MIFACE INVESTIGATION: #04MI160

SUBJECT: Carpenter Dies When Eight-foot Trench Wall Collapses During Sewer Pipe Replacement

Summary

On October 21, 2004, a 22-year-old male carpenter died when the walls of an eight-foot excavation he was working in collapsed and completely covered him (See Figure 1). A homeowner hired his employer to replace the six-inch clay tile sewer pipe leading from his home to the alley behind the home and garage. The firm was "threading" a new four-inch PVC pipe through the deteriorating existing clay six-inch pipe, and leaving the existing six-inch pipe in place. Prior to the victim's arrival, the employer excavated an approximately eight-foot-deep trench from the home's basement to the homeowner's garage. Once beyond the garage the employer dug another eight-foot excavation from the garage to the alley where the sewer connection was located. The soil conditions in the second excavation were sand/gravel and the angle of repose (maximum permissible slope) for the excavation sides varied from 60-80 degrees. To determine how far away the four-inch PVC pipe was from the sewer line, the victim either kneeled or laid down at the bottom of the excavation. The victim was either still kneeling or lying on the ground when the south side of the excavation collapsed, completely burying him and burying his coworker up to his waist. 911 was called, and at the same time all employees jumped into the excavation to rescue the individuals in the trench. Emergency personnel arrived within minutes, removed the victim and transported him to a local hospital where he died the next day.

Figure 1. Picture of Trench after cave-in

RECOMMENDATIONS

- Employers should ensure when employees are working in excavations that require a supporting system that a supporting system is implemented in accordance with MIOSHA standard requirements.

- Employers should ensure that a qualified person inspects the excavation, adjacent areas, and supporting systems on an ongoing basis and that the qualified person takes the appropriate measures necessary to protect workers.

- Employers should design, develop, and implement a comprehensive safety program.

- Employers should provide workers with training in the recognition and avoidance of unsafe conditions and the required safe work practices that apply to their work environments.

- Employers should ensure that equipment is moved away from open trenches when not in use.

- Employers should develop a trench emergency action plan that describes rescue and medical duties and ensure that all employees are knowledgeable of those procedures.

INTRODUCTION

On October 21, 2004, a 22-year-old carpenter was killed in an excavation as the crew was replacing sewer pipe. On October 22, 2004, the Michigan Occupational Safety and Health Administration (MIOSHA) personnel, who had received a report on their 24-hour-a-day hotline that a work-related fatal injury had occurred on May 28, 2004, notified MIFACE investigators of the fatality. On May 18, 2005, the MIFACE researcher interviewed the owner of the company, the local police department. The medical examiner's report, the local police department's incident report and pictures, and the MIOSHA file and citations were reviewed. Pictures used as Figure 1 and Figure 3 were taken at the scene by MIOSHA and Figure 2 was taken by the local police agency at the incident scene.

The employer, his father, was a licensed construction contractor. The company's building license permitted the company to perform all construction activities except plumbing, electrical and mechanical work. The company usually performed concrete work, sewer line work, and building construction. Seventy percent of their business was flat work, 20% was wood construction, and 10% was masonry. The company had seven employees. The victim had worked seven years on and off for other residential building contractors, but he also enjoyed working at his father's company. The company did not have a written health and safety program. They did not conduct employee training, nor did they have a disciplinary policy for violations for health and safety.

The MIOSHA Construction Safety and Health Division investigation resulted in four Serious violations being issued to the company; three of the Serious violations cited Part 9, Excavation, Trenching and Shoring. Citation #1: Excavation, Trenching and Shoring, Part 9, Rule 932(5) addressed the failure to have a qualified employee in charge of the excavating operation. The employer was not familiar with the Part 9 standard, did not have excavation training, and did not know the required angle of repose for the soil condition (sand/gravel). Citation #2: Excavation, Trenching and Shoring, Part 9, Rule 933(2) addressed the location of the excavated materials. The excavated materials were not stored and retained more than two feet from the excavation edge. Citation #3: Excavation, Trenching and Shoring, Part 9, Rule 941(1) addressed the non-supported excavation walls. The excavation was not cut to the proper angle of repose, and no shoring or trench box was used to prevent employee engulfment. The fourth Serious violation cited General Rules, Part 1, Rule 114(1) that addressed the lack of an accident prevention program at the company.

