Analysis of Selected Scaffold-Related Fatal Falls

Thomas G. Bobick, Catherine A. Bell, Ronald L. Stanevich, Dwayne L. Smith and Nancy A. Stout

Proceedings of the Human Factors and Ergonomics Society Annual Meeting 1990 34: 1072
DOI: 10.1177/154193129003401424

ANALYSIS OF SELECTED SCAFFOLD-RELATED FATAL FALLS

Thomas G. Bobick, Catherine A. Bell, Ronald L. Stanevich,
Dwayne L. Smith, and Nancy A. Stout

National Institute for Occupational Safety and Health
944 Chestnut Ridge Road, Morgantown, WV 26505

Data collected by the National Institute for Occupational Safety and Health, Division of Safety Research contain information on work-related deaths in the U.S. from 1980 through 1985. During this six-year period, a total of 3,491 fatal workplace falls occurred. Of this total, 2,705 (77.5%) were classified as falls from elevations, where 461 (17.0%) were falls from scaffolds. During the period October 1988 to February 1990, 50 fall-related deaths were investigated by NIOSH. Ten (20%) were falls from scaffolding. Descriptive information on both the victims and employers is discussed, along with recommendations for improving workplace safety through known intervention techniques.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) conducts the Federal government's occupational injury and disease research program with the Division of Safety Research (DSR) responsible for injury control. DSR recently completed collection and analysis of six years of data on occupational fatalities (NIOSH, 1989). These data, collected through the National Traumatic Occupational Fatality (NTOF) surveillance project, profile work-related deaths in the U.S. from 1980 to 1985. The information was obtained from death certificates supplied by all 52 U.S. vital statistics reporting units (the 50 States, New York City, and the District of Columbia).

Analysis of the NTOF data indicates that a total of 3,491 fatal workplace falls occurred during the six-year period from 1980 through 1985. Of these, 2,705 (77.5%) were classified as falls from elevations and represent 7.4% of all NTOF-documented deaths. Additional analysis of the fall-from-elevation deaths reveals that 461 (17.0%) fell from scaffolds. Thus, a total of 77 workers are fatally injured each year while working on scaffolds. Because of missed cases, incorrect classification, and under-reporting, this total should be interpreted as the minimum number of workers killed each year in falls from scaffolds.

The Supplementary Data System (SDS) of the Bureau of Labor Statistics is a database, which is composed of workers' compensation claims from approximately 27 states, that provides information on occupational injuries and illnesses. The SDS data for the period 1980-1985 contains 696,276 compensation claims filed by workers from U.S. industries for injuries sustained from falls from elevations. Interestingly, 146,218 (21%) of these claims were filed by construction workers, yet these workers represent only 5% of the nation's workforce. Of the 146,218 fall-related construction injuries recorded in SDS, 24,748 (16.9%) involved scaffolds. However, these construction-related data represent 48% of all scaffolding incidents reported by all participating industries.

Both the NTOF and SDS data have shown that falls from elevations are a significant cause of workplace mortality and morbidity. As a result, NIOSH began investigating selected fatal workplace falls as part of the DSR Fatal Accident Circumstances and Epidemiology (FACE) project. This project is aimed at characterizing the risks associated with fall-related incidents to prevent these types of deaths in the future. The purpose of this paper is to discuss descriptive information on both the victims and their employers involved with falls from scaffolds, and also to present recommendations for utilizing existing fall protection/prevention techniques.

SOURCE OF DATA

The FACE project is a passive surveillance system focusing on the identification and investigation of work-related fatalities. DSR personnel collect data using an epidemiologic model that examines the work environment, the victim, and the energy source(s) involved. The goal of the FACE project is to reduce the risk of future fatalities in the workplace by identifying potential risk factors, developing recommended intervention strategies, and disseminating findings to appropriate worker groups. The on-site investigations conducted for the FACE project are for research purposes only, and not to determine culpability.

The FACE project relies on a cooperative notification procedure to identify deaths. Eleven states voluntarily report fatalities to DSR. Since the notification procedure is voluntary, some state agencies are more responsive than others. Also, the agencies responsible for notifying DSR receive their information from different sources. This is reflected in the reliability and comprehensiveness of their reporting.

