MICHIGAN State FACE Program
Fatality Assessment & Control Evaluation

Michigan State University
Department of Medicine • Occupational and Environmental Medicine
909 Fee Road, 117 West Fee Hall • East Lansing, MI 48824 • 1-517-353-1846 • https://oem.msu.edu

REPORT#: 15MI117 **REPORT DATE:** 10/23/18

Construction Laborer Died in a Trench Wall Collapse

INCIDENT HIGHLIGHTS

DATE:
Winter, 2015

TIME:
9:13 a.m.

VICTIM:
Pipe layer

INDUSTRY/NAICS CODE:
Construction/23

EMPLOYER:
Excavation Company

SAFETY & TRAINING:
Trench safety

SCENE:
Residential Subdivision

LOCATION:
Michigan

EVENT TYPE:
Struck By

SUMMARY

In winter 2015 a male pipe layer in his 40s died when the wall of a 6'4"-deep, 7'-wide at the top, 4'-wide at the base, 25'-foot long trench collapsed. The trench base was wet sand and had wet, stiff clay walls. The excavator operator noticed moisture in the trench and asked the decedent if he would like to utilize the trench box on site; the decedent declined. The decedent and his coworker were preparing to install drain tile pipe when the foreman (competent person) arrived at the excavation and noticed the impending wall collapse. The foreman yelled to the workers to exit. His coworker safely exited the trench, the decedent was struck by debris ...
READ THE FULL REPORT> (p.3)

CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

- Inadequate excavation protection system (shoring, benching, sloping)
- A qualified person did not inspect the trench
- Inadequate employee training in the recognition and avoidance of unsafe conditions and required safe work practices

LEARN MORE> (p.7)

RECOMMENDATIONS

MIFACE investigators concluded that, to help prevent similar occurrences, employers should:

- Protect employees from trench wall cave-in with an appropriate protective system, such as trench boxes, shields, benching and/or appropriate sloping of trench sides. To ensure this is done correctly, a qualified person must inspect and approve the excavation, adjacent areas, and supporting systems on an ongoing basis.... ... LEARN MORE> (p.7)

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Michigan Fatality Assessment and Control Evaluation (FACE) Program

MIFACE (Michigan Fatality Assessment and Control Evaluation), Michigan State University (MSU) Occupational & Environmental Medicine, 909 Fee Road, 117 West Fee Hall, East Lansing, Michigan 48824-1315; http://www.oem.msu.edu.

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SUMMARY

In winter 2015 a Hispanic male pipe layer in his 40s died when the south wall of a 25-foot long trench collapsed. The construction site had a high water table. The trench was part of a 175-foot long trench. The trench in the incident area was approximately 7 feet wide at its top, 6½ feet deep, and 4 feet wide at its base. An 18-inch bench was cut approximately 18 inches below the top of the trench and 5 feet from the base. The trench had a 1½-foot seam of wet sand at its base, and then another 5 feet of wet clay. A sand/clay ramp located on the east side of the trench provided access. The excavator operator noticed moisture in the trench and asked the decedent if he would like to utilize the trench box on site; the decedent declined. The decedent and his coworker were preparing to install drain tile pipe when the competent person who had just arrived at the excavation after performing other site work, noticed the impending wall collapse. He yelled to the two workers to get out of the trench. Both ran toward the ramp. One worker was able to exit safely. The decedent was struck by the falling earth. The clay forced a shovel to strike his right side and pinned him into the opposite side of the excavation burying him to his waist. His coworkers entered the trench and manually dug him out. They carried him out of the trench and called for emergency response. Emergency responders transported him to a local hospital where he was declared dead in the emergency room.

INTRODUCTION

MIFACE personnel contacted the executive vice president of the firm who agreed to be interviewed by MIFACE personnel. MIFACE reviewed the MIOSHA compliance officer file, death certificate, medical examiner and police reports during the writing of this report. Pictures used in the report are courtesy of the responding police department and pictures taken by the MIOSHA compliance officer at the time of the MIOSHA compliance inspection.

