This is the second course covering the hazards described in our Construction Focus Four Hazards series. The Focus Four Hazards series was developed to help educate workers in the construction industry about understanding the hazards they face, and knowing what their employer’s responsibilities are to protect workers from workplace hazards. Once students complete this course they will be able to identify common caught-in or -between hazards, describe types of caught-in or -between hazards, protect themselves from caught-in or -between hazards, and recognize employer requirements to protect workers from caught-in or -between hazards.
OSHAcademy Course 807 Study Guide

807: Focus Four – Caught-In or –Between Hazards

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Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 807.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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# Contents

Introduction ................................................................. 1

Module 1: What are Caught-In or-Between Hazards? ......................................................... 2
  Introduction ........................................................................ 2
  Examples ............................................................................. 2
  Statistics ............................................................................. 4
  Types of Caught-in or -between Hazards ................................................................. 4
  Machinery with Unguarded Moving Parts ................................................................. 5
  Real-World Accidents ........................................................................ 7
  Buried-in or -by ..................................................................... 9
  Pinned between ..................................................................... 14

Module 2: Protective Measures ........................................................................... 20
  Use Properly Guarded Machinery ........................................................................... 20
    Hazardous Motions and Actions ......................................................................... 20
    Motions .................................................................................. 20
    Actions .................................................................................. 21
  Use Guards on Tools and other Equipment with Moving Parts ........................................ 22
  Protective Clothing, Jewelry, and Long Hair ............................................................. 22
  Use Other Methods to Secure Machinery ................................................................... 22
  Pinned-Between or Crushed-by Hazards .................................................................... 23
  Excavation Sites ........................................................................ 26
  Sloping ................................................................................... 27
  Trench Box ............................................................................. 28
  Shoring ................................................................................... 29
  Buried-by Structures and Materials ......................................................................... 30
  Designate a Competent Person .............................................................................. 31
  Training .................................................................................. 31
  Glossary ................................................................................ 34
  Endnotes ................................................................................ 37
Introduction

Welcome to Focus Four-Caught-In or-Between Hazards for the construction industry. This is the second course covering the hazards described in our Construction Focus Four Hazards series. Please be sure to complete the series by also taking courses 806, 808, and 809. The Construction Focus Four course was developed in support of the Occupational Safety and Health Administration (OSHA) Construction Outreach Program’s effort to help educate workers in the construction industry about:

- understanding the hazards they face; and
- knowing what their employer’s responsibilities are to protect workers from workplace hazards.

Construction is among the most dangerous industries in the country and construction inspections comprise 60% of OSHA's total inspections. In 2013, preliminary data from the Bureau of Labor Statistics indicate there were 796 fatal on-the-job injuries to construction workers more than in any other single industry sector and nearly one out of every five work-related deaths in the U.S. that year. Also, in 2013, private industry construction workers had a fatal occupational injury rate nearly three times that of all workers in the United States: 9.4 per 100,000 full-time equivalent construction workers vs. 3.2 for all workers.

Given current OSHA and industry information regarding construction worksite illnesses, injuries and/or fatalities, students who complete this course will be able to recognize fall hazards, caught-in or-between hazards, struck-by hazards, and electrocution hazards (focus four hazards) employees face in the construction industry.

Students completing the four courses in the Focus Four Hazards series will be able to recognize fall hazards, caught-in or-between hazards, struck-by hazards, and electrocution hazards employees face in the construction industry.

Specifically, once students complete the Focus Four Hazards series, they will be able to:

- Identify common focus four hazards.
- Describe types of focus four hazards.
- Protect themselves from focus four hazards.
- Recognize employer requirements to protect workers from focus four hazards.
Module 1: What are Caught-In or-Between Hazards?

Introduction

According to OSHA, caught-in or -between hazards are defined as: Injuries resulting from a person being squeezed, caught, crushed, pinched, or compressed between two or more objects, or between parts of an object. This includes individuals who get caught or crushed in operating equipment, between other mashing objects, between a moving and stationary object, or between two or more moving objects.

