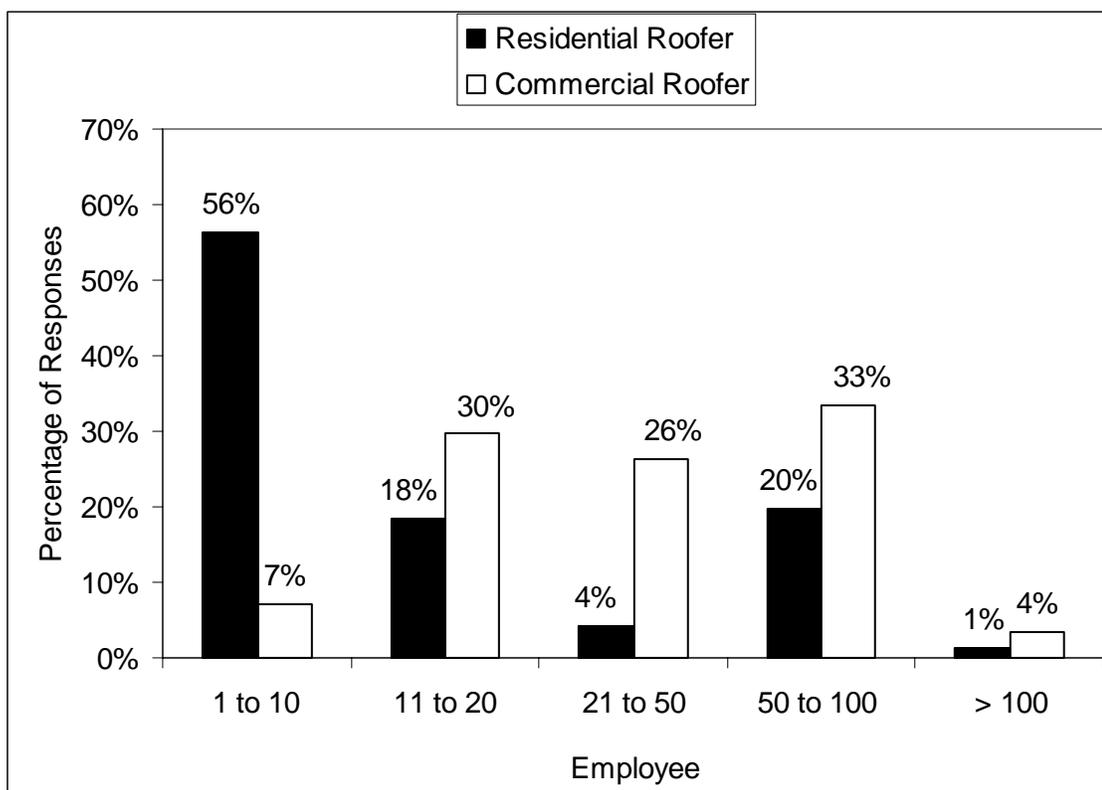


Figure 5.2: The size of the participating roofers' companies

The participants were asked whether or not safety programs were maintained at their companies.

As shown in Figure 5.3, seventy-two percent of residential roofers (51 of 71) had fall protection programs and 18% (13 of 71) did not have them in their companies. Ten percent of workers (7 of 71) did not know if their companies maintained fall protection

programs or not. Ninety-seven percent of commercial roofers (56 of 58) reported having fall protection programs. Two percent of workers (1 of 58) did not have fall protection programs and 2% (1 of 58) did not know if their companies maintained fall protection programs or not.

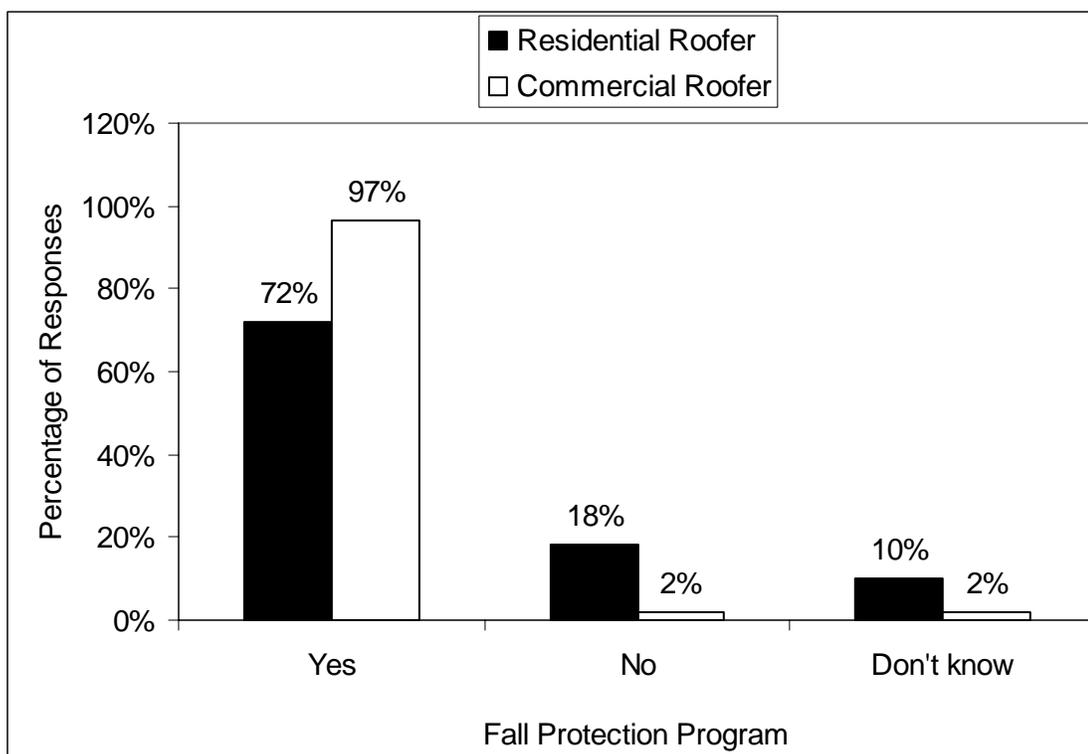


Figure 5.3: Responses for fall protection program

The interviewees were also asked if fall protection training programs were maintained or not at their companies.

Figure 5.4 shows 59% of residential roofers (42 of 71) had safety training programs and 30% (21 of 71) did not have them. Eleven percent (8 of 71) did not know if they maintained the programs or not. In commercial roofing, 95% of participants (55 of

58) had the programs and 5% (3 of 58) did not have them. Residential roofers had less implementation of fall protection training programs than commercial roofers did.

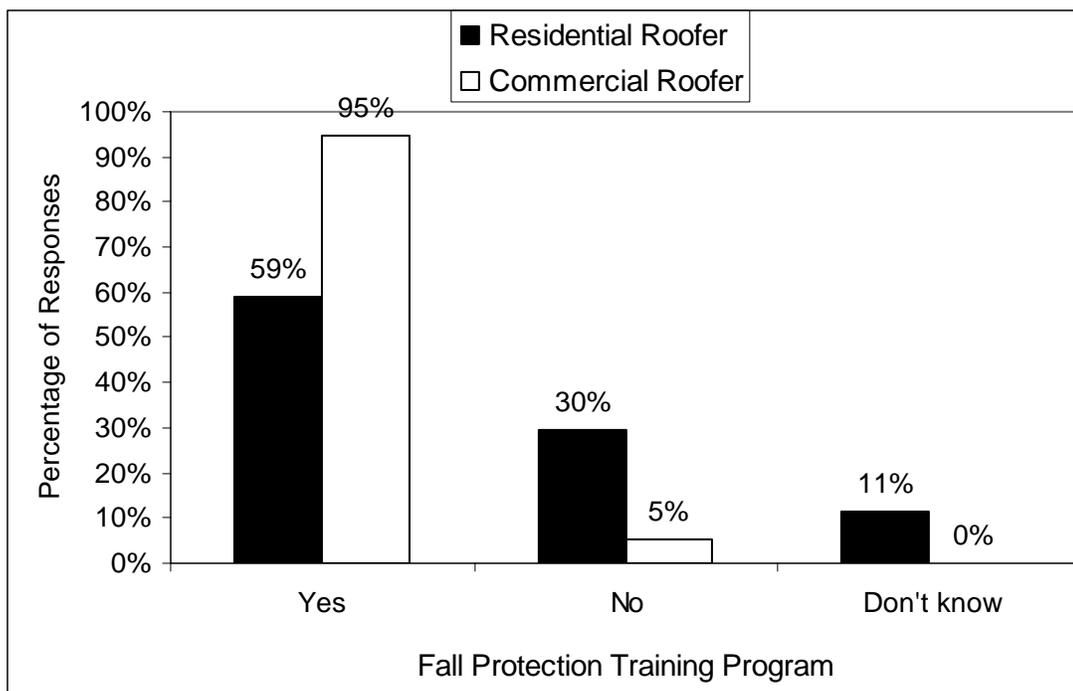


Figure 5.4: Response for fall protection training program

Forty-two residential roofers and 55 commercial roofers who reported that their companies had fall protection training programs were asked to record how often they had the training programs. Options were divided into four categories: (1) every day; (2) every week; (3) every month; (4) every year.

Forty-six percent of residential roofers (19 of 42) had the training programs every month and 26% (11 of 42) responded to having them every year (Figure 5.5). Fourteen percent (6 of 42) had the training programs every week. Seven percent (3 of 42) reported having the training programs every day and 7% (3 of 42) stated that they did not know

how often they had them. One commercial roofer did not answer this question. Thirty-six percent of commercial roofers (20 of 54) had the training programs every month and twenty-eight percent (15 of 54) had them every year. Twenty-four percent (13 of 54) selected having them every week. Six percent (3 of 54) had the training programs every day and 6% (3 of 54) did not know how often they were trained in them.

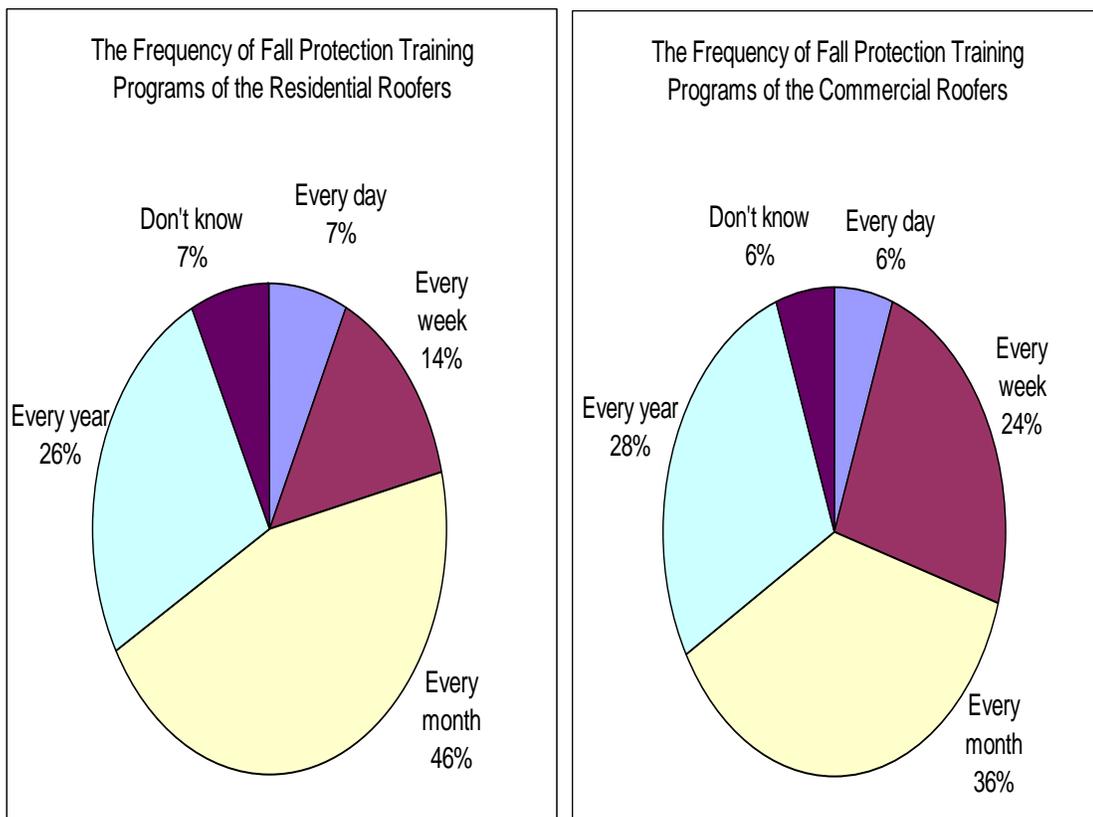


Figure 5.5: The frequency of fall protection training programs

Injuries and the issue of falls

The second section of the survey asked questions that focused on types of injuries, what season the injuries occurred, time frame of injuries, and the parts of the body

affected by the injury. A few of the questions were developed to deal with the issue of falls. Participants were asked to answer yes or no.

As shown in Figure 5.6, seventy-six percent of residential roofers (54 of 71) had injuries at the jobsites and 24% (17 of 71) did not have any injury. Seventy-one percent of commercial roofers (41 of 58) had injuries and 29% (17 of 58) did not.

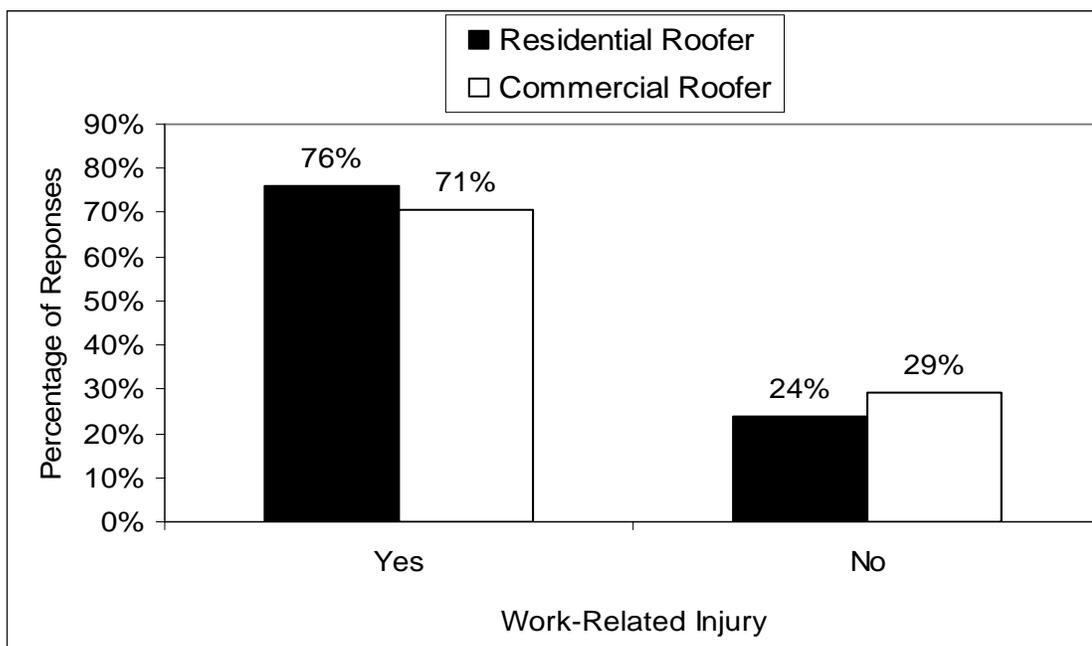


Figure 5.6: Response for work-related injury

Fifty-four residential roofers and 41 commercial roofers who had injuries were asked to choose common types of injuries that occurred at the jobsite. Choices were sprain/strain, fracture, burn, cut, and other. They could also list other injuries that were not included in the given list and were able to check all applicable categories.

