

REPORT#: 17MI127

REPORT DATE: 06/07/19

INCIDENT HIGHLIGHTS



DATE:

Fall, 2017



TIME:

1:36 p.m.



VICTIM:

Laborer in his 30s



INDUSTRY/NAICS CODE:

Construction/23



EMPLOYER:

Landlord



SAFETY & TRAINING:

None



SCENE:

Front yard of home



LOCATION:

Michigan



EVENT TYPE:

Struck By/Asphyxiation

Construction Laborer Died in Trench Wall Collapse

SUMMARY

In fall 2017, a male laborer in his 30s died in a trench wall collapse. The decedent and his coworker were working in a 7-foot deep 4-foot wide trench dug next to and in parallel to an asphalt driveway. The decedent was hand-digging to attempt to locate a sewer blockage in a sewer discharge pipe from a residential home. While he was bent at the waist to hand dig, the trench wall collapsed... [READ THE FULL REPORT](#)> (p.3)

CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

- *Excavation protection (shoring, benching, sloping) was inadequate*
- *A qualified person did not inspect the trench or the soil type/compaction in the work area*
- *The company owner did not recognize the risks of working in an unprotected trench*

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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.*

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State **FACE** Program

Fatality Assessment & Control Evaluation

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Michigan Fatality Assessment and Control Evaluation (FACE) Program

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SUMMARY

In fall 2017, a male laborer in his 30s died when a 7-to 8-foot deep trench wall collapsed. The decedent and the company owner were attempting to locate a clogged sewer pipe at a residential home. The company owner used an excavator to dig an approximately 70-foot long trench from the sidewalk to the house. The north/south side of the trench was located right next to the west side of the property's driveway. The excavation was approximately 7- to 8-feet deep, 3- to 4-feet wide at the base and 5- to 6-feet wide at the top. The west wall of the excavation was at a 74-degree angle. The east wall of the excavation, right next to the driveway, was nearly vertical. The soils consisted of dry, coarse, brown sand with a gravel mix. The company owner placed the spoil piles on both sides of excavation. The two workers went into the excavation to hand dig to attempt to find the plugged areas and clean them out or replace the sewer. While in the excavation, the east trench wall (next to the driveway) collapsed, completely burying the decedent and burying the company owner to his neck. The company owner called out for help and a neighbor called for emergency response. An excavator was brought in to remove a portion of the spoils to allow for a vacuum truck to be positioned near the decedent's location to remove the dirt surrounding him. The vacuum truck could not get close enough to remove all soil from around the decedent, so the responding fire department performed a trench recovery by placing shoring and bracing in the excavation around the deceased. This was the first time the company owner had performed a deep, long excavation.

INTRODUCTION

In fall 2017, a male laborer in his 30s died when a 7-to 8-foot-deep trench wall collapsed. MIFACE learned of this death from the MIOSHA fatality reporting system. MIFACE personnel contacted the firm owner, who agreed to be interviewed at his home. MIFACE reviewed the death certificate, police and medical examiner's report and the MIOSHA compliance officer file during the writing of this report. Pictures used in the report are courtesy of the responding police department and the MIOSHA compliance officer who was assigned to investigate this death.

EMPLOYERS

The rental property owner (employer) utilized a limited liability corporation (LLC) to manage this property. The owner of the LLC had seven LLCs for various rental homes and other income-generating endeavors. The LLC managing this rental property had no employees. The owner's spouse did all of the LLC's clerical and accounting work.

One of seven LLCs owned by the employer owned the excavator used at the jobsite. This LLC provided dumpster service, dropping off empty dumpsters and picking up full ones, then disposing their contents. The excavator was used to demolish older trailer homes and dispose of debris. The owner indicated to the MIFACE investigator that he had performed excavations in the past, but that these excavations were much shallower – three to four feet deep. This was the first time he had excavated a deep, long trench.

WRITTEN SAFETY PROGRAMS and TRAINING

The employer did not have a written accident (safety) prevention program nor was he familiar with the MIOSHA Construction Safety Standard - Part 9: Excavation. The employer had never received instruction on excavations, did not know at what depth an excavation needed to be sloped or shored, did not know the angle of repose or slope required for the type of soil that was on the jobsite, did not know at what depth a ladder was required to be placed in an excavation, and did not know how far apart from a ladder an employee can be in an excavation or how far away the spoils pile must be located from the side on an excavation. The employer acknowledged that no qualified person was on the site and that

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no safety training had been provided to family members or the part-time employee who worked at the LLC owning the excavator.