The key factor in making a determination of a Caught event and a Struck event is whether the impact of the object alone caused the injury. When the impact alone creates the injury, the event should be recorded as Struck. When the injury is created more as a result of crushing injuries between objects, the event should be recorded as Caught.

Events that should be classified as Caught-in or -between include:

- cave-ins (trenching)
- being pulled into or caught in machinery and equipment (this includes strangulation as the result of clothing caught in running machinery and equipment)
- being compressed or crushed between rolling, sliding, or shifting objects such as semi-trailers and a dock wall, or between a truck frame and a hydraulic bed that is lowering

Examples

Caught-in or-between hazards in construction cause accidents such as the following:

- A worker was ripping a 6-inch piece of wood on an unguarded compound miter saw. His left thumb was caught in the saw and amputated.
- An employee was performing diagnostic work on a water truck at a construction site. The worker crawled under the operating truck. The employee’s work shirt collar and coveralls became caught on a projecting set screw on the rotating pump shaft. The set screw pulled him into the pump shaft. The employee died en-route to the hospital.
- A worker climbed onto an I-beam to clean muck off the tail pulley of a conveyor belt attached to a separator. The conveyor system was energized and in operation. The employee reached between the feed and return of the belt in front of the tail pulley with his hand to brush the muck off the belt. He was caught by the moving belt, and his
hand and arm were pulled into a pinch point in the tail pulley. The employee’s arm was fractured.

- Two workers were in an unprotected trench reconnecting drainpipe at Fort Bragg on July 24, 2014, when, without warning, the walls collapsed around them. One of the workers was able to escape uninjured, but the second worker was not. There was no protection against a side wall collapse and no exit in a 62-foot long trench.
- An employee and a co-worker were working in a 9-foot deep excavation installing water pipes when the south side of the excavation caved in on the employee and buried him. The employee was killed.
- Two laborers were framing out footing for foundation walls in an excavation 100-foot long by 45-foot wide by 10-foot deep. The adjacent property along the north wall of the excavation consisted of seven garages, with a 10-foot high cinderblock wall. The cinderblock wall was undermined approximately 2 feet and was not supported. The wall collapsed, crushing the laborers. One was killed, and the other was taken to the hospital for back and shoulder injuries.
- A worker was operating a road grader when the engine died, and the vehicle began to roll toward a small ravine. The employee jumped off the grader but was pulled under the grader as it overturned. He was killed when he was crushed underneath the tires.
- An employee was working from an aerial lift, which was in the “up” position, under an I-beam. He accidentally came into contact with the “drive/steer” lever, which made the manlift move. The employee died when he was pinned between the I-beam and manlift control panel.
- A worker was cleaning an asphalt paving spreader. Another worker was repairing a pavement roller. The roller was accidentally put into motion, and it rolled toward the spreader. The first employee was injured when he was pinned between the two machines.
- An employee was placing dunnage underneath the sheet metal. A co-worker was operating a powered industrial forklift loading sheet metal onto a flatbed truck. As the co-worker was loading the sheet metal onto the flatbed truck, one of the bands holding the sheet metal together either broke or, the clamp was not properly secured. The back band failed, and the load of sheet metal slid forward onto the employee, pinning him under the sheet metal and against a dumpster. The employee was hospitalized and treated for a fractured leg and a dislocated knee.

**Quiz Instructions**
After each section, there is a quiz question. Make sure to read the material in each section to discover the correct answer to these questions. Circle the correct answer. When you are finished go online to take the final exam. This exam is open book, so you can use this study guide.

1. Which event below should be classified as a "caught-in" accident?
   
   a. A nail puncturing a worker’s eye  
   b. A worker being struck by a vehicle  
   c. A worker being hit by a falling object  
   d. A worker trapped by a cave-in

Statistics

In 2018, the Bureau of Labor Statistics (BLS) reported the total number of 5,250 fatal occupational injuries. Of that total, 1,008 fatal occupational injuries were in construction, a 2‰ increase over 2017.

Of the 1,008 construction worker fatalities in 2018, 55 of them (5.5‰) died as a result of caught-in or-between hazards.

This lesson will help you identify these hazards at your worksite so that you can be protected.

