



The National Institute for Occupational Safety and Health (NIOSH)

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Three Ironworkers Die and One was Seriously Injured in the Collapse of a Structural Steel Framework in Ohio

FACE 9033

SUMMARY

Three ironworkers were killed and one was seriously injured when the structural steel skeleton of a four-story office building under construction partially collapsed. Those killed were members of a three-man crew who were lifting and leveling a floor section prior to bolting it in place at the fourth floor level. Apparently, the crew had attached a lifting device(s) to a roof beam in order to use the beam as a support for raising the floor section to a level position. However, the roof beam was a cantilever (a projecting beam or member supported at only one end) that had been temporarily attached to a structural column with only three bolts, rather than the eight bolts required to permanently secure it. Apparently, while the crew was hoisting the floor section, the load exceeded the shear strength of the three bolts, causing the structure to partially collapse. Two ironworkers who were tied off to the roof beam were thrown to the ground. The beam to which they were tied landed on top of one of them. The third member of the crew landed on the second floor, and was crushed to death by pieces of falling steel. A fourth ironworker, who was placing steel decking on the floor just below the section being leveled, was seriously injured when he was struck by falling steel members and forced through the steel decking. NIOSH investigators concluded that, in order to prevent future similar occurrences, the project client/owner should ensure (through unambiguous contract language) that contracted employers:

- develop a project construction process plan detailing proper construction sequences and associated safe work procedures
- implement job-specific employee training programs addressing the job hazards and methods of control
- establish an on-site safety inspection program as required by 29 CFR 1926.20(b)(2), and
- delineate project staff safety and health responsibilities.

INTRODUCTION

On May 22, 1990, a 44-year-old male journeyman ironworker, a 24-year-old male journeyman ironworker, and a 24-year-old male apprentice ironworker were killed when the structural steel skeleton of a four-story building under construction partially collapsed. A 44-year-old male journeyman ironworker was also seriously injured. On May 23, 1990, officials of the Bureau of Workers' Compensation, Division of Safety & Hygiene, notified the Division of Safety Research (DSR) of this incident, and requested technical assistance. On June 6, 1990, a DSR safety engineer and a safety specialist conducted an on-site investigation of this incident. The case was discussed with personnel from the Bureau of Workers' Compensation, the employer, and the project client's construction management team representative. The erected steel skeleton, and the steel components involved in the incident, were visually inspected and photographed during the investigation.

The employer in this incident is a subsidiary of a large steel fabrication company specializing in structural steel erection. The employer maintains a permanent staff of management and administrative employees who are assigned to field projects. The tradesmen and craftsmen required during construction projects are hired out of the local union halls on an "as needed" basis. The employer had a total of 44 workers on site the day of the incident. The employer has a designated safety officer at its headquarters, but no full time, on-site safety personnel. The project superintendent is responsible for managing the company's written safety and health program at the worksite. New employees are provided with a list of 10 general safety rules which they acknowledge by signing a form on their first day of work. The employer began to erect the steel skeleton on this project 8 days prior to the incident, and was the only steel erection contractor on the site.

INVESTIGATION

On the day of the incident, members of a three-man crew were "trueing" (i.e., aligning, leveling, and bolting) cantilevered structural steel floor sections of a new four-story building. The crew consisted of two journeyman ironworkers and one apprentice ironworker. At the time of the incident, they were leveling a section of the fourth floor (Figures 1 & 2). Floor sections consisted of I-beams measuring 2 feet 6 inches high by 8 feet 2 inches long, with smaller steel floor joists running between, and perpendicular to the I-beams. One end of each of the cantilevered beams was temporarily bolted to a steel column. Until the structural steel members could be aligned, leveled, and permanently bolted standard work practice involved temporarily securing them with the minimum number of bolts necessary to support the structural framework. Three bolts had been used to temporarily secure each I-beam in place. The design specifications for this project required the installation of eight bolts to permanently secure each beam to the appropriate steel column. The alignment and leveling operation began after several building tiers had been erected. The contractor "trued" the ground/foundation level support framework and proceeded to each of the upper levels in turn.

The crew had completed work on the three lower floors and was leveling a section of the fourth floor when the incident occurred. Although the actual event was not witnessed, the crew was apparently using a 3-ton "chain fall" and/or a 2-ton "come-along" to lift the fourth floor section into a level position. One journeyman ironworker was working on the outer end of one of the cantilevered I-beams comprising the fourth floor section (Figure 2). He was apparently operating the manual lifting device(s), while the apprentice ironworker was standing on the secured end of the beam near the column. The apprentice was to complete final bolt-up after the section was in a level position. The second journeyman ironworker was on a cantilevered I-beam at roof level (presumably, he had attached the lifting device(s) to this I-beam). A fourth ironworker (journeyman) was installing steel decking on the third floor directly beneath the fourth floor section being leveled.