INVESTIGATION

The residential property where the company was performing the sewer replacement had fairly narrow lots. The company owner stated that the lots were only 50 feet wide, and the sewer taps were very close to the property line. In this case, there was only six feet of room between their work area and the adjacent property line, making it difficult to cut the trench to the proper angle of repose for the soil conditions (See Figure 2).

Figure 2. Overall scene – alley view

The company had been hired by the homeowner to replace the existing six-inch clay tile sewer pipe from the home to the sewer line in the alley. The clay pipe to the alley was not laid in a straight line. The company was required to dig two separate excavations to make the new sewer connection. The first eight-foot-deep, 12-14-foot wide excavation was between the home and the garage. Work was completed in this excavation without incident, and prior to the victim's arrival at the work site.

The second excavation (incident site) was between the garage and the alley that provided access to the garage and the location of the sewer connection. This excavation was 20- to 30- feet long, 8-feet deep, 20-feet wide at the top and approximately 6-feet wide at the base. The soil conditions in this excavation were sand/gravel. The angle of repose (maximum permissible slope) for the excavation sides varied from 60 to 80 degrees. The north/south sides of the trench were cut back at a 60- to 70-degree angle. At the east end, the walls were cut at an 80-degree angle. The excavation had been completed when the victim arrived and began working in the trench.

Figure 3. Soil composition and tree roots

The company was replacing the existing six-inch clay tile sewer pipe by "threading" a new four-inch PVC pipe through the existing six-inch pipe from the home to the sewer connection at the alley. Employees had been in the first excavation and had "threaded" the new four-inch pipe inside the existing six-inch clay pipe from near the house to under and past the garage. The workers were able to push the pipe through under the garage but they needed to clear tree roots from the old clay crock in order to continue pushing the four-inch PVC pipe through the crock. Therefore, they dug another excavation extending from the garage to the alley to make the sewer tap. Once beyond the garage the employer dug the second eight-foot excavation from the garage to the

alley. The soil conditions in this excavation were sand/gravel (See Figure 3). The owner states that at the time of the wall collapse, the backhoe was located approximately six feet from the edge of the trench and was not idling. The company blocked off the alley throughway so there was no vibration from the alley traffic.

The victim's workday began at approximately 8:30 a.m. Prior to arriving at the excavation site, he had performed some flat work for a residential porch, constructed a dog run, and had completed general site clean-up duties. To finish up the day, he went to the excavation site at approximately 3:00 p.m. When interviewed by MIFACE, the company owner stated three employees were in the trench at the time of the cave-in; the MIOSHA file and police report indicated two employees were in the trench.

After arriving at the incident site, the victim entered the trench with either one two other workers. They were in the excavation to determine how far the four-inch pipe had pushed through the six-inch clay pipe. After finding that the four-inch pipe was almost to the sewer tap area, there was a question as to how far away the four-inch pipe was from the main sewer line. To check this distance, the victim either kneeled or laid down at the bottom of the excavation. He looked in the direction of the city water main, and pushed a shovel handle into the old clay pipe. After finding out that the main sewer line was approximately four feet away, the crew and the city inspector were deciding whether to remove one more section of the six-inch clay pipe. The victim remained kneeling or laying on the ground, and one of his coworkers was standing near him. The third coworker, according to the owner, was standing a greater distance from him at the base of the trench. While the crew and inspector were deciding a course of action, the south side of the excavation collapsed. The victim was completely buried and the coworker standing nearest to the victim was buried to his waist. The third coworker, according to the company owner, had dirt only around his ankles.

It is unclear who called 911 for emergency response. Two employees attempted to rescue the two trapped individuals by trying to dig them out from under the soil. Emergency personnel arrived within minutes and removed the victim. They transported him to a local hospital where he died the next day.

After the incident, the city in which the company is located bought a trench box for the city workers. The company is constructing a portable trench box for its own use.

CAUSE OF DEATH

The cause of death as stated on the death certificate by the medical examiner was asphyxiation due to a trench cave-in. An autopsy was not performed.

DISCUSSION/RECOMMENDATIONS

- Employers should ensure when employees are working in excavations that require a supporting system that a supporting system is implemented in accordance with MIOSHA standard requirements.

The MIOSHA Construction Safety Standard Part 9, Excavation, Trenching and Shoring R408.40925 defines an excavation as any man-made cavity or depression in the earth's surface, including its sides, walls or faces, formed by earth removal. Part 9, Excavation, Trenching and Shoring R408.40926 defines a supporting system as the total system necessary to restrain the sides of an excavation from moving. A trench is defined in R408.40927 as an excavation having a depth greater than its width measured at the bottom.