Types of Caught-in or -between Hazards

Some of the working conditions which contribute to these types of accidents include:

- machinery which has unguarded moving parts or is not locked out during maintenance;
- unprotected excavations and trenches;
- heavy equipment that tips over, collapsing walls during demolition; and
- working between moving materials and immovable structures, vehicles, or equipment.

2. Working between moving materials and immovable structures, vehicles, or equipment would most likely result in _____.
   
   a. slip, trip, or fall accidents  
   b. caught-in or -between accidents  
   c. struck-by or -with accidents  
   d. being crushed or buried
Machinery with Unguarded Moving Parts

Major Hazards:

Almost all sites use machinery that has moving or rotating parts or that requires maintenance or repair at some point during construction. If machinery is not properly guarded or de-energized during maintenance or repair, injuries from caught-in or –between hazards may result, ranging from amputations and fractures to death. When machines or power tools are not properly guarded, workers can get their clothing or parts of their body caught in the machines. If machines are not de-energized (locked-out) when they are being repaired, they may cycle or otherwise start up and catch a worker's body part or clothing and cause injury or death.

Workers can be trapped and crushed under heavy equipment that tips, especially if they are thrown from the equipment.

Practice Identifying Hazards

Try to identify the hazards in each picture on the following pages. Then continue to the next page to see if you correctly identified the hazards.
Answers: Now, let’s take a look at the hazards. Did you correctly identify them?
Real-World Accidents

Horizontal Drilling Machine
By FRAC CC BY-SA 2.5

A three-person crew was installing an underground telephone cable in a residential area. They had just completed a bore hole under a driveway using a horizontal boring machine. The bore hole rod had been removed from the hole. While the rod was still rotating, the operator straddled it and stooped over to pick it up. His trouser leg became entangled in the rotating rod, and he was flipped over. He struck tools and materials, sustaining fatal injuries.

Inspection Results

Following its inspection, OSHA issued one citation for one alleged serious violation of its construction standards. Had the equipment been properly guarded, this fatality might have been prevented.

What would you recommend?

Recommendations

Employees must be instructed to recognize and avoid unsafe conditions associated with their work (29CFR 1926.21(b)(2)).

Guards must be installed on moving parts of equipment with which employees may come into contact (29 CFR 1926.300(b)(2)).
Description of Accident
A laborer was steam cleaning a scraper. The bowl apron had been left in the raised position. The hydraulically controlled apron had not been blocked to prevent it from accidentally falling. The apron did fall unexpectedly, and the employee was caught between the apron and the cutting edge of the scraper bowl. The apron weighed approximately 2500 pounds.

What would you recommend?
Recommendations
- Employees must be instructed to recognize and avoid unsafe conditions associated with their work (29 CFR 1926.21(b)(2)).
- Guards must be installed on moving parts of equipment with which employees may come into contact (29 CFR 1926.300(b)(2)).

Description of Accident
An employee was driving a front-end loader up a dirt ramp onto a lowboy trailer. The tractor tread began to slide off the trailer. As the tractor began to tip, the operator, who was not wearing a seat belt, jumped from the cab. As he hit the ground, the tractor’s rollover protective structure fell on top of him, crushing him.

Inspection Results
Following its inspection, OSHA cited the employer for two serious violations and one other than serious violation. Had the front-end loader been equipped with seat belts and had the employee worn them, he might not have been killed.

What would you recommend?
Recommendations
- Provide seat belts in material handling equipment which has rollover protective structures (29 CFR 1926.602(a)(2)(I)).
- Instruct employees to recognize and avoid unsafe conditions associated with their work (29 CFR 1926.21(b)(2)).
Course 807

- Permit only employees qualified by training or experience to operate equipment and machinery \((29\text{ CFR 1926.20(b)(4)})\).

3. If machines are not properly de-energized (locked-out) while they are being repaired, they ______.

   a. will cause an overload condition
   b. may cycle or otherwise start up
   c. will unexpectedly stop operating
   d. can prevent normal operations

**Buried-in or -by**

**Major Hazards:**

The major hazard related to buried-in or -by is cave-ins of unprotected trenches and excavations. Cave-ins crush or suffocate workers.