EMPLOYER

The decedent worked for an excavation company. The company had been in existence for 41 years and performed underground projects, site preparation, road construction and structural concrete work. The firm employed approximately 600 individuals at the time of the incident.

WRITTEN SAFETY PROGRAMS and TRAINING

The firm was a member of the Michigan Infrastructure and Transportation Association (MITA) and utilized the Association's training that included excavation safety. Workers received the MITA Trench Safety Handbook as part of their training. The company representative indicated that the firm had a written safety and health program that addressed trench safety issues. The firm had a safety and health professional responsible for safety management at the firm. Safety responsibilities were delegated to the job site foreman. Employees received training by management, utilizing both in-house developed and MITA developed training programs. Training records were maintained.

WORKER INFORMATION

The decedent had worked at the firm for an unknown number of years. Although he was born in Mexico, he was proficient in English; there was no language barrier. He was an hourly employee. The workers were members of a union; the union steward was not present on site at the time of the incident.

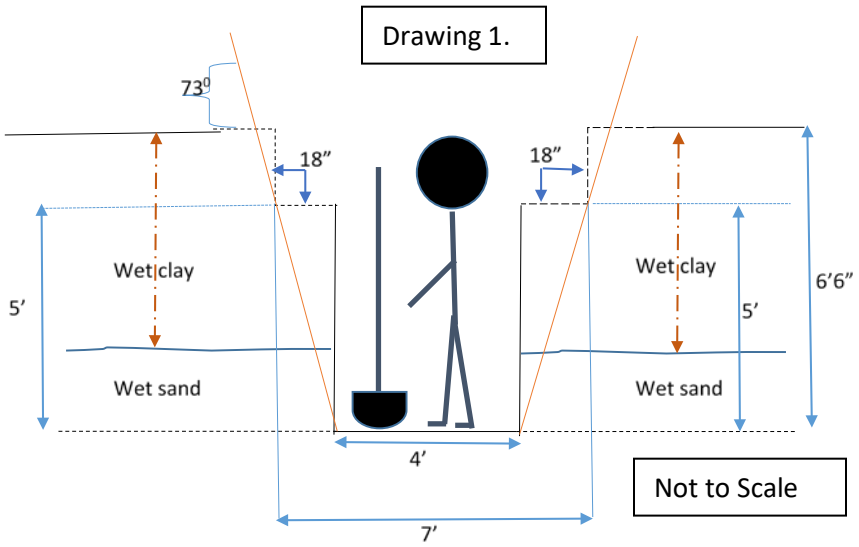
The decedent had received training from the firm regarding trench safety. There were three additional firm personnel at the incident site at the time of the trench collapse. It is unknown how long each of the three workers (Coworker 1,

Coworker 2 (excavator operator), and the foreman had been with the company. All workers had received trench safety training.

The foreman was designated as the qualified person. Under Michigan OSHA Construction Safety Standard Part 9: Excavation, Trenching and Shoring, a qualified person means: 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, when asked by the MIOSHA compliance officer investigating the incident to calculate appropriate angles of repose and at what height the first trench bench should be, could not calculate the angle of repose nor was he able to state at what height the trench bench should be, even though he had successfully completed the MITA training material.

INCIDENT SCENE

The incident scene was near the intersection of two roads. The new residential construction site had a known high water table and an engineering firm had designed a drainage system to be installed to facilitate the sale of the property. The decedent's employer was adhering to the drainage plan. Responding police measured the entire trench and it was found to be approximately 175 feet long, from its beginning to the position of the excavator at the end of the trench. The trench was constructed in an east-west direction (trench walls were on the north and south side). The incident occurred in the last 35 feet of the trench.



Due to the length of the trench, its measurements varied in depth (5- to 7-feet), base width (30 inches to 4½ feet), and top width (7- to 12-feet). The bench height was also variable (no heights mentioned in reviewed documents).

The trench in the incident area was approximately 7 feet wide at its top, 6½ feet deep, and 4 feet wide at its base. An 18-inch bench was cut approximately 18 inches below the top of the trench and 5 feet from the base. The trench had a 1½-foot seam of wet sand at its base, and then another 5 feet of wet clay. (See Drawing 1).