Figure 5.7 shows that cuts made up the majority of the selected injuries totaling 64% (48 of 75) among residential roofers. Sprains/strains and burns accounted for 16%

(12 of 75) and 15% (11 of 75), while fractures was 5% (4 of 75). In commercial roofers, 46% of respondents (33 of 72) experienced cuts. Burns consisted of 26% (19 of 72) and sprains/strains constituted 24% (17 of 72). Four percent (3 of 72) had fractures.

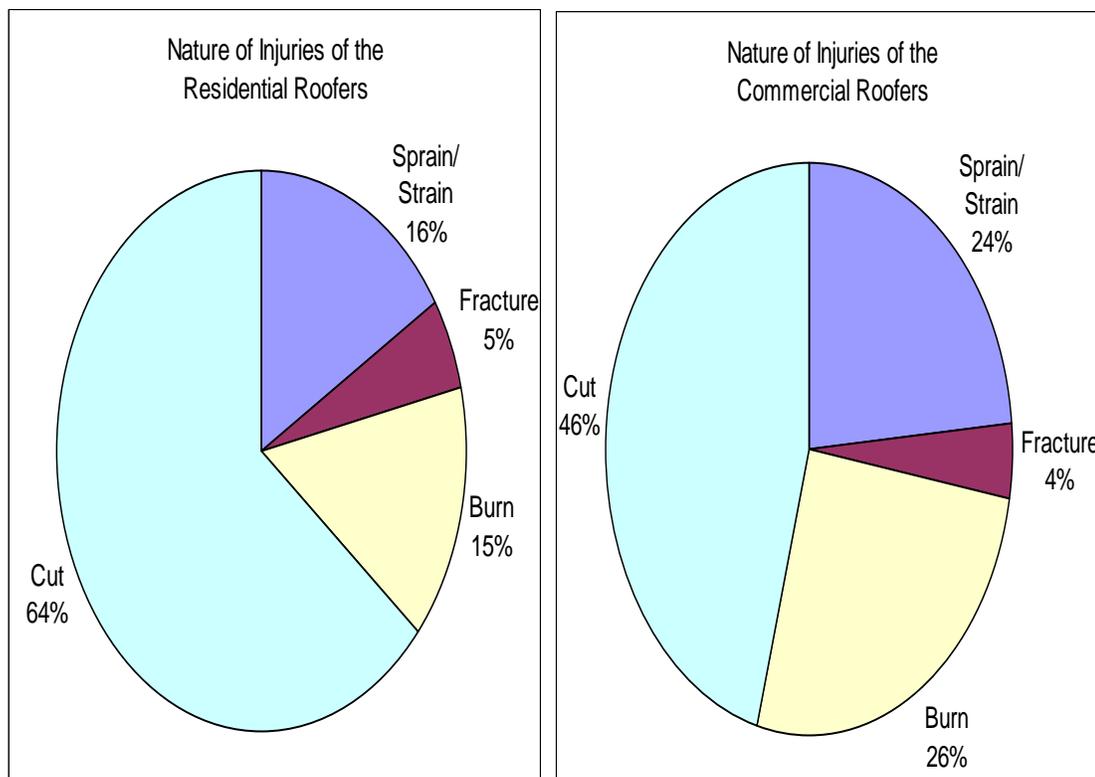


Figure 5.7: Nature of injuries

The survey contained questions in which 54 residential roofers and 41 commercial roofers were asked to pick the season when the majority of injuries occurred. They again were able to check all applicable.

As shown in Figure 5.8, 36% of residential roofers (37 of 102) had injuries in the Summer and 25% (26 of 102) experienced them in the Winter. Spring followed with 23% (23 of 102), and Fall made up 16% (16 of 102) of the injuries. Thirty-three percent of

commercial roofers (27 of 83) experienced injuries in the Summer. Spring accounted for 24% (20 of 83) and Winter comprised 24% (20 of 83) as well. Nineteen percent (16 of 83) had injuries in the Fall.

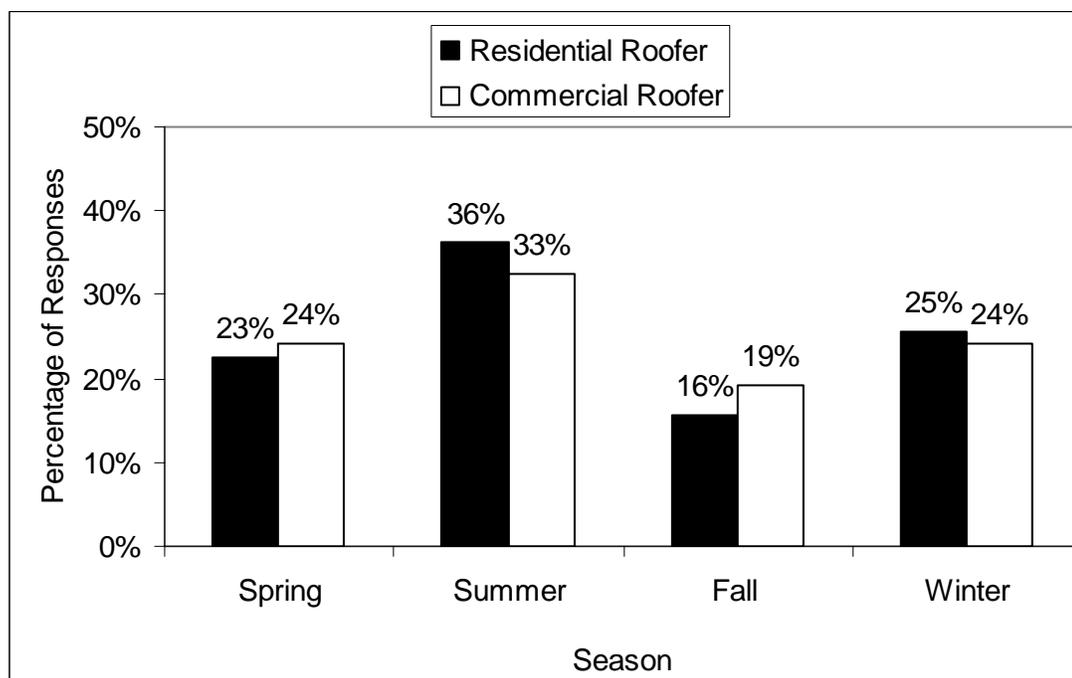


Figure 5.8: Seasons when injuries occur

The survey also contained questions in which the 54 residential roofers and 41 commercial roofers who had injuries were asked to rank the time frame when injuries occurred after they started work on roofs. Five options were listed: (1) Before 8 AM; (2) 8-10 AM; (3) 10-12 PM; (4) 1-3 PM; (5) 3-Completion (Figure 5.9). Participants also were able to check all applicable.

The most prevalent time frame of injury for residential roofers was 10-12 PM totaling 31% (26 of 83). The next prevalent time frame was 1-3 PM accounting for 24%

(20 of 83). Twenty percent of residential roofers (17 of 83) experienced injuries from 8 to 10 AM, and 16% (13 of 83) had them from 3 to Completion. Only 8% (7 of 83) consisted of Before 8 AM. The most frequent time frame for commercial roofers was 8-10 AM consisting of 27% (21 of 77). 1-3 PM followed with 26% (20 of 77), and 10-12 AM constituted 25% (19 of 77). Before 8 AM, 14% (11 of 77) had injuries and 8% (6 of 77) experienced them from 3 to Completion.

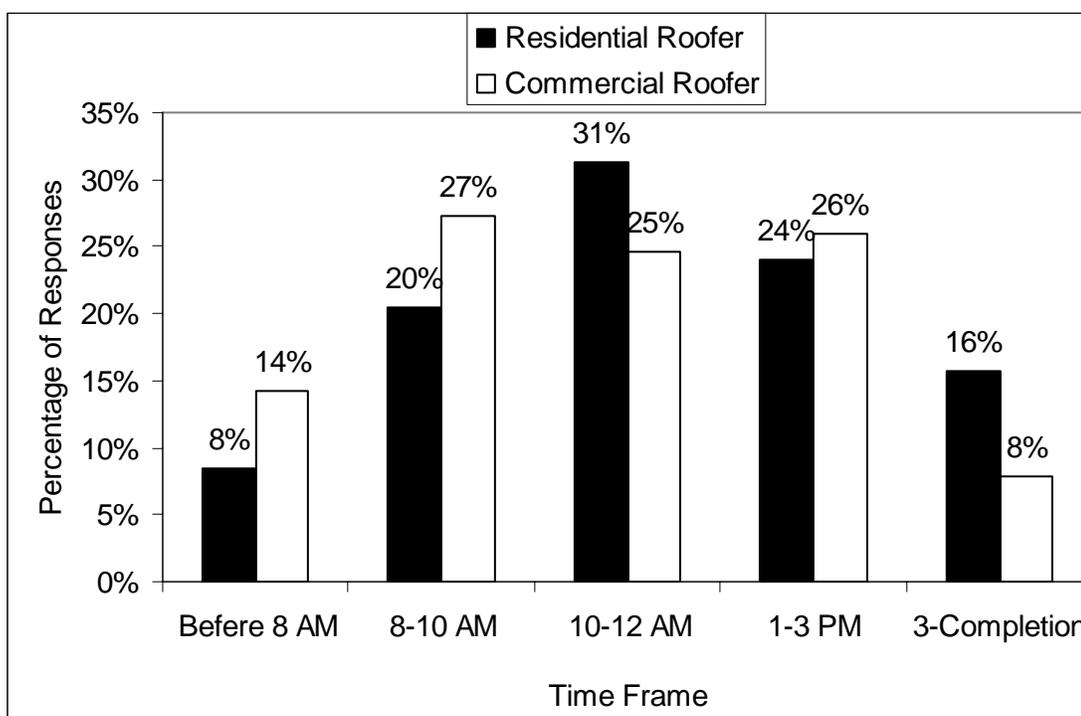


Figure 5.9: Time frame when injuries occurred

Fifty-four residential roofers and 41 commercial roofers who had injuries were asked to rank the frequency at which some parts of the body were affected by injuries. Six parts of the body were listed: (1) head/neck; (2) shoulders; (3) back; (4) fingers/hand; (5) knees; (6) foot/ankle. Participants could specify other types of injuries that were not

included in the given list. They were able to check all applicable.

Figure 5.10 shows that finger/hand injuries had the highest ranking with 44% (42 of 98) among residential roofers. Back and foot/ankle injuries each had the second highest ranking with 16% (16 of 98). Knee and shoulder injuries had the third and fourth highest ranking with 12% (12 of 98) and 5% (5 of 98), respectively. Head/neck followed with 4% (4 of 98). Only 3% (3 of 98) comprised other (e.g., pelvis, rib, and leg). For commercial roofers, finger/hand injury recorded the highest ranking with 36% (29 of 80). Back injuries had the second highest ranking with 18% (14 of 80). Knee and foot/ankle injuries each had the third highest ranking with 16% (13 of 80). The other two parts of the body were head/neck accounting for 6% (5 of 80) and shoulder consisting of 4% (3 of 80). Four percent (3 of 80) made up other (e.g., carpal tunnel, thigh, and elbow).

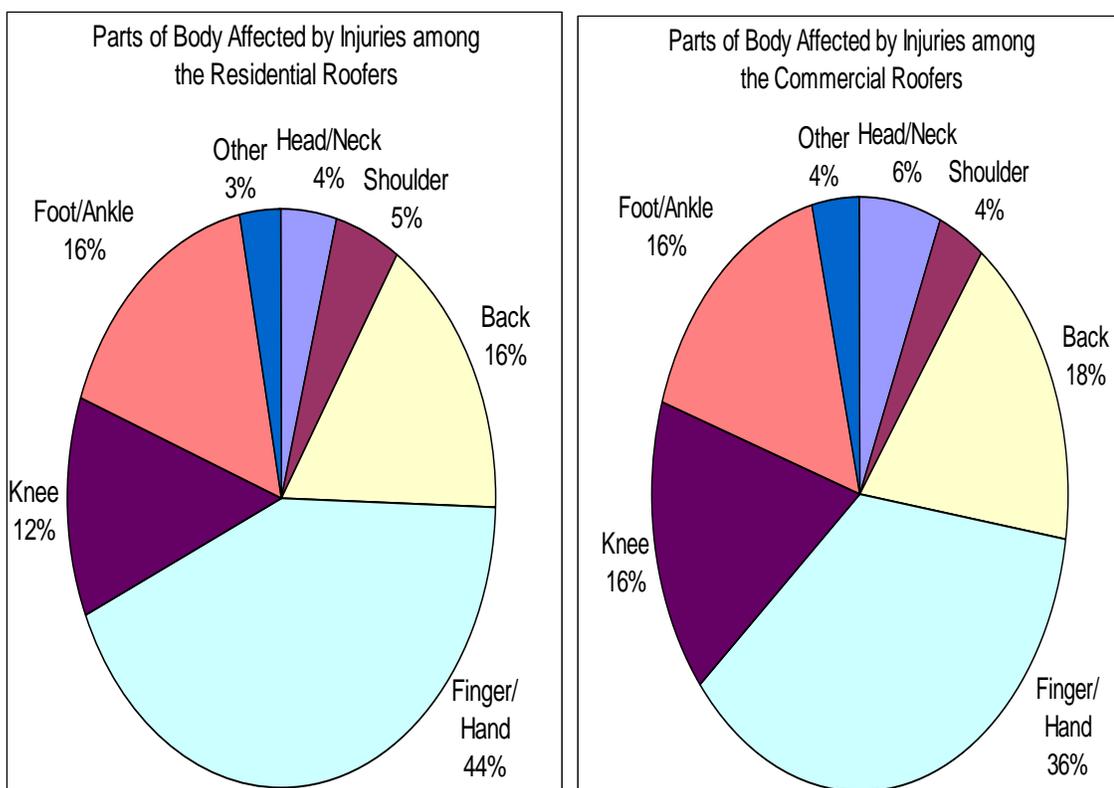


Figure 5.10: Parts of body affected by injuries

Fifty-four residential roofers and 41 commercial roofers were then asked to choose the causes of the injuries at the jobsite. They could specify other causes of injuries that were not included in the given list. They again were able to choose all applicable. Options included overexertion, fall, slip, trip, and tools/machinery (Figure 5.11).

Tools/machinery made up the most leading cause of injury ranking at 39% of residential roofers (28 of 73), while slip had the second leading cause of injury ranking at 25% (18 of 73). Fall was the third leading cause accounting for 16% (12 of 73) and overexertion remained the fourth leading cause constituting 12% (9 of 73). Trip followed with 5% (4 of 73). Only 3% consisted of other (e.g., carelessness and lack of experience). Slip consisted of the most leading cause of injury ranking at 34% of commercial roofers (22 of 67). Tools/machinery accounted for the second leading cause totaling 27% (18 of 67) and trip remained the third cause constituting 13% (9 of 67). Overexertion followed with 12% (8 of 67). Unlike residential roofers, fall was the fifth leading cause of injury only consisting of 10 % (7 of 67). Four percent comprised other (e.g., lifting, material handing, and repetitive motion).