Workers may also be injured or killed by buried-in or -by accidents in the following situations:

- working in silos filled with grain;
- working under suspended loads; and
- working under construction or demolition operations

Workers who are working underneath large scaffolds may also be buried if the scaffolds collapse. Workers may be buried and crushed by walls that collapse during demolition.

**Practice Identifying Hazards**

Try to identify the hazards in each picture on the following pages. Then continue to the next page to see if you correctly identified the hazards.
Answers: Now, let’s take a look at the hazards. Did you correctly identify them?
Description of Accident

An employee was installing a small diameter pipe in a trench 3 feet wide, 12-15 feet deep and 90 feet long. The trench was not shored or sloped nor was there a box or shield to protect the employee. Further, there was evidence of a previous cave-in. The employee apparently reentered the trench, and a second cave-in occurred, burying him. He was found face down at the bottom of the trench.

Inspection Results
OSHA issued a citation for three serious violations of its construction standards. If the required support had been provided for the trench, it might not have collapsed.

What would you recommend?

Recommendations

- Employers must shore, slope, or otherwise support the sides of trenches to prevent their collapse (29 CFR 1926.652(a)(1)).
- Employers must protect employees with adequate personal protective equipment (29 CFR 1926.95(a)).
- Employers must provide an adequate means of exit from trenches (29 CFR 1926.651(c)(2)).
- Employees must be instructed to recognize and avoid unsafe conditions associated with their work (29 CFR 1926.21(b)(2)).

Description of Accident

An employee was working in a trench 4 feet wide and 7 feet deep. About 30 feet away a backhoe was straddling the trench when the backhoe operator noticed a large chunk of dirt falling from the side wall behind the worker in the trench; he called out a warning. Before the worker could climb out, 6 to 8 feet of the trench wall had collapsed on him and covered his body up to his neck. He suffocated before the backhoe operator could dig him out. There were no exit ladders. No sloping, shoring or other protective system had been used in the trench.

Inspection Results

As a result of its investigation, OSHA issued citations alleging three serious violations. OSHA’s construction standards include several requirements that, if they had been followed here, might have prevented this fatality.

What would you recommend?

Recommendations

- Instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to the work environment [29 CFR 1926.21(b)(2)].
- Provide protection from cave-ins by an adequate protective system [29 CFR 1926.652(a)(1)].
• Provide a means of egress within 25 feet of employees in a trench 4 feet or more deep, such as a ladder or stairway [29 CFR 1926.651(c)(2)].

4. Each of the following accidents could result in a "buried-in or -by" accident EXCEPT working _____.
   
   a. on a suspended scaffold
   b. in a trench or excavation
   c. in underground utilities
   d. in silos filled with grain

Pinned between

Major Hazards:

You can be pinned between equipment and a solid object, such as a wall or another piece of equipment; between materials being stacked or stored and a solid object, such as a wall or another piece of equipment; or between shoring and construction materials in a trench. These types of hazards can result in multiple broken bones, asphyxiation, or death.

Practice Identifying Hazards

Try to identify the hazards in each picture on the following pages. Then continue to the next page to see if you correctly identified the hazards.
Answers: Now, let’s take a look at the hazards. Did you correctly identify them?
Description of Accident

The contractor was operating a backhoe when an employee attempted to walk between the swinging superstructure of the backhoe and a concrete wall. As the employee approached the backhoe from the operator's blind side, the superstructure hit the victim crushing him against the wall.

Inspection Results

OSHA issued two citations to the employer. One was based on failure to train employees in safe work practices regarding the dangers of construction machinery. The other citation was for failure to erect barricades to prevent entry into a swinging superstructure's radius.
What would you recommend?

Recommendations

• Instruct each employee on the danger of passing between swinging superstructures of large construction equipment and solid objects at the demolition site [29 CRF 1926.21(b)(2)].
• Provide each employee employment and place of employment which are free from recognized hazards causing or likely to cause death or serious physical harm to his employees [OSH Act Sec. 5(a)(1)].

