Fatality Assessment and Control Evaluation Program

NIOSH • 1095 Willowdale Road, Morgantown, West Virginia 26505 • 304-285-5916

REPORT#: 2014-02 **REPORT DATE:** January 30, 2018

Laborer, Pipefitter, and Utility Foreman Crushed by Falling Block Wall—Tennessee

INCIDENT HIGHLIGHTS

DATE:
April 18, 2013

TIME:
9:45 a.m.

VICTIM:
51-year old maintenance Hispanic worker; 37-year old Hispanic pipefitter

INDUSTRY/NAICS CODE:
Construction/23

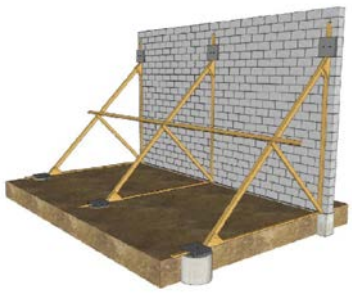
EMPLOYER:
Commercial building contractor & subcontractors

SAFETY & TRAINING:
The contractor did, but some subcontractors did not

SCENE:
Retail development area

LOCATION:
Tennessee

EVENT TYPE:
Struck by



SUMMARY

On April 18, 2013, a 24-year-old Hispanic laborer and a 37-year-old Hispanic pipefitter were crushed by a falling block wall when it failed; they died immediately of their injuries. A 46-year-old utility foreman was also injured in the incident. At the time of the incident, the laborer was applying caulking to the expansion joints of a block wall, and the pipefitter and the utility foreman were installing piping for the building's sprinkler system... READ THE FULL REPORT> (p.3)

CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

- Deviation from engineering drawings
- Inadequate inspection of rebar placement
- Inadequate bracing for the block wall
- Wall height extending too far above the bracing LEARN MORE> (p.9)

RECOMMENDATIONS

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

- Ensure that employees follow the engineering/architectural drawings during building construction and obtain engineering approval before plan changes are made.
- Develop and follow a masonry wall bracing plan, train employees on proper masonry wall bracing, and ensure masonry walls are properly braced throughout the project.
- Develop and implement a restricted/limited access zone. LEARN MORE> (p.9)

Fatality Assessment and Control Evaluation (FACE) Program

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In 1982, NIOSH initiated the Fatality Assessment and Control Evaluation (FACE) Program. FACE examines the circumstances of targeted causes of traumatic occupational so that safety professionals, researchers, employers, trainers, and workers can learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent occupational deaths and are completely separate from the rule making, enforcement and inspection activities of any other federal or state agency. Under the FACE program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. For further information, visit the program website at **www.cdc.gov/niosh/face/** or call toll free at 1-800-CDC-INFO (1-800-232-4636).

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH • 304-285-5916
1095 Willowdale Road
Morgantown, West Virginia
26505

NIOSH • 1095 Willowdale Road, Morgantown, West Virginia 26505 • 304-285-5916

SUMMARY

On April 18, 2013, a 24-year-old Hispanic laborer and a 37-year-old Hispanic pipefitter were crushed by a falling block wall when it failed; they died immediately of their injuries. A 46-year-old utility foreman was also injured in the incident. At the time of the incident, the laborer was applying caulking to the expansion joints of a block wall, and the pipefitter and the utility foreman were installing piping for the building's sprinkler system in a trench next to the block wall. A wind gust caused the block wall to fall onto the laborer, pipefitter, and utility foreman. The project superintendent called 911, and emergency medical services were dispatched and arrived at the incident within 4 minutes. The laborer and pipefitter were pronounced dead at the scene, and the utility foreman was airlifted to a local hospital.

INTRODUCTION

At 9:45 a.m. on April 18, 2013, an Hispanic laborer and Hispanic pipefitter were killed and a utility foreman was injured when an inadequately braced 24 foot tall block wall they were working near fell on them during a 33-mph wind gust. On November 19, 2013, the Tennessee Department of Labor and Workforce Development/Occupational Safety and Health Division (TOSHA) notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research, of the incident. On September 9, 2014, a NIOSH health scientist conducted an investigation of the fatality and reviewed circumstances of the incident with the investigating TOSHA safety compliance officer. Photographs of the incident site and witness statements taken by TOSHA and the fire department were reviewed.

EMPLOYERS

- The prime contractor, a commercial building contractor, had 75 employees, had been in business for 21 years, and had 3 employees on-site the day of the incident. The prime contractor had hired three subcontractors to complete the commercial building project.
- The masonry subcontractor had 14 employees, had been in business for 2 years, and had 5 employees on-site the day of the incident.
- The excavation subcontractor had 14 employees, had been in business since 1963, and had 3 employees on-site the day of the incident.
- The waterproofing subcontractor had 46 employees, had been in business for 8 years, and had 3 employees on-site the day of the incident.

WRITTEN SAFETY PROGRAMS and TRAINING

At the time of the incident, according to TOSHA, the masonry subcontractor had an employee safety manual that included a special emphasis checklist, a section on structure construction, a section on wall bracing to prevent collapse, and training on restricted/limited access areas. The employees for the masonry subcontractor had been trained on April 4, 2013. The excavation subcontractor did not have a comprehensive safety and health plan but provided verbal on-the-job training in English. The excavation subcontractor provided hard hats and high visibility safety vests. The waterproofing subcontractor did not have a comprehensive safety and health plan and there was no evidence of worker training.

WORKER INFORMATION

The 24-year-old male Hispanic laborer who worked for the waterproofing subcontractor, was from Mexico, and his first language was Spanish, but he could speak some English. At time of the incident, the laborer was not wearing personal protective equipment. The 37-year-old Hispanic pipefitter who worked for the excavation subcontractor, was from

Mexico, had been in the United States for 17 years, and his first language was Spanish, but he spoke English. At the time of the incident the pipefitter was wearing a high-visibility vest. The 46-year-old utility foreman who worked for the excavation subcontractor, was injured when the block wall collapsed, and was wearing a high-visibility vest.

INCIDENT SCENE

The building being constructed was a 28,000-square-foot retail store in a retail development area. Construction began in March of 2013 with a concrete footer measuring 2 feet wide and 1 foot deep. Rebar was to be placed 40 inches on center in the footer. The walls were constructed of typical concrete masonry unit blocks that were 8 inches tall, 8 inches wide, and 16 inches long. The walls were 36 courses (24 feet) tall and consisted of panels, with masonry control joints between each panel. Masonry control joints prevent the wall from cracking caused by shrinkage, wind, soil pressure, seismic forces, or settlement. The masonry walls were completed at different times so they were all in different stages in their curing process. The west wall was completed on March 26, the east wall was completed on April 3, the north wall was completed on April 5, and the south wall was completed on April 12. On the day of the incident the masonry subcontractor's 5 employees were in the process of constructing the loading dock wall (Diagram).