WORKER INFORMATION

The decedent was a family member. He had never worked and required supervision due to the medical issues. On the day of the incident, the decedent was at the incident site because the individual who normally supervised the decedent's activities was unable to do so. The property owner wanted to ensure the decedent was supervised/watched and kept busy, so the decedent joined him at the work site.

INCIDENT SCENE

The incident occurred in the front yard of a rental home in a residential neighborhood. The renter indicated that they had been renting the house for the past 7 years and that the sewer line had been backing up for about 2 weeks.

The trench was 70 feet long, approximately 7- to 8-feet deep, 3- to 4-feet wide at the base and 5- to 6-feet wide at the top. The trench was located adjacent to the west side of the rental property's asphalt driveway. The west side trench wall was excavated to a 74-degree angle. The east side of the excavation, which was adjacent to the driveway, was nearly vertical (See Photo 1). MIOSHA noted that the soil consisted of dry, coarse, brown sand with a gravel mix.

The excavator had a 30-inch wide bucket.

WEATHER

Weather Underground was utilized to check the weather conditions on the day of the incident. The weather on the day of the incident was approximately 74 degrees Fahrenheit, 50% humidity, calm winds and fair skies; it had not rained on the day of the incident. The historical summary indicated periodic heavy and light rain for several days prior to the incident. [[Weather Underground](#)]

INVESTIGATION

The renter of the property contacted the property owner (employer) that the sewer line was backing up. The property owner contacted a plumbing company to inspect the sewer line to determine the cause of the problem. The plumbing company dropped a scope down the sewer line and found that the sewer line was blocked/broken in two places, approximately 23 and 40 feet from the house. The property owner indicated that he and the decedent were planning to replace the damaged sections, not the entire sewer line.

The company owner contacted MISS DIG to locate utility lines, but did not apply for a plumbing permit from the city's building inspections department to perform the excavation. The owner and the decedent arrived at approximately 10:00 a.m.



Photo 1. Overview of incident scene near driveway trench wall collapse, looking north.

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The owner dug the trench using the excavator and placed the spoils at the edge of the west side of the trench; the spoils were approximately five feet high. Near the sidewalk the spoils were placed on both the east and west side of the trench. His coworker entered the trench several times during the excavation operation to inspect and hand dig around the pipes.

The south end of the trench was approximately the width of the excavator bucket. He sloped the south end of the trench to enable entrance to the base and did not place a ladder in the trench to assist with entering and leaving (See Photo 2).

In the MIFACE interview, the owner stated the following: The trench was dry and the dirt was packed like concrete, especially near the edge of the driveway. He was unsure of where the sewer line issues were so they kept digging. He and the decedent kept going into and out of the trench to hand dig around the sewer line because there was a water line located near the sewer line. He left the excavator left running while performing work in the trench. He also stated that the responding police could not turn off the excavator when they arrived at the scene. He did not want to leave the scene until they recovered the decedent but was forced to go to the hospital due to his injuries.

The owner indicated he was watching the trench walls for cracks, fissures, or material falling in the excavation. He did not notice any sign of wall failure until it failed. The decedent had been digging with a hand shovel approximately 20 feet to the north of the south end of the trench when the east wall next to the driveway collapsed. Portions of the asphalt came down with the soil (See Photo 3). The owner, who was located at the north end of the trench at the time of the collapse, was buried up to his neck but was able to move dirt away, down to his waist. The decedent was completely buried by approximately three feet of dirt. The owner could not move to assist the decedent.

The owner began to yell for help. A neighbor heard him yell. The neighbor opened her window and asked if he needed help. Indicating yes, she called for emergency response. Emergency response dispatch asked her to go over to the property while on the call with 911 to report observations. The neighbor reported that the owner was buried to his waist and that she could not see anyone else in the trench.

Emergency responders entered the trench upon arrival and were able to free the owner. Responders placed a ladder in the trench and the owner climbed out of the trench under his own power. He was transported to the hospital for treatment of the serious multiple injuries he sustained when the wall collapsed.