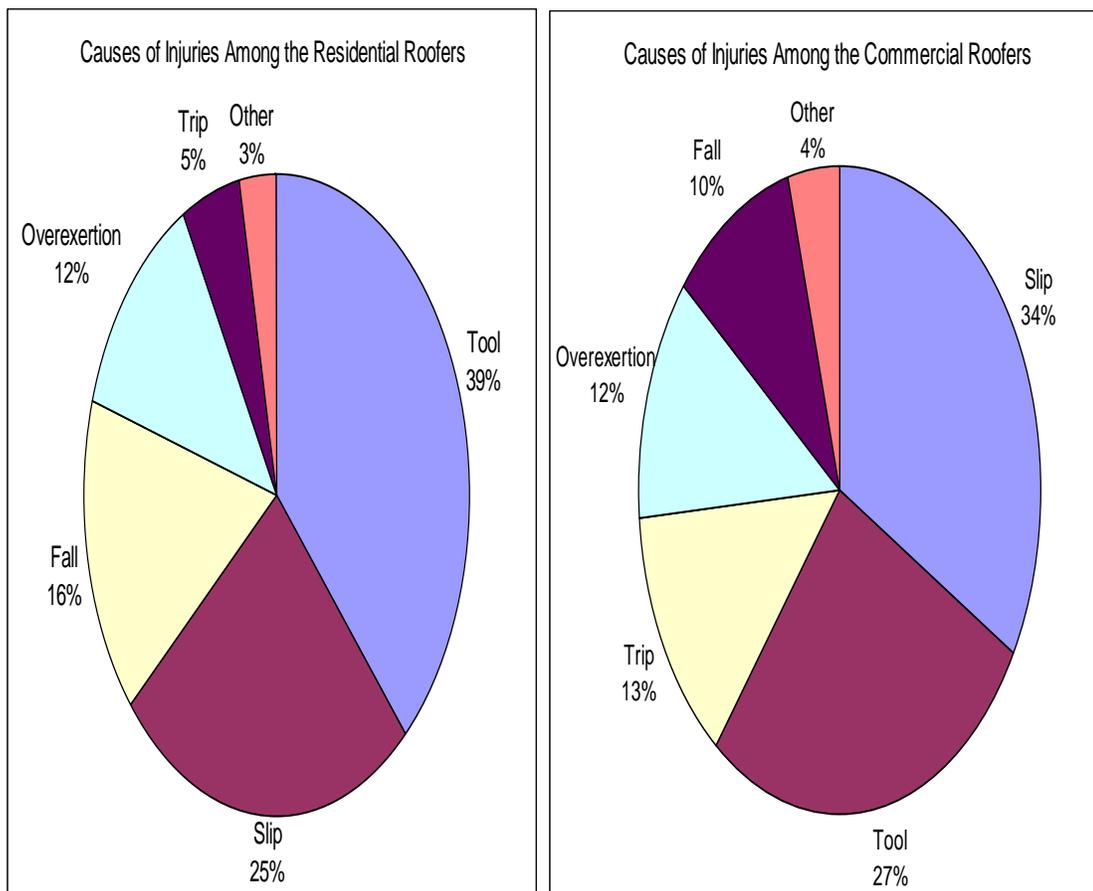


Figure 5.11: Causes of injuries

A few questions were designed to examine fall experiences, the causes of falls, and the most common types of falls. Also, participants were asked to record fall protection device usage when they had falls. These questions were important to the study in determining information about falls from roofs.

As shown in Figure 5.12, while 35% of residential roofers (25 of 71) experienced falls from roofs, 65% (46 of 71) did not have falls. In contrast to residential roofers, only 21% of commercial roofers (12 of 58) experienced falls. Seventy-nine percent (46 of 58)

did not have them. According to this survey, residential roofers were 14% more likely than commercial roofers to experience falls.

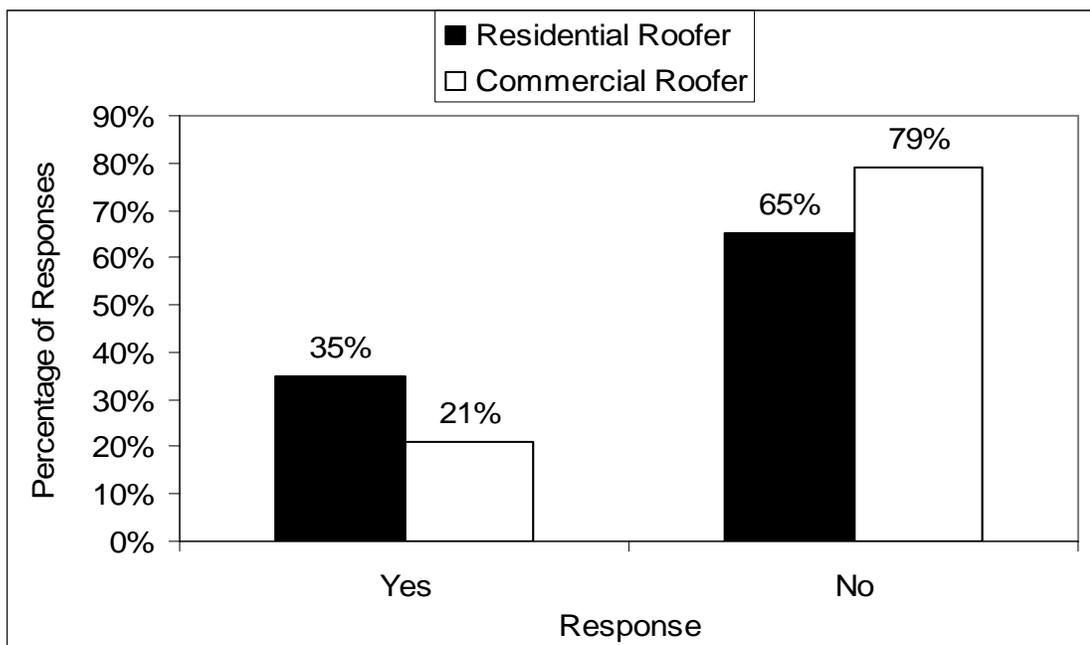


Figure 5.12: Percentage of having falls

Twenty-five residential roofers and 12 commercial roofers who had falls from roofs were asked to record causes of the falls in the given list. They were able to select all the pertinent choices. The causes were listed: (1) slip; (2) trip; (3) loss of balance. Participants again were able to specify other types of causes that were not included in the given list.

Figure 5.13 shows that the most leading cause was slip totaling 61% (17 of 28) and the second cause remained loss of balance comprising 29% (8 of 28) among residential roofers. The third cause was trip accounting for 7% (2 of 28). Four percent (1 of 28) constituted other (e.g., wind). Like residential roofers, slip and loss of balance

made up the most and second leading cause of falls among commercial roofers totaling 57% (8 of 14) and 21% (3 of 14), respectively. Fourteen percent (2 of 14) accounted for other. One commercial roofer had a fall due to a roof collapse. Helping a co-worker who was falling resulted in a fall. Trip comprised 7% (1 of 14).

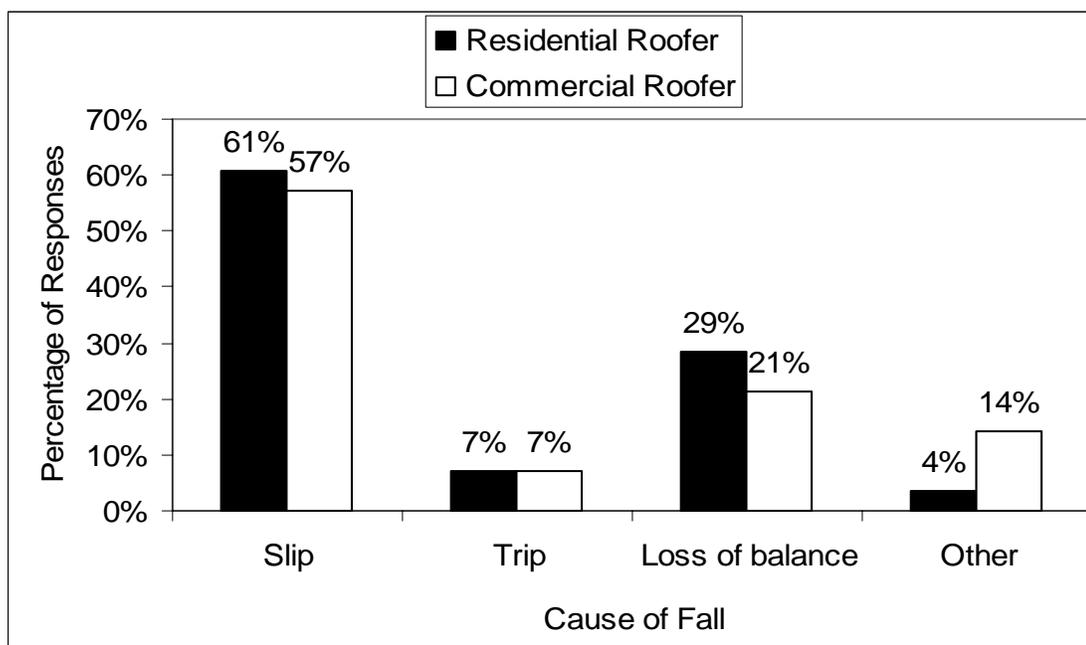


Figure 5.13: Causes of fall

Twenty-five residential roofers and 12 commercial roofers were also asked to record the common types of falls. The types of falls were categorized: (1) fall to same level; (2) fall to lower level. They could select all the pertinent choices.

Sixty-nine percent of residential roofers (18 of 26) accounted for falls to lower level and 31% (8 of 26) had falls to same level (Figure 5.14). As with residential roofers, 77% of commercial roofers (10 of 13) experienced falls to lower level and 23% (3 of 13) comprised falls to same level.

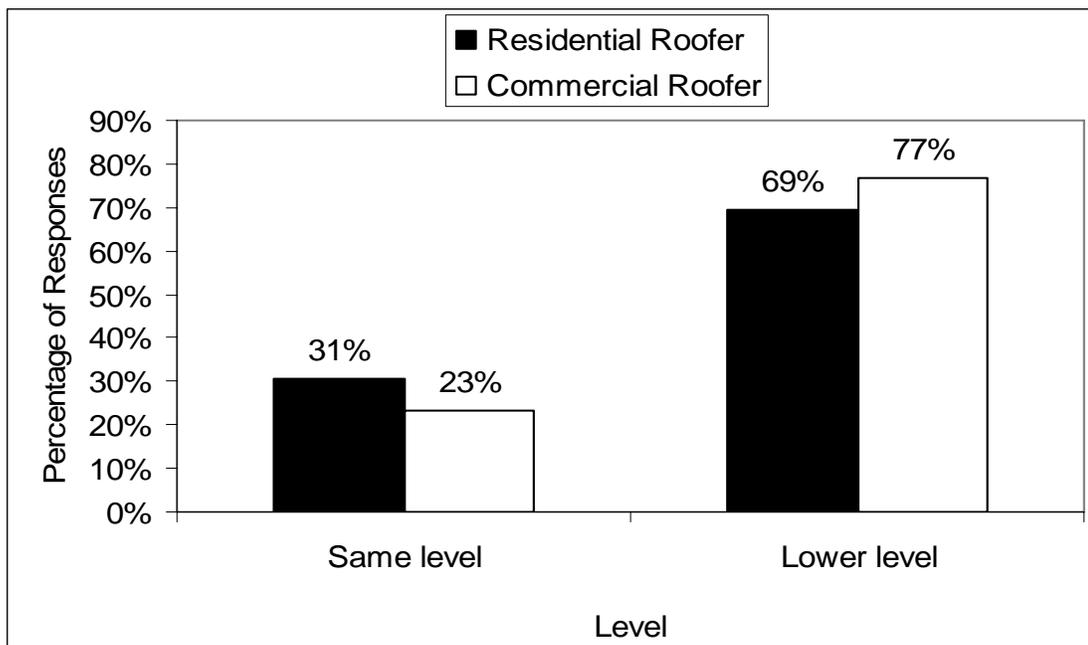


Figure 5.14: The common types of falls

Eighteen residential roofers and 10 commercial roofers who had falls to lower level were asked to record the fall heights.

Table 4 provides the descriptive statistics on the fall heights for the 18 residential roofers who had falls to lower level.

Table 4

Descriptive Statistics for the 18 Residential Roofers

Fall to lower level (feet) among the 18 residential roofers	
Count	18.0
Mean	12.5
Median	10.0
Mode	10.0
Standard Deviation	6.7
Range	

Minimum	8.0
Maximum	30.0

Table 5 provides the descriptive statistics for the 10 commercial roofers who had falls to lower level. One Iowa roofer experienced falls to lower level 3 times (10, 15, and 25 feet).

Table 5

Descriptive Statistics for the 10 commercial Roofers

Fall to lower level (feet) among the 10 commercial roofers	
Count	12.0
Mean	12.3
Median	11.0
Mode	10.0
Standard Deviation	5.9
Range	
Minimum	4.0
Maximum	25.0

The fall heights were divided into 0 to 5 feet (1.5 m), 6 (1.8 m) to 10 feet (3.0 m), 11 (3.4 m) to 15 feet (4.6 m), 16 (4.9 m) to 20 feet (6.1 m), 21 (6.4 m) to 25 feet (7.6 m), and 26 (7.9 m) to 30 feet (9.1 m).

The findings show that the most frequent heights of falls were at elevations from 6 (1.8 m) to 10 feet (3.0 m) making up 72% of falls (13 of 18) among residential roofers (Figure 5.15). Eleven percent (2 of 18) had falls at heights between 21 (6.4 m) and 25 feet (7.6 m). Six percent (1 of 18) were at elevations between 11 (3.4 m) and 15 feet (4.6 m) and 6% (1 of 18) occurred at elevations between 16 (4.9 m) and 20 feet (6.1 m). The other 6% (1 of 18) occurred at elevations between 26 (7.9 m) and 30 feet (9.1 m). Similar to residential roofers, the most frequent heights of falls were at elevations from 6 (1.8 m)

to 10 feet (3.0 m) totaling 42% of falls (5 of 12) among commercial roofers. The second most frequent heights of falls occurred at elevations between 11 (3.4 m) and 15 feet (4.6 m) accounting for 33% (4 of 12). Eight percent (1 of 12) were at elevations between zero and five feet (1.5 m) and 8% (1 of 12) occurred between 16 (4.9 m) and 20 feet (6.1 m). The other 8% occurred between 21 (6.4 m) and 25 feet (7.6 m).

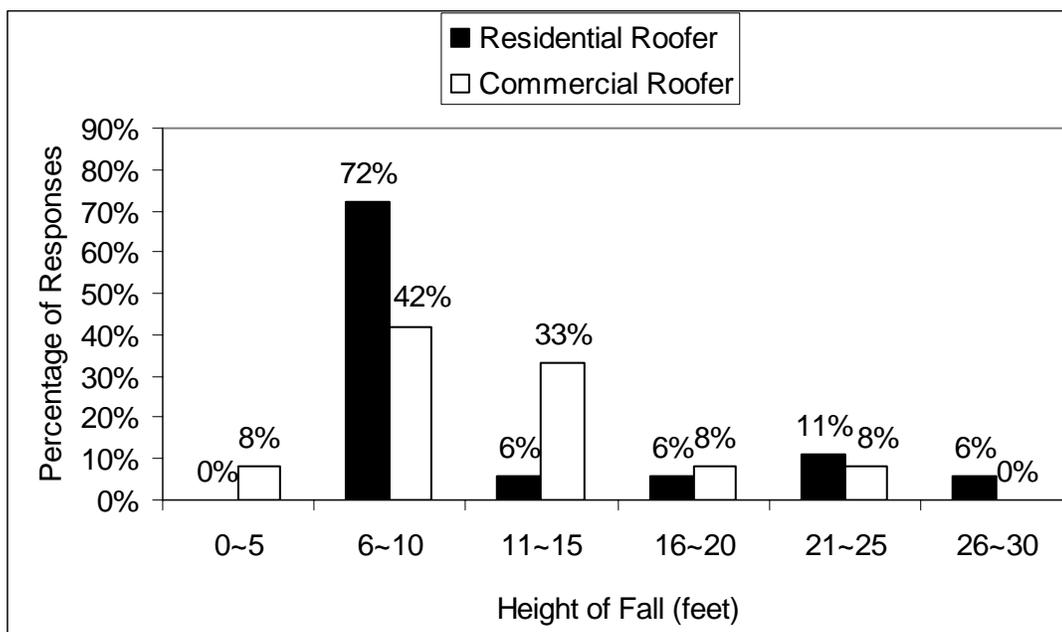


Figure 5.15: Distribution of the height of falls

Twenty-five residential roofers and 12 commercial roofers who had falls from roofs also were asked if they wore or installed fall protection devices prior to experiencing the falls. They could answer the question choosing yes or no.