The workers accessed the trench by using a sand/clay ramp, which was located on the east side of the trench within 12 feet of the location of the two workers

The surviving coworker (Coworker 1) described the ground as "wet, but not too bad".

Coworker 2 was using a Kawasaki excavator with a 3-foot wide bucket. He placed the spoils on the side of the trench that collapsed. The spoils were placed more than 2 feet away from the trench wall as required by MIOSHA standard Part 9. (See Figure 1).

WEATHER

Weather Underground was utilized to check the weather conditions on the day of the incident. The weather was in the upper 40s and partly cloudy. The day prior to the incident, it rained, with occasional heavy rain, from approximately 0300 to 0800, resulting in 0.33 inches of precipitation. [Weather Underground]

INVESTIGATION

The workday began at approximately 0700. The trench was not inspected by the competent person prior to the workers entering the trench. The decedent and Coworker 1 were in the trench, waiting for a stone delivery at their location to spread it as the base for the drain tile piping. Coworker 2 and his excavator were positioned at the east end of the trench, near the exit ramp. The foreman was working to the east/northeast of the excavator placing survey stakes. The decedent was using a shovel to spread the stone.

Figure 1. Placement of spoils

Earlier that morning the excavator operator noticed more water at the west end of the trench and asked the decedent if he wanted the trench box that was onsite. The decedent stated no. (See Figure 2).

When the foreman finished the placement of the survey stakes, he walked the site to check out progress. He came to the incident trench area where the decedent and Coworker 1 were working. The foreman looked over and noticed the south wall starting to give way and yelled for the decedent and Coworker 1 to get out of the trench. Both workers began to run east toward the ramp. Coworker 1 was able to safely exit the trench. The south clay/dirt wall collapsed, striking the decedent on his right side, burying him from the waist down side and pinning him against the north trench wall (See Figure 3). The decedent's shovel was pushed into the decedent's right side but never penetrated. The force of the south wall collapse caused the decedent to strike the north wall also causing part of the north wall to also collapse, although the bench was still intact.

Figure 2. Water location in trench

The foreman, Coworker 1 and Coworker 2 jumped into the trench and freed the decedent from the chunks of dirt/clay, pulled him out of the trench, and laid him down on his back. They found his shovel by his side. The coworkers called for emergency response. The decedent was having trouble breathing, so they then

turned him to his side. Emergency response arrived and transported the decedent to the hospital where he was declared dead.

The MIOSHA compliance officer investigating the fatality utilized a penetrometer to determine the consistency/hardness of the soil from the spoils pile. Readings found predominately sand and read 0.0 T.S.P. and clay clumps at 3.0 T.S.P. Based on trench measurements provided by one of the top management employees, the MIOSHA compliance officer calculated angle of repose of the trench walls at 73 degrees. Based on the soil characteristics, the trench walls should have been 34 degrees.

Figure 3. Trench wall collapse

MIOSHA Citations

MIOSHA Construction Safety and Health division issued the following Serious citations to the employer at the conclusion of its investigation:

SERIOUS: EXCAVATING, TRENCHING AND SHORING, CS PART 9:

- RULE 408.40932(4): An ongoing inspection of an excavation or trench shall be made by a qualified person. After every rainstorm or other hazard-producing occurrence, an inspection shall be made by a qualified employee for evidence of possible slides or cave-ins. Where these conditions are found, all work shall cease until additional precautions, such as additional shoring or reducing the slope, have been accomplished.

  Employees engaged in pipe installation activities in an excavation that had not been inspected by a qualified person exposed to a cave in the excavation resulting in a fatality.

- RULE 408.40944(2): When benching the side of an excavation, the vertical rise shall not be more than 5 feet and the step back shall extend at least to the angle of repose as required by table 1.

  Employees engaged in pipe installation activities in an excavation that had been benched on each side where the step back of the benches did not extend to the angle of repose as required by table 1, exposing the employees to a cave-in of the excavation, resulting in a fatality. The excavation, as observed by employees and others on site, was 6'-4" deep, 7' wide at the top, 4' wide at the bottom, and 25' long. The north and south sides of the excavation each had a 5' high bench that stepped back 18", achieving an angle of repose of 73 degrees. The soil was a wet sand at the bottom 18" of the excavation, with the remainder being a wet clay.

