TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (FACE) Program

SUBJECT: Construction superintendent dies when crushed by a falling crane boom.

SUMMARY

California FACE Report #96CA003

A 43-year old male construction superintendent (victim) died after being crushed under the lattice boom of a 175-ton crawler crane. Two days before the incident, the slings attached to the load broke causing the boom to recoil and bounce back and forth. Thereafter, a thorough inspection of the cables was not performed. At the time of the incident, the boom was in the process of being lowered so the victim could check the load, a special probe. The boom was to be lowered, with no provision for supporting it, so that the probe could be laid out on the ground and be repaired. The victim was standing near the tip of the boom observing the probe when the 7/8-inch boom hoist cable broke. The boom fell straight down and pinned the superintendent under the area of the boom tip. The CA/FACE investigator concluded that, in order to prevent future occurrences, employers should:

. Keep all personnel out of the area of danger of the load or the boom by delineating the danger area's boundaries.

. Assure the boom hoist cable is relaxed when the boom has been fully lowered to perform an inspection so any cable damage becomes apparent.

. Ensure the boom is supported when it is lowered to check loads so it cannot fall or collapse when employees are underneath it.

INTRODUCTION

On February 29, 1996 at 0900 hours, a 43-year old male construction superintendent was crushed when he was pinned under a crane's lattice boom which fell on him when the boom hoist cable broke. The victim was declared dead at 0913 hours. The CA/FACE investigator learned of the incident on March 13, 1996 from a coroner's report. The CA/FACE investigator traveled to the site of the incident twice on March 27, 1996 and met with the replacement construction superintendent and the Cal/OSHA investigator. He also interviewed one of the oilers and, on the second visit, the crane operator. A copy of the police report, coroner's report, Cal/OSHA preliminary report and the death certificate were obtained by the CA/FACE investigator.

The construction company has been in business for 15 years. The company had been working at the site where the fatality occurred since January of 1996. The victim had been on this job site working for this construction company since January of 1996. He had also worked 2 1/2 years for the same construction company on other job sites. The decedent had received extensive safety training from the company including training involving the probe and the crane.

A site survey was performed by the crane operator and the oiler prior to the boom lowering procedure. The construction company employs 177 people with 8 working at the site at the time of the incident.

INVESTIGATION:

After the initial meeting with the replacement construction superintendent, the CA/FACE investigator and the superintendent drove to the site of the incident where we met with an oiler who was present during the incident. The site is a large area of mostly rough ground having muddy spots, piles of gravel and soil throughout. There were railroad tracks running just to the east of the position of the crane which was involved in the incident. The major project was a grade separation where the ground would be lowered and two railroad bridges were to be built over the area. The specific job on the day of the incident was to install stone columns 47 feet deep into the soil. The stone columns were 4-feet in diameter and were constructed to withstand soil liquefaction in the event of an earthquake. Once a column was finished, a surcharge load of five times the load for which it was designed would be applied. This assured that the column was compacted and stable. When all 1600 columns are finished, the ground will be graded four feet lower than its present grade.

The columns were installed with a special probe designed by the construction company. The probe weighed 20,000 pounds and consisted of two 47-foot long, steel columns, each about 8-inches in diameter, a cylindrical steel chamber, and a hopper (**Exhibit 1**). One of the columns was hollow and was pressurized with air to force rock into the ground. The other column contained an electric cable which ran to a vibrator. The vibrator was on an eccentric which caused the probe to swing in a circle in order to place the rock in a four-foot circle.

The tall, cylindrical steel chamber was fitted with a valve which was pneumatically operated. The valve allowed rock to enter the chamber from the hopper above. The chamber was then pressurized with air to force the rock to the bottom of the hollow probe. A skip bucket was filled with about 2 cubic feet of rock and lifted with a whip line up to the probe's hopper (**Exhibit 2**). The hopper had two hooks which caught a bar on the skip bucket causing it to turn and dump its load of rock into the hopper.

The probe was lifted into place by the crane at each of the stone column sites by a four-part, 1 1/8-inch load line. The crane would then lift the probe up and down as necessary which helped to displace soil and ground water, and assure the placement of the rock. As more rock was needed, additional skip buckets would be dumped into the hopper until the 47-foot deep stone column was completed. The crane involved in this incident was rented for the job by the contractor. The crane had its last annual certification performed on July 13, 1995 and had no limitations imposed. During transport from one job site to another, the crane hit a bridge abutment and the equalizer was damaged. On January 5, 1996 the equalizer sheaves were replaced by workers from the crane owner's company. The crane company's workers also replaced the 7/8-inch boom hoist cable at the same time. According to the oiler who was standing next to the decedent, several lattice members on a section of the boom were also damaged. The damaged lattice members of the boom were not replaced as it was determined by the decedent, upon initial setup, not to be necessary. The crane was last inspected on the evening

before the day of the incident. All items examined passed inspection.

The crane was a self-propelled 175 ton crawler with a 120 foot lattice boom (**see exhibit 3**). The boom hoist cable was 7/8-inches in diameter and was used in a 10-part line. The operator's cab was accessed by stepping on the tracks and then onto a catwalk which led to the cab. There was an operator's manual at the rear of the cab. The operator's station had a load chart and a level indicating device. The controls were well placed, but the labels indicating their function were mostly illegible. Although the operator's seat was adjustable, there was no safety belt system. Outriggers are not used on this type of crane. Although the crane had pneumatic boom stops, it did not have a two-blocking device.