Prior to building the east wall, the masonry subcontractor noticed the rebar in the east wall footer was not positioned in the center of the footer according to the engineering drawings, but was 2 to 4 inches off center, positioning them near the exterior of the wall. The masonry subcontractor notified the prime contractor of the error, and the prime contractor instructed the masonry contractor to fix it by bending the rebar toward the center of the footer so it would fit inside the center of the blocks. The out-of-place rebar went unnoticed by the engineer during inspection and the engineer was not notified of the change in the rebar.

The east wall, the incident wall, was 149 feet long and was not structurally tied to the other three walls at the time of the incident. The east wall had seven panels, with a control joint between each panel. The east wall was originally braced with three wooden braces on the inside and three wooden braces on the outside, with the braces opposing each other. The braces consisted of three pieces: one vertical scaffold board, positioned on the wall but not attached to the wall; a cleat board measuring 2-inch by 4-inch placed horizontally across the vertical scaffold board approximately 9 to 10½ feet up the scaffold board (Photo 1); and another scaffold board was wedged at an angle between the cleat and a 4-foot long piece of rebar driven into the ground. Two masonry blocks were placed on top of the rebar and board as extra weight for the scaffold board and as protection around the rebar (Photo 2). The spacing between braces varied, as did the angle of the braces (Photo 3). Two of the three outside braces were removed, leaving one brace in the center of the outside wall the day before the incident to allow the waterproofing subcontractor to caulk the control joints. No permanent supporting elements of the structure were in place. A 3 foot deep, 5½ foot wide, and 8 foot long trench ran parallel to the east wall. The trench was positioned 15 feet from the wall and was dug to allow installation of the building's sprinklers back-flow system. There was a 3½-foot tall concrete meter box toward the south end of the trench that was being used as a table (Photo 4).

NIOSH • 1095 Willowdale Road, Morgantown, West Virginia 26505 • 304-285-5916

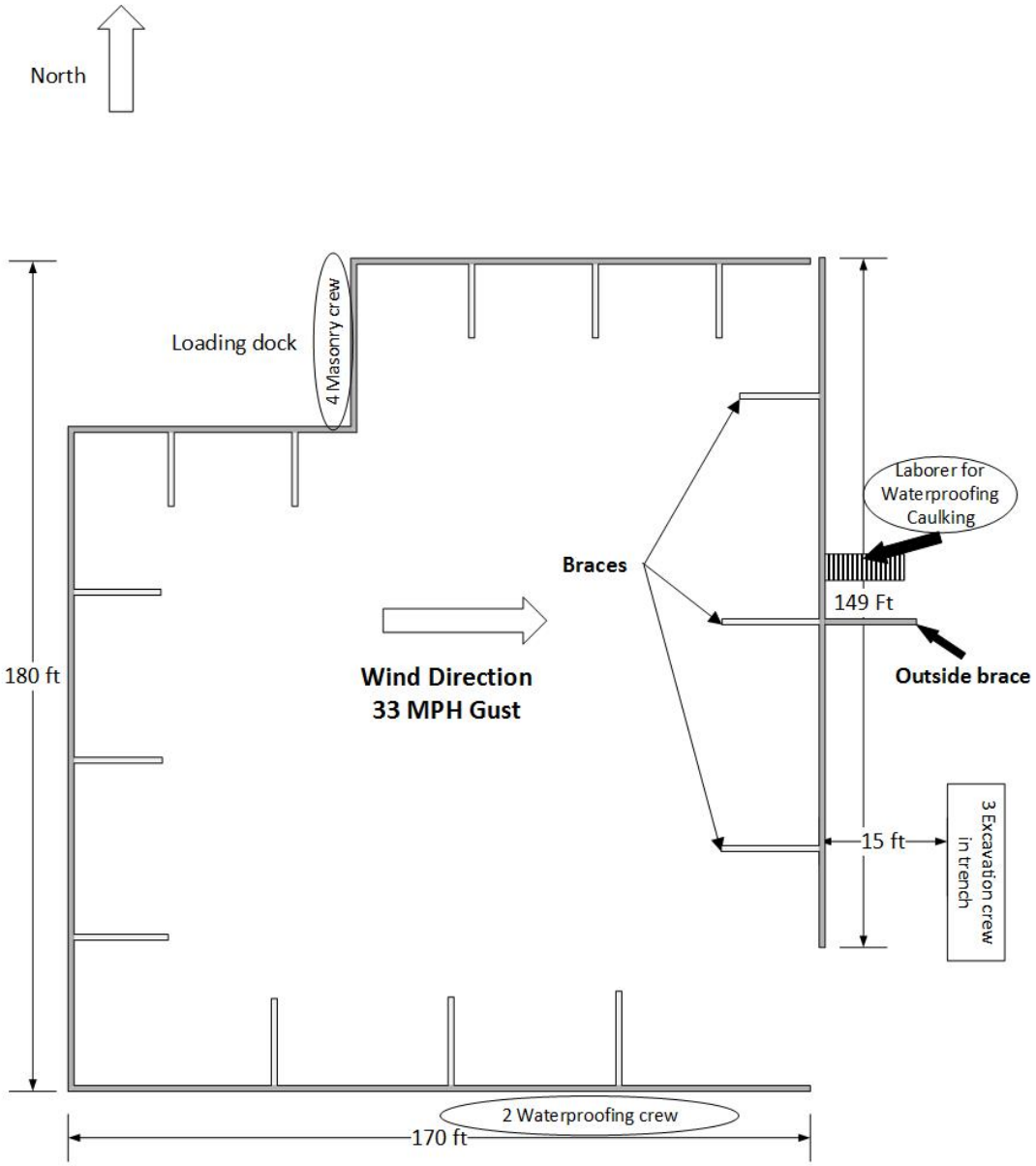


Diagram. Incident scene.

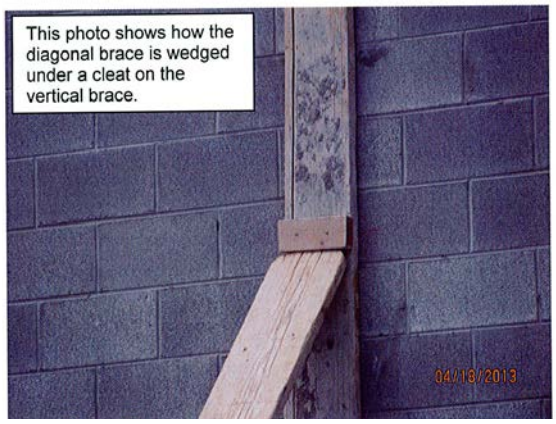


Photo 1. Top cleat of wall brace. (*Photo courtesy of TOSHA.*)

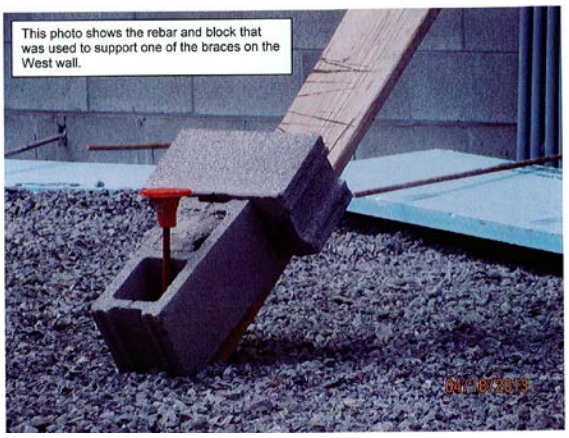


Photo 2. Blocks and rebar used to secure wall brace. (*Photo courtesy of TOSHA.*)