Description of Accident

Four employees were boring a hole and pushing a 20-inch pipe casing under a road. The employees were in an excavation approximately 9 feet wide, 32 feet long and 7 feet deep. Steel plates 8' × 15' × 3/4", being used as shoring, were placed vertically against the north and south walls of the excavation at approximately a 30-degree angle. There were no horizontal braces between the steel plates. The steel plate on the south wall tipped over, pinning an employee (who was killed) between the steel plate and the pipe casing. At the time the plate tipped over, a backhoe was being operated adjacent to the excavation.

Inspection Results

As a result of its investigation, OSHA issued a citation for two alleged serious violations of its construction standards. OSHA's construction safety standards include several requirements that, if they had been followed here, might have prevented this fatality.

What would you recommend?

Recommendations

• Provide an adequately constructed and braced shoring system for employees working in an excavation that may expose employees to the danger of moving ground (29 CFR 1926.651(a)(1)).
• If heavy equipment is operated near an excavation, stronger shoring must be used to resist the extra pressure due to superimposed loads (29 CFR 1926.652(c)(1)).
5. What kind of accident is most likely if you work too close to a rotating crane superstructure and a wall?

   a. A crush or buried-by accident
   b. A contact-with accident
   c. An amputation accident
   d. A pinned-between accident
Module 2: Protective Measures

The employer is required by OSHA standards to perform a number of actions to protect workers from caught-in or –between hazards. Here is a summary of the requirements:

- Provide guards on power tools and other equipment with moving parts.
- Support, secure or otherwise make safe equipment having parts that workers could be caught between.
- Take measures to prevent workers from being crushed by heavy equipment that tips over.
- Take measures to prevent workers from being pinned between equipment and a solid object.
- Provide protection for workers during trenching and excavation work.
- Provide means to avoid the collapse of structures scaffolds.
- Provide means to avoid workers' being crushed by collapsing walls during demolition or other construction activities.
- Designate a competent person.
- Provide training for workers.

Use Properly Guarded Machinery

Moving machine parts have the potential to cause severe workplace injuries, such as crushed fingers or hands, amputations, burns, or blindness. Any machine part, function, or process that may cause injury must be safeguarded.

Hazardous Motions and Actions

Different types of hazardous mechanical motions and actions in varying combinations are required to automate tools, equipment, and machinery. Recognizing the hazards they present is the first step toward protecting workers from the danger these motions and actions present. There are three basic hazards motions and associated actions that can injure employees when exposed.

Motions

- **Rotating** - a circular motion around an axis or center such as a rotating shaft.
- **Reciprocating** - a push-and-pull motion common to saws.
- **Transversing** - a continuous straight-line movement typical of moving belts.
Actions

- **cutting** - Cutting action may involve rotating, reciprocating, or transverse motion at the point of operation (circular saws, band saws, drills, etc.).
- **Punching** - Punching action results when power is applied to a slide (ram) for the purpose of blanking, drawing, or stamping metal or other materials.
- **Shearing** - Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials.
- **Bending** - Bending action results when power is applied to a slide in order to draw or stamp metal or other materials.

These parts include the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic in varying combinations to nearly all machines and recognizing them is the first step toward protecting workers from the danger they present.

For more information on machine safeguarding, see [OSHAcademy Course 726, Introduction to Machine Guarding](https://www.oshaacademy.com/courses/726-introduction-to-machine-guarding).

- belts;
- gears;
- shafts;
- pulleys;
- sprockets;
- spindles;
- drums;
- flywheels; and
- chains.

1. Each of the following is a type of hazardous machine motion EXCEPT _____.

   a. reciprocating
   b. rotating
   c. cutting
   d. transversing
Use Guards on Tools and other Equipment with Moving Parts

The employer must ensure hand-held power tools are fitted with guards and safety switches. The type of guard will be determined by the power source of the tool (electric, pneumatic, liquid fuel, hydraulic, or powder-actuated). Here are some examples:

- Exposed moving parts of power tools, such as belts, gears, shafts, pulleys, etc. must be guarded.
- Points-of-operation, where the work is actually performed on the materials, must also be guarded.
- Power saws are a primary type of equipment which requires a point-of-operation guard.
- In-running nip points, such as where the sanding belt runs onto a pulley in a belt sanding machine, must also be guarded.