When earth is removed from the ground, the walls are left unsupported and pressures are generated at the face of the excavation. Where the soil can no longer withstand the pressure, the wall will shear and break away. Usually, soil at the base of the excavation falls into the hole first, then, as support is lost from below, higher wall failure may occur. One cubic foot of soil can weigh 100 pounds or more, depending on the soil's composition. Each cubic yard of soil may weigh more than one ton (2,500 pounds), producing a crushing injury to anyone caught in the wall collapse. A cubic yard of soil weighs nearly the same amount as a mid-size automobile.

To protect workers from the danger of wall collapse, the MIOSHA Excavation, Trenching and Shoring Standard requires that an excavation, five feet or more in depth (unless soil conditions mandate protection in excavations less than five feet) be protected from cave-in. Rule 942 of the Excavation standard details what must be evaluated during an excavation to protect workers inside the excavation. The angle of repose and the design of the supporting system for a side of an excavation shall be based on the evaluation of all of the following factors: (a) depth of cut and type of soil, (b) possible variation in the water content of the material while the excavation is open, (c) anticipated changes in the material due to exposure to air, sun, water, or freezing, (d) load imposed by structures, equipment, overlying material, or stored material, (e) vibration from traffic, equipment, or blasting.

The selection of preventative measures is based on this evaluation. Methods such as angle of repose , sloping and benching, tight sheeting/sheet piling, or trench boxes and shields may be used to protect personnel in the excavation. Sloping involves positioning the soil away from an excavation trench at an angle that would prevent the soil from caving into the trench. Shoring systems are structures, such as a metal hydraulic, mechanical or timber that provide support to the walls of the trench and prevents cave-ins. If either adequate sloping or shoring had been used in this incident, this fatality may have been prevented.

Employers should consult Table 1 in the MIOSHA Excavation Standard that details the maximum allowable angle of repose for the side of an excavation in excess of five-foot depth that is required depending upon the type of soil and environmental conditions present at the site. Employers can consult with manufacturers of protective systems to obtain detailed guidance for the appropriate use

of these products. The Appendix in Part 9 has examples of good engineering practices based on the rules of Part 9.

- Employers should ensure that a qualified person inspects the excavation, adjacent areas, and supporting systems on an ongoing basis and that the qualified person takes the appropriate measures necessary to protect workers.

Part 9, Rule 932(5) defines a qualified person as a person, who by possession of a recognized degree or certificate of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work. The foreman/supervisor typically is the person given qualified-person responsibilities. If an inspection by a qualified person had been carried out in compliance with MIOSHA regulations, unsafe conditions may have been recognized and the workers may have been removed from the trench until necessary safety precautions had been taken. When the qualified person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions, exposed employees must be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

- Employers should design, develop, and implement a comprehensive safety program.

Employers should be aware of and recognize their knowledge limitations and seek advice, assistance, consultation, and specific training as necessary. MIOSHA R408.40114(2)(d) requires that the employer have an accident prevention program that provides instruction to each employee in the recognition and avoidance of hazards. A comprehensive safety program should address all aspects of safety related to specific tasks that employees are required to perform. Safety rules, regulations, and procedures should include the recognition and elimination of hazards associated with tasks performed by employees.

- Employers should provide workers with training in the recognition and avoidance of unsafe conditions and the required safe work practices that apply to their work environments.

Employers should ensure that all employees are trained to recognize and avoid hazardous work conditions. Employers should also ensure that the training in recognizing and avoiding hazards is coupled with employer assessment that workers are competent in the recognition of hazards and safe work practices.

The employer did not demonstrate adequate knowledge about safe work practices in excavation techniques. When MIFACE interviewed the company owner, he stated that at the time of the fatality he was unfamiliar with the requirements of Part 9. This lack of knowledge not only limited the employer from adequately training his personnel about proper excavation techniques, but also from providing adequate health and safety training, including hazard recognition and prevention.

The MIOSHA Consultation, Education and Training (CET) Division presents many health and safety courses, including excavation safety. These courses are held at various locations across the State. MIFACE encourages employers to contact the MIOSHA CET division to learn about the

course schedule and locations. The MIOSHA CET division website can be accessed through the Michigan Department of Labor and Economic Growth website at www.michigan.gov/cis/. Click on the MIOSHA link located in the box on the left side of the web page, then click on the Consultation, Education, and Training link. MIOSHA CET can also be contacted by telephone: (517) 322-1809.