Thirty-two percent of residential roofers (8 of 25) answered yes and 68% (17 of 25) reported that they did not wear or install fall protection equipment at those times, as shown Figure 5.16. Among 12 commercial roofers, 17% (2 of 12) answered yes and 83%

(10 of 12) indicated no.

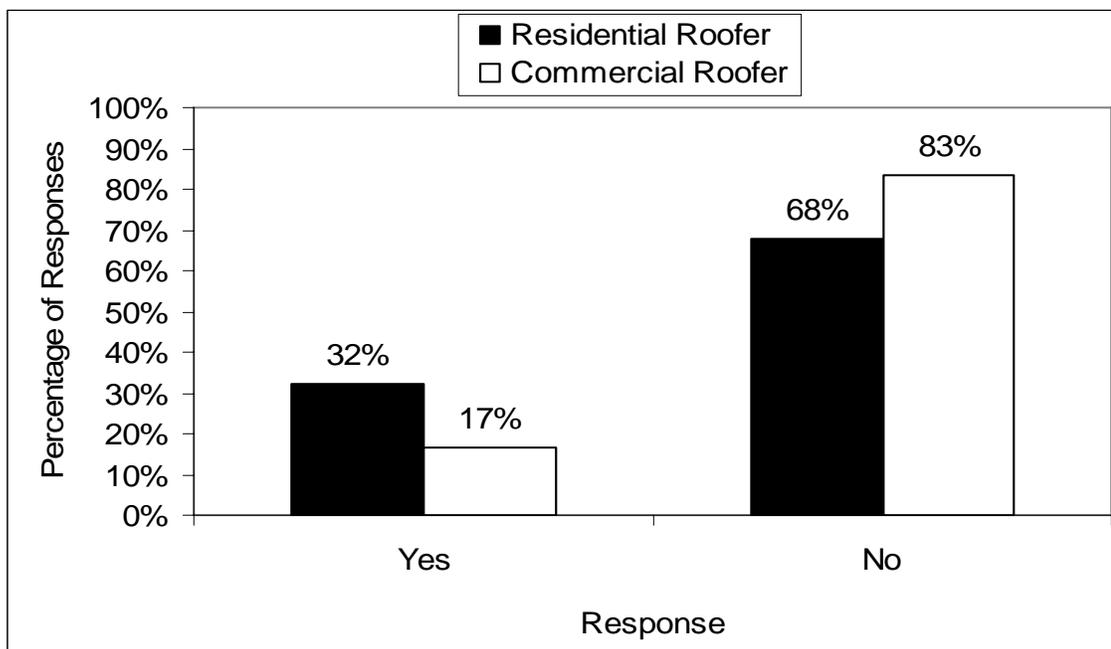


Figure 5.16: Response of using or not using fall protection devices

Eight residential roofers and 2 commercial roofers who experienced falls although they wore or installed fall protection devices were again asked to record the causes of the falls. The roofers were asked to check all applicable cases. The causes were listed: (1) incomplete connection of personal fall arrest system; (2) improper use of fall protection devices; (3) old fall protection devices. Participants also were able to specify other types of causes that were not included in the given list.

Forty-four percent of the 8 residential roofers (4 cases of 9 total cases) reported that they experienced falls due to improper use of fall protection devices, as shown in Figure 5.17. Twenty-two percent (2 of 9) resulted from old fall protection devices and 22% (2 of 9) was *due* to other (tripping over fall protection ropes and carelessness).

Incomplete connection of personal fall arrest system consisted of 11% (1 of 9). Fifty percent of the 2 commercial roofers (1 of 2) had a fall because of improper use of fall protection devices and 50% (1 of 2) experienced a fall due to old fall protection devices.

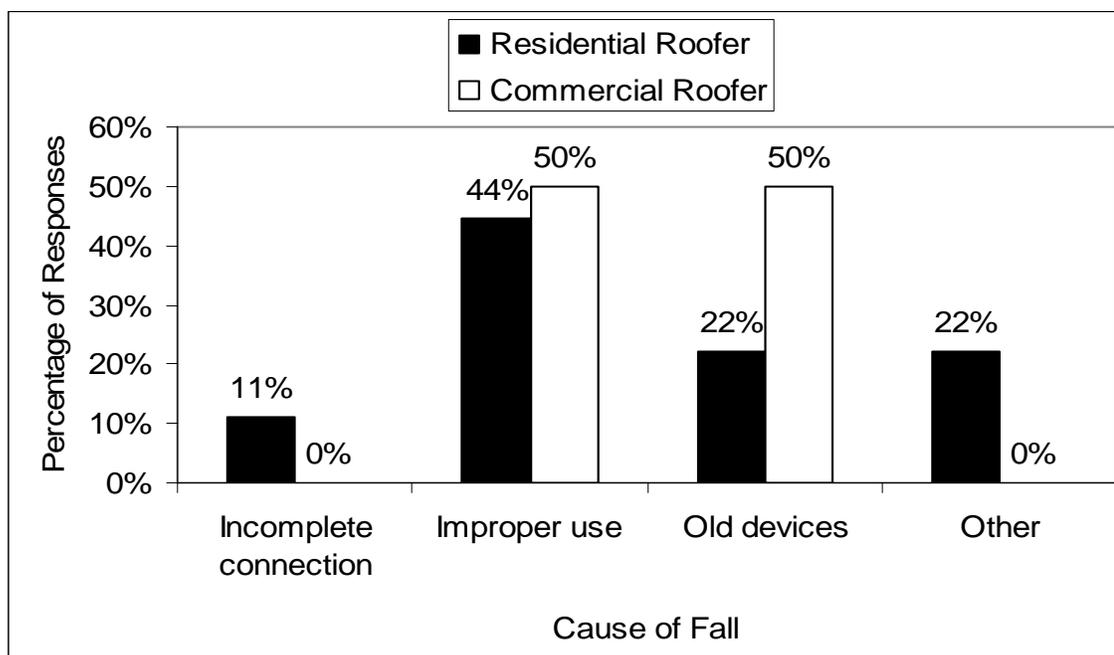


Figure 5.17: Causes of fall

Results of Study of Fall Protection Devices

The third section of the survey was designed to collect information about fall protection equipment. Participants were asked to report if their companies provided them with fall protection devices. They were able to answer the question choosing yes, no, or don't know.

Eighty-two percent of residential roofers (58 of 71) selected yes and 10% (7 of 71) answered no (Figure 5.18). Eight percent (6 of 71) did not know whether or not their companies provided them with fall protection devices. While 97% of commercial roofers (56 of 58) chose yes, only 2% (1 of 58) answered no. Two percent (1 of 58) did not know

if his company provided them with protection equipment or not.

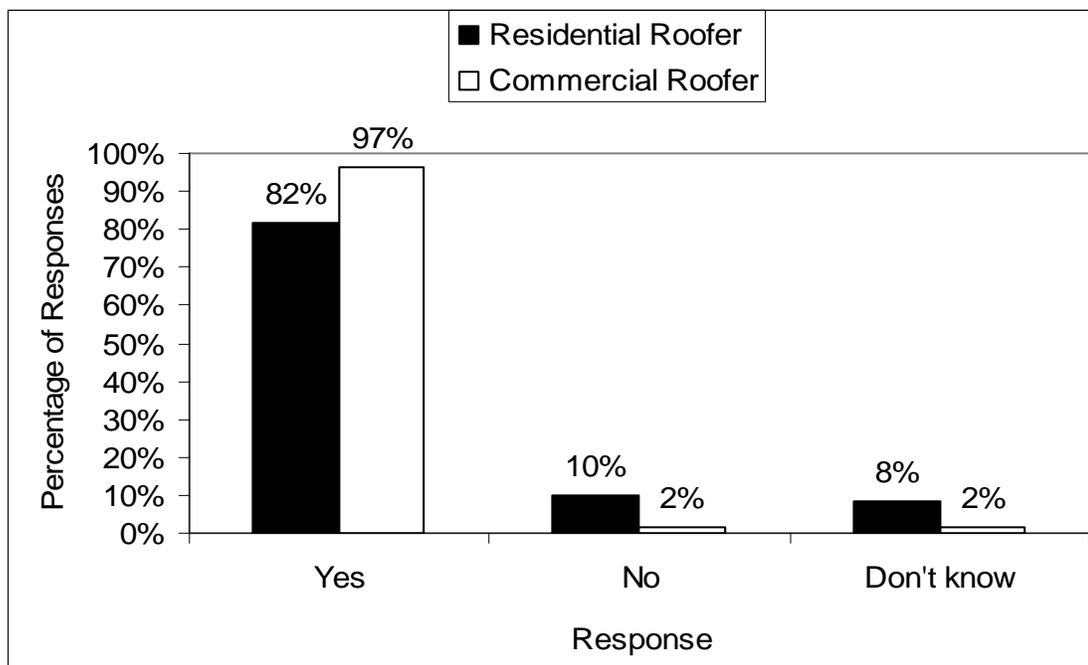


Figure 5.18: Response of providing fall protection devices

Fifty-eight residential roofers and 56 commercial roofers who answered yes again were asked to choose fall protection equipment that their companies provided. Fall protection devices were listed: (1) guardrails; (2) safety nets; (3) personal fall arrest system (PFAS); (4) safety monitors; (5) warning lines; (6) and slide guards (Figure 5.19). They could specify other types of fall protection devices that were not included in the given list. They again were able to select all applicable.

The most provided fall protection device was PFAS accounting for 34% (44 of 128) in residential roofing and slide guards were the second most common protection equipment consisting of 27% (34 of 128). Guardrails comprised the third most provided

device totaling 15% (19 of 128). Warning lines were the fourth most common device accounting for 10% (13 of 128). The other two kinds of protection equipment were safety monitors consisting of 9% (12 of 128) and safety nets totaling 5% (6 of 128). For commercial roofers, the most provided fall protection device was PFAS accounting for 23% (52 of 231). Safety monitors and warning lines constituted the second most provided device making up 22% (50 of 231) each. Guardrails were the third most provided protection equipment consisting of 21% (48 of 231). Slide guards followed with 10% (22 of 231) accounting for the fourth device. Safety nets were the fifth most common device totaling 3% (8 of 231). One Wisconsin commercial roofer specified a fall protection device that was not included in the given list. He mentioned a Manbasket. It is a vehicle that has about 20 feet (6.1 m) wide baskets that are placed at eaves level or above the gutter. Roofers with Manbaskets can access roofs directly without ladders or scaffolds and they can control the height and direction.

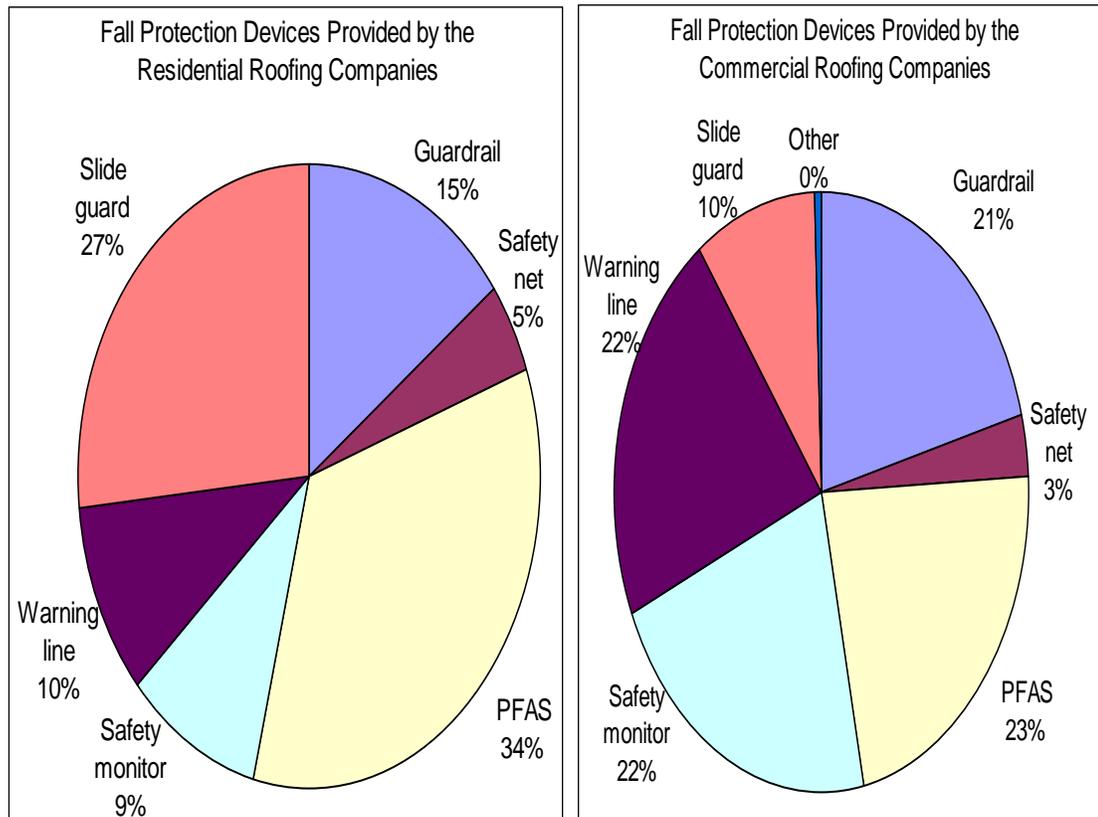


Figure 5.19: Fall protection devices provided

Participants were divided into two groups with a question: “Do you actually use fall protection devices?” The participants who said yes were asked to answer four specific questions. The others who answered no were asked to respond to two questions.

While 80% of residential roofers (57 of 71) answered yes, 98% of commercial roofers (57 of 58) responded yes as well, as shown in Figure 5.20. Twenty percent (14 of 71) of residential roofers said no and only 2% of commercial roofers (1 of 58) answered no.