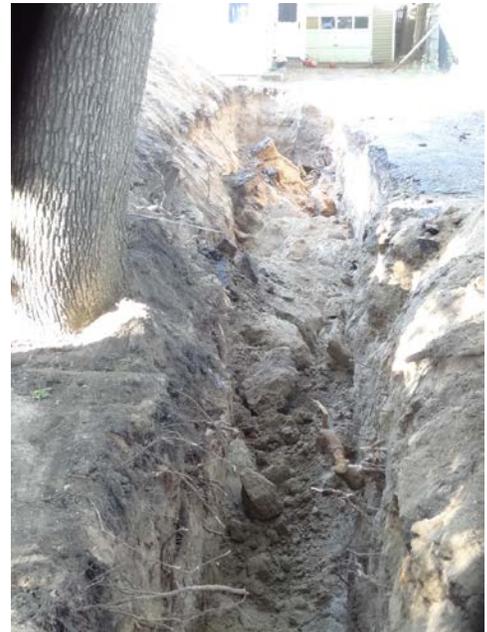


Photo 2. Overview of incident scene looking north.



Photo 3. Area of trench wall collapse, looking south.

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Fire EMS located the decedent and they were able to partially unearth his body. He was located face down and was not breathing. Emergency responders attempted to resuscitate him but were unsuccessful and then began a body recovery operation.

A local Trench Recovery team arrived and started to prepare the scene for recovery of the decedent. An excavator was brought to the site to remove a portion of the spoils to permit a vacuum truck to be positioned near the decedent's location to remove the dirt surrounding him (See Photo 4). The vacuum truck could not get close enough to remove a sufficient amount of soil from around the decedent. The walls of the trench were not secure. The trench recovery team stabilized the trench walls by placing shoring and bracing around the decedent before he could be extricated. When the decedent was uncovered, he was bent at the waist with his chin against his chest. The decedent was removed from the excavation approximately three hours after the trench wall collapsed.



Photo 4. Vacuum truck removing soil from around decedent. Red circle is location of decedent.

MIOSHA Citations

MIOSHA Construction Safety and Health Division issued the following Serious citations and a Notice of Potential Hazard to the employer at the conclusion of its investigation.

SERIOUS: GENERAL RULES, CS PART 1, RULE 408.40114(1): An employer shall develop, maintain, and coordinate with employees, an accident prevention program, a copy of which shall be available at the worksite.

The employer did not develop an accident prevention program. Employees engaged in excavation activities.

SERIOUS: PERSONAL PROTECTIVE EQUIPMENT, CS PART 6, RULE 408.40622(1): An employer shall ensure that every affected employee is provided with, and wears, head protection equipment and accessories when the employee is required to be present in areas where a hazard or risk of injury exists from any of the following:

- (a) Falling or flying objects or particles.
- (b) Electrical shock and burns.
- (c) From other harmful contacts or exposures.

Employees engaged in excavation activities were exposed to head injuries by not wearing head protection while working in a 7- to 8-foot deep excavation.

SERIOUS: EXCAVATION, 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 did not have a qualified person available at the jobsite to inspect the excavation for hazards.

- RULE 408.40933(2): An excavation that an employee is required to enter shall have excavated and other material stored and retained not less than 2 feet from the excavation edge.

Employees engaged in excavation activities were exposed to a hazard by having the spoils piles located directly next to the excavation that they were working inside.)

- RULE 408.40933(4): An excavation 48 or more inches in depth and occupied by an employee shall be provided with either a ladder extending not less than 3 feet above the top as a means of access or with a ramp meeting the requirements of subrule (5) of this rule. Lateral travel along the wall of a trench to a ladder or other means of egress shall not exceed 25 feet.

Ladders were not installed in an excavation that was 7- to 8-foot deep and approximately 70-foot long. Employee was engaged in excavation activities.)

- RULE 408.40941(1): The side of an excavation more than 5 feet deep shall be sloped as prescribed in Table 1, unless supported as prescribed in this part.

Employees engaged in excavation activities did not have the sides of the excavation cut to the proper angle. No shoring or trench box was utilized. The excavation was approximately 70 foot and 7-to 8-foot deep. The west side of the excavation was at a 74-degree angle. The east side of the excavation was near vertical. The soils consisted of dry, coarse, brown sand with a gravel mix. Employees were along the west side of the driveway.