- Employers should ensure that equipment is moved away from open trenches when not in use.

Employers should park their equipment well away from the trench when the equipment is not in use. When digging is performed, workers should be removed from the trench. The weight of equipment places additional stress on trench walls and can contribute to trench collapse.

- Employers should develop a trench emergency action plan that describes rescue and medical duties and ensure that all employees are knowledgeable of those procedures.

Soil walls may collapse multiple times, or in phases, in the same trench. The first collapse of the trench wall may result in an undercut area of the remaining trench wall, creating a large unsupported overhang of soil. Phase two of the collapse can occur when the overhanging section falls into the trench, and may result in a smaller section of unsupported soil near the top of the trench. This section of unsupported soil is held in place only by the cohesion with the soil columns around it and will finally fail as phase three.

Although not a factor in this incident, a trench emergency action plan did not exist for the site. Untrained coworkers attempted to uncover and remove the victim from the trench before trained rescue personnel arrived at the scene. When the victim's coworkers first recognized that the victim was covered with sand, their first reaction was to come to the aid of their fellow worker. Their reactions were driven by emotion and when they entered the trench, they put their own lives in danger. Thankfully, the trench did not collapse further during their rescue attempt. Many injuries and deaths to rescuers, coworkers or emergency responders are the result of forging ahead without stopping and assessing the situation.

Following formal procedures in the event of an emergency situation such as this are essential in order to avoid further injury and to make sure that the lives of those performing the rescue are not also endangered. To the extent feasible and practical, the employer should analyze jobsites for all foreseeable emergencies. A plan based on specific events should be developed. The plan should describe what actions to take regarding rescue and/or first aid.

Only those persons trained in the requirements of NFPA 1670 should attempt rescue operations after a trench cave-in occurs. All persons at the incident site should follow the directions given by the Incident Commander or his/her designee in order to provide the most optimal circumstances for the safety of all persons on the site during rescue operations.

RESOURCES

MIOSHA standards cited in this report may be found at and downloaded from the MIOSHA, Michigan Department of Labor and Economic Growth (DLEG) website at: www.michigan.gov/mioshastandards. MIOSHA standards are available for a fee by writing to: Michigan Department of Labor and Economic Growth, MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan 48909-8143 or calling (517) 322-1845.

The MIOSHA Consultation Education & Training Division (CET) services are provided throughout the state by an in-house staff of professional occupational safety consultants, occupational safety specialists and industrial hygienists. The staff in the CET Division are non-enforcement personnel. These consultants and specialists are located throughout Michigan and collectively they serve the employers and the employees in all 83 Michigan counties. MIOSHA CET division can be contacted by writing to: Consultation Education and Training, 7150 Harris Drive, P.O. Box 30643, Lansing, MI 48909-8143 or calling (517) 322-1809.
http://www.michigan.gov/cis/0,1607,7-154-11407_15317---,00.html

MIOSHA Construction Safety Standard, Part 9. Excavation, Trenching and Shoring.
http://www.michigan.gov/documents/CIS_WSH_part_9_47126_7.pdf

Excavations. OSHA Publication 2226 (2000), 2.3 MB PDF file.
www.osha.gov/Publications/Osha2226.pdf

Trenching and Excavation: Safety Principles. National Ag Safety Database.
www.cdc.gov/niosh/nasd/docs/as41600.html

Excavations: Hazard Recognition in Trenching and Shoring. OSHA Technical Manual (TED 1-0.15A), Section V – Chapter 2 (1999, January 20)
www.osha.gov/dts/osta/otm/otm_v/otm_v_2.html

ARK Technical Rescue Services, Inc**.,** 5630 Flagler Drive, Centreville, VA. 20120. Telephone: (703) 378-0855 Office. http://arkrescue.com/news/stories/60.shtml

Texas FACE 98TX145 report: A Pipe Layer Working in a Trench for a General Contractor in Texas, Died when a Trench Wall Gave Way and He was Fully Engulfed in Sand/Dirt.
http://www.cdc.gov/niosh/face/stateface/tx/98tx145.html

NFPA[1999]. NFPA 1670, Standard on Operations and Training for Technical Rescue incidents. 1999 Edition, Chapter Nine, Trench and Excavation. Quincy, MA; National Fire Protection Association

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11/10/05

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