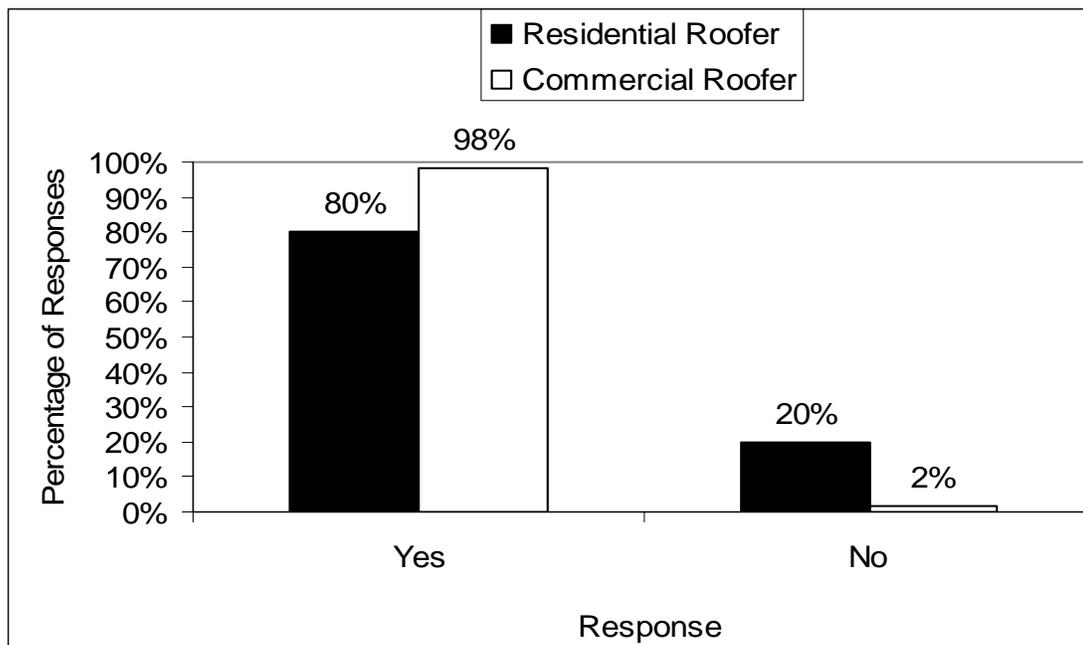


Figure 5.20: Responses of using fall protection equipment or not

Fifty-seven residential roofers and 57 commercial roofers who stated that they used fall protection devices were also asked why they used them. Reasons were listed: (1) requirement of employment; (2) personal concern for safety; (3) supervisory enforcement; (4) peer pressure (Figure 5.21). They were able to specify other types of reasons that were not included in the given list. They again could select all applicable.

For residential roofers, the most prevalent reason was personal concern for safety accounting for 55% (49 of 89) and the second reason was requirement of employment making up 29% (26 of 89). Supervisory enforcement followed with 12% (11 of 89) and the last reason was peer pressure consisting of 3% (3 of 89). For commercial roofers, the most prevalent reason was the requirement of employment accounting for 40% (56 of 140) and the second reason was personal concern for safety totaling 31% (44 of 140). The

other two reasons were supervisory enforcement accounting for 24% (34 of 140) and peer pressure consisting of 4% (5 of 140). One Michigan commercial roofer comprised 1% (1 of 140). He reported that he used the protection devices because of safety bonus.

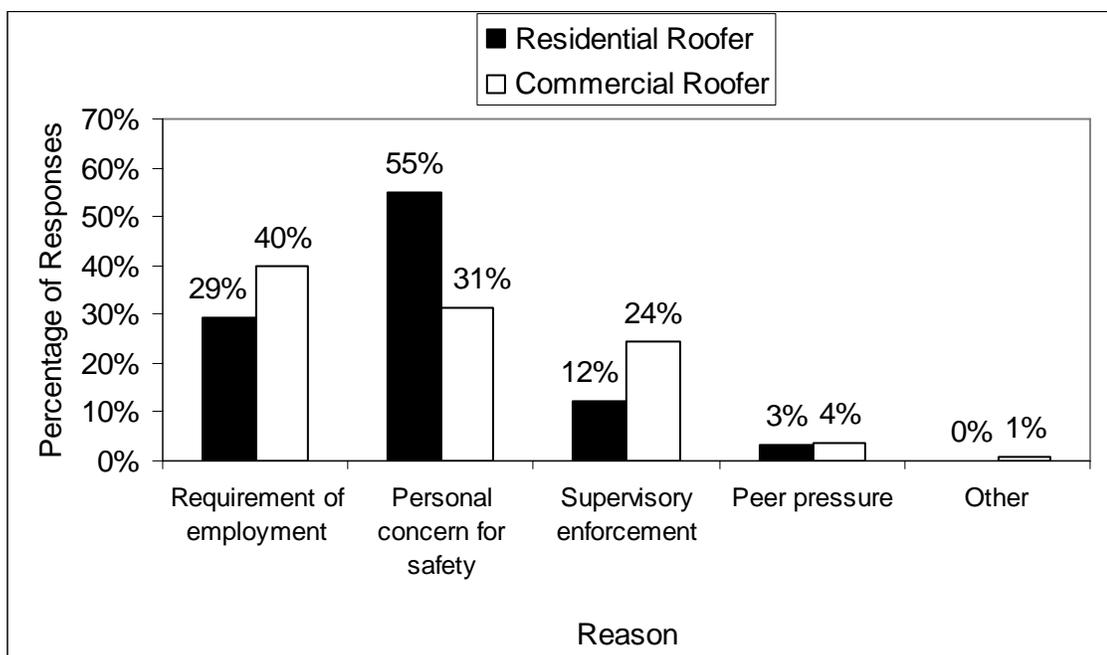


Figure 5.21: Reasons of using fall protection equipment

Fifty-seven residential roofers and 57 commercial roofers who reported that they used fall protection devices were again asked what kind of fall protection devices they used. They could mention other types of fall protection devices that were not included in the given list. They were able to choose all applicable.

Figure 5.22 shows that the most prevalent protection device used was PFAS totaling 38% (42 of 109) among residential roofers and the second equipment was slide guards making up 27% (29 of 109). The third device was guardrails consisting of 14% (15 of 109). Warning lines were the fourth device constituting 10% (11 of 109) and safety

monitors were the fifth one accounting for 8% (9 of 109). Safety nets only comprised 3% (3 of 109). For commercial roofers, the most prevalent device was PFAS making 24% (52 of 214). Safety monitors and warning lines each were the second protection equipment consisting of 22% (46 of 214). Guardrails accounted for the third one totaling 21% (44 of 214). Slide guards were the fourth device making up 9% (20 of 214). As with residential roofers, the least used device was safety nets totaling only 3% (6 of 214).

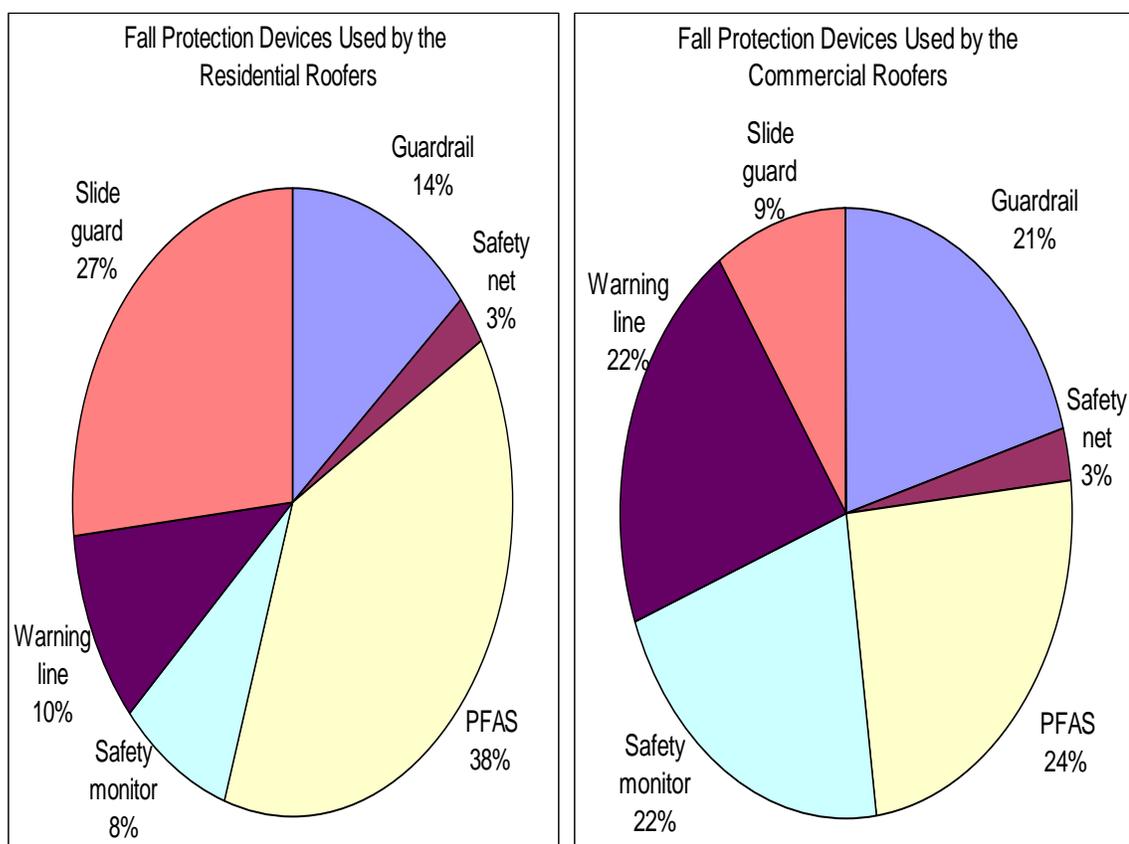


Figure 5.22: Fall protection devices used

Fifty-seven residential roofers and 57 commercial roofers were asked to rank the percentage of work time using fall protection devices. Options included in the percentage

of work time using protection devices included 100% (always), 75%, 50%, 25%, and less than 25%.

Forty-four percent of residential roofers (25 of 57) used the protection devices 100%, as shown in Figure 5.23. Eighteen percent (10 of 57) answered 75%. Sixteen percent (9 of 57) chose 50% and twelve percent (7 of 57) responded 25%. Eleven percent (6 of 57) answered less than 25%. Of the 57 commercial roofers, fifty-three percent (30 of 57) used the protection devices 100%. Twenty-one percent (12 of 57) responded 75% and 16% (9 of 57) answered 25%. Seven percent (4 of 57) accounted for 50% and 4% (2 of 57) consisted of less than 25%.

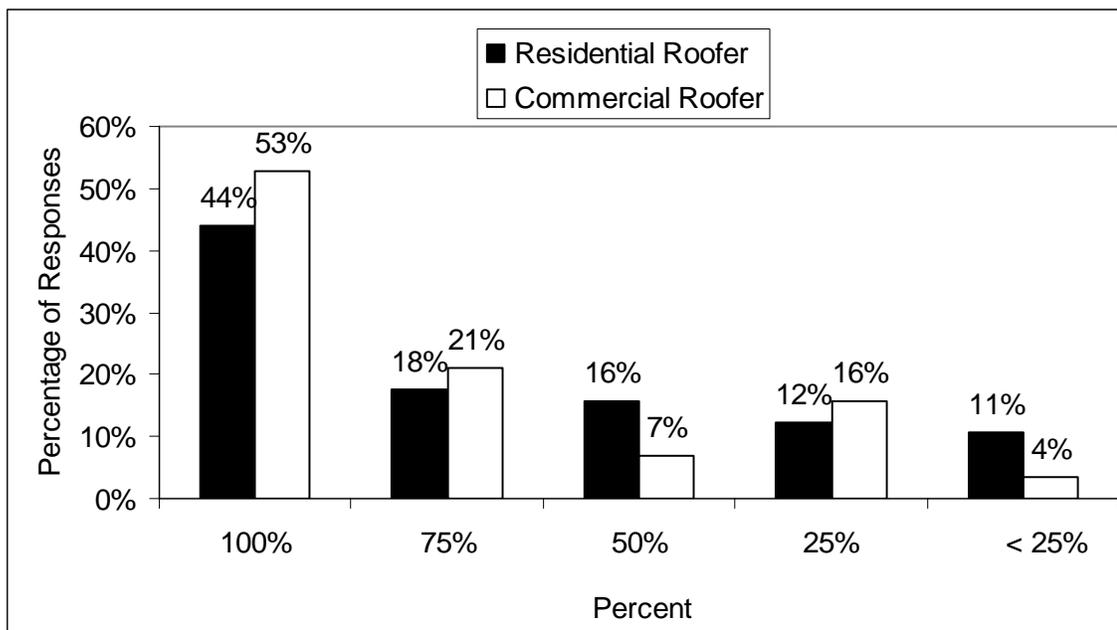


Figure 5.23: Percentage of work time using fall protection devices

Fifty-seven residential roofers and 57 commercial roofers who mentioned that they used fall protection equipment also were asked how they felt not using fall

protection devices. Responses were listed: (1) no problem; (2) minor problem; (3) serious problem; (4) very serious problem.

As seen in Figure 5.24, 32% of residential roofers (18 of 57) reported that not using fall protection equipment was a very serious problem. Twenty-six percent (15 of 57) chose a serious problem and 25% (14 of 57) answered no problem. Eighteen percent (10 of 57) responded a minor problem. The order of responses of commercial roofers exactly followed those of residential roofers. Thirty-seven percent of commercial roofers (21 of 57) recorded a very serious problem. Thirty-two percent (18 of 57) answered a serious problem and 25% (14 of 57) said no problem. Only 7% (4 of 57) chose a minor problem.

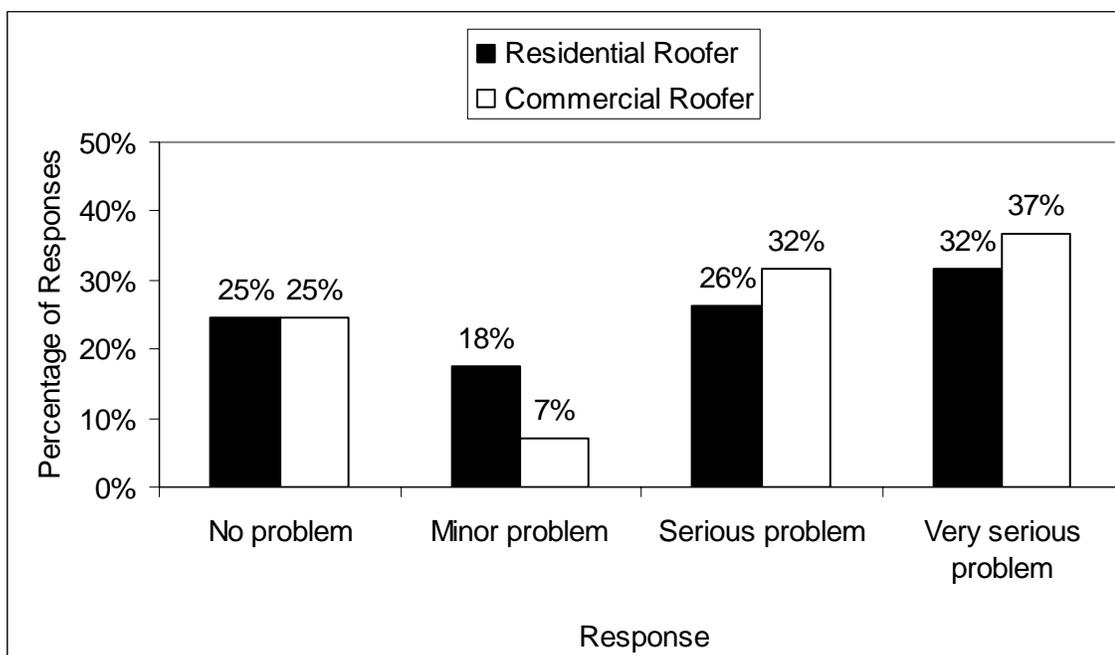


Figure 5.24: Responses of not using fall protection devices

Fourteen residential roofers and 1 commercial roofer who recorded that they did

not use fall protection equipment were asked to answer two questions. First of all, they were asked to pick reasons why they did not use the protection devices. The reasons were listed: (1) the protection devices decrease productivity; (2) the protection devices make me uncomfortable; (3) supervisory enforcement; (4) peer pressure. They could specify other reasons that were not included in the given list. They were able to select all applicable.

