PUBLIC HEALTH SERVICE/CDC/NIOSH/DSR
FACE-92-11
DATE: October 3, 1992

TO: **Director, National Institute for Occupational Safety and Health**

FROM: **Division of Safety Research, NIOSH**

SUBJECT: **Ironworker Dies Following an 18-foot Fall From Structural Steel Framework - Alaska**

SUMMARY

A 41-year-old male ironworker (the victim) died after falling from a structural steel framework to a concrete floor during the construction of an automobile repair shop. The victim and two other ironworkers (co-workers) were assembling the steel frame "skeleton" (measuring 50 feet wide, 86 feet long and 18 feet high at the roof edge) of the structure. Sway-bracing rods had not been installed between the beams (combination column-roof truss units), the bolts at the base of the beams had not been fully tightened, and two steel beams had not yet been connected at the roof-line apex. As the victim walked on top of a stack of unsecured purlins (steel joists) along one edge of the frame to make a final measurement, the frame began to sway. The victim lost his balance, and fell 18 feet to the concrete floor, receiving fatal injuries. There was not fall protection equipment in place, and the victim was not wearing a helmet. NIOSH investigators concluded that in order to prevent similar occurrences in the future, employers should:

- *ensure that workers follow building plans and procedures for pre-fabricated structures, and comply with existing standards regarding structural steel assembly*
- *ensure that workers comply with existing standards regarding the use of personnel hoists and work platforms*
- *ensure that workers comply with existing standards regarding the use of personal protective equipment*
- *ensure that workers develop and implement a jobsite hazard analysis as an ongoing part of each construction phase.*

INTRODUCTION

On October 20, 1991, a 41-year-old ironworker died from severe head injuries sustained 8 days previously, after falling 18 feet from a structural steel framework. On November 28, 1991, officials of the Alaska Department of Occupational Safety and Health (AKOSH) notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), Alaska Activity of the death. On December 12, 1991, a safety specialist from DSR, Alaska Activity and an injury prevention specialist candidate from the State of Alaska, Department of Health and Social Services, Division of Public Health, Section of Epidemiology

traveled to the incident site and conducted an investigation. The incident was reviewed with the AKOSH compliance officer, and the owner of the company. The police report, medical examiner's report, emergency medical service report, and photographs were obtained.

AKOSH determined that the employer in this incident was the owner of an automobile repair shop that had been in business for 12 years. The employer was in the process of constructing a new repair shop, and had contracted with three ironworkers to complete the construction project. The employer did not require any type of safety policy, or established safe work procedures for construction of the repair shop, nor did the contracted ironworkers have any such safety policy or procedures. The victim had 6 years of work experience, in structural steel erection.

INVESTIGATION

The employer contracted with three ironworkers to construct an automobile repair shop which consisted of a pre-fabricated (pre-fab) structural steel building. The pre-fab package for the building came with a set of plans and some basic assembly procedures that the ironworkers did not entirely follow. After 2 weeks of construction, the skeletal steel frame of the shop was nearly complete. The frame consisted of four 8-inch sets of steel beams interconnected with purlins around the perimeter (eaves), with an overall dimension of 50 feet by 86 feet, and a height of 18 feet from the concrete floor to the top of the eave purlins (Figures 1 and 2). Each beam set was to be bolted together at the apex to form the longitudinal cross-section of the building structure. The three workers used a forklift with a pallet laid over the forks as a personnel hoist and work platform for connecting and bolting the steel frame units together.

At approximately 3:30 p.m. on the day of the incident, the construction had progressed to the following stage:

- A temporary guy cable was installed (one end of the cable anchored in the concrete below beam #1, the middle of the cable attached to the apex of beam #2, and the opposite end of the cable anchored to the base of beam #3). This was not in accordance with the building plans and assembly procedures which required 3/4-inch sway-bracing steel rods to be installed (in an "X" configuration between the vertical beams) and kept in place immediately after hoisting the beams into place.

- All the beams had been bolted to the concrete base, but had not been fully wrench-tightened so that final adjustments could be made at a later time.

- All the beams except beam #4 had been bolted (wrench tightened) together at the apex. Beam #4 was being held in place temporarily by a choker cable suspended by the forks of a forklift. The final bolting of this beam was delayed until final measurements could be made for minor adjustments to the structure.

- All the eave purlins had been bolted (wrench tightened) to the steel beams.

- An unsecured stack of purlins was placed on top of one side of the structure between beam #3 and beam #4.

The victim was on top of the unsecured stack of purlins between beams #3 and #4; the two co-workers were working at ground level. The victim walked from beam #4 to beam #3 on top of the stack of purlins to take a measurement. The co-workers observed that the entire structure began to sway beneath him, causing the victim to lose his balance and fall to the concrete floor 18 feet below.

The co-workers hurried to the victim and noted that he was unresponsive and bleeding from the side of the head. One of the co-workers called 911, and an emergency medical service (EMS) team responded, arriving at the scene 3 minutes later. The EMS team noted the victim was traumatized and unresponsive, yet breathing. They stabilized the victim, and transported him to a local hospital where he remained in a comatose condition. He died 8 days later.

CAUSE OF DEATH

The medical examiner listed the cause of death as blunt force trauma to the head.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that workers follow pre-fab building plans and procedures, and comply with existing standards regarding structural steel assembly.

Discussion: There were at least five factors in this incident that contributed to the instability or sway effect of the structure, which may have caused the victim to lose his balance and fall. All of these factors were contrary to either the building plans and procedures, the existing standards pertaining to structural steel assembly, or both:

1. Sway bracing rods had not been installed between the beams.

2. The bolts at the base of the beam columns had not been fully tightened.

3. The apex of beam #4 had not been bolted together.

The building plans and procedures specified that 3/4-inch steel sway bracing rods be installed (in an "X" configuration between the beam columns) and kept in place immediately after hoisting the beams into place. Regarding structural steel assembly, AKOSH Standard, CC 05.180 (b) requires that during the final placing of structural members, "the load shall not be released from the hoisting line until the members are secured with not less than two bolts, or the equivalent at each connection and drawn up wrench tight."