Protective Clothing, Jewelry, and Long Hair

Be sure to remove personal protective equipment, loose clothing, and jewelry to prevent being caught by moving parts. Also cover your hair because each of these can create hazards. A protective glove can become caught between rotating parts causing multiple serious injuries or death. Long hair can get caught in rotating parts, pulling the worker into the machinery. Jewelry and loose clothing can catch on machine parts causing amputation or serious injury by pulling the hand/body into the machinery.

Use Other Methods to Secure Machinery

Use other methods to ensure that machinery is sufficiently supported, secured or otherwise made safe. Make sure your equipment is de-energized and cannot be started accidentally using lockout/tagout procedures.

Here are some examples of parts that need to be guarded:

- Disconnect tools when not in use, before servicing, and when changing accessories such as blades, bits, and cutters.
- Turn off vehicles before you do maintenance or repair work.
- If possible, lockout the power source to the equipment. The type of power source may be electric, pneumatic, liquid fuel, hydraulic, or powder actuated.
• Lower or block the blades of bulldozers, scrapers, and similar equipment before you make repairs or when the equipment is not in use.
• Use lockout/tagout procedures for machinery and equipment used in concrete and masonry operations.

2. To protect against caught-in or -between hazards, workers should _____.
   a. not wear loose clothing or jewelry
   b. use pull-back straps and other PPE
   c. remove gloves and hair nets
   d. disconnect tools while in use

Pinned-Between or Crushed-by Hazards

The employer must take measures to prevent workers from being pinned between equipment and a solid object, such as a wall or another piece of equipment; between materials being stacked or stored and a solid object, between shoring and construction materials in a trench.

The best way to prevent workers from being pinned or crushed by heavy equipment that tips over is to prevent the equipment from tipping over in the first place. For example, cranes can tip over if the load capacity is exceeded, or the ground is not level or too soft.

• The employer must designate a competent person to inspect crane operations to identify hazardous working conditions, including ensuring the support surface is firm and able to support the load.
• The employer must also make sure the material handling equipment is equipped with rollover protective structures.
• Motor vehicles, forklifts, and earthmoving equipment must be equipped with seat belts and use is required.

3. The best way to prevent workers from being pinned or crushed by heavy equipment that tips over is to _____.
   a. install outriggers when digging trenches
   b. prevent the equipment from tipping over in the first place
   c. designate a worker to monitor equipment stability
d. lower tire pressure to increase stability

Workers may be pinned or crushed by equipment, machinery, or structures if parts break, power is lost, or structures become unstable. For instance, a crane boom, scaffold, trench plates, or a wall might unexpectedly collapse.

During demolition, your employer must ensure any stand-alone walls more than one story must have lateral bracing unless the wall was designed to be stand-alone and is otherwise in a safe condition to be self-supporting.

Jacks must have a firm foundation. If necessary, the base of a jack must be blocked or cribbed. After a load has been raised, it must be cribbed, blocked, or otherwise secured at once.

When balling or clamming is being performed, only the personnel absolutely necessary to the work must be allowed in the work area.

Your employer must make sure that proper bracing is used between heavy plates used as shoring in a trench.

The employer must carefully arrange the path of travel when loading/unloading, stacking, and storing materials so that no workers will be caught between materials and moving equipment or between materials and a wall.

Here are some additional measures to take to protect yourself from being pinned between or crushed by equipment, objects, or materials.

- be aware at all times of the equipment around you and stay a safe distance from it;
- never place yourself between moving materials and an immovable structure, vehicle, or stacked materials;
- make sure all loads carried by equipment are stable and secured;
- never walk or work under a load that is suspended;
- stay out of the swing radius of cranes and other equipment; and
- wear a seat belt, if required, to avoid being thrown from a vehicle and then potentially being crushed by the vehicle if it tips over.

Pinned-Between Accident

Description of the accident
The son of the owner of a commercial drywall construction company, an employee of the company, was preparing an aerial lift for a job and had replaced two battery terminals. He had raised the aerial boom and was reaching toward the battery compartment across the metal enclosure that houses the lift's toggle controls when the boom dropped and pinned him to the control panel. His father discovered him and summoned emergency responders, but he died at the site.