Forty-one percent of residential roofers (7 of 17) did not use fall protection equipment because the protection devices decreased productivity, as shown in Figure 5.25. Another 41% (7 of 17) stated that the devices made them uncomfortable. Twelve percent (2 of 17) did not use the devices because the protection devices were expensive. Six percent (1 of 17) did not use them due to peer pressure. One commercial roofer did not use the devices because they made him uncomfortable.

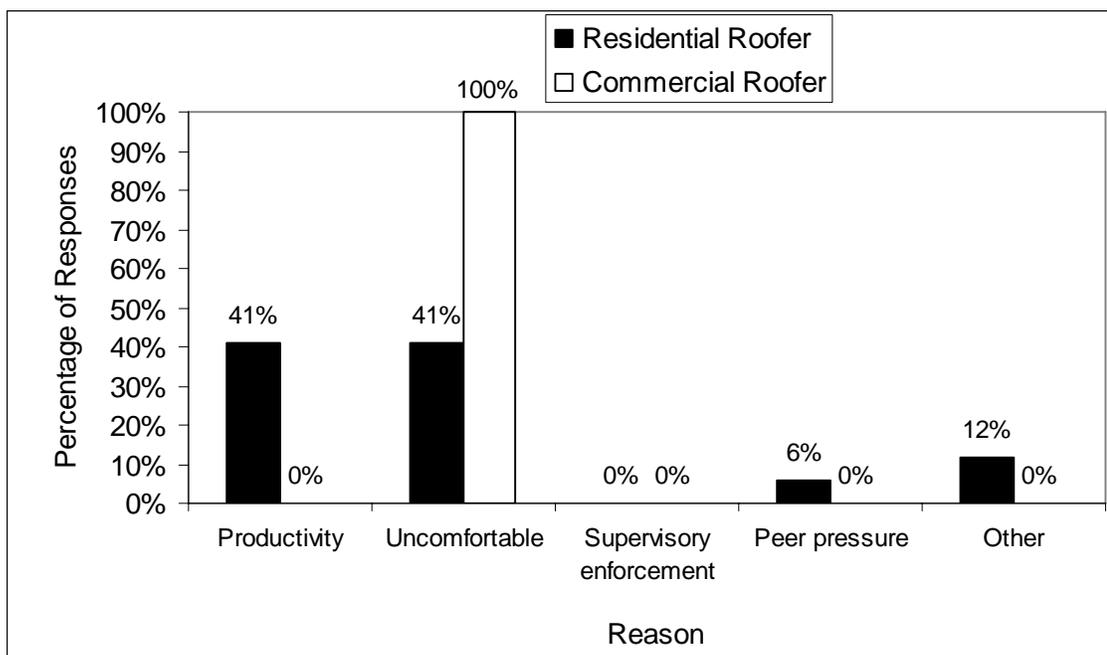


Figure 5.25: Reasons for not using fall protection devices

Fourteen residential roofers and 1 commercial roofer were also asked how they felt not using fall protection devices. Responses were listed: (1) no problem; (2) minor problem; (3) serious problem; (4) very serious problem.

As shown in Figure 5.26, 50% of residential roofers (7 of 14) answered no problem. Thirty-six percent (5 of 14) reported that it was a minor problem. Only 14% (2 of 14) thought that it was a very serious problem. One commercial roofer stated that it was no problem.

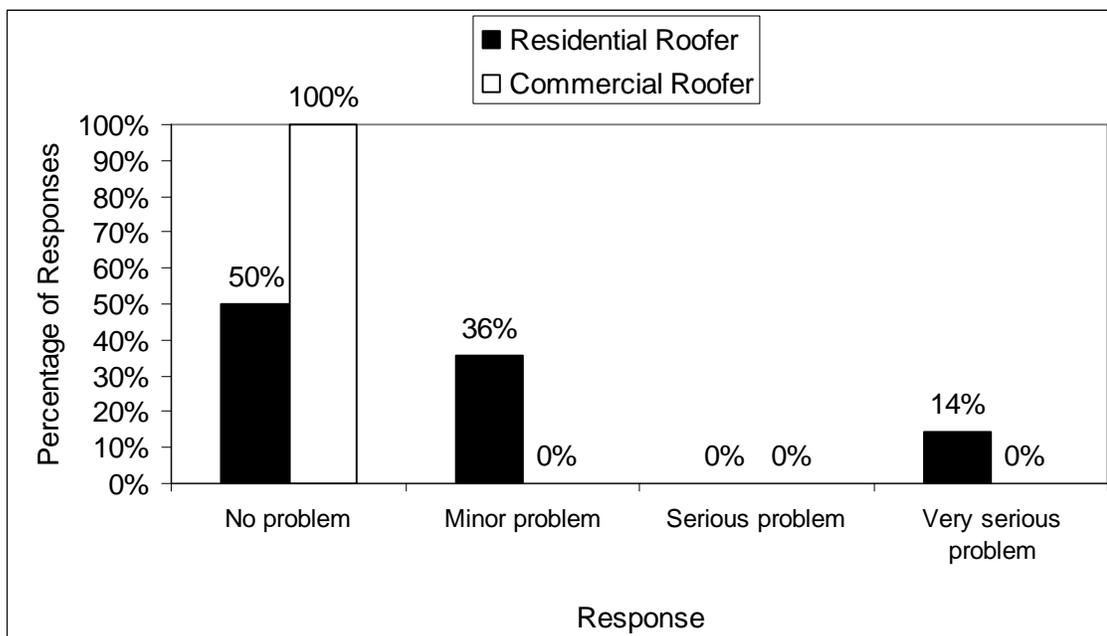


Figure 5.26: Responses of not using fall protection devices

Participants were asked to pick fall protection devices that they preferred. They could mention other types of fall protection devices that were not included in the given list. They were able to select all applicable.

Figure 5.27 shows that the most preferred protection device was PFAS making up 38% of residential roofers (36 of 95). Johnson et al. (1998) examined fall protection equipment and concluded that PFAS was feasible, protective, simple, and economical. The second device was slide guards consisting of 25% (24 of 95) and the third one was guardrails totaling 15% (14 of 95). Fourteen percent (13 of 95) selected warning lines and 4% (4 of 95) preferred safety monitors. Only 3% (3 of 95) chose safety nets as their preferences. Foot jacks accounted for other totaling 1% (1 of 95). For commercial roofers, the most preferred fall protection device was also PFAS totaling 25% (38 of 153). The second device was warning lines accounting for 23% (36 of 153) and the third device was safety monitors consisting of 23% (35 of 153). The rates of the first, second, and third devices preferred by commercial roofers were very closely distributed. Seventeen percent (26 of 153) accounted for guardrails and slide guards comprised 8% (13 of 153). Only 3% (4 of 153) preferred safety nets. Manbasket made up other accounting for 1% (1 of 153).

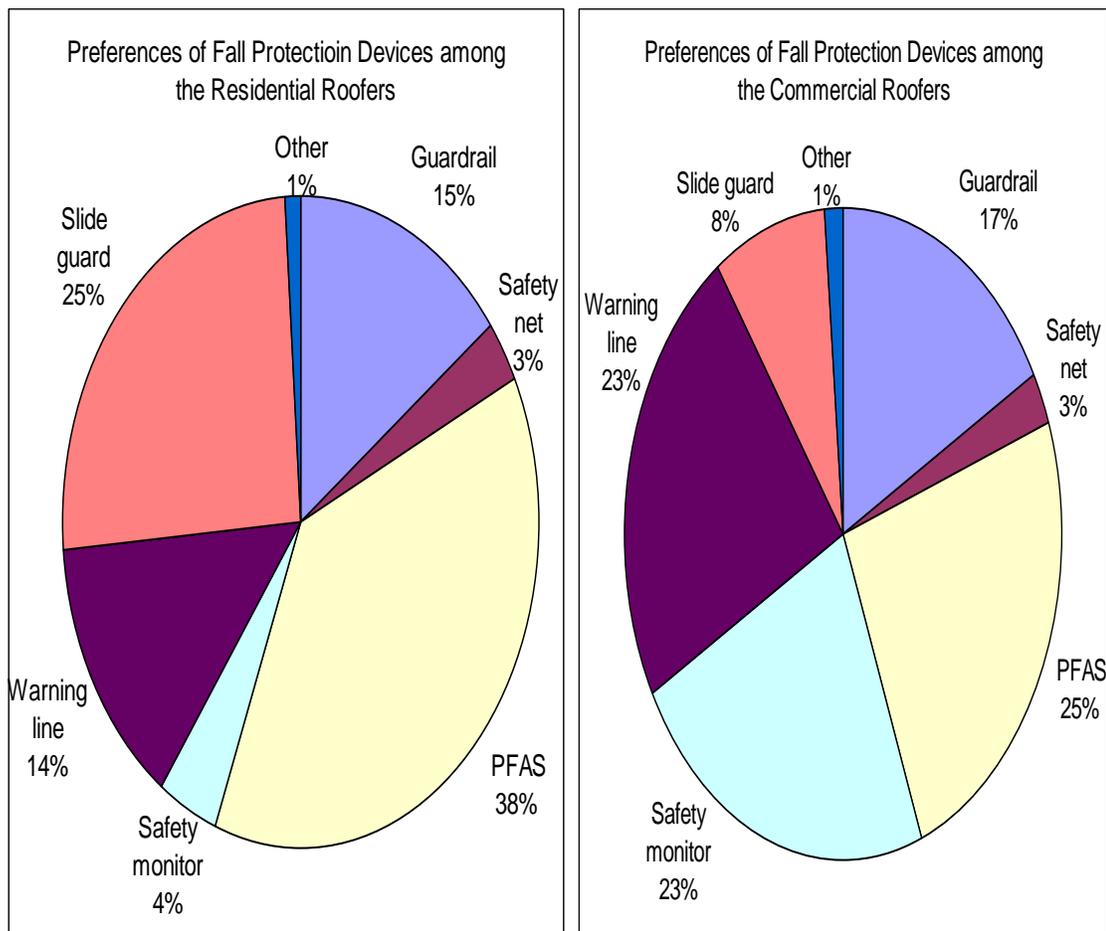


Figure 5.27: Preferences of fall protection devices

Participants were asked to record anyone who enforces them to wear or install fall protection devices at the jobsite. They could answer the question selecting yes, no, or don't know.

While 52% of residential roofers (37 of 71) answered yes, 44% (31 of 71) chose no, as shown in Figure 5.28. Four percent (3 of 71) did not know if there is any person who required wearing or installing fall protection equipment or not. Ninety-five percent of commercial roofers (55 of 58) responded yes. Only 2% (1 of 58) answered no and 3%

(2 of 58) did not know whether or not anyone who required them to wear or set up fall protection devices.

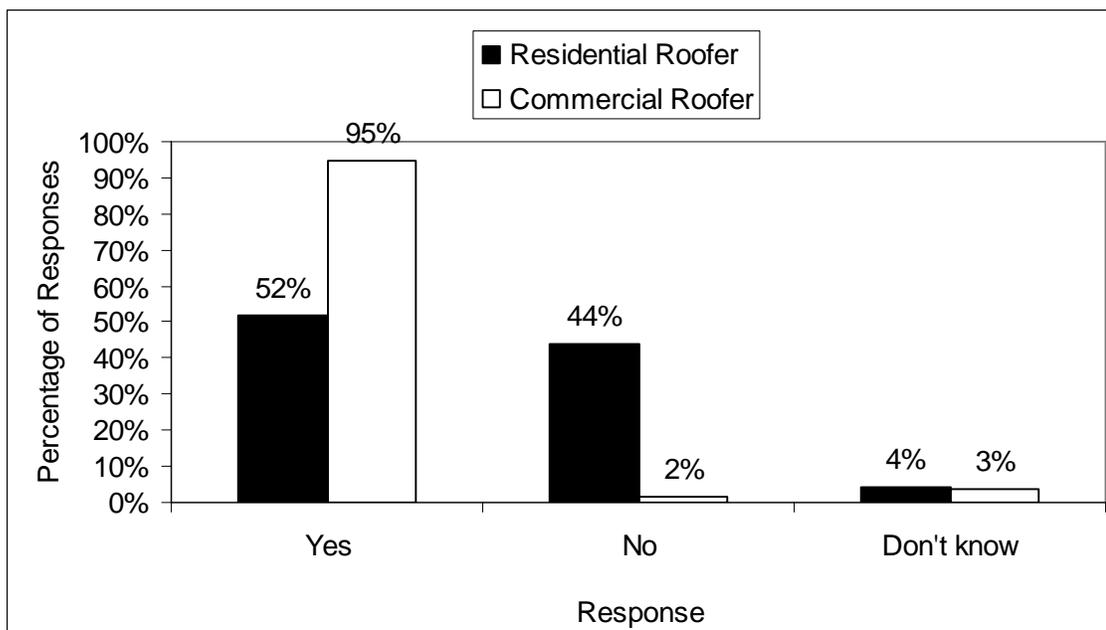


Figure 5.28: Responses of knowing who enforces roofers to wear or install fall protection devices

Thirty-seven residential roofers and 55 commercial roofers who stated that there was somebody who enforced roofers to wear or install fall protection equipment were asked to report who required them to wear or set up the protection equipment. Options were listed: (1) employer; (2) safety manager; (3) co-worker. They could mention other types of positions that were not included in the given list. They were able to select all applicable.

Fifty-five percent of residential roofers (27 of 49) chose employers and 31% (15 of 49) answered safety managers (Figure 5.29). Only 14% (7 of 49) accounted for co-

workers. As with residential roofers, 45% of commercial roofers (48 of 106) selected employers. Twenty-six percent (28 of 106) chose safety managers and 18% (19 of 106) mentioned co-workers. Ten percent (11 of 106) accounted for other (e.g., foreman, job supervisor, operation manager, and myself).

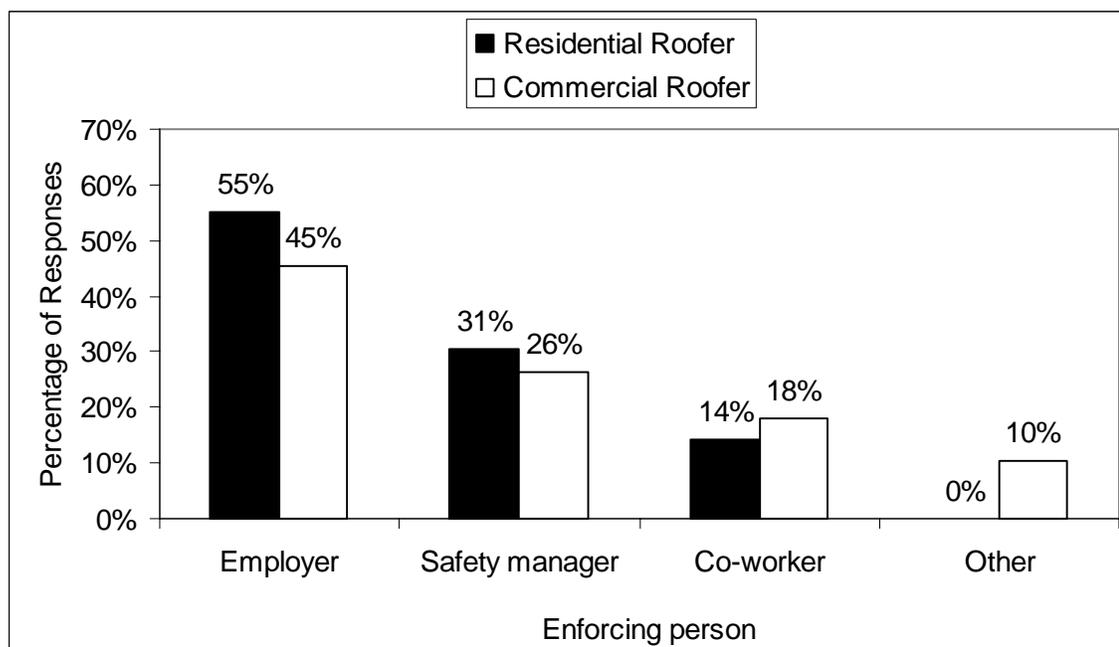


Figure 5.29: Persons who enforces roofers to wear or install fall protection devices

Results of Study of Work Condition

This section of the survey was designed to study a variety of work conditions of residential roofers and commercial roofers. A question was focused on types of surfaces on which roofers walk. Factors also included information about height and pitch (degree).