NOTICE OF POTENTIAL HAZARD: The following information is provided to the employer to correct an identified hazard. A MIOSHA rule violation exists, but employee exposure has not been determined or evidence is not sufficient to document a violation at this time.

Part 9. EXCAVATION, TRENCHING AND SHORING. R 408.40933. Excavation; obstructions; retaining materials; egress; guarding; heavy equipment. Rule 933. (1) A tree, boulder, rock fragments, or other obstructions whose movement could cause injury to an employee shall be removed or supported.

Firm Remediation

The firm has determined it will no longer perform any trenching operations.

CAUSE OF DEATH

The death certificate listed the cause of death as traumatic asphyxia. Post-mortem toxicological tests were not performed.

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 hazards were identified as key contributing factors in this incident:

- *Excavation protection (shoring, benching, sloping) was inadequate*
- *A qualified person did not inspect the trench or the soil type/compaction in the work area*
- *The company owner did not recognize the risks of working in an unprotected trench*
- *The company did not have a safety program or provide safety training*
- *The company did not acquire a permit for the sewer trench operation*

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: 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. Soil walls may collapse multiple times, or in phases, in the same trench. Where soil can no longer withstand the pressure, the wall will shear and break away. 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. 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.

Weight of excavated soil may place additional stresses on trench walls due to the weight of the soil and cause a cave-in. Additionally, spoils and equipment can roll back on top of workers if the spoil pile is located too close to the trench wall. Spoil piles should be, at a minimum, two feet away from the trench opening. If the site configuration does not allow for a two-foot setback, the soil should be hauled away.

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.

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

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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.

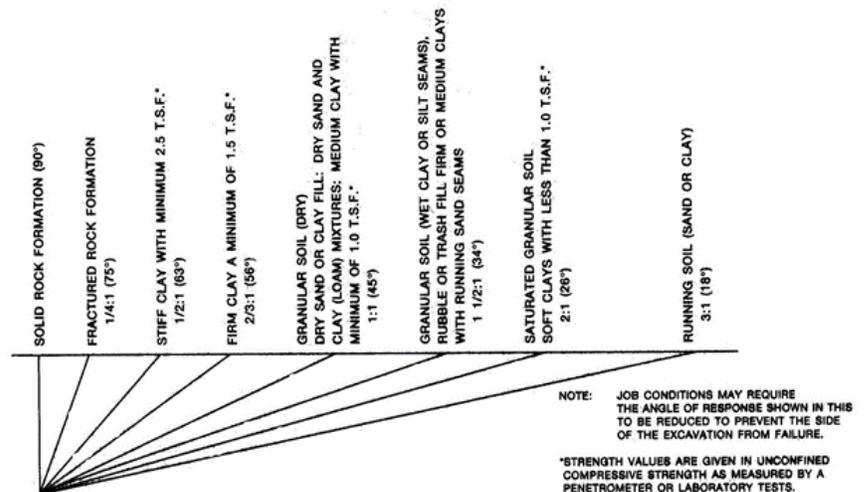
To assist employers in complying with Part 9, MIOSHA Construction Safety Division has a [Trenching and Excavation – Protective Systems](#) Fact Sheet and MIOSHA Consultation, Education and Training division has an [Excavation Training By the Numbers](#) Fact sheet.

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](#).

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



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. To select appropriate trench protective systems for a given jobsite, the qualified person should visually and manually test the soils, and also consult the shoring or shielding manufacturer’s tabulated data or MIOSHA’s Table 1 designed for this purpose. A pre-work assessment should include:

- Soil characteristics that affect its stability, such as granularity, saturation, cohesiveness, and unconfined compression strength (the capacity of the soil to withstand pressure);
- Site conditions such as the presence of previously disturbed soils, potential vibration sources, stability of adjacent structures, and utility locations;
- Factors such as excavation depth and width, the nature of the work, and any nearby activities that could increase the risk of collapse.

The company owner was unfamiliar with the requirements of the MIOSHA standard. Although he had dug other trenches, none had been to the depth and length of the incident trench. The company owner did not hire or utilize

anyone meeting the definition of qualified person to determine soil type or trench protection system requirements. The decedent also did not have any excavation safety experience or training. If the qualified person responsibilities had been carried out in compliance with MIOSHA regulations, unsafe conditions would have been recognized and appropriate precautions taken prior to both workers entering the trench.