- RULE 408.40944(3): When benching a side of a trench, the height of the lower bench shall not be more than the lesser of 5 feet or width of the trench measured at the bottom.

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Employees engaged in pipe installation activities in a benched excavation where the height of the lower bench on each side was greater than the width of the trench measured at the bottom, exposing employees to a cave-in that resulted in a fatality.

CAUSE OF DEATH

The death certificate listed the cause of death as multiple blunt traumatic injuries. Blood toxicological results were negative for alcohol and illegal drugs. Prescription and non-prescription medications were not a contributing factor in the death.

CONTRIBUTING FACTORS

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. The following were identified as key contributing factors in this incident:

- *Inadequate trench support systems.*
- *Qualified person did not inspect trench prior to entry*
- *Insufficient understanding of hazards*

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that employees working in excavations are protected from cave-in by an appropriate protective system, such as trench boxes, shields, benching and/or appropriate sloping of trench sides designed in accordance with MIOSHA Construction Safety Standard, Part 9, Excavation, Trenching, and Shoring. To ensure this is done correctly, a qualified person must inspect and approve the excavation, adjacent areas, and supporting systems on an ongoing basis.

Discussion: Neither the foreman nor the decedent adhered to the written company policy concerning trenching. Per the company handbook, which included stipulations that employees in an excavation work within a protective system, and that the trench, which was over five feet, should be cut to the angle of repose, sheeted or shored.

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, wall or faces, formed by earth removal. When earth is removed from the ground, the walls are left unsupported and pressures are generated at the face of the excavation. Where 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. This is dependent on the horizon structure, substrate composition, hydration, and importantly consistence. 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 2,500 pounds producing a crushing injury to anyone caught in the wall collapse.

R408.40942 of Part 9 details what must be evaluated during an excavation to protect workers inside the excavation. 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. If either adequate sloping or shoring had been used in this incident, the fatality would likely have been prevented.

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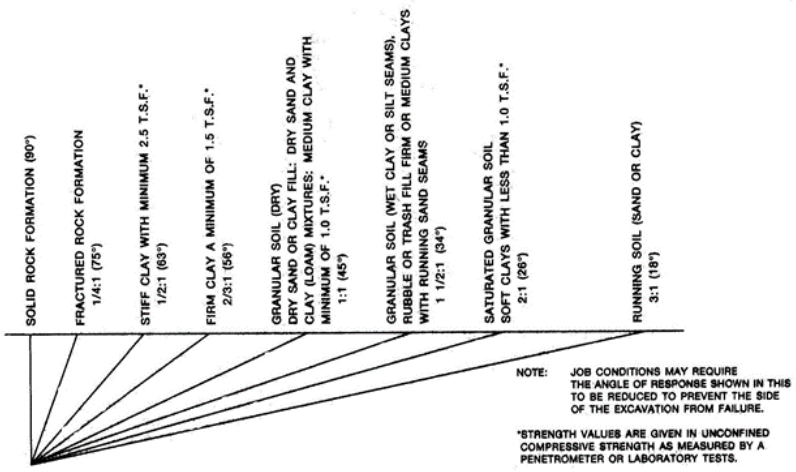
Employers should consult Table 1 of Part 9 that details the maximum allowable angle of repose for the side of an excavation in excess of five-foot depth that is required, which depends upon the soil and environmental conditions present at the site. Employers can also consult the manufacturers of protective systems to obtain detailed guidance for the appropriate use of these products. The Appendix in Part 9 has examples of good engineering practices.

TABLE 1
MAXIMUM ALLOWABLE ANGLE OF REPOSE FOR THE SIDE OF AN EXCAVATION IN EXCESS OF 5' DEPTH



To assist employers in complying with Part 9, MIOSHA Construction Safety Division has a Trenching and Excavation – Protective Systems Fact Sheet and MIOSHA Consultation, Education and Training division has an *Excavation Training By the Numbers* Fact sheet.