From October 1, 1987 through February 1, 1990, a total of 49 fall-related incidents, which resulted in 50 fatalities, were investigated by DSR personnel for the FACE project. Data collected from field survey forms, medical examiner reports, and FACE investigative reports were entered into a computer database, edited,

and analyzed using the Epi Info software program (Centers for Disease Control, 1988). Of these 50 fatalities, a total of 10 (20%) involved workers falling from scaffolds.

RESULTS

Employment environment

A total of nine investigations were conducted since one of the incidents involved two workers. (Short descriptions of the nine incidents are contained in the Appendix.) The nine employers had an average time in business of 21 years (range: 18 months to 61 years, median: 10 years). Eight of the employers were special trades contractors and one was a general building contractor. The average number of workers employed by these companies was 80 (range: 2 to 500, median: 20). Two companies had less than 10 employees; three companies employed between 11 and 20; three employed between 21 and 100; and, the last employed 500 workers.

Five of the nine companies reported having no written safety rules or procedures, and three reported that they did not have a safety officer for the company. One of the nine companies did not provide any type of safety training for its employees; the other eight companies provided only on-the-job training. None of the nine companies had any type of formal classroom safety training. Eight of the nine companies did not have an emergency response procedure for the workforce to follow.

In most situations, personal protective equipment (ppe) was not required by the employer. Six of nine companies did not require the use of personal fall protective equipment. Even though the employees were not required to use ppe, six companies made ppe available to the workers. Only two of the ten victims chose to use any type of protective equipment. For the two victims who used ppe, one died when a previously damaged lanyard failed when subjected to the stress of the worker falling. In the second situation, almost immediately after the victim had disconnected from an independent lifeline, the scaffold platform collapsed (case no. 7 in Appendix).

Descriptive data on victims

All of the victims were male and all worked in the construction industry. Their average age at the time of death was 35.1 years (range: 21 to 55 years; median age: 31.5 years). Seven of the 10 were at least a high school graduate; information was unavailable on the other three. In addition, seven of the ten were white, one was black, one was Asian, and one was an American Indian.

The 10 victims comprised six occupational classifications. Five were painters; the other five were: an asbestos remover, a caulking mechanic, a cement finisher, a drywall finisher, and a stucco mason. They worked in two major sectors of the construction industry--nine were with special trades contractors (major SIC code 17) and one was with a general contractor of non-residential buildings (SIC code 1542).

All ten victims were employed by private companies. They worked for their respective employers an average of 5.1 years (range: 1 day to 16 years; median time: 2.5 years). Four had worked for their employer 6 months or less. In addition, the average time on the job when the fatality occurred was 17 days (range: 1 day to 60 days; median time: 7 days).

Fall information

Workers were engaged in various activities prior to the fatal incident. Six incidents involved suspended scaffolds, while the remaining three involved welded tubular scaffolds. Six victims were using the tools or equipment that were required for the job. Two were climbing upward (one was going up a ladder that was positioned on top of a mobile scaffold, and the other worker was climbing up on the scaffolding guardrail). Another worker was moving portions of dismantled scaffolding, and the last worker was walking on a site-fabricated scaffold when normal job activities contributed to the loosening of a support cable that slipped free permitting the scaffold to collapse.

Work surface collapse preceded the death of six of the victims, while two deaths related to equipment failure (previously damaged lanyard failed, and previously damaged nylon suspension rope failed). In another case, the victim lost his balance, and the victim's activities were unknown in the final situation.

The average distance fallen was 55.5 ft (range: 12 ft to 160 ft; median distance: 48 ft). Two workers fell 25 ft or less, seven fell 26 to 75 ft, and one worker fell 160 ft.

One worker fell to a metal surface, one fell to loose soil, two fell onto tools or work materials, three fell to a concrete or asphalt surface, and three fell to hard-packed ground.