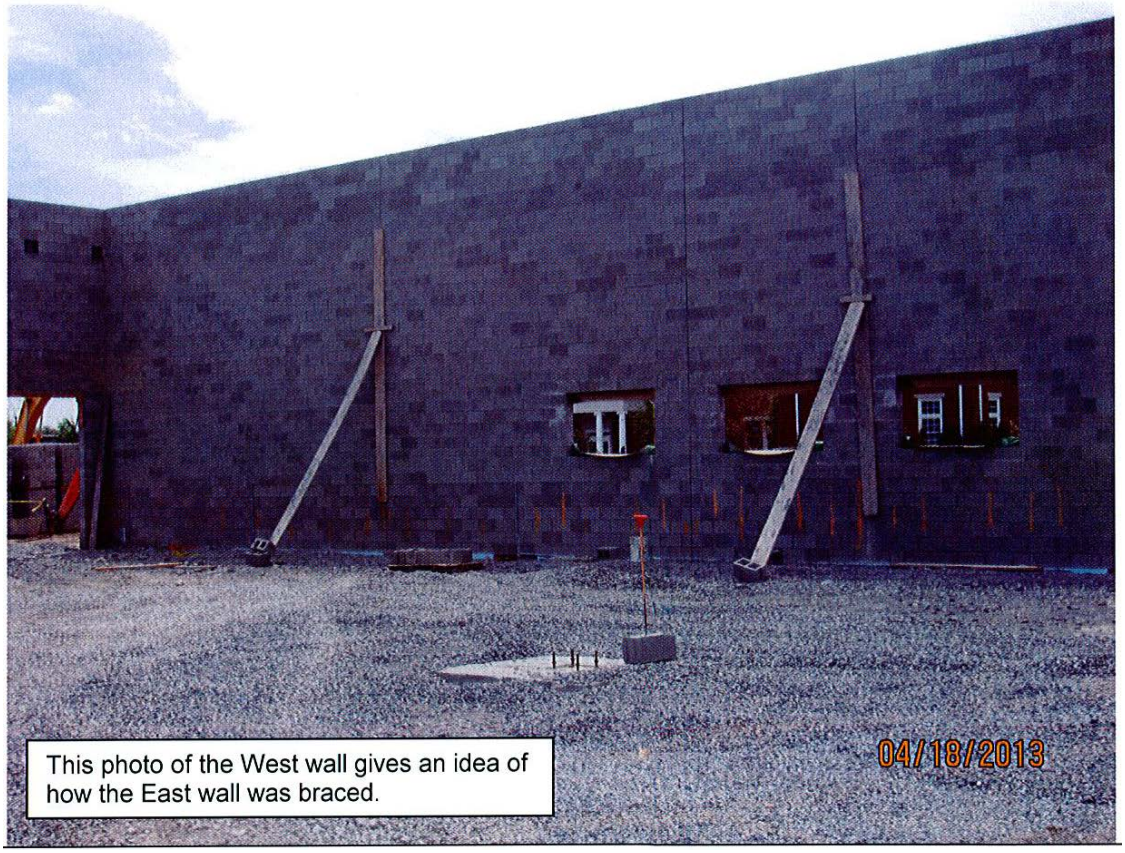


Photo 3. Interior wall bracing. (*Photo courtesy of TOSHA.*)

WEATHER

The weather on the day of the incident was approximately 80 degrees Fahrenheit, 65% humidity, 18 mph average southerly wind speed, 32 mph maximum wind speed, and 39 mph wind gusts [Weather Underground 2013]. The weather is believed to have been a factor in this incident.

INVESTIGATION

The excavation crew arrived at work on April 18, 2013, around 6 a.m. The masonry crew arrived around 7:30 a.m. The waterproofing crew arrived at work at 8 a.m. Between 9 and 9:15 a.m., the subcontractor crews took a break and returned to work around 9:30 a.m. The waterproofing laborer (decedent) was caulking the control joints on the east wall from a 16-foot fiberglass extension ladder. Two other waterproofing crew members were spraying waterproofing on the south wall. The three excavation crew members, including the utility foreman (injured) and pipefitter (decedent), were in the trench installing a backflow preventer for the building's sprinkler system. The foreman for the masonry subcontractor was meeting with the prime contractor and a framing subcontractor at the south end of the project. The four other employees for the masonry subcontractor were constructing the loading dock wall on the north side (Diagram).

Photo 4. Concrete meter box. Arrow indicates where three excavation employees were working. (*Photo courtesy of TOSHA.*)