OSHA and NIOSH have several resources: OSHA Construction e-Tool for Trenching and Excavation, OSHA's Safety and Health Topics Trenching and Excavation, and NIOSH Workplace Safety and Health Topics Trenching and Excavation.

The Michigan Infrastructure and Transportation Association (MITA) has developed a Trench Safety Handbook. Although not intended to be a substitute for the MIOSHA standards, the handbook provides employers with a quick reference to identify and avoid potential hazards associated with excavation activities. The Handbook is available for purchase by accessing the MITA website. Click on the MITA Store link and then Safety.

A free resource available to employers is the Trench Right application (app) developed by Ingenious Robot, Inc., and sponsored by MITA using MIOSHA Consultation, Education and Training Division grant funds. The Trench Right "app" has a step-by-step process that asks users to enter information about the trench's dimensions, soil type, and penetrometer's TSF reading to assist the determination of the required angle of repose. The Trench Right app can be downloaded from the Apple Store.

A qualified person means 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 company had assigned the job foremen as the qualified person.

Although the work crew on-site had been through the company-required training program, none of them implemented the company's written program nor followed safe work practices. The company's Accident Prevention Program/General Safety Rules required that a "qualified employee" is designated for each crew or project. The designated individual has many responsibilities on the jobsite, including trench safety.

The conditions and the directions given to the employees were not consistent with those of a qualified person demonstrating adequate knowledge about safe work practices in excavation techniques. If the qualified person responsibilities had been carried out in compliance with MIOSHA regulations, unsafe conditions would have been

recognized and the workers would have been removed from the trench until necessary safety precautions had been taken.

Recommendation #2: 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. In addition, a job safety analysis (JSA could be completed prior to working so that the hazards could be recognized.

Discussion: Because jobsite conditions change on a daily basis, MIFACE recommends that individuals (especially qualified persons) responsible for safety on the site inspect excavations on the site prior to permitting employees to work in them, and discuss the day's work with the employees prior to the start of the work. This could be accomplished in short daily "tailgate" talks, covering applicable health and safety issues, weather issues, equipment issues, etc.

Employees who work in or around excavations should receive training covering the hazards associated with working in and around trenches and other excavations. Training should include the hazards of water accumulation, vibration, heavy equipment operations, underground utilities, hazardous atmospheres, soil types, and stability of surrounding structures. Other elements of excavation training should include requirements regarding means of access and egress, emergency rescue equipment, inspections, competent persons, professional engineer services, and protection of employees by sloping, benching, and support systems. 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.

Employers can systematically assess the jobsite for health and safety hazards using a job safety analysis (JSA). Development of a JSA forces those conducting the analysis to view each operation as part of a system. In so doing, each step in the operation is assessed while consideration is paid to the relationship between steps and the interaction between workers and equipment, materials, the environment, and other workers. Other benefits of a JSA include: identifying hazardous conditions and potential accidents, providing information with which effective control measures can be established, determine level of knowledge and skill as well as the physical requirements that workers need to execute specific tasks, and discovering and eliminating unsafe procedures, techniques, motions, positions and actions.

MIOSHA has developed a JSA booklet containing guidelines for conducting a JSA. An example of an Excavation JSA, developed by Brookhaven National Laboratory can be found here.

Recommendation #3: Employers should develop a trench emergency action plan that describes rescue and medical duties and ensure that all employees are knowledgeable of those procedures.

Discussion: 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 in Phase Three.

A trench emergency action plan did not exist for the site. The decedent's coworkers entered the trench to uncover and remove the decedent from the trench before trained rescue personnel arrived at the scene. When the decedent's coworkers first recognized that he was covered with soil, 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.

Fortunately, the trench did not collapse further onto them during their rescue attempt. Many injuries and deaths to rescuers, coworkers or emergency responders are the result of forging ahead without stopping to assess the situation.

Following formal procedures in the event of an emergency situation such as this is essential to avoid further injury and to make sure that the lives of those performing the rescue are not also endangered. 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. The plan should also instruct employees to first call 9-1-1 for emergency assistance, and then call the office/supervisor to update them on the emergency.

