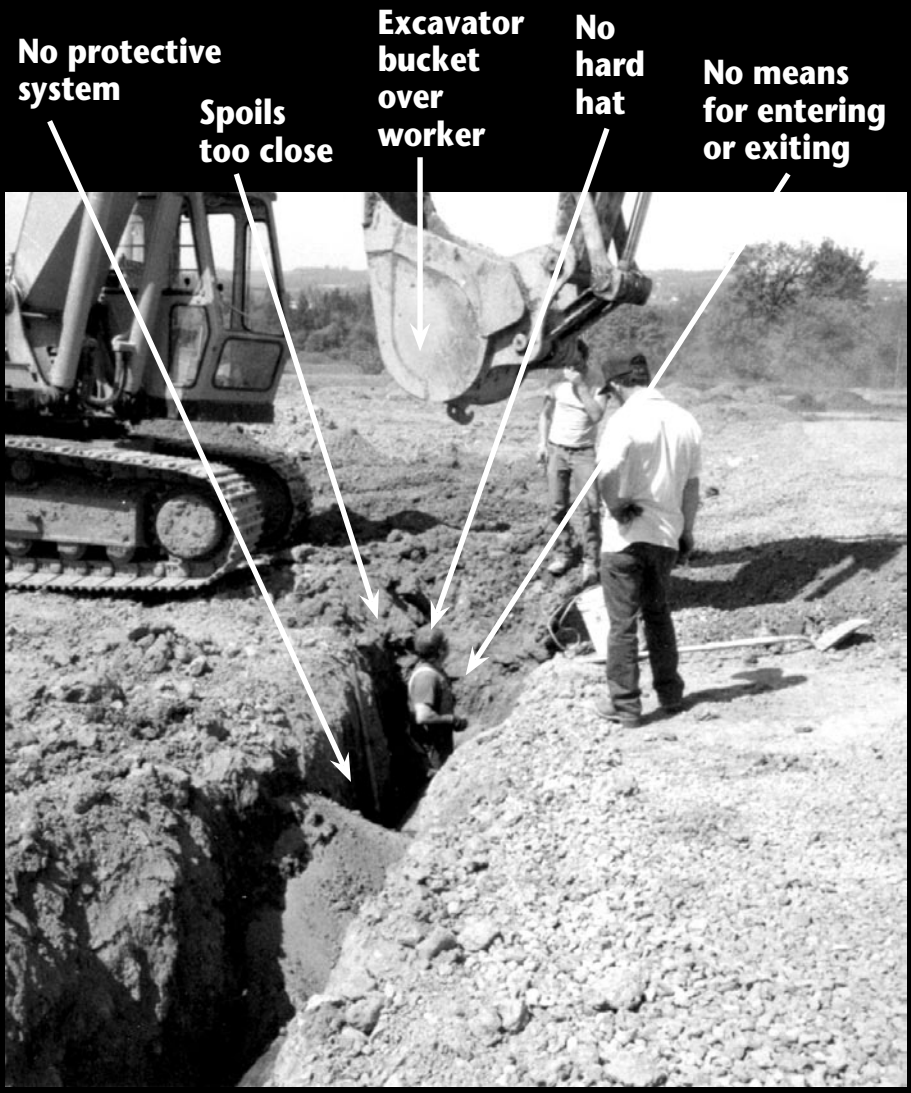
Excavations

Oregon OSHA

How to dig your own grave



About this document

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Topic category: *excavation*

DEPARTMENT OF CONSUMER & BUSINESS SERVICES

Oregon OSHA

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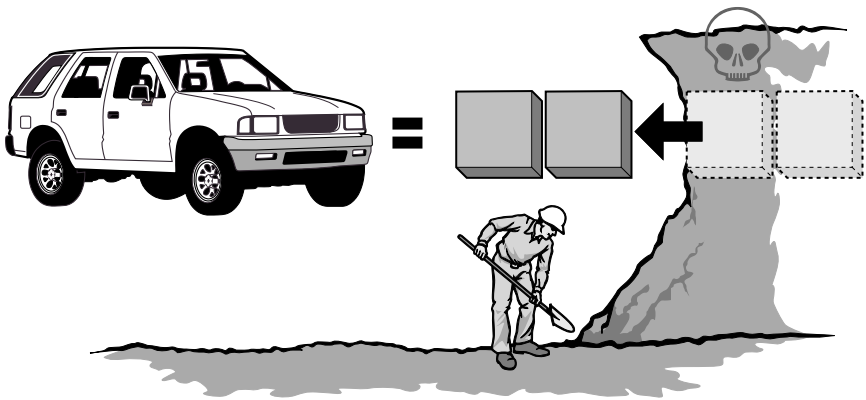
Introduction