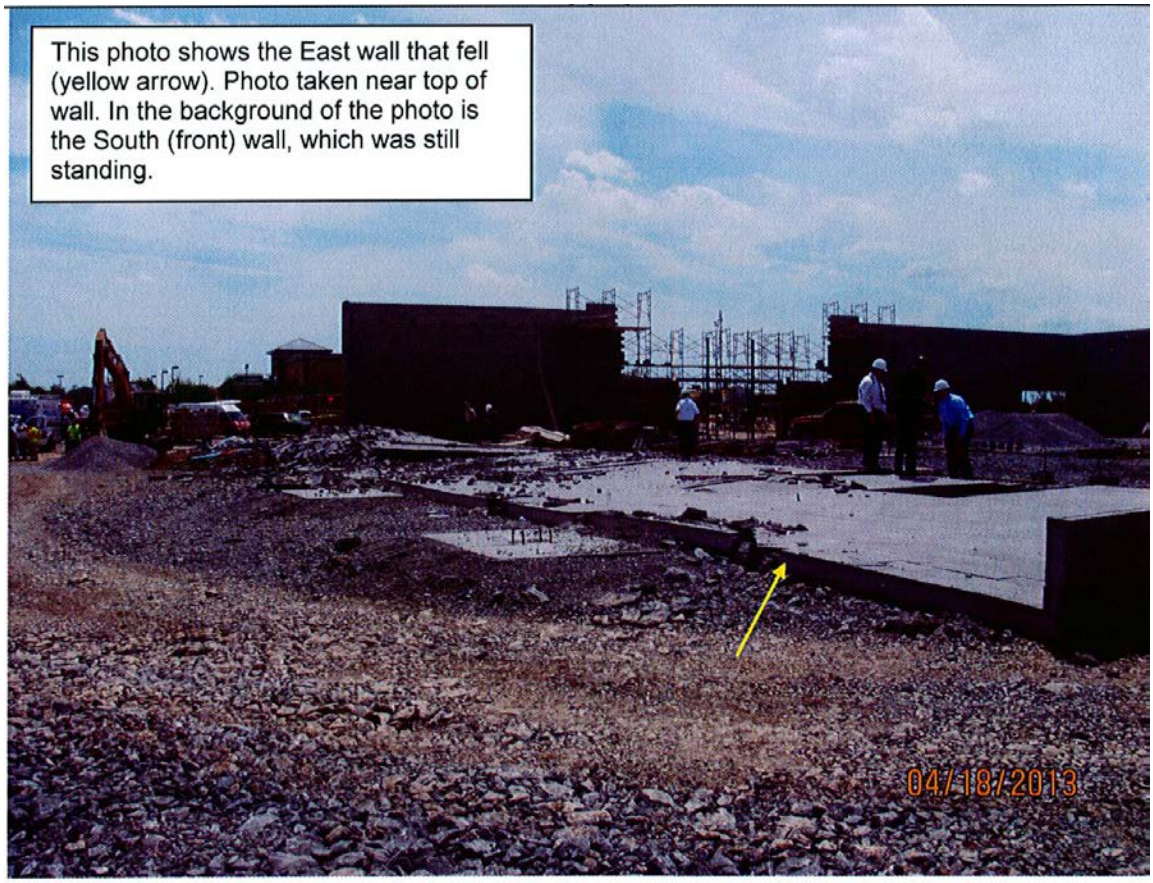


Photo 5. Collapsed wall.
(*Photo courtesy of TOSHA.*)

At 9:45 a.m., the east wall fell during a 33-mph wind gust, on top of the waterproofing laborer, the pipefitter, and the utility foreman (Photo 5). The excavation foreman was able to run to safety. Once the wall fell, the project superintendent called 911 and emergency medical services (EMS) were dispatched and arrived within four minutes. Several crew members ran to remove the block wall from the utility foreman before EMS arrived. The laborer and pipefitter were pronounced dead at the scene. The utility foreman was airlifted to a local hospital.

CAUSE OF DEATH

According to the TOSHA report, the cause of death was multiple blunt force injuries.

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. NIOSH investigators identified the following unrecognized hazards as key contributing factors in this incident:

- *Deviation from engineering drawings*
- *Inadequate inspection of rebar placement*
- *Inadequate bracing for the block wall*
- *Wall height extending too far above the bracing*
- *Worker proximity to unbraced block wall*
- *Lack of competent person to monitor wind speed*
- *Inadequate training related to masonry wall safety*

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that employees follow the engineering/architectural drawings during building construction and obtain engineering approval before plan changes are made.

Discussion: Based on the original engineering drawing, with rebar placed in the center of each block and secured with grout, the unsupported block wall in the intermediate period should have been able to sustain wind speeds up to 35 mph [MIOSHA 2010; MCCA 2012; NMCA 2005; NCMA 2014]. Additionally, masonry control joints were designed to prevent wall damage due to cracking caused by shrinkage, wind, soil pressure, seismic forces, or settlement. The wall panels were designed to fail independently in the event of a wind gust. The rebar dowel coming out of the footer for the east wall was not placed in the center of the footer as specified in the engineering drawings, but was off-center by 2 to 4 inches toward to exterior edge [Photo 6]. The engineer did not notice the misplacement of the rebar during inspections. The masonry subcontractor brought the rebar placement issue to the attention of the general contractor. The masonry subcontractor was instructed to fix the problem by bending the rebar toward the center of the footer to fit within the centers of the concrete masonry blocks. The resultant rebar/grout combination was no longer strong enough to resist the lateral loads of the wind coming from the west, based on an analysis conducted by the OSHA Directorate of Construction, Engineering Services section, at the request of TOSHA, and the wall presented properties similar to an unreinforced wall design. This rebar misalignment was consistent across all seven wall panels that failed. Procedures to address this issue include placing the rebar dowels in the center of the blocks according to the engineering drawing or correcting the misalignment by drilling correctly positioned holes in the grout and epoxying rebar in place.

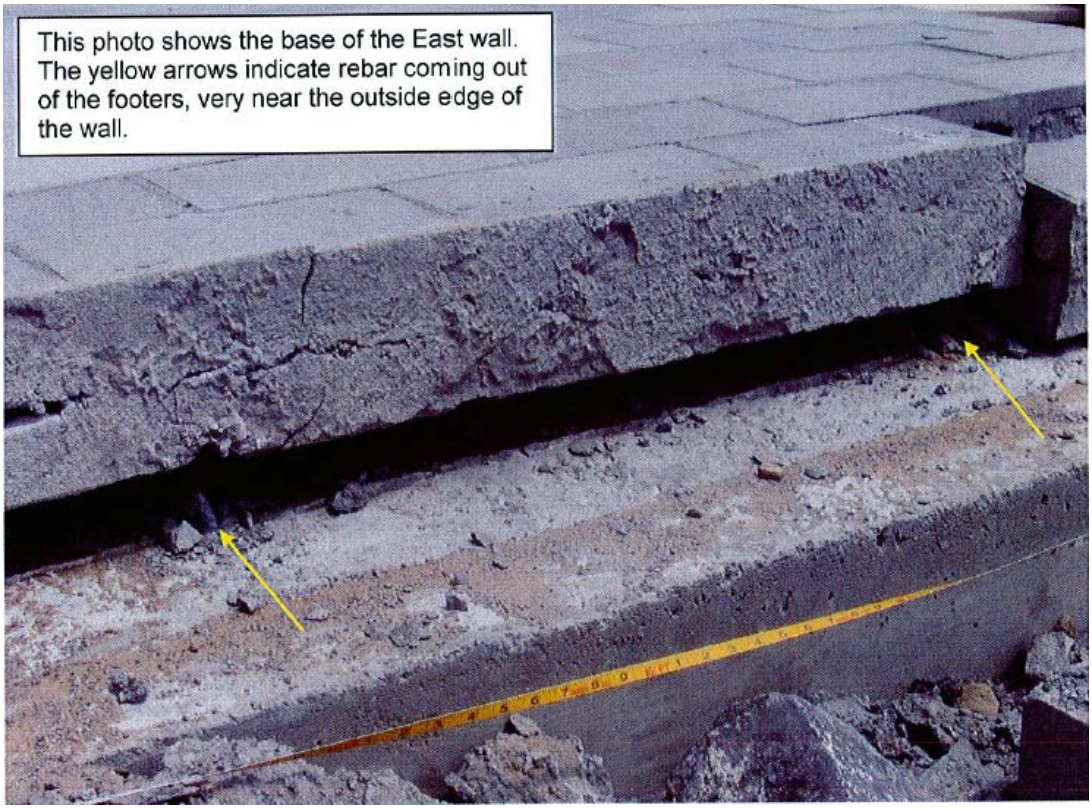


Photo 6. Rebar coming out of footer.
(*Photo courtesy of TOSHA.*)

Recommendation #2: Employers should develop and follow a masonry wall bracing plan, train employees on proper masonry wall bracing, and ensure masonry walls are properly braced throughout the project.
Discussion: Employers should develop a masonry wall bracing plan before construction begins. A masonry wall bracing plan includes notification criteria and detailed bracing locations, based on masonry wall structure and construction periods. The notification criteria details who is responsible for the erection and dismantling of the bracing, monitoring wind speeds, and establishing restricted/limited access zones. The plan also delineates who has the authority to supervise subcontractors and employees who work in the restricted/limited access zone and how to communicate the plan.