The participants were asked to allocate percentages to various types of surface conditions that roofers commonly walk on. The types of surface conditions were listed: (1) roof; (2) ladder; (3) scaffold; (4) ground. Participants were able to specify other

surface conditions that were not listed in the given list.

Results show that the majority of time spent by residential roofers was on roofs (67%), as shown in Figure 5.30. Fifteen percent was spent on the ground. Fourteen percent was assigned on ladders. Only 4% was allotted on scaffolds. In commercial, most time spent on roofs (82%). Eight percent was spent on ladders and the ground, respectively. Only 2% was allocated on scaffolds.

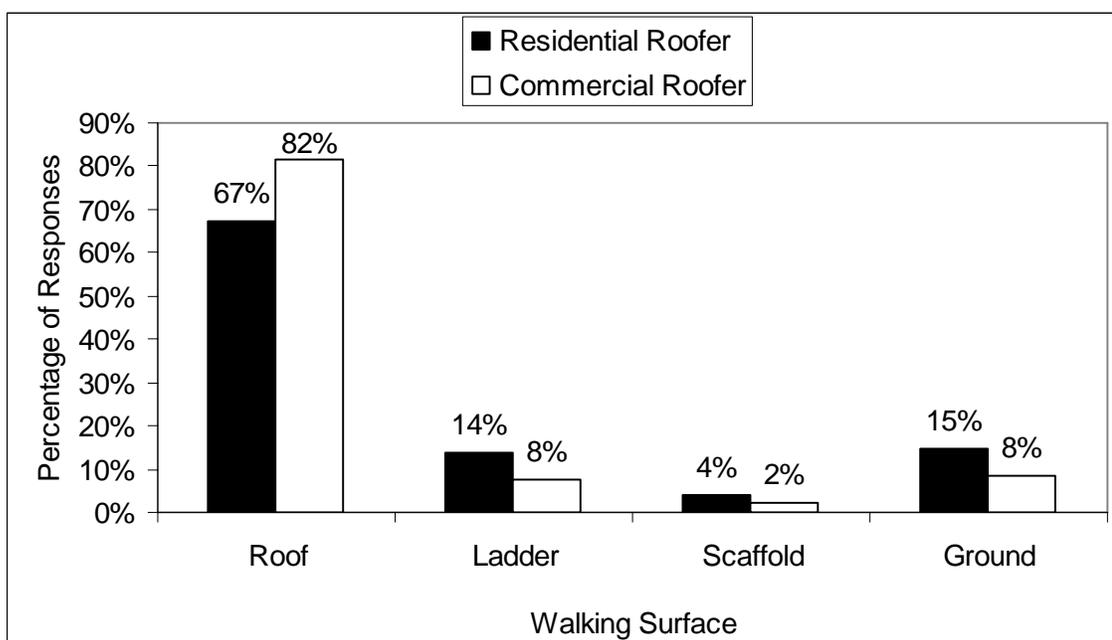


Figure 5.30: Percentages of time spent on different walking surfaces

The participants were also asked to report common heights at which roofers operate. Choices included less than six feet (1.8 m), seven (2.1 m) to ten feet (3.0 m), 11 (3.4 m) to 15 feet (4.6 m), 16 (4.9 m) to 20 feet (6.1 m), 21 (6.4 m) to 25 feet (7.6 m), and more than 26 feet (7.9 m). Participants were able to select all applicable.

The most common height reported in residential roofing was from 11 (3.4 m) to

15 feet (4.6 m) consisting of 39% (29 of 75), as shown in Figure 5.31. Twenty-eight percent (21 of 75) recorded working on heights from 16 (4.9 m) to 20 feet (6.1 m) and 16% (12 of 75) selected 21 (6.4 m) to 25 feet (7.6 m). Thirteen percent (10 of 75) worked on heights from 7 (2.1 m) to 10 feet (3.0 m). Only 4% (3 of 75) chose more than 26 feet (7.9 m). Unlike residential roofers, the most common height in commercial roofing was from 16 (4.9 m) to 20 feet (6.1 m) accounting for 43% (28 of 65). Twenty-nine percent (19 of 65) recorded working on heights more than 26 feet (7.9 m) and 20% (13 of 65) worked 21 (6.4 m) to 25 feet (7.6 m). Six percent (4 of 65) chose from 11 (3.4 m) to 15 feet (4.6 m). Only 2% (1 of 65) selected from 7 (2.1 m) to 10 feet (3.0 m).

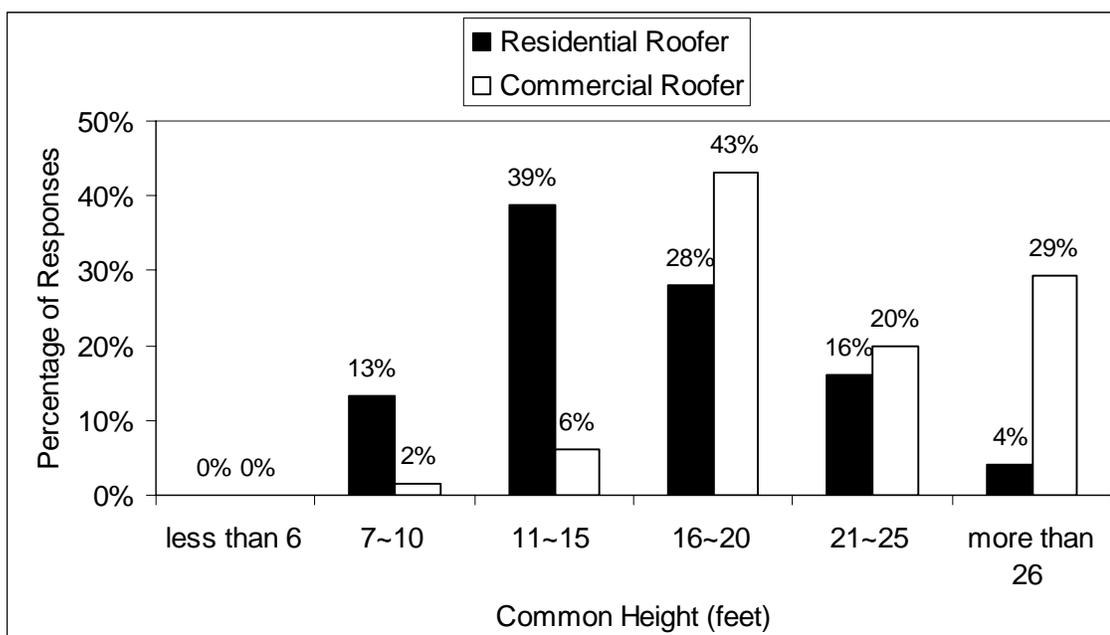


Figure 5.31: Common heights worked

The participating roofers were asked to list the most common pitches on which they commonly work. The types of common pitches included less than 2/12 (10°), 2/12

(10°) to 4/12 (18°), 4/12 (18°) to 8/12 (34°), more than 8/12 (34°). The recorded percentages were averaged.

As shown in Figure 5.32, 49% of residential roofers recorded that they usually worked on pitches 4/12 (18°) to 8/12 (34°). Thirty-three percent selected pitches ranging more than 8/12 (34°) and 13% worked on pitches 2/12 (10°) to 4/12 (18°). Only 5% were in the range of less than 2/12 (10°). In contrast to residential roofers, 71% of commercial roofers reported that they commonly spent work time on pitches less than 2/12 (10°). 12% selected pitches ranging 2/12 (10°) to 4/12 (18°) and 12% worked on pitches 4/12 (18°) to 8/12 (34°), respectively. Only 5% were in the range of more than 8/12 (34°).

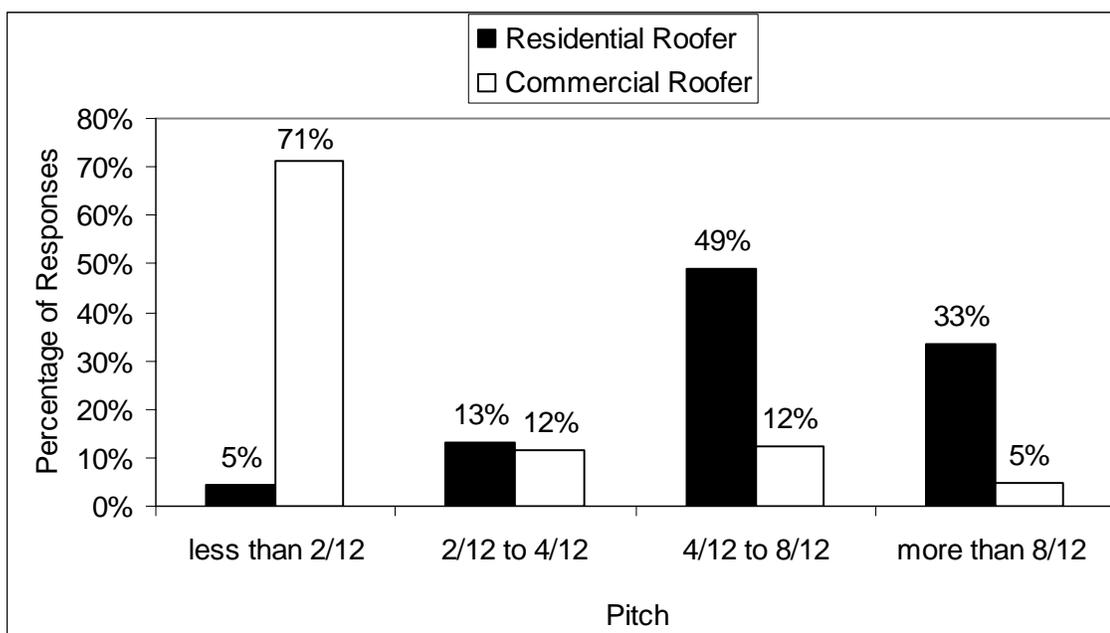


Figure 5.32: Percentage of work time spent on different pitches-survey results

Participants were asked to rate the overall level of safety of their worksites.

Choices were listed: (1) very unsafe; (2) unsafe; (3) neither safe nor unsafe; (4) safe; (5)

very safe.

Figure 5.33 shows that 49% of residential roofers (35 of 71) felt that their worksites were safe. Twenty-five percent (18 of 71) selected very safe and 13% (9 of 71) said neither safe nor unsafe. Ten percent (7 of 71) chose very unsafe and 3% (2 of 71) rated unsafe. In contrast to residential roofers, 52% of commercial roofers (30 of 58) believed that their worksites were very safe. Forty-five percent (26 of 58) chose safe and only 3% (2 of 58) selected neither safe nor unsafe.

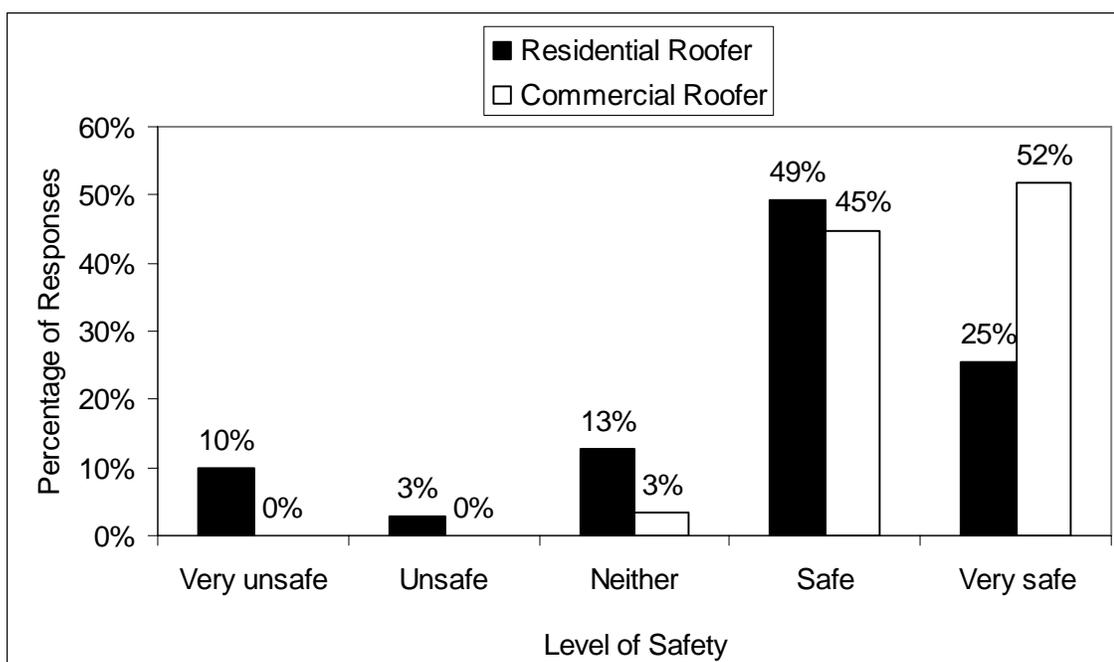


Figure 5.33: Overall level of safety at roofing sites-survey results

Results of Correlation Study

One hundred twenty nine participants (71 residential and 58 commercial roofers) were included in the correlation analysis (Pearson correlation). All the data were

analyzed using Minitab version 14 statistical package (Minitab, 2004).

Correlation between having fall protection programs and experiencing falls from roofs in residential roofing is low, at $r = -0.04$ ($p = 0.73$). In contrast to residential roofing, correlation between them in commercial roofing is significant, at $r = -0.26$ ($p = 0.05$) which means that if commercial roofers have fall protection programs, they would have fewer falls from roofs.

For residential roofers, correlation between having fall protection training programs and experiencing falls from roofs is low, at $r = -0.05$ ($p = 0.70$). Like residential roofers, correlation between them in commercial roofing is also low, at $r = -0.07$ ($p = 0.60$). This result indicates that the existence of a training program by itself was not enough to mitigate fall accidents for residential and commercial roofers.

The correlation efficient of $r = -0.03$ ($p = 0.79$) between providing fall protection equipment and having falls in residential roofing shows that there is no relationship. Unlike residential roofers, a significant negative correlation value of $r = -0.26$ ($p = 0.05$) between them in commercial roofing is found in this study. This finding shows that providing fall protection equipment would be associated with having fewer fall accidents in commercial, whereas in residential it would not.

For both residential and commercial roofing, there is a significant negative relationship between enforcing roofers to use fall protection equipment and having fall accidents. The correlation values of $r = -0.24$ ($p = 0.05$) for residential, and $r = -0.33$ ($p = 0.01$) for commercial indicate that the enforcement of the use of the fall protection systems would be significantly related to having fewer fall accidents. Additionally, there

is a very strong positive relationship between the enforcement and the actual usage of fall protection equipment. Both the correlation coefficients of $r = 0.56$ ($p = 0.001$) for residential, and $r = 0.66$ ($p = 0.001$) for commercial show a strong linear relationship.