A cave-in can trap you within seconds and kill you within minutes. Two cubic yards of soil weigh about 6,000 pounds. If you're buried, you'll suffocate in less than three minutes and if you do survive, the weight of the soil is likely to cause serious internal injuries.

Cave-ins aren't the only hazard in excavation work. Lack of oxygen, toxic fumes, explosive gases, and buried power lines may also be present. Unfortunately, many contractors who do excavation work still think that it's too expensive or takes too much time to provide appropriate safeguards.



Two cubic yards of soil weigh as much as a full size SUV – about 6,000 pounds!

The difference between an excavation and a trench

Dig a hole in the earth and you've made an excavation. Excavations can be wide, narrow, deep, or shallow. A trench is also an excavation but it's narrow and not more than 15 feet wide at the bottom. If forms or other structures are installed in an excavation that reduce its width to less than 15 feet, measured at the bottom, the excavation is also considered a trench.

If you work in an excavation more than 5 feet deep, you must be protected from a cave-in.

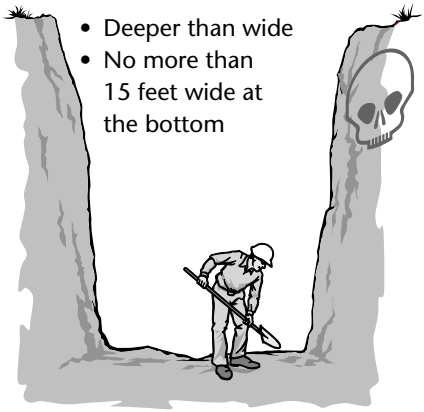
Exavation

A man-made cut, cavity, or depression in the earth's surface.

Open-face excavation

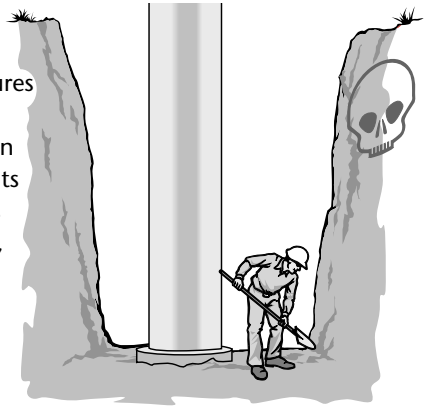
Trench

- Deeper than wide
- No more than 15 feet wide at the bottom



Open-face trench

Forms or other structures installed in an excavation that reduce its width to less than 15 feet, measured at the bottom.



Plan before you dig

Planning reduces the chance that something will go wrong when you start the job. Consider the following before you start excavating:

- Surface debris near the excavation site that could create a hazard
- Weather conditions
- Stability of soil at the excavation site
- Location of underground utility lines
- Overhead power lines
- Vehicle traffic near the excavation site
- Stability of structures adjacent to the excavation site
- How employees will get in and out of the excavation
- Vehicles and other mobile equipment that will operate near the excavation
- Possibility of atmospheric hazards in the excavation
- Possibility of water accumulation in the excavation
- How to respond to emergencies
- How to protect people from falling into the excavation

The role of the competent person

A designated competent person who has training in soil analysis, protective systems, and OR-OSHA's Subdivision 3/P excavation requirements must be on site to classify the soil, select a protective system, oversee installation, and inspect the system after installation. If there are no existing hazards, the competent person can leave the site until the protective system is moved, at which time soil conditions could change requiring the competent person to be present. The competent person can only be gone for a short time while the trench is open — new hazards could arise that may require the competent person's judgment.