**Investigation Findings**

1. The lift's emergency valve, hydraulic hoses and fittings, and electrical wiring were inspected after the accident and were not defective; however, the on/off key switch had been bypassed so that the operator could use the toggle switches without using the key.
2. The battery charging system was missing a fuse that would stop the system from charging, and the spring-loaded toggle switches that controlled the boom did not have guards to prevent accidental contact.
3. The employee did not use lockout procedures while he was working on the lift and did not block the boom to prevent it from dropping.
4. The owner had not reviewed the lift's instruction manual with the victim or other company employees.
5. Although the company had more than 10 employees, it did not have a safety committee.

The accident resulted in the OSHA violations listed below:

1. The employer failed to ensure that employees did not remove or tamper with required safety devices.
2. The employer did not develop, document, and require employees to use lockout procedures to control hazardous energy during maintenance work.
3. The employer had more than 10 employees but did not have a safety committee (State of Oregon requirement).

4. Each of the following is a measure that workers can take to help prevent pinned-between or crushed-by accidents EXCEPT _____.
   a. making sure loads are stable and secure
   b. being aware of equipment around you
   c. staying out of the swing radius
d. walking quickly below any suspended load

**Excavation Sites**

OSHA standards on trenching and excavation require your employer to designate a competent person to inspect the trenching operations.

You must be protected from equipment or materials that could fall or roll into excavations. This could include spoils that could fall into the trench and bury the workers. Mobile equipment used near or over an excavation presents a hazard. A warning system must be used (such as barricades, hand or mechanical signals, or stop logs), when mobile equipment is:

- operated next to an excavation or
- is required to approach the edge of an excavation, and
- the operator does not have a clear and direct view of the edge of the excavation. If possible, the grade should be away from the excavation.

To protect yourself on an excavation site you must not:

- work in a trench if a crane or earthmoving equipment is operating directly over the top of the trench;
- work in an unprotected trench five feet deep or more;
- enter or exit a trench or excavation using a ladder, stairway or properly designed ramp that is placed within the protected area of the trench; or
- not work outside of the confines of the protection system.

**5. Which of the following is required if mobile equipment is used near or over an excavation?**

- a. Horizontal bracing for plates
- b. Hard hats for workers in the trench
- c. A competent observer
- d. A suitable warning system

The type of protection working in trenches 5-20 feet deep may be one of the following:
**Sloping or benching:** Sloping is cutting back the sides of the trench to a safe angle so it won’t collapse. Benching uses a series of steps that approximate the safe sloping angle. The angle depends on the soil type.

**Trench box or shield:** These do not prevent cave-ins but protect the workers who are in them if a cave-in happens.

**Shoring:** Shoring are wooden structures or mechanical or hydraulic systems that support the sides of an excavation.
Trench Box

All simple slope excavations 20 feet (6.11 meters) or less deep should have a maximum allowable slope of 1-1/2:1. A slope of this gradation or less is safe for any type of soil.
Shoring
Your employer must make sure all excavations and trenches five feet deep or more, but less than 20 feet, are protected by sloping or benching, trench box or shield, or shoring. There must also be adequate means of access and egress from the excavation. If an excavation is more than 20 feet deep, a professional engineer must design the system to protect the workers.

6. Which of the following protection measures is required for excavations more than 20 feet in depth?
   a. Engineered system
   b. Trench box
   c. Shoring
   d. Sloping

Buried-by Structures and Materials

Measures need to be taken by your employer to avoid the collapse of other structures, such as scaffolds, that could bury workers underneath them.

There is a danger of collapse anytime there is inadequate support, improper construction, or a shift in the components of a scaffold (including the base upon which the structure is built). For instance, cinder blocks or other similar materials should not be used to support a scaffold because they could be crushed. To support scaffolds, use only suitable base plates on wood sills.

OSHA standards require that scaffolds can only be erected, moved, dismantled or altered under the supervision of a competent person. The competent person selects and directs the workers who erect the scaffold. The selected workers must be trained by a competent person on correct procedures and hazards of scaffold erection.