The area in which the crane was working was alternately muddy and dry throughout. Ground water was found at a depth of two to five feet in the area. When the crane began to sink, it was rolled back so gravel could be placed underneath the area where the crane's tracks would be. It was then moved back into working position. Two days prior to the day of the incident, the crane was set up to work the probe. The probe was rigged to the load hook with two slings doubled around the hook. This tended to pinch the chokers and, eventually, the wire rope broke. This caused the boom to bounce back. The bounce was said not to be severe. A quick check was done from the ground. Since no problem was noted, it was decided to rig the probe to the load hook with three slings (not doubled) instead of two from that point on (**Exhibit 4**).

A common occurrence with this type of work is to get the probe stuck in the ground. In order to release it, the crane operator would pick it up as far as possible with the air on and the vibrator working. It would then be dropped in a type of free fall. However, because of the friction with the soil, the probe would not fall quickly and, therefore, not cause a shock to the boom. Eventually, the hole was enlarged and the probe would be freed. In at least seven instances on a previous job in the area, the probe was broken when trying to extricate it. The broken portion would be left in the ground. The load capacity of the crane was such that the probe would break before any damage would occur to the crane itself. On the day of the incident, the crane was set up just west of the railroad tracks so another stone column could be constructed. During the operation, the cylindrical chamber failed to seal and could not be pressurized. This was a common problem, but in this instance it could not be resolved with the probe in a working position. The decision was made to extract the probe to perform repairs.

The probe was pulled fully out of the ground with the boom at an angle of 75 degrees to the horizontal. Because of the position of the railroad tracks and several piles of material in the area, it was necessary to lower the probe over the side of the crane. The bottom of the probe was set on the ground and the boom then began to be lowered. The superintendent and an oiler were standing a few feet away from one another at a point they thought to be beyond the range of the tip of the boom. They were both giving signals to the crane operator since the boom blocked the operator's vision. The boom continued to be lowered so the probe could be laid out flat on the ground. The crane operator indicated to the superintendent that something did not feel right, but the decision was made to continue the lowering of the boom. The oiler had just stepped away from the superintendent when the boom reached an angle of between 25 and 30 degrees to the horizontal. Suddenly, a loud snap was heard when the boom hoist cable broke and the boom hoist cable was quickly played out. The boom fell instantly in a straight line. It fell across the

probe, crushing it as it fell (**Exhibit 5**). The superintendent was struck by and pinned underneath the area of the point sheave at the tip of the boom (**Exhibit 6**). The oiler was also very nearly struck. He was able to jump to the east and out of harm's way. The paramedics were dispatched at 9:13 a.m. and arrived at 9:18 a.m. The decedent was found to have no pulse or spontaneous respirations and was pronounced dead at 9:20 a.m.

The boom hoist cable apparently had become caught in the horizontal sheaves of the gantry when the boom bounced two days earlier and the boom hoist cable became slack. After two days of use it was cut through enough to cause it to break. There were several cut marks on the horizontal sheaves to indicate that the boom hoist cable was cut. Daily crane inspections failed to reveal this.

CAUSE OF DEATH

The death certificate stated the cause of death to be multiple traumatic injuries.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should keep all personnel out of the area of danger of the load or the boom by delineating the danger area's boundaries.

Discussion: Although the collapse of a crane's boom is not a frequent occurrence, when it does happen it is often the failure of the boom hoist cable. When the boom does fall in these instances, it comes down as one unit along its full length (in this case 120 feet). Employees should not stand under the boom along its full length. To prevent employees from entering the danger area, the area should be marked with flags or other markers. Section 5002 of Title 8 of the California Code of Regulations states that "Employees should not work in the area directly beneath a suspended load." The boom is suspended by the boom hoist cable which is subject to failure and should be considered part of the load. Had the danger area, 120 feet in the direction of the boom, been marked and employees had not entered the area, this incident may not have happened.

Recommendation #2: Employers should assure the boom hoist cable is relaxed when the boom has been fully lowered to perform an inspection so any cable damage becomes apparent.

Discussion: When crane inspections are performed, the wire rope cables should be relaxed so damage, such as kinking or birdcaging, can be seen. The entire length of the cables should be inspected. All areas of the crane should be inspected including the gantry area. Had the gantry area of the crane involved in this incident been thoroughly and properly inspected, it would have been noted that the boom hoist cable was being cut through because it had become caught in horizontal equalizer sheaves. Section 5031(a) of Title 8 of the California Code of Regulations states "A qualified person shall visually inspect the crane's controls, rigging and operating mechanism prior to the first operation on any work shift. Any unsafe conditions disclosed by the inspection requirements of this Article shall be corrected promptly. Defective components of equipment which create an imminent safety hazard shall be replaced, repaired or adjusted prior to use." Thorough inspections are of paramount importance when the crane boom is subjected to

abnormal conditions (such as bouncing). Had a thorough inspection been performed, the unsafe boom hoist cable situation would have been noted. If immediate corrective action had been taken, this incident may not have happened.

Recommendation #3: Employers should ensure the boom is supported when it is lowered to check loads so it cannot fall or collapse when employees are underneath it.
Discussion: Since the breakage of the boom hoist cable is a situation which does happen, employees should be protected when underneath the lowered boom of a crane. Employees needed to access the area underneath the boom to check and repair the probe. Protection could be afforded by supporting the crane boom to prevent its movement. Had the crane's boom been prevented from moving or falling, this accident most likely would not have happened.

References:
Barclays Official California Code of Regulations, Vol. 9, Title8, Industrial Relations, South San Francisco, 1990

Dickie, D.E., Crane Handbook, First Edition, Construction Safety Association of Ontario publications, 1978

MacCollum, David V., Crane Hazards and Their Prevention, ASSE publications, First Edition

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the Public Health Institute and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations of work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal by studying the work 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. NIOSH-funded, state-based FACE programs include: Alaska, California, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, Oregon, Washington, West Virginia, and Wisconsin.

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Additional information regarding the CA/FACE program is available from:

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