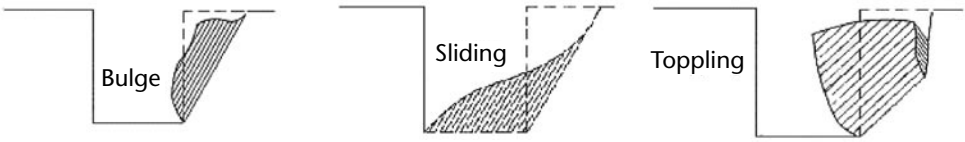
The competent person must be knowledgeable about the type of soil excavated and the protective system used and must inspect them daily for signs of instability, damage, or other hazards; any changes must be approved by the competent person. Inspections are also necessary after heavy rain or activities such as blasting that may increase the risk of a cave-in.

The competent person must have authority to immediately correct the hazards and to order workers to leave the excavation until the hazards have been corrected. An employee who is trained and can identify excavation hazards but doesn't have the authority to correct them is not a competent person.

How cave-ins occur

Undisturbed soil stays in place because of opposing horizontal and vertical forces. When you create an excavation, you remove soil that provides horizontal support. Soil will eventually move downward into the excavation. The longer the face (a side of the excavation) remains unsupported, the more likely it is to cave in.

When you create an excavation, you remove the soil that provides horizontal support.



Stability and soil

The type of soil is one of the factors that helps determine the stability of an excavation and the chance that it will cave in. There are three soil types that you may encounter in Oregon:

- Type A soil is very stable. Clay is an example.
- Type B soil is less stable than type A soil. Crushed rock, silt, and soils that contain an equal mixture of sand and silt are examples.
- Type C soil is less stable than type B soil. Gravel and sand are examples.

Soil has other qualities that affect its stability. These include *granularity, saturation, cohesiveness*, and *unconfined compressive strength*. Granularity refers to the size of the soil grains; the larger the grains, the less stable the soil. Saturation means how much water soil will absorb. Cohesiveness means how well soil holds together; clay is a cohesive soil. Unconfined compressive strength is determined by a test that shows how much pressure it takes to collapse a soil sample. For example, type A soil must have an unconfined compressive strength of at least 1.5 tons per square foot.

How soil is tested

A competent person must conduct visual and manual soil tests before anyone enters an excavation. Visual and manual tests are a critical part of determining the type of protective system that will be used.

Visual tests

Visual testing involves looking at the soil and the area around the excavation site for signs of instability and for other hazards. The competent person might conduct visual tests such as the following:

- Observe the soil as it is excavated. Soil that remains in large clumps when excavated may be cohesive. Soil that breaks up easily is granular.
- Examine the particle sizes of excavated soil to determine how they hold together.
- Look for cracks or fissures in the faces of the excavation.
- Look for layers of different soil types and the angle of the layers in the face of the excavation that may indicate instability.
- Look for water seeping from the sides of the excavation.
- Look for signs of previously disturbed soil from other construction or excavation work.
- Consider vibration from construction activity or highway traffic that may affect the stability of the excavation.

Manual tests

Manual testing involves evaluating a sample of soil from the excavation to determine qualities such as cohesiveness, granularity, and unconfined compressive strength. Soil can be tested either on site or off site but should be tested as soon as possible to preserve its natural moisture. Examples of manual tests:

Plasticity test. Shape a sample of moist soil into a ball and try to roll it into threads about 1/8-inch in diameter. Cohesive soil will roll into 1/8-inch threads without crumbling.

Dry strength test. Hold a dry soil sample in your hand. If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it's granular. If the soil breaks into clumps that are hard to break into smaller clumps, it may be clay combined with gravel, sand, or silt.

Thumb penetration test. This test roughly estimates the unconfined compressive strength of a sample. Press your thumb into the soil sample. If the sample resists hard pressure, it may be Type A soil. If it's easy to penetrate, the sample may be type C.

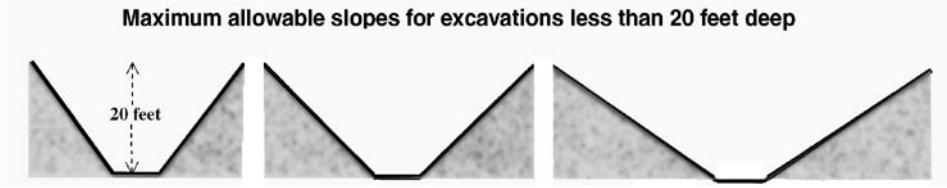
Pocket penetrometers offer more accurate estimates of unconfined compressive strength. These instruments estimate the unconfined compressive strength of saturated cohesive soils. When pushed into the sample, an indicator sleeve displays an estimate in tons per square foot or kilograms per square centimeter.