DISCUSSION

Although the number of cases analyzed in this paper is small, the causes of scaffold failure and distribution of fatalities is consistent with other data analyses. Suruda (1990) has reviewed unpublished OSHA data for 1984-1986. A total of 996 fatal falls were investigated, of which 17% involved scaffolds. Suspended scaffolds accounted for 35% of the deaths, welded tubular frame scaffolds 20%, inadequate descriptive information prevented the identification of the scaffold type in 30% of the cases, and mobile and other scaffolds accounted for 15%. Anchorage failure was the most common cause of injuries involving suspended scaffolds. Failure to install rails or secure planking was the main cause of injuries involving welded tubular frame scaffolds; the second most common cause was scaffold collapse due to inadequate bracing or assembly. Comparing the ten

fatalities discussed here with the unpublished OSHA investigation data indicates that the ten cases investigated by FACE are representative of most fatal scaffold incidents (Suruda, 1990).

Only one of the nine companies required the use of the three components of a complete personal fall protection system for suspended scaffolds--safety belt, lanyard, and independent lifeline (case no. 7). In this particular situation, the worker had unfortunately disconnected himself so he could hand equipment to a co-worker located on a level above him when, at that exact instant, the U-bolts, which secured the cable supporting the scaffold, loosened and let the cable slip free and the scaffold collapse. In another incident, the company required the use of the safety belt and lanyard, but not the use of a lifeline. In retrospect, it would not have mattered whether the worker had been attached to the lifeline, since the lanyard broke where it was previously burned. In the third situation, the company required the use of the lifeline and safety belt, but did not require the use of the lanyard. Regardless of what was required, neither the victim or a co-worker who survived used any personal protective gear whatsoever.

Six of the nine companies had a safety officer, but only four companies had written safety rules, policies, or procedures. The smaller companies (less than 15 employees) did not have written safety policies and procedures; however, one larger company, employing 50, also did not have a written set of safety rules. It will be more meaningful to the workers if management can refer to and actively support written safety policies and procedures prepared and endorsed by company management and ownership.

Eight companies provided on-the-job training (OJT); the ninth apparently offered no training at all. Information, however, is not available regarding the extent of the OJT. Perhaps it was only superficial and was insufficient to prepare the workers. Perhaps it was quite thorough, but the workers were not receptive to the training or, if conducted on-site, maybe external conditions (noise, weather, etc.) interfered with the worker's ability to understand the training being provided. Data presented earlier showed that 50 percent of these fatalities occurred within 7 or less days on the job; in three instances, the workers died on the first workday. In two instances, workers used equipment (a lanyard and a suspension rope) that had been previously damaged. An adequate training program should give instruction on proper equipment care and inspection.

Six fatal incidents involved suspended scaffolds. During the use of suspended scaffolds, a standard safety practice, which should be enforced by management, should be followed unwaveringly: workers should install independent lifelines, utilize them in conjunction with their safety belts and lanyards, and the lanyards should be equipped with rope-grab devices.

Worker safety can be improved through engineering solutions. Structures (commercial/industrial buildings, bridges, dams, etc.) that will undergo regular maintenance activities should be designed to include permanently fixed tie-off points so scaffolds, rigging equipment, safety nets, and lifelines can be securely anchored. During renovation of existing structures, design specifications should require the installation of permanently fixed anchor points.

Economics plays a major role in choosing equipment to be used in any construction job. The presence of permanent anchorage points will encourage the proper use of tie-offs to ensure a safe workplace. Installation of anchorage points will involve a nominal capital investment during structure erection. This minor expense, however, will result in long-term safety and economic benefits.

The three fatalities involving welded tubular scaffolding (cases 1, 6, and 8 in the Appendix) differ widely. However, in each situation, available equipment was not used appropriately to ensure a safe and hazard-free workplace. In each instance, incorrect or unsafe set-up of the scaffolding intensified the repercussions of the unsafe action. Correct use of the most appropriate equipment to meet the demands of the job or workplace must be a high priority.

If incorrect or faulty equipment is used, or if the right equipment is used improperly, a job may be completed without incident, but safety will be compromised and the risk of injury will be increased. Pre-planning and conducting a thorough hazard analysis is essential to maximize job safety. For example, in case number 2, a thorough site hazard analysis, conducted when the job estimate was prepared, would have noted the nearness of overhead power lines. With adequate notice, the power company could have insulated the exposed power lines at the job site. This may have prevented the death of one worker and a severe injury to another.