MIFACE recommends only those persons trained in requirements of National Fire Protection Association (NFPA) 1670 should attempt rescue operations after a trench cave-in.

ADDITIONAL RESOURCES

- MIOSHA Excavations, Trenching and Shoring Card.
  https://www.michigan.gov/documents/lara/lara_miosha_cet0204_406724_7.pdf
- OSHA Construction Safety and Health Topics.
  https://www.osha.gov/SLTC/trenchingexcavation/construction.html
- OSHA Trenching and Excavation Safety Publication: OSHA 2226-10R 2015.
  https://www.osha.gov/Publications/osha2226.pdf
- OSHA Excavations in Construction/Trenching v-Tool (video available in English and Spanish).
  https://www.osha.gov/dts/vtools/construction/trench_fnl_eng_web.html
- OSHA Construction e-tool: Trenching and Excavation.
  https://www.osha.gov/SLTC/etools/construction/trenching/mainpage.html
- OSHA Quick Card: Working Safely in Trenches.
  https://www.osha.gov/Publications/trench/trench_safety_tips_card.pdf
- OSHA Construction e-tool – Trenching and Excavation: Guide for Daily Inspection Trenches and Excavations.
  https://www.osha.gov/SLTC/etools/construction/trenching/excavchec.html
- NIOSH Workplace Solutions: Preventing Worker Deaths from Trench Cave-Ins.
  https://www.cdc.gov/niosh/docs/wp-solutions/2011-208/pdfs/2011-208.pdf
- E-LCOSH: Safety Walk-around Checklist: Trenches and Excavations.
  http://www.elcosh.org/record/document/1345/d000246.pdf
- Michigan Infrastructure and Transportation Association. https://thinkmita.org/
- CPWR subsite www.cpwrconstructionsolutions.org . They have a series of JSA/THA analysis for a variety of hazards for different “lines of work”. One line of work is Excavation and Demolition. Various tasks can be selected, including Excavate Sites. http://www.cpwrconstructionsolutions.org/hazard/2168/collapse.html
- State and NIOSH Fatality Assessment and Control Evaluation (FACE) Reports
  - Michigan FACE Investigation #06MI004: Male Hispanic Landscape Laborer Dies When Nine-Foot-Deep Trench Collapses. https://oem.msu.edu/images/MiFACE/Investigation%20Report%2006MI004.pdf

- Michigan FACE Investigation #06MI174: Hispanic Laborer Dies as a Result of a Trench Collapse https://oem.msu.edu/images/MiFACE/06MI174.pdf
- Michigan FACE Investigation #12MI121. Pipefitter Dies When Excavation Wall Collapses, Causing Water Tank to Rotate and Pin Him Against Excavation Wall. https://oem.msu.edu/images/MiFACE/12MI121.pdf
- NIOSH In-house FACE Report 99-02: Youth Dies in Trench Collapse – Arizona. https://www.cdc.gov/niosh/face/in-house/full9902.html
- Minnesota FACE Investigation 96MN073: Construction Worker Dies After Being Buried In A Trench That Caved In. https://www.cdc.gov/niosh/face/stateface/mn/96mn073.html

DISCLAIMER

Mention of any company or product does not constitute endorsement by the Michigan FACE program or the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

REFERENCES

Weather Underground [2015]. Weather history for nearby weather station. The Weather Channel Interactive, Inc.

MIOSHA standards may be found at and downloaded from the MIOSHA, Michigan Department of Licensing and Regulatory Affairs (LARA) website at: www.michigan.gov/mioshastandards. MIOSHA standards are available for a fee by writing to: Michigan Department of Licensing and Regulatory Affairs, MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan 48909-8143 or calling (517) 322-1845.

- Construction Safety Standard, Part 9. Excavation, Trenching and Shoring https://www.michigan.gov/documents/lara/lara_miosha_CS_9_3-18-2013_414603_7.pdf

ACKNOWLEDGEMEMENT

The Michigan FACE Program would like to acknowledge the company representative for providing assistance and information for this investigation.