Protective systems

The basic systems for protecting employees from cave-ins are *sloping*, *benching*, *shoring*, and *shielding*. The system that you should use depends on factors such as soil type and water content, excavation depth and width, the nature of the work, and nearby activities that could increase the risk of a cave-in. The competent person has the responsibility for considering these factors and for determining the appropriate protective system. A registered professional engineer must design protective systems for all excavations that are more than 20 feet deep.

Sloping and benching

Sloping and benching provide protection by removing material from the faces of an excavation at an angle to its floor. The flatter the angle, the greater the protection. A slope not steeper than 1½ feet back for every foot of depth is safe for any soil type. However, a registered professional engineer must determine the angle of slopes in trenches that are deeper than 20 feet.

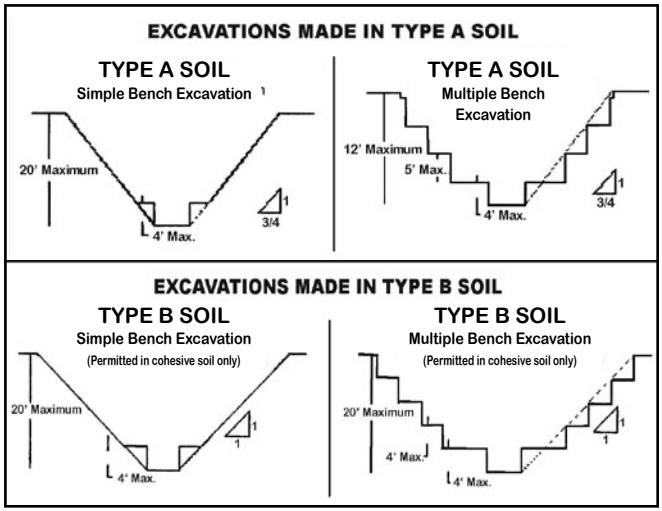


Type A soil ¾:1 *Type B soil 1:1* *Type C soil 1½:1*

Benches are cuts in the slope that give it a stair-step appearance. There are two types of benches: simple and multiple. Benched slopes are permitted only in type A and type B soils. Rain, vibration, and pressure from heavy equipment can make soil unstable and increase the risk of

a cave-in. Sloped or benched excavations that show signs of cracks, bulges, or clumps of soil that fall away from the faces must be inspected by a competent person. Employees must immediately get out of the excavation and stay away from the area until the competent person determines it is safe to enter.

Benched slopes are permitted only in type A and type B soils



Shoring and shielding

Shoring and shielding systems prevent cave-ins in excavations with or without sloped or benched faces. The safest way to install and remove them is from outside the excavation.

Photo credit: Speed Shore Corp.

Vertical shore

Shores are vertical or horizontal supports that prevent the faces of an excavation from collapsing. Vertical shores are called uprights. They're easy to install, relatively inexpensive, and often used in stable soil or in shallow excavations that have parallel faces. Vertical shores must be sized for the excavation's dimensions and soil type.

Photo credit: Speed Shore Corp.

Waler system

Horizontal shores are called *walers*. Walers are often used when unstable soil makes sloping or benching impractical and when sheeting is necessary to prevent soil from sliding into the excavation.

Shields provide employees a safe work area by protecting them from collapsing soil. Shields don't prevent cave-ins but "shield" workers if a face does collapse. They are usually placed in the excavation by heavy equipment.

Shoring and shielding systems are available from manufacturers in a variety of dimensions, usually aluminum or steel, or they can be custom-built from *tabulated data* approved by a registered professional engineer. Manufacturers will also provide tabulated data with their systems that includes engineering specifications, depth ratings, special instructions, and system limitations. Only by carefully studying and understanding the manufacturer's tabulated data can the competent person choose the correct protective system.

Photo credit: Speed Shore Corp.

Trench shield

Getting in and out of an Excavation

An excavation that has a depth of 4 feet or more must have a means for entering and exiting — such as a stairway, ladder, or ramp — within 25 feet of employees; their safety may depend on how quickly they can climb out. When an excavation is 5 feet or more in depth, the stairway, ladder, or ramp must be located inside the protective system.