OSHA regulation 29CFR1926.706(b) states that all masonry walls over 8 feet in height shall be "adequately braced" to prevent overturning and to prevent collapse unless the wall is adequately supported such that it will not overturn or collapse. The bracing shall remain in place until permanent supporting elements of the structure are in place. Permanent supporting elements include roof systems, trusses, and decking [OSHA 1988]. There is no additional guidance from OSHA on what is meant by "adequately braced", how to adequately brace a wall, or what comprises an adequately brace, but OSHA recommends bracing should follow guidelines provided by industry associations and organizations like the Mason Contractors Association of America (MCCA) and National Concrete Masonry Association (NCMA).

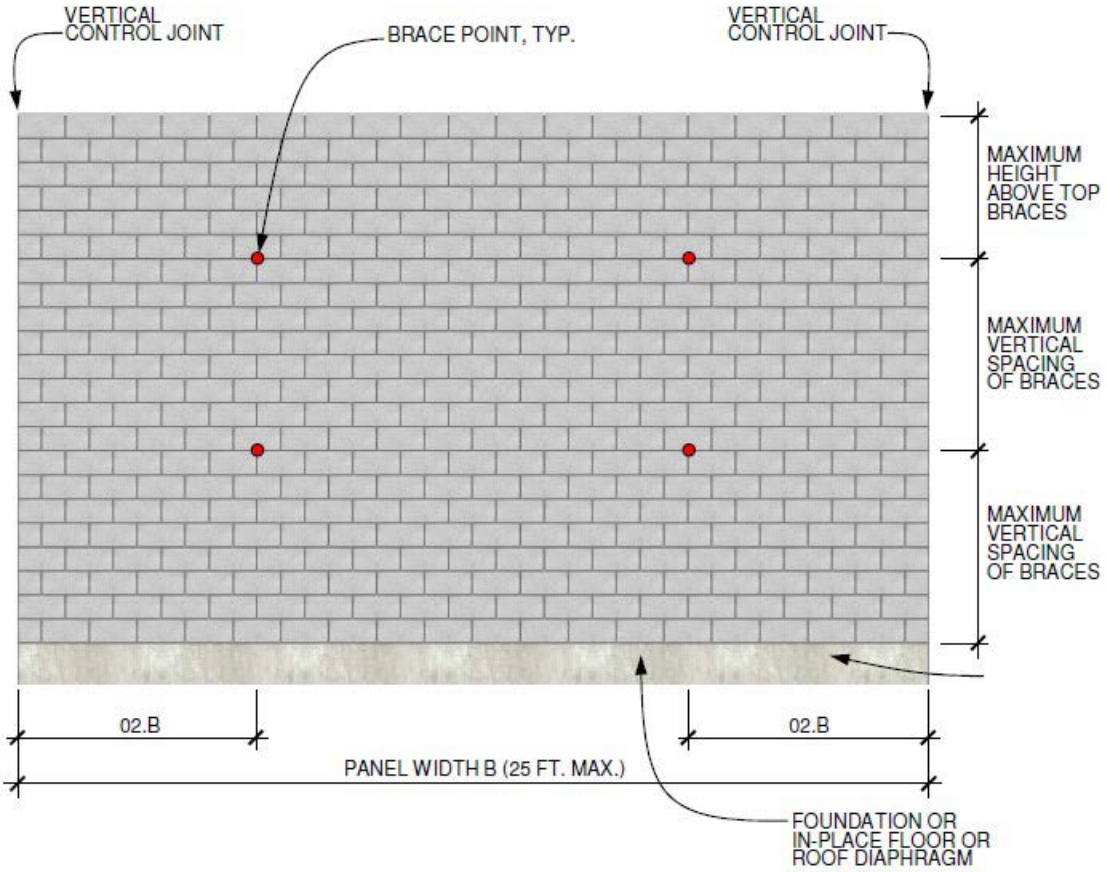
OSHA does not require that employers train employees on proper masonry wall bracing. However, the MCAA recommends employers provide training to those employees engaged in masonry activities. Michigan OSHA (MIOSHA) requires the use of bracing plans or the use of a registered professional engineer like those found in the *Standard Practice for Bracing Walls Under Construction or Masonry Wall Bracing Design Handbook* [MIOSHA 2015a]. Other states have provided requirements beyond the federal OSHA standard and added masonry wall bracing requirements of their own [Oregon OSHA 2003]. Bracing guidelines have also been developed by the MCAA [MCAA 2012]. Additionally, the NCMA recommends alternative bracing systems should be approved by a registered professional engineer [NCMA 2014]. The bracing locations should be identified before work begins to maximize safety and efficiency. This allows the contractor to delineate the restricted/limited access zone throughout the life of the project [Johnson 2008].

Factors that affect wall bracing design include period of construction, density of wall material, wall length, control joints, wall height, wall thickness, method of grouting, age of grout, and wind speed. Bracing materials include pipe bracing, cable bracing, and wood bracing. Wood bracing is common, although pipe bracing provides more resistance to wind loads than wood or cable. Cable braces require bracing on both sides to apply constant tension on the wall [Palmer 2000]. Standard industry practice recommendations allow a length of a wall between control joints of approximately 25 feet for concrete and clay masonry units, with a minimum of two braces per panel on each side of the wall (four total), and the braces need to be within 20% of the distance from each end of the panel (Figure 1). The east wall had seven panels and should have had fourteen braces on each side based on the MCAA guidelines. The entire 149-foot east wall was braced with one exterior brace and three interior braces.

The wall bracing system used in this incident was a modified triangle system and composed of two scaffold boards. The vertical board was positioned on the wall but not attached to the wall. The vertical board had a 2- by 4-foot cleat across it horizontally (Photo 1 and Photo 3). The inclined brace boards were wedged at an angle that varied between 34 and 41 degrees. A 4-foot length of rebar was driven into the ground; one masonry block was placed over the rebar with the other placed on top of the inclined board (Photo 2 and Photo 3). There was no permanent tie from the ground to the wall brace. The wall extended between 13½ and 15 feet above the brace.

The MCCA Standard Practice for Bracing Masonry Walls Under Construction recommends that for a 23-foot, 4-inch wall with 8-inch block, reinforced with No. 5 rebar 4 feet on center, the wall should extend no more than 8 feet, 8 inches above the brace and the angle of the inclined brace should be between 35 and 45 degrees. A typical triangle wood bracing system should include a horizontal brace, a vertical brace, a diagonal brace positioned with a cleat on both ends of the brace, and a diagonal stiffener anchored to the wall or footer and nailed to the diagonal brace [MCCA 2012] (Figures 2 and 3). Michigan OSHA requires the masonry contractor to maintain a copy of the *Masonry Wall Bracing Design Handbook* or other permitted method of bracing on the jobsite [MIOSHA 2015a].