OSHA has many resources available for employers and employees working in a trench (excavation). OSHA standard [1926 Subpart P App B - Sloping and Benching](#) contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2). Additional sources of information from OSHA include Excavations, Scope, application and definitions applicable to this subpart [29 CFR 1926.650](#), Excavations: Specific Excavation Requirements [29 CFR 1926.651](#), and Excavations: Requirements for Protective Systems [29 CFR 1926.652](#).

Recommendation #2: Employers should ensure anyone working in or around trenches 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: The owner indicated that he did not slope, shore or use a trench box to prevent a cave-in because he did not think that the wall would collapse; the soil was so hard. Individuals 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 and self-employed contractors should design, develop, and implement a comprehensive safety program that includes training in hazard recognition and avoiding unsafe conditions.

Discussion: The employer did not have a formal health and safety program and did not provide employee safety education and training.

Employers should be aware of and recognize their knowledge limitations and seek advice, assistance, consultation, and specific training as necessary. MIOSHA Construction Safety Standard, Part 1 – General Rules (MIOSHA R408.40114(2)(d)) requires the employer to 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.

Recommendation #4: Always obtain the appropriate construction permits prior to performing a construction activity.

Discussion: The owner of the business did not obtain the required plumbing permit for the sewer repair at the rental property. A permit is required if any owner or owner’s authorized agent who intends to construct, enlarge, alter, repair, move, demolish or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by the Michigan 2015 building code.

If the owner had applied for the plumbing permit to perform the sewer work, the owner would have been denied by the agency issuing the permit because he did not meet permit issuance requirements. The company owner was not a licensed plumber and did not fall under the homeowner exemption as defined by Michigan law. Michigan law defines a homeowner as an individual who owns the home *and occupies* the home. If the owner had followed the permit protocol, the owner would have had to subcontract the work to a licensed residential builder or Maintenance and Alteration contractor because the project total would have been more than \$600.00. This sub-contracted firm may have had more expertise in excavation safety and this incident could have been prevented.

Recommendation #5: Emergency medical services and fire-rescue personnel should be knowledgeable about proper rescue techniques involving excavation sites.

Discussion: Emergency responders entered the trench to assess the decedent’s status and assist with extrication without providing trench wall stabilization/shoring, placing the emergency responders at risk of becoming victims. According to NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents, general hazards associated with search and rescue operations can present the authority having jurisdiction with uniquely challenging situations. Within this standard, all trench and many excavation collapses necessitate a confined space rescue. Responding personnel should be familiar with and trained in confined space rescue requirements and techniques. Workers should never, under any circumstances, enter a hazardous environment to attempt a rescue operation unless properly equipped and trained in the use of the equipment and methods required for rescue.

ADDITIONAL RESOURCES

- MIOSHA Resources
 - MIOSHA Excavations, Trenching and Shoring Card.
https://www.michigan.gov/documents/lara/lara_miosha_cet0204_406724_7.pdf
 - MIOSHA Sample Accident Prevention Program SP#1
 - MIOSHA Job Safety Analysis Booklet
 - MIOSHA Trenching and Excavation – Protective Systems Fact Sheet

- MIOSHA Consultation, Education and Training division [Excavation Training By the Numbers](#) Fact sheet.
- OSHA Resources
 - 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 sub-site 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>
 - Michigan FACE Investigation #15MI117: Construction Laborer Died in a Trench Wall Collapse.
www.oem.msu.edu/images/MiFACE/InvestigationReport_Construction/15MI117InvestgationReport.pdf
 - Michigan FACE Investigation #14MI119: Construction Owner Died in Trench Wall Collapse.
www.oem.msu.edu/images/MiFACE/InvestigationReport_Construction/14MI119InvestgationReport.pdf

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- 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

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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 1. General Rules. https://www.michigan.gov/lara/0,4601,7-154-89334_11407_15368-39938--,00.html
- 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
- Electronic Code of Federal Regulations. OSHA Subpart P: Excavations. <https://www.ecfr.gov/cgi-bin/text-idx?SID=2344d4a19c4c46a93869c609f6159aba&mc=true&node=sp29.8.1926.p&rgn=div6>
- NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents
- State of Michigan Department of Licensing and Regulatory Affairs Construction Code 2015, Part 5. Residential Code https://www.michigan.gov/documents/.../lara_bcc_2015_residential_code_502813_7...
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