Structural ramps that are used to enter and exit the excavation must have nonslip surfaces and be designed by a competent person. A competent person must also evaluate earthen ramps that are used to enter and exit an excavation.

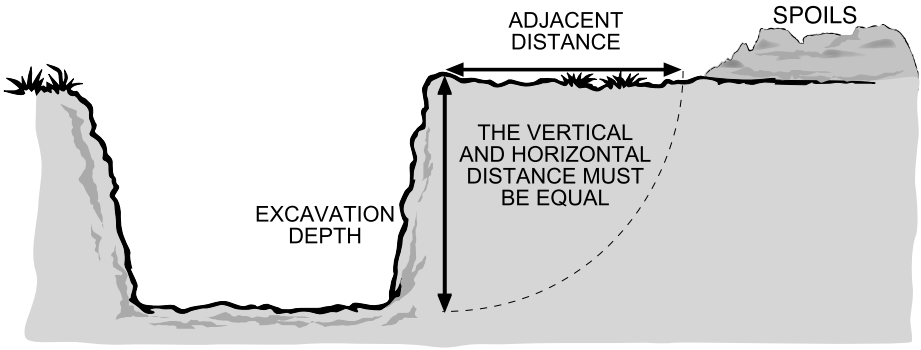
Don't do this!

Never use a folded stepladder as a straight ladder.

Materials and Mobile Equipment

These spoils exert an excessive load on ground adjacent to the excavation and must be moved.

Excavated soil, called spoils, piled too close to the edge of an excavation can cause a cave-in. So can heavy equipment. Keep spoils and heavy equipment at least 2 feet from the edge; when possible, use vertical shores or shields that extend above the top of the excavation to restrain spoils. Spoils and heavy equipment that exert an excessive load on ground *adjacent* to the excavation could cause a cave-in and must be moved. They must be moved back from the edge a distance equal to the depth of the excavation.



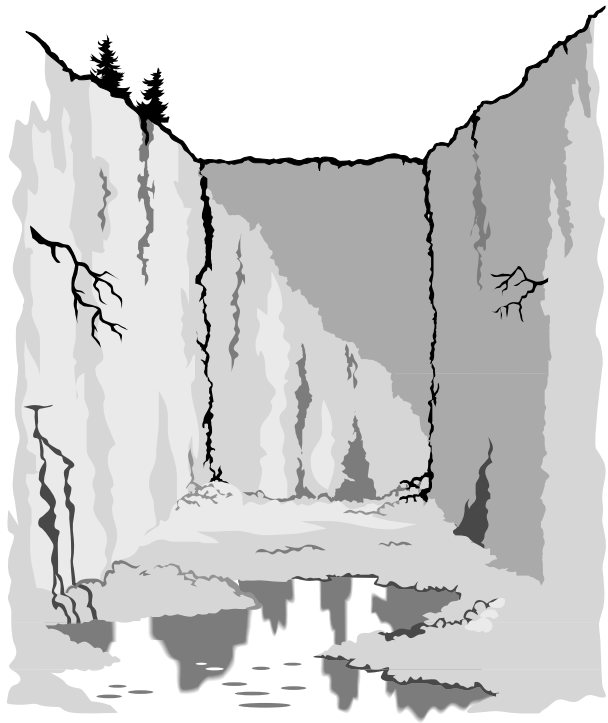
"Adjacent" means the area within a horizontal distance from the edge of a vertical-sided excavation equal to the depth of the excavation.

Hazardous atmospheres

Hazardous atmospheres can occur in excavations near landfills, sites contaminated by leaking gas lines or storage tanks, in sewers, and in other confined spaces. If these conditions are possible, a competent person must test for oxygen deficiency (oxygen levels less than 19.5 percent) and hazardous atmospheres before employees enter.

Water accumulation

Water makes soil unstable. Employees can't enter excavations when water has built up unless they are protected from the increased risk. Protection includes specialized support systems and water-removal equipment. A competent person must inspect the excavation and monitor methods used to control water accumulation.