7. Which of the following is suitable for supporting scaffolds so they won’t collapse?
   a. Base plates
   b. Cinder blocks
   c. Equipment
   d. Barrels
Designate a Competent Person

OSHA defines a "competent person" as:

"one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

Your employer must designate a competent person for certain construction activities that may have caught-in or-between hazards:

- training for scaffold erection
- inspections of excavations, the adjacent areas, and protective systems
- engineering survey prior to demolition of a structure (and any adjacent structure where workers may be exposed) to determine the condition of the framing, floors, and walls, and possibility of unplanned collapse
- continuing inspections during demolition to detect hazards resulting from weakened or deteriorated floors, or walls, or loosened material

8. Who must train, inspect, and survey safe conditions on most construction sites?

   a. A designated manager
   b. An experienced operator
   c. A safety supervisor
   d. A competent person

Training

Make sure you have the proper training on the equipment and hazards of your job so you can work safely. Specific and detailed training is a crucial part of any effort to safeguard employees from worksite hazards.

OSHA’s general training requirement for construction workers is:

The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury. One way to do this is to review and discuss OSHA Accident Facts.

Your employer must train you to perform your job and use the provided equipment safely. If working with scaffolding your employer should be aware of specific training requirements
found in OSHA standards. These standards can be found in 29 CFR 1926.454 (Scaffolds – workers who are involved in erecting, disassembling, moving, operating, repairing, maintaining, or inspecting a scaffold).
9. Providing worker training on the safe use of the equipment being operated is the responsibility of _____.

   a. the lead contractor
   b. an experienced safety professional
   c. OSHA
   d. the employer
Glossary

Aluminum Hydraulic Shoring: a pre-engineered shoring system comprised of aluminum hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (wales). Such system is designed specifically to support the sidewalls of an excavation and prevent cave-ins.

Barricade: an obstruction to deter the passage of persons or vehicles.

Boom (equipment other than tower crane): an inclined spar, strut, or other long structural member which supports the upper hoisting tackle on a crane or derrick. Typically, the length and vertical angle of the boom can be varied to achieve increased height or height and reach when lifting loads. Booms can usually be grouped into general categories of hydraulically extendible, cantilevered type, latticed section, cable supported type or articulating type.

Cave-in: the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person: one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Defect: any characteristic or condition which tends to weaken or reduce the strength of the tool, object, or structure of which it is a part.

Equivalent: alternative designs, materials or methods to protect against a hazard which the employer can demonstrate will provide an equal or greater degree of safety for employees than the methods, materials or designs specified in the standard.

Excavation: any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Hazardous atmosphere: an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.
Load: refers to the object(s) being hoisted and/or the weight of the object(s); both uses refer to the object(s) and the load-attaching equipment, such as, the load block, ropes, slings, shackles, and any other ancillary attachment.

Operator: a person who is operating the equipment.

Pressure: a force acting on a unit area. Usually shown as pounds per square inch. (p.s.i.)

Protective system: means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Qualified: one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

Ramp: an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Rated capacity: the maximum working load permitted by the manufacturer under specified working conditions. Such working conditions typically include a specific combination of factors such as equipment configuration, radii, boom length, and other parameters of use.

Registered Professional Engineer: a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Scaffold: any temporary elevated platform (supported or suspended) and it’s supporting structure (including points of anchorage), used for supporting employees or materials or both.

Shield (Shield system): a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with 1926.652(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."
**Shoring (Shoring system):** a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

**Signs:** the warnings of hazard, temporarily or permanently affixed or placed, at locations where hazards exist.

**Signals:** moving signs, provided by workers, such as flaggers, or by devices, such as flashing lights, to warn of possible or existing hazards.

**Sloping (Sloping system):** a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

**Spoil:** The dirt, rocks, and other materials removed from an excavation and either temporarily or permanently put aside.

**Tags:** temporary signs, usually attached to a piece of equipment or part of a structure, to warn of existing or immediate hazards.

**Trench (Trench excavation):** a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

*Source for definitions: [29 CFR 1926](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10454), i.e. OSHA’s definitions for terms in the construction industry*
Endnotes