In this incident, the wall extended more than 8 feet 8 inches above the braces in some instances, and several of the recommended brace system components were missing. If a masonry wall bracing plan had been in place and one of the employers had a trained competent person at the time of the incident, the competent person could have recognized the hazard posed by the unbraced wall and made the appropriate changes to provide a safe bracing system. Since this incident, the masonry subcontractor has trained their employees on proper concrete and masonry wall bracing.



Footnotes
1. For maximum height above braces see Table 4.2 for Initial Period requirements or Table A.1 for Intermediate Period requirements.
2. For maximum vertical spacing of braces, see Table A.1.
3. Walls shall be considered unreinforced until grout has been in place at least 12 hours.

Figure 1. Wall bracing placement diagram.
(*Figure courtesy of MCCA* [MCCA 2012].)

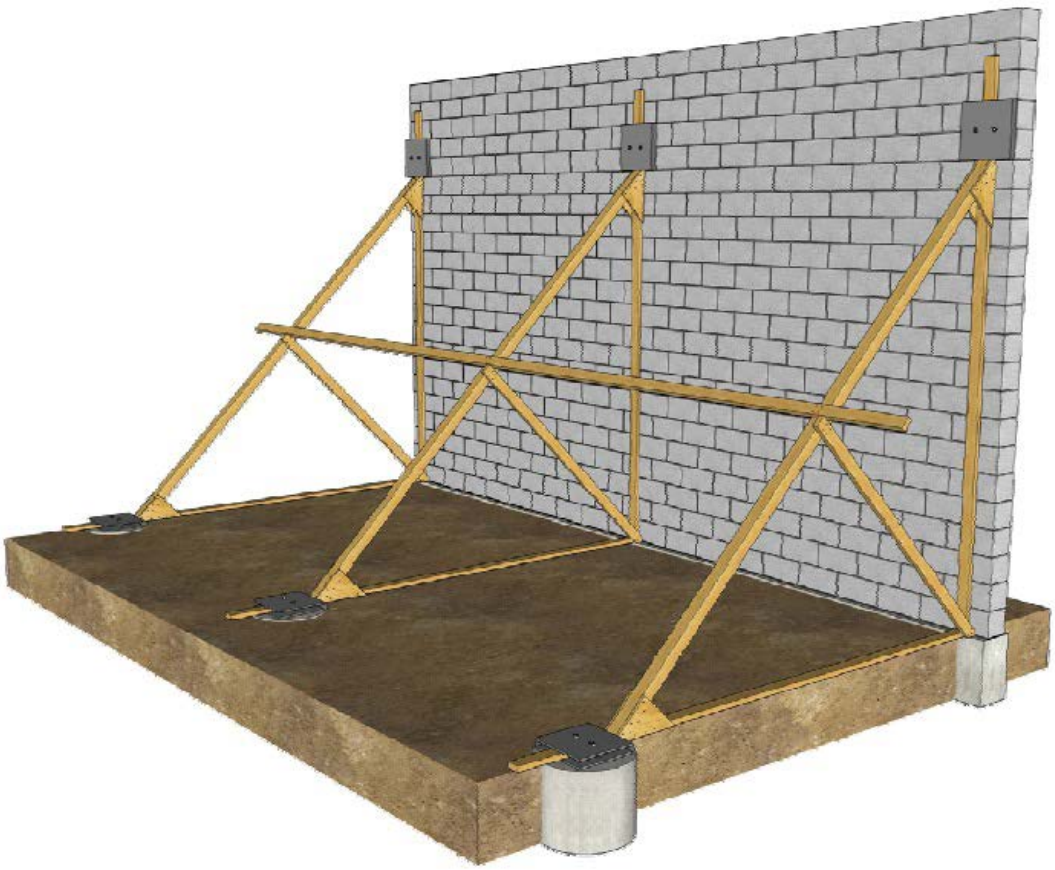
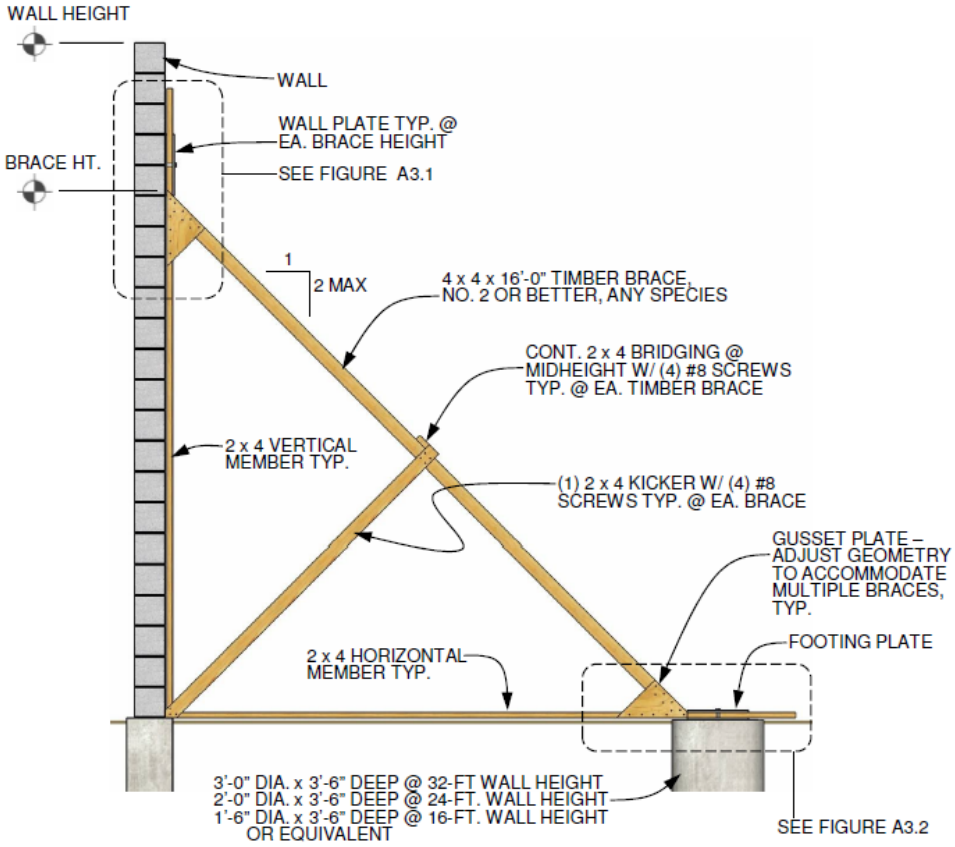


Figure 2. Wall bracing construction diagram.
(*Figure courtesy of MCCA* [MCCA 2012].)



Footnote:
The maximum length of wood bracing as detailed is 16'-0". This corresponds to a maximum brace height of 14'-4" utilizing the maximum brace angle of 1:2 as shown.

Figure 3. Wall bracing construction diagram.
(*Figure courtesy of MCCA* [MCCA 2012].)

Recommendation #3: Employers should develop and implement a restricted/limited access zone.