Apparently, the crew had anchored the lifting device(s) to one of the cantilevered I-beams located at roof level that had been only temporarily attached with three bolts. While the fourth floor section was being raised to a level position, the bolts securing the roof beam to the column failed. A section of the roof (including the supporting beam), a section of the fourth floor where two of the victims were working, and other supporting steel members, collapsed in a domino fashion, causing a portion of the third floor to collapse onto the second floor. The apprentice ironworker and the journeyman ironworker on the roof beam, both of whom were tied off to the roof beam, were thrown to the ground when the beam collapsed. The roof beam and attached joists landed on top of the journeyman ironworker. The journeyman ironworker working on the end of the fourth floor beam, landed on the second floor decking and was crushed by falling steel. The journeyman ironworker who was placing decking on the third floor level, was struck by falling steel and forced through the decking. He was found dangling upside down from the collapsed third floor section.

Of the two ironworkers who had been tied off to the roof beam, the journeyman was pronounced dead at the scene, and the apprentice died in transit to the hospital. The journeyman ironworker who was trapped under the steel on the second floor, died at the hospital 3 hours after being extricated from the collapsed steel skeleton. The journeyman ironworker who had been placing decking on the third floor received serious injuries to the head and upper torso.

The two journeyman ironworkers who were fatally injured had been working on this job for 7 days at the time of the incident. It was the first day on the job for the apprentice ironworker. The journeyman ironworker who sustained serious injuries but survived the incident, had been on the job for 2 days.

CAUSE OF DEATH

The Medical Examiner's reports on these three deaths had not been released at the time this report was prepared; however, it is anticipated that the cause of death in all three cases will be multiple traumatic injuries.

RECOMMENDATIONS/DISCUSSION:

Recommendation #1: Project client/owners and contractors should develop detailed construction process plans that specify the construction sequences and procedures for safe construction for each site.

Discussion: Using the roof-level cantilevered I-beam as an anchor for raising the fourth floor section did not provide sufficient support, particularly since the beam was only temporarily secured with three bolts. The adjoining column could have provided adequate support for lifting the floor section (refer to Figure 1, which shows a more appropriate location for attaching the lifting devices). The preparation of a construction process plan prior to the start of work, detailing the proper construction procedures in appropriate sequence, may have revealed the potential hazards posed by this construction procedure. Upon identification of hazardous procedures, control measures can be developed and implemented prior to the start of work.

Recommendation #2: Employers should implement a job-specific employee training program addressing the expected hazards and exposures, and the employer's methods for controlling each of those hazards.

Discussion: Employers should provide job- and/or task-specific safety training concerning worksite hazards to all employees before they begin their assigned tasks. For example, ironworkers should be given task-specific training on proper "trueing" procedures prior to the initiation of steel erection tasks.

Recommendation #3: Employers should utilize an on-site safety inspection program, as required by 29 CFR 1926.20(b) (2), to identify workplace hazards.

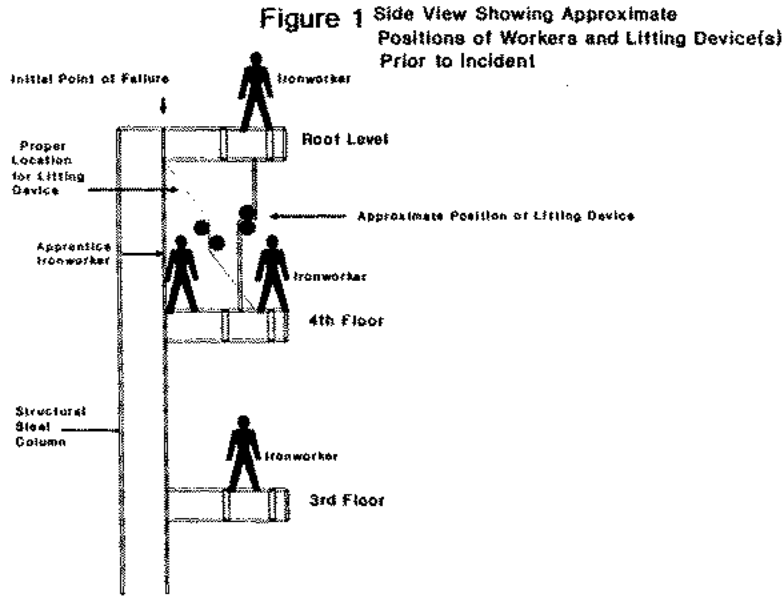
Discussion: On-site safety inspections by a competent person serve to identify hazards and initiate prompt corrective action before an incident occurs. A program of daily, on-site safety and health inspections can help to ensure that appropriate construction and/or hazard control procedures are being utilized.

Recommendation #4: On projects where a single project contractor (construction manager, general contractor, prime contractor) is responsible for supervising and controlling a construction project, the project client should stipulate safety and health program responsibilities through unambiguous contract provisions.

Discussion: The project client/owner had an on-site construction management team to supervise construction activities. It is unclear which safety and health responsibilities were assigned to the construction management team, and which were assigned to the victims' employer. The construction management team representative and the victims' employer have different opinions. Specific safety responsibilities for all involved parties should be clarified during the contract bidding and award phases. On construction sites involving multiple subcontractors, the primary contractor is often the best candidate for managing the safety and health program throughout the entire project.

REFERENCE

29 CFR 1926.20. Code of Federal Regulations, Washington, D.C., U.S. Government Printing Office, Office of the Federal Register.



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