4. An unsecured stack of purlins had been placed on top of one side of the structure between beams #3 and #4.

The AKOSH Standard states that steel joists (such as purlins) "shall not be placed on any structural steel framework unless such framework is safely bolted or welded."

5. The victim walked on top of the unsecured stack of purlins between beams #4 and #3.

Walking on top of this unstable structure may have caused it to sway. This task could have been accomplished from a work platform (such as a mobile scaffold or scissors-jack platform) meeting AKOSH and Federal OSHA standards, thus greatly reducing the potential for a fall.

Recommendation #2: Employers should ensure that workers comply with existing standards regarding the use of personnel hoists and work platforms.

Discussion: In this incident, the victim and co-workers used a forklift with a pallet laid over the forks as a personnel hoist and work platform. This does not comply with AKOSH (and Federal OSHA) Standards CC 05.140 (c) and CC 05.140 (g) (also cited in Federal OSHA Standards 29 CFR 1926.552 (c) and 29 CFR 1926.556) which specify acceptable types of personnel hoists and work platforms. The victim in this incident could have worked from a mobile elevating work platform or wheel-mounted scaffolding which met these standards (instead of from the structural steel beam from which he fell), greatly reducing the likelihood of a fall.

Recommendation #3: Employers should ensure that workers comply with existing standards regarding the use of personal protective equipment.

Discussion: The victim in this incident was not using any type of fall protection equipment and was not wearing a protective helmet. AKOSH Standard, CC 05.030 (j) (1) [also USDOL Standard 29 CFR 1926.28 (a)] states, "The employer is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions or where this subchapter indicates the need for using such equipment to reduce the hazards to the employees." The use of a traditional safety belt/lanyard (or preferably the safety harness/lanyard) combination as required by AKOSH and USDOL standards CC 05.050 (e) and 29 CFR 1926.104 respectively, is sometimes not practical during construction operations, particularly where worker mobility is required. However, in this incident, the use of a perimeter guide, attached to the top of the beams (for anchoring the worker's safety harness/lanyard) could have provided sufficient worker mobility. Additional forms of fall protection, such as safety nets [as specified in CC 05.050 (f) and 29 CFR 1926.105], or a catch platform, could also be considered. Safety nets can effectively prevent injury or death when a worker falls. Also, in this situation, wheel-mounted scaffolding might have been placed under the victim to serve as a catch platform. This portable type of catch platform can be moved to a new location as each area is completed. The use of alternative fall protection systems should always be carefully considered when the potential for a serious or fatal fall from elevation exists. Protective helmets are another type of personal protective equipment required by AKOSH and Federal OSHA standards for this type of work: "Employees working in areas where there is a danger of head injury from impact, or from falling or flying objects ... shall be protected by protective helmets." [AKOSH CC 55.050 (a) (1), and USDOL 29 CFR 1926.100 (a)] Although such helmets are not specifically designed for head protection in the event of a fall from elevation, protective helmets that meet ANSI Standard Z89.1-1986 (and if equipped with a chin strap, also worn properly) do provide impact attenuation (including the impact from some types of falls) by limiting the magnitude and concentration of impact forces (Phase I in the Development of Criteria For Industrial and Firefighters' Head Protective Devices, January 1975,

and Experimental Program for Industrial Head Protective Devices, Phase II, December 1976, Dayton T. Brown, Inc. under NIOSH contract). Currently, there are industrial protective helmets available that can provide some head protection for falls from elevation.

Recommendation #4: Employers should ensure that workers develop and implement a jobsite hazard analysis as an ongoing part of each construction phase.

Discussion: The employer owned and operated an automobile repair shop, requiring safety procedures specific to that type of operation. However, in this incident the same employer contracted with the victim and two co-workers to construct a building. Therefore, the employer should have required the victim and co-workers to develop and implement safety procedures specific to each construction phase of the building. Before starting each phase of construction, the employer should ensure that the potential hazards have been identified and reviewed with the work crew or contracted employees, including how to implement appropriate safety controls. Federal OSHA Standard 29 CFR 1926.21 (b) (2) states, "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury." AKOSH has a voluntary compliance program which offers safety training to employers and employees on a request basis. Effective safety training in structural steel erection will increase the employees' awareness of the hazards which confront them.

REFERENCES

Construction Code, Volume 1, Occupational Safety and Health Standards, Alaska Department of Labor, Division of Labor Standards and Safety, August 1990.

General Safety Code, Volume 1, Occupational Safety and Health Standards, Alaska Department of Labor, Division of Labor Standards and Safety, September 1990.

29 CFR 1926 Code of Federal Regulations, Washington D.C.: U.S. Government Printing Office, Office of the Federal Register, July 1990.

American National Standards Institute, Inc., Z89.1-1986, Personal Protection - Protective Headgear for Industrial Workers - Requirements, December 1986.

NIOSH Contract, HSM-99-72-86, Phase I in the Development of Criteria For Industrial and Firefighters' Head Protective Devices, Dayton T. Brown Inc., January 1975, pages 23 and 47.

NIOSH Contract, 210-75-0031, Experimental Program for Industrial Head Protective Devices, Phase II, Dayton T. Brown Inc., December 1976, pages 4 and 2-22.

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Fatal Accident Circumstances and Epidemiology (FACE) Project

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

States participating in this study: Alaska, Georgia, Indiana, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

Additional information regarding this report is available from:

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