Discussion: OSHA regulation 29 CFR 1926.706(a) states that a restricted/limited access zone shall be established whenever a masonry wall is being constructed. The restricted/limited access zone shall conform to the following:

- Be established prior to the start of construction of the wall.
- Be equal to the height of the wall to be constructed plus 4 feet and shall run the entire length of the wall.
- Be established on the side of the wall that will be unscaffolded.
- Be restricted to entry by employees actively engaged in constructing the wall. No other employees shall be permitted to enter the zone.
- Remain in place until the wall is adequately supported to prevent overturning and to prevent collapse unless the height of the wall is over 8 feet, in which case, the restricted/limited access zone shall remain in place until permanent supporting elements of the structure are in place [OSHA 1988].

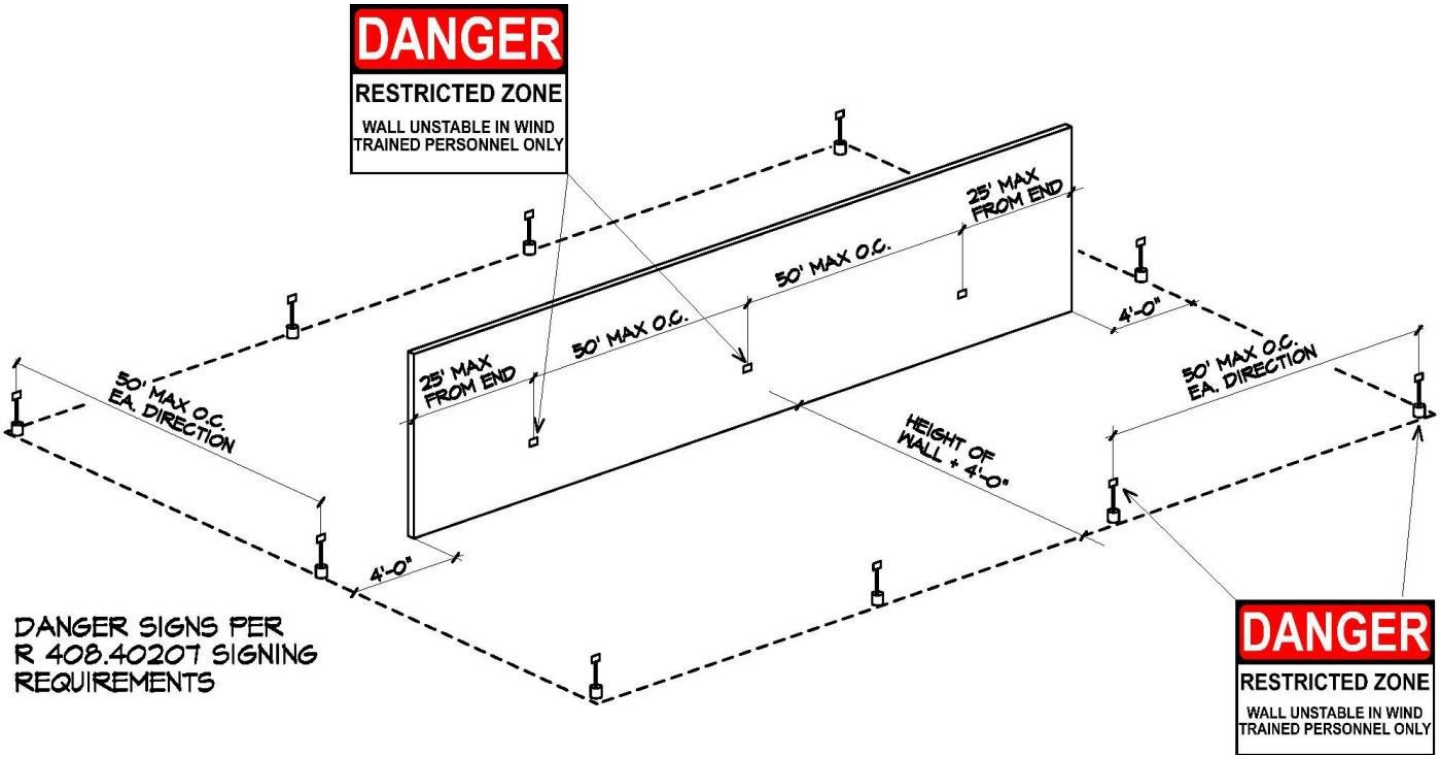


Figure 4. Restricted/limited access zone diagram.
(*Figure courtesy of MIOSHA* [MIOSHA 2015b].)

Some states have implemented regulations with additional requirements beyond the OSHA requirements. Michigan OSHA (MIOSHA) Construction Safety Standard Part 2 – Masonry Wall Bracing (R 408.40206) further defines the requirements for restricted/limited access zone. MIOSHA (R 408.40207) requires signage stating "DANGER restricted/limited access zone; wall unstable in wind; trained personnel only" on walls over 8 feet in height [MIOSHA 2010]. These signs must also be posted on the four corners of the restricted/limited access zone, and the signs posted around the perimeter must be no more than 25 feet apart (Figure 4). This restricted/limited access zone should be in place before construction begins but is not required until the wall is over 8 feet in height. Other states have gone beyond the federal OSHA standard and developed limited access zone requirements of their own [OROSHA 2003]. At the time of the incident there was not a restricted access zone in place. Additionally, signage should be posted in all languages understood by workers on the site.

Recommendation #4: Employers should train workers on the hazards of working around unsupported masonry walls.
Discussion: As evidenced by this incident, workers not directly involved in erecting masonry walls may not recognize the hazards of working near unsupported walls while they are curing. Michigan OSHA established masonry wall rules that take a step beyond the federal OSHA regulations. Michigan OSHA requires training for all workers who enter a restricted zone of a masonry wall under construction. This training must be provided by a qualified person to any worker who enters a restricted zone. The competent person receives additional training on installing, altering, repairing, maintaining, or inspecting the wall bracing system and restricted zone. This training must be documented and include names, dates,

and signature of the trainer and the latest record of training must be maintained and available during the workshift. [MIOSHA 2010].

MIOSHA elements of training should include:
The training shall enable an employee to recognize and understand all of the following:

- *The nature of hazards involving masonry walls under construction.*
- *Instruction in the general use and maintenance of wall bracing systems, signage, and restricted zone requirements as prescribed in these rules.*
- *Procedures for monitoring wind speeds.*
- *Procedures for vacating the restricted zone during windy conditions.*
- *The nature of hazards involving electrical lines within the restricted zone.*
- *The nature of hazards involving excavating within the restricted zone.*
- *Any other pertinent requirements.*

Additional training is required in each of the following situations:

- *When changes at the worksite present a hazard about which an employee has not been previously trained.*
- *When changes in the types of wall bracing systems present a hazard for which an employee has not been previously trained.*

None of the subcontractors had trained their employees on proper concrete and masonry wall bracing. The excavation and waterproofing subcontractors had not trained employees on the hazards of working near an unbraced masonry wall. Since this incident, the excavation subcontractor has trained their employees on the hazards of working near masonry walls.

Recommendation #5: Employers should assign a competent person trained to monitor wind speeds.
Discussion: The Mason Contractors Association of America (MCAA) recommends employers provide training to those employees engaged in masonry activities. Michigan OSHA requires additional training for employees who are designated as a competent person provided by a qualified person related to masonry wall construction.