CHAPTER VI

DISCUSSION

The main goal for this study was to analyze and compare residential and commercial roofers in terms of fall protection usage and preference to find any differences and common elements between them. Some different working conditions between residential and commercial roofers such as common working heights and common pitches were identified in this study. Also, certain common factors that cause fall accidents were found in the survey results. The results from our study mostly corresponded to other studies.

Hsiao and Simeonov (2001) found that male workers are at risk of fall hazards on roof work environments. The survey results also showed that all falls studied were experienced by men. This is primarily because of the fact that males (i.e., 180527 cases of 185662 cases) grossly outnumber females (i.e., 4904 cases of 185662 cases) injured in the construction industry (BLS, 2004).

The occurrence of falls was examined in regard to the distribution of the timing of their occurrence. Kines (2002) studied construction workers' falls through roofs. He found that the largest number of the construction workers' serious injuries occurred in the morning hours between 7:00 AM and 12:00 PM. The results from this study also showed that the most prevalent time frame of injury for residential roofers and commercial roofers was 10-12 PM and 8-10 AM, respectively. This is also similar to the distribution of accidents as noted in other research studies (Hinze et al., 2002). Choi (2003) studied the effects of sloped surfaces on shingling frequency and postural balance of a simulated

roofing task and reported that a greater postural sway was experienced at the earlier phase of task on the sloped surface. His findings suggest that there might be an adaptation period associated with working on a slope and the body's ability to compensate for a loss of balance. Together, these findings highlight that an effective fall protection program should be fully in place for the workers in a phase of postural adaptation to the sloped surfaces.

Our study showed that all fall accidents occurred at elevations below 30 feet. Of the roofers who had falls, the majority of them did not wear or install fall protection devices when they experienced falls. Other researchers also demonstrated similar results. Janicak (1998) and Hinze et al. (2002) reported that most falls occurred at elevations below 30 feet and concluded that the implementation of fall protection devices are lacking or unsuccessful at these lower elevations. Hinze et al. (2002) mentioned that some workers in construction had falls because they did not tie-off their body harnesses. In our study, one residential roofer had a fall due to incomplete connection of PFAS. It was found that only a few residential roofers (4%) worked at more than 26 feet (7.9 m) and 29% of commercial roofers recorded working on heights more than 26 feet (7.9 m). However, more residential roofers (35%) experienced falls from roofs than commercial roofers (21%) did. It is contributed to the fact that workers who work at elevations of less than 30 feet may not work carefully or ignore the fall hazards (Hinze et al., 2002).

The study findings also indicated that the most prevalent reason for using fall protection devices in residential roofing was personal concern for safety. Similar to our findings, Johnson et al. (1998) mentioned that most residential roofers complied with

regulations due to a personal concern for their own safety. Suruda et al. (1995) and Johnson et al. (1998) stated that residential roofers did not comply with regulations due to productivity and a desire for comfort. The results from our study also demonstrated that many residential roofers did not use fall protection equipment because the fall protection devices decreased productivity and made them uncomfortable.

Only 3 groups such as employers, safety managers, or co-workers enforced roofers to wear or set up fall protection devices in the residential roofing industry. In addition to the three groups, foremen in commercial roofing also played a role in enforcing workers to use fall protection systems. If residential roofing companies would designate foremen, more roofers would use fall protection equipment.

The survey results also pointed out that most residential roofers usually worked on pitches 4/12 (18°) to more than 8/12 (34°) and they had more falls than commercial roofers who commonly spent work time on pitches less than 2/12 (10°) did. Hsiao and Simeonov (2001) stated that inclined surfaces increase the risk of fall accidents. Roofers also perceived a greater loss of balance with the increase of slopes (Choi, 2005).

Many Hispanic residential roofers were interviewed on residential roofing sites in particular in Wisconsin and Illinois regions. However, they had difficulties reading the three page survey or could not read it at all. Moreover, they did not know fall protection regulations and guidelines, and were not enforced to wear or install fall protection devices by employers, safety managers, or foremen. It is obvious that an increase in Hispanic work population and lack of safety awareness in roofing construction would result in more fall accidents. The U.S Census Bureau has projected that by the year 2050

one of four workers will be Hispanic, making it the fastest growing sector of the workforce. Growth of the Hispanic workforce has been especially significant in the construction industry. A survey carried out by the National Safety Council (NSC) suggested that about 1.5 million Hispanic workers were in U.S construction in 2000 which was 16% of the total construction workforce. According to the NSC, Hispanic construction workers are at significantly higher risk for fatal and non-fatal injuries on the job and this could be said for every age group. The survey carried out by the NSC also found out that Hispanic construction workers die more frequently in falls and mostly of head injuries. Roofing is the construction sector that accounts for most of the falls (NSC, 2002).

Data gathered by the survey depended on the memories of workers. The main limitation of this study was, as expected, the inaccuracies of memories of roofers who had injuries or falls on roofing sites. The results from this study should, therefore, be interpreted with caution and simply as examples that would possibly occur at the jobsite. A possible problem is that some residential roofers were interviewed and participated in the survey without approval from their employers, managers, or foremen on roofing sites. An apparent problem is that when some participants filled out the surveys, their employers or safety managers carefully watched them. There would be a possibility that the participants could not answer the survey questions freely because of the employers or safety managers.

The results of this study show that roofers are at risk of fall hazards. As Janicak (1998) pointed out that 4 major prevention areas such as employee training, the

enforcement of the use of fall protection systems, and inspection and testing of the fall protection systems in use should be highlighted as a means of preventing falls in construction, roofers should be trained and enforced to have complete connection of PFAS and set up fall protection equipment prior to work. Additionally, roofers should inspect fall protection devices prior to use and work with extra care at elevations below 30 feet where most fall accidents occur.

Safety managers or foremen should monitor roofers who are exposed to fall hazards. They should enforce workers to have complete connection of PFAS or install fall protection equipment properly. As shown in the survey results, if roofers always use fall protection devices, they would not have falls. Safety managers or foremen should, therefore, oversee if workers always use fall protection equipment or not.

Employers should plan fall protection programs to prevent workers from falling from roofs. They also should provide roofers with fall protection equipment and require them to have complete connection of PFAS or install fall protection equipment properly. As shown in the results of the survey, falls also occurred due to old fall protection devices. Employers should, therefore, not provide workers with old fall protection devices.

CHAPTER VII

CONCLUSION AND RECOMMENDATIONS

Conclusions

The conclusions drawn from this study are summarized in terms of the objectives and are enumerated below:

1. While most of commercial roofers did use fall protection devices, a significant number of residential roofers did not comply with fall protection regulations and guidelines. Thus, it is within these smaller roofing companies where the greatest room of improvement can be achieved.

2. Two main reasons of noncompliance with fall protection regulations and guidelines in roofing construction were: (1) fall protection devices decrease productivity; (2) fall protection equipment makes roofers uncomfortable. These findings suggest that a greater detailed safety and ergonomics research is needed for more flexible personal fall protection system that might be able to save more lives.

3. The most prevalent fall protection device used was personal fall arrest system (PFAS) among residential and commercial roofers. Moreover, the most preferred fall protection device was PFAS among residential and commercial roofers as well.

4. The fall protection regulations and guidelines are cumbersome and difficult for workers and contractors alike to understand and to implement, especially for residential roof construction. To improve worker protection, the following courses of action have support from the residential construction community: (1) developing innovative methods of protection, (2) increasing worker and contractor training, (3) subsidizing costs of fall

protection system, (4) increasing collaboration of industry, academia, and governmental agencies, (5) enforcing roofers to wear or install fall protection devices, (6) changing the safety climate in residential construction.

5. It was determined that many falls occurred at elevations between 6 (1.8 m) to 10 feet (3.0 m). Employers, safety managers, and foremen should pay particular attention and enforce roofers to wear or set up fall protection equipment at these elevation ranges. For fall protection systems to be implemented on residential construction projects, the fall protection equipment should be feasible, simple, economical, passive, protective, and flexible.

Recommendations for Future Research

Based on the results and conclusion of this study, the following recommendations for future research are stated:

1. Investigation should be made to develop an innovative and practical fall protection program particularly for the smaller roofing contractors.
2. Research should be performed to develop different kinds of new technology which can help prevent falls and protect workers from injury by falls.
3. Investigation should be conducted on the level of impact on productivity and safety as a result of the installations and usages of personal fall arrest system.
4. Research should be performed to determine the main contributing factors for the fall accidents in regards to the distribution of the timing of their occurrence in the residential and commercial roofing worksites.
5. Investigation should be performed to assess a relationship between an increase in Hispanic workforces in residential roofing and occupational accidents due to falls.
6. Research should be made to improve the safety climate related to the enforcement of the use of fall protection systems as a means of preventing falls from roofs in the roofing industry.

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Appendix A

Approval Letter from the University of Wisconsin-Whitewater Institutional Review Board

Your project titled *An Investigation of Fall Protection Systems in the Roofing Industry* has been reviewed by the University of Wisconsin-Whitewater Institutional Review Board for the Protection of Human Subjects Chair, Stephen Friedman. He has determined that under rules governing protocol review, the project qualifies for expedited review and is approved for one year without modification.

If you should make any changes in the future in the protocol involving 1) method, 2) subjects, 3) informed consent, and/or 4) subject identification, you must submit a protocol modification. (Instructions for protocol modification may be found in the IRB GUIDE available at our website <http://www.uww.edu/orsp/compliance/human/>)

The case number assigned to this protocol is **C04504086Q**; please reference this number in all future correspondence. You are responsible for maintaining all records related to this project for at least three years after completion of the research project.

Your protocol approval is valid from 29 April 2005 to 28 April 2006. You will be required to submit an Annual Progress Report (APR) to the IRB. Approximately 60 days before your protocol approval period ends, you will be sent an APR form. You must complete this form and return it to the Research and Sponsored Programs office, even if you have completed your research.

If you have questions or require additional information, please do not hesitate to contact me.

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ANNA MILLER
Compliance/File Clerk
Research and Sponsored Programs
University of Wisconsin-Whitewater
2023 Roseman, 800 West Main Street
Whitewater, WI 53190
Telephone: 262.472.5212

Appendix B

The purpose of this survey is to investigate fall protection device usages and reduce fall-related injuries and fatalities in the roofing industry. Your participation is voluntary and you may choose to discontinue participation at any time. If you choose to participate, please complete this survey and return it to the researcher. The researcher will not share the information obtained from you with your employer or co-workers. The researcher will not even ask for your name or address. So your responses are strictly confidential. **Please place a checkmark in boxes or write what you think.** *There are no right or wrong answers.* Please answer each question honestly. Thank you for your time in advance.

*For any more questions regarding this research, please contact the researcher: **Dr. Sang Choi, Assistant Professor, Department of Occupational and Environmental Safety & Health, University of Wisconsin-Whitewater, (262) 472-1641 or chois@uww.edu** or The institutional Review Board Administrator: Ms. Denise Ehlen, (262) 472-5212 or ehlehd@uww.edu*

I. Background

Gender: Male Female

What is your race? Black Hispanic White Asian/Pacific Islander Other

Location (State): MN IA WI IL IN MI

Work experience as a roofer: Year(s) _____ Month(s) _____

What is the type of work that you do? Commercial roofing ___% Residential roofing ___ %

How many employees including you are in your company? _____ employees

Does your company have fall protection programs? Yes No Don't know

Does your company have fall protection training programs? Yes No Don't know

If yes, how often do you have the training programs?

Every ___ day(s) Every ___ week(s) Every ___ month(s) Every ___ year(s) Don't know

II. Injuries

Have you ever had injuries at the jobsite? Yes No

If yes, what types of injuries have you had? (Please check all applicable)

Sprain/Strain Fractures Burns Cuts Other _____

When have you had injuries? Spring Summer Fall Winter

In what time frame have you had injuries after you started work on roofs? (Please check all applicable)

Before 8 AM 8-10 AM 10-12 PM 1-3 PM 3-completion

Please check parts of your body where injuries have occurred:

Head/Neck Shoulder Back Finger/Hand Knee
 Foot/Ankle Other _____

What caused injuries at your work? (Please check all applicable) Overexertion

Fall Slip Trip Tools/Machinery Other (please explain)

Have you ever experienced falls from roofs? Yes No

If yes, what caused the falls? Slip Trip Loss of balance
 Other (please explain) _____

What are the most common types of falls that you have experienced?

Fall to same level Fall to lower level (Height of fall _____ feet)

Did you wear or install fall protection devices at those times?

Yes No

If yes, what caused the falls?

Incomplete connection of personal fall arrest system

Improper use of fall protection devices

Old fall protection devices

Other (please explain) _____

III. Fall protection devices

1. Guardrails	2. Safety nets	3. Personal fall arrest system	4. Safety monitors	5. Warning line	6. Slide guards
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Does your company **provide** you with fall protection devices listed above? Yes No
 don't know

If yes, what kind of fall protection devices does your company provide? (Please check all applicable)

1 2 3 4 5 6 other (please explain) _____

Do you **actually use** fall protection devices? Yes No

<p>If yes, why do you use fall protection devices?</p> <p><input type="checkbox"/> Requirement of employment</p> <p><input type="checkbox"/> Personal concern for safety</p> <p><input type="checkbox"/> Supervisory enforcement</p> <p><input type="checkbox"/> Peer pressure</p> <p><input type="checkbox"/> Other (please explain)</p>	<p>If no, why do you not use fall protection devices?</p> <p><input type="checkbox"/> They decrease productivity</p> <p><input type="checkbox"/> They make me uncomfortable</p> <p><input type="checkbox"/> Supervisory enforcement</p> <p><input type="checkbox"/> Peer pressure</p> <p><input type="checkbox"/> Other (please explain)</p>
<p>What kind of fall protection devices do you use? (please check all applicable)</p> <p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6</p> <p><input type="checkbox"/> Other (please explain)</p>	<p>How do you feel not using fall protection devices?</p> <p><input type="checkbox"/> it is no problem at all <input type="checkbox"/> a minor problem</p> <p><input type="checkbox"/> a serious problem</p> <p><input type="checkbox"/> a very serious problem</p>
<p>What percent of work time do you use the devices? <input type="checkbox"/> 100% (Always) <input type="checkbox"/> 75%</p> <p><input type="checkbox"/> 50%</p> <p><input type="checkbox"/> 25% <input type="checkbox"/> Less than 25%</p>	
<p>How do you feel not using fall protection devices?</p> <p><input type="checkbox"/> it is no problem at all <input type="checkbox"/> a minor problem</p> <p><input type="checkbox"/> a serious problem</p> <p><input type="checkbox"/> a very serious problem</p>	

What kind of fall protection devices do you **prefer**? (Please check all applicable)

1 2 3 4 5 6 other (please explain) _____

Is there anyone who enforces you to wear or install fall protection devices?

Yes No Don't know

If yes, who enforces you to wear or install fall protection devices? Employer

Safety manager Co-worker Other (please explain) _____

IV. Work Conditions

What types of surface conditions (in % of time) are you commonly walking on?

Roof _____% Ladder _____% Scaffold _____% Ground _____%

Other (Please list): _____ %

When you work on roofs, what is the most common height in feet?

Less than 6 feet 7-10 feet 11-15 feet 16-20 feet 21-25 feet More than 26 feet

What percent of work time do you spend on the following ranges of pitch (degree)?

Less than 2/12 _____% 2/12 to 4/12 _____% 4/12 to 8/12 _____%

More than 8/12 _____ %

How would you rate the overall level of safety of your worksite?

- Very unsafe Unsafe Neither safe nor unsafe Safe Very safe

Any comments:

Thank you again for your time