The FACE investigations have identified potential risk factors related to workers falling from scaffolds. Future data may lead to the evaluation of techniques to prevent falls from occurring, and to evaluate protective equipment to reduce the severity of the injury after the fall has occurred.

CONCLUSIONS

Falls from elevations in the construction industries are both common and preventable. The best solution is to use the engineering modifications just discussed. The design of future structures should incorporate permanent anchorage points to encourage workers to quickly and easily tie off or to install fall protection systems. If workers who labor at elevations do not use personal fall protection or fall prevention/protection systems, then they are at an increased risk of sustaining a serious or fatal injury. The attitudes and behaviors of management and the workforce have to be oriented so safe work practices are developed, implemented, enforced, and remain a priority item.

RECOMMENDATIONS

The best way to increase job safety for suspended scaffolds is through engineering modifications and new design procedures. Using personal protective equipment and fall prevention systems is an important part of a complete safety program, but should not be the only method of protecting the workforce. Management has a responsibility to provide appropriate, well-maintained, and structurally sound scaffolding and fall protection systems. In addition, a national special emphasis program concerning implementation of enforcement and preventive measures should be targeted to the use of scaffolds.

Policies and procedures

Companies of all sizes that have employees working at elevations should have written safety policies and procedures that both management and workers are required to follow. Policies should address: (a) the hazardous exposures, (b) techniques that should be used to prevent falls, and types of fall protection to be used, (c) requirements for orientation training before starting a new job, and training on how to properly use and inspect fall protection equipment, and (d) disciplinary action for employees failing to comply with the policies and procedures regarding using this equipment. Policies and procedures should be reviewed and updated annually.

Training

Companies should use a fall prevention and protection training program, developed and endorsed by all levels of management, for each different job environment that is encountered. Thorough job hazard analyses, which will identify and discuss as many risks as possible, should be part of the orientation and refresher training for those employees who will work at elevations. As part of the program, companies should provide on-the-job training, as often as necessary, that will be sufficiently thorough to provide a safe working environment for all employees. At a minimum, companies should train employees to correctly erect, install, and inspect scaffolding. (The inspection should be conducted by an individual other than the worker(s) who erect and install it.) Companies should also consider using training programs for specific trades, such as any of the Department of Labor's approved Apprenticeship Programs. In addition, the training program should include correct methods of inspecting and using the safety protection equipment issued to the workers.

Personal fall protection equipment

Finally, employees who have to work at elevations should view fall protection equipment (personal gear and entire systems) as vitally important. Ideally, appropriate fall protection should be used at all times. Economic reality and workplace feasibility may compromise this goal. However, analysis of this limited data has shown that fatal injuries can occur rather easily. Management must provide adequate fall protection systems and/or appropriate personal protective gear to all workers exposed to fall hazards.

REFERENCES

Centers for Disease Control, U.S. Dept. of Health and Human Services, 1988, Epi Info Computer Programs for Epidemiology.

National Institute for Occupational Safety and Health, U.S. Dept of Health and Human Services, 1989, National Traumatic Occupational Fatalities: 1980-1985, DHHS (NIOSH) Pub No 89-116.

Suruda, A., Personal communication, internal memorandum, June 8, 1990.

APPENDIX

Case 1. FACE #88-27. A 55-year-old drywall finisher died after falling 22 feet from a portable wooden stepladder he had placed on top of a 17-ft-high mobile tubular scaffold. The victim had intentionally left the casters on the scaffold unlocked to be able to move the scaffold without descending. The victim had leaned the ladder against a wall and was climbing it when the scaffold moved, causing the victim to fall. No form of personal fall protection equipment had been used.

Case 2. FACE #88-29. A 30-year-old painter died and a co-worker was seriously injured when the two-point metal suspension scaffold that they were working on fell 52 ft. The scaffold was suspended by two 5/8-inch-diameter steel cables lying across a horizontal sheet metal gutter. When the slack portion of one of the cables contacted a 7200-volt powerline, both suspension cables were grounded and burned in half where they contacted the gutter, causing the scaffold to fall. No personal fall protection equipment was being used.