A competent person, defined by MIOSHA as ""“Competent person” means a person who is trained, experienced, and capable of identifying existing or potential hazards in surroundings, or under working conditions, that are hazardous or dangerous to an employee and who has the authority and knowledge to take prompt corrective measures to eliminate the hazards [MIOSHA 2010]. The competent person should understand and be involved in installation, altering, maintaining, and inspecting the wall bracing. The competent person must inspect the walls and wall bracing systems at the beginning of each shift and after any occurrence that could affect the structural integrity of the wall or wall bracing system. The employer shall train all employees entering the restricted/limited access zone of the masonry wall under construction. Training shall be on the recognition and avoidance of hazards associated with masonry wall bracing, collapse area/restricted/limited access zone, and conditions requiring evacuation. These training records must be maintained at the jobsite [MIOSHA 2010].

The MIOSHA competent person training shall enable an employee to recognize hazards associated with the work and shall include all of the following topics, as applicable:

- *The nature of hazards involving masonry walls under construction*
- *Instruction in the general use and maintenance of wall bracing systems, signage, and restricted zone requirements as*

prescribed in these rules
- *Identifying unsupported masonry walls requiring bracing*
- *The procedures for installing, altering, repairing, inspecting, and maintaining the wall bracing system being used*
- *Proper installation and maintenance of a restricted zone and signage*
- *Procedures for monitoring wind speeds*
- *Procedures for vacating the restricted zone during windy conditions*
- *Inspecting the worksite for overhead and underground utilities and other hazards*
- *Inspecting the worksite for excavations in the restricted zones*
- *Any other pertinent requirements*

The competent person should know the current design period of masonry construction and be able to evacuate the restricted/limited access zone if wind speeds meet the evacuation criteria. The hazard associated with a masonry wall change as the masonry wall cures over time. Contributing factors include wall thickness, unit weight of masonry, cement mortar type, reinforcement, wall height, and stage of construction. There are 2 stages of cure that occur which influences the safety of the masonry wall. The first stage is within the first 24 hours of cure time, this is the initial period. Masonry walls in the initial period have less strength to sustain wind loads and must be evacuated at lower wind speeds, up to 20 mph [MIOSHA 2010; MCCA 2012; NCMA 2014]. The second stage is the intermediate period, once the wall has cured 24 hours, it enters the intermediate period and can resist wind speeds up to 35 mph when properly supported before evacuation is required [MIOSHA 2010; MCCA 2012; NCMA 2014]. Bracing systems for masonry walls in the intermediate period are typically designed for wind speeds of 40 mph allowing a safety factor for the mandatory evacuation at 35 mph. Wind speed may be monitored either by using the Beaufort scale or by using wind speed measuring device like an anemometer under the OSHA standard. The wind speed should be measured using an instrument with a wind speed measurement device +/- 2 mph accuracy [MIOSHA 2010; MCCA 2012]. Wind speed shall be monitored by the competent person of each contractor working in the restricted/limited access zone [MIOSHA 2010]. MIOSHA recommends the competent person may need to take several wind speed measurements throughout the day if conditions warrant it [MIOSHA 2015b]. There are devices that constantly measure wind speed and will alarm when the wind speed meets the set limits.

During the day of the incident, wind speeds in the general area of the incident began to increase starting at 8 a.m. from 11 mph to 20 mph. Wind gusts of 24 mph were recorded at 7:53 a.m. and 28.8 mph at 8:53 a.m. A competent person monitoring wind speed at the time of the incident may have noticed the increase in wind gusts and evacuated the workers to a safe area [Weather Underground 2013].

Recommendation #6: Employers should schedule work tasks to limit exposure of nonessential workers to hazards posed by masonry walls under construction.

Discussion: Prime contractors develop the work plan for a construction job before construction begins. Subcontractors are frequently scheduled before the job begins as well. The prime contractor has the opportunity to schedule work tasks to limit down-time, re-work, and safety issues. The work activities of the waterproofing contractor could have been scheduled before and after the installation of a permanent support system for the masonry wall. The work activities of the utility contractor could have been scheduled before the masonry wall was constructed and finalized after the permanent support system for the masonry wall was in place.

NIOSH • 1095 Willowdale Road, Morgantown, West Virginia 26505 • 304-285-5916

ADDITIONAL RESOURCES

IMI [2013]. IMI Internal bracing design guide for masonry walls under construction. Annapolis, MD: International Masonry Institute.

Lochonic K [2011]. Masonry wall bracing, life safety under windy conditions paramount to updated standard. *Masonry Edge* 6(1):44–46.

DISCLAIMER

Mention of any company or product does not constitute endorsement by 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

Johnson R [2008]. Masonry wall bracing, what goes up, doesn't have to come down. *Structure Magazine*, May, 38–41.

MCCA [2012]. *Standard practice for bracing masonry walls under construction*. Lombard, IL: Mason Contractors Association of America, Council for Masonry Wall Bracing.

MIOSHA [2010]. Construction Safety Division, Part 2 - Masonry Wall Bracing. Lansing, MI: Michigan Occupational safety and Health Administration.

MIOSHA [2015a]. Masonry wall bracing, CSH fact sheet #028. Lansing, MI: Michigan Occupational safety and Health Administration, Construction Safety & Health Division.

MIOSHA [2015b]. Part 2 Masonry wall bracing questions and answers, CSHD Fact Sheet #031. Lansing, MI: Michigan Occupational safety and Health Administration, Construction Safety & Health Division.

NCMA [2005]. NCMA TEK 3-4B Bracing concrete masonry walls during construction. Herndon, VA: National Concrete Masonry Association.

NCMA [2014]. NCMA TEK 3-4C Bracing concrete masonry walls under construction. Herndon, VA: National Concrete Masonry Association.

OROSHA [2003]. 437-003-0706 Protection of employees on or near masonry walls. In: Construction, subdivision Q, concrete and masonry construction. Salem, OR: Oregon Occupational Safety and Health Division.

OSHA [1993]. 29CFR1926.32 (f) Definitions. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

OSHA [1988]. 29CFR1926.706 Requirements for masonry construction. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

Palmer WD [2000]. A bracing sensation, bracing systems for masonry walls meet OSHA requirements. Masonry Construction, August.

Weather Underground [2013]. Weather history for KBNA. Atlanta, GA: The Weather Channel Interactive, Inc.

NIOSH • 1095 Willowdale Road, Morgantown, West Virginia 26505 • 304-285-5916

INVESTIGATOR INFORMATION

This investigation was conducted by Jennifer E. Lincoln, Health Scientist, Fatality Investigations Team, Surveillance and Field Investigation Branch, Division of Safety Research.

ACKNOWLEDGEMEMENT

The NIOSH FACE Program would like to acknowledge the compliance officer and staff of the Tennessee Department of Labor and Workforce Development, the OSHA Directorate of Construction, Engineering Services, and Bryan Wimer, NIOSH engineer, for providing assistance and information for this investigation.