Case 3. FACE #89-07. A 53-year-old foreman and a 28-year-old painter died when the two-point suspension scaffold they were using to paint a surface storage tank fell 48 ft to the ground. The scaffold was suspended from two counterbalanced steel outriggers. The counterweights being used on the outriggers were 1/3 the amount specified by the manufacturer and the outriggers were not tied off to prevent them from slipping. As the two men were working on the scaffold, both outriggers slipped off the roof of the tank, letting the scaffold and workers fall to the ground. No personal fall protection equipment was being used.

Case 4. FACE #89-21. A 27-year-old cement finisher was dismantling a suspended scaffolding inside a 172-ft-high circular concrete silo when he lost his balance and fell from the scaffold. The victim was wearing a safety belt and nylon lanyard that he had obtained from a common equipment bin. When the victim fell, the lanyard stopped the victim's fall and caused him to "bounce." When the lanyard was subjected to the shock following the bounce, it failed. The victim fell 160 feet to the silo floor. An investigation revealed burn marks on the lanyard, apparently caused by previous cutting or welding operations. The lanyard failed at one of the burned areas.

CASE 5. FACE #89-29. A 33-year-old caulking mechanic died after falling 60 feet from a two-point suspension scaffold. The victim and one other worker were sealing the sixth floor windows of a new structure. The victim had not been on this particular scaffold in the past. The investigating team's speculation was that the victim did not disengage the parking brake prior to lowering the scaffold. This caused the suspension cable on the victim's end to loosen in the climber unit, causing that end of the scaffold to fall when the parking brake was disengaged. A centrifugal safety brake inside the hoist mechanism, which is designed to arrest such a fall, failed. An investigation determined that a loose spring in the unit prevented the centrifugal brake from activating. Neither the victim nor the co-worker, who was able to hang onto the other end of the scaffold, were wearing any type of personal fall protection. Both employees had left their safety belts and lifelines in their service truck.

Case 6. FACE #89-35. A 28-year-old stucco mason died after falling 48 feet from a welded tubular scaffold. The victim was attempting to climb from one level to another without using the built-in scaffold ladder. As he stepped onto the bottom guardrail it gave way, causing the victim to fall to the ground. The guardrail was not properly secured to the tubular scaffolding.

Case 7. FACE #90-12. A 37-yr-old painter died when the suspension scaffold on which he was working fell 65 feet inside a municipal water tank. The scaffold was a site-built single-point suspension "boom" scaffold, consisting of two steel stirrups that held an aluminum ladder horizontally. This unit was supported by a single steel cable that looped around a vertical steel pipe on top of the tank and was secured back to itself by two U-bolts. The scaffold had been used for two weeks prior to the incident and the U-bolts had apparantly loosened during normal work activities. The victim was wearing a safety belt-lanyard combination secured to an independent lifeline. The victim unhooked his lanyard and moved to another position on the scaffold platform. At this precise instant, the U-bolts loosened enough to allow the cable to slip through them, causing the scaffold and victim to fall to the tank floor.

Case 8. FACE #90-13. A 21-year-old asbestos worker died when he fell 12 feet from a welded tubular scaffold. The scaffold was not fully decked, and had only a single 8-foot-long, 2- by 12-inch plank for a working surface. The plank overhung the edge of the scaffold by 10 inches on one side and 14 inches on the other. The plank was not fastened securely to the scaffold tubing, but was simply held against the tubing by two nails driven in each end at a 45 degree angle. The victim was sitting on the end of the plank with the 14-inch overhang when his weight caused the nails on the opposite end to loosen, allowing the plank to rise up, thus dropping the victim to the ground, where he was then struck by the falling plank. No personal fall protection equipment was used.

Case 9. FACE #90-16. A 39-year-old painter died as a result of falling 40 feet when a nylon suspension rope on the scaffold from which he was working broke. The scaffold was a site-built two-point suspension scaffold, with a nylon suspension rope at either end. The victim and a co-worker were at opposite ends of the scaffold. As the victim pulled on a suspension rope to raise his end of the scaffold, the rope broke dropping the end of the scaffold on which the victim was standing. The victim fell 40 feet to the bottom of a water storage tank. The co-worker, who was wearing a safety belt secured to a lifeline with a rope grab device, did not fall. The victim had declined to wear a safety belt, stating that "it would get in his way." An investigation revealed that the rope had failed at a point where it had previously been burned during cutting or welding operations.