Working with hydraulic excavators and backhoe loaders

You can dig an excavation with a hand shovel or a machine. Use a hand shovel improperly and you risk blisters. Use a machine improperly and you risk a life. Too many workers are injured or killed because they are not properly trained or supervised and don't follow safe practices when they use mechanical equipment for excavation work. Most accidents happen for three reasons:

1: Entering the excavator's swing area

Workers need to be aware of the excavator's swing area and blind spots. Always maintain at least 3 feet of unimpaired clearance between the excavator's rotating superstructure and adjacent objects. Keep workers outside the area by marking it with rope, tape, or a similar barrier if necessary.

- Require the operator to lower the boom to a safe position with the bucket on the ground and turn off the excavator before getting off.
- Require the operator to keep the bucket as close to the ground as possible when workers are attaching loads.
- Do not allow workers to stand under a suspended load, the boom, arm, or bucket.

2: Using quick-coupling devices improperly

After-market "quick-coupling" devices make it easy for workers to quickly change buckets or replace other attachments. However, a number of workers have been killed when the coupling devices have not been locked properly and the buckets have detached. Manufacturers of quick couplers recognized the hazard and newer devices have locks that prevent buckets from detaching unintentionally, but not all users may be aware of the problem. Retrofit locking pins are available for older equipment.

- Follow the manufacturer's instructions for using positive locks on quick-disconnect equipment.
- Securely latch attachments such as quick-disconnect buckets before beginning work.
- Make frequent visual inspections of quick-disconnect systems — especially after changing attachments.

3: Using unsafe rigging methods to drag a trench shield

Using an excavator to drag a shield through a trench can put tremendous forces on rigging components. For example, the force required to drag a 10,000-pound trench shield through a narrow trench will increase dramatically with resistance from the trench walls or from plowing of the front of the shield. Know the sling's rated capacities and never exceed them. The whiplash effect of a broken or improperly rigged sling can kill anyone in its path.

- Follow the instructions in the operator's manual when using an excavator to lift or move an object.
- "Lift and drag" to move a trench shield horizontally in a trench; avoid "plowing" with the front of the shield. Plowing significantly increases the tension on the slings.
- Some manufacturers of trench shields warn workers to stay out of the "box" while it is being moved. Always check the manufacturers' requirements.
- Never use damaged chains, frayed cables, slings, straps, or ropes.
- Use an appropriate lifting shackle for attaching cables or slings.
- Never stand in line with or next to a sling that is under tension.

Important terms

Adjacent	The area within a horizontal distance from the edge of a vertical-sided excavation equal to the depth of the excavation.
Aluminum hydraulic shoring	A pre-engineered system of aluminum hydraulic cylinders (cross braces) and vertical rails (uprights) or horizontal rails (walers). Designed to support the faces of an excavation.
Benching	A method of sloping the sides of an excavation by forming a series of steps.
Cave-in	The separation of a mass of soil or rock from the face of an excavation into an excavation.
Competent person	A person capable of identifying existing and predictable hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate the hazards.
Cross brace	Horizontal member of a shoring system installed perpendicular to the sides of an excavation, the end of which bears against uprights or wales.
Excavation	A man-made cut, cavity, or depression in the earth's surface.
Face	The side of an excavation.
Hazardous atmosphere	An atmosphere that could cause an injury or illness. Examples: explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, or toxic.
Previously disturbed soil	Soil that has been disturbed from excavation work or other digging. Soil cannot be classified type A if it has been previously disturbed. Use visual tests to identify previously disturbed soil.

Protective system	A system designed to protect workers in excavations. Sloping and benching, shores, and shields are examples of protective systems.
Ramp	An inclined walking or working surface constructed from earth or from structural materials such as steel or wood.
Registered professional engineer	A professional engineer registered in the state where the work is performed. A professional engineer registered in any state can approve designs for manufactured protective systems or tabulated data used in interstate commerce.
Sheeting	Component of a shoring system that prevents soil from sliding into an excavation.
Shield	A structure able to withstand forces caused by a cave-in. Shields can be manufactured or custom-built in accordance with 1926.652(c)(3)-(c)(4). Shields are also called trench boxes and trench shields.
Shore	A structure that supports the sides of an excavation and prevents cave-ins.
Sloping	A method of inclining the face of an excavation to minimize the risk of a cave-in. The maximum allowable slope varies with soil type, environment, and work done at the excavation site.
Soil	Weathered rock, gravel, sand, or combinations of clay, silt, and loam.
Stable rock	Natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed.
Structural ramp	A ramp made of steel or wood, usually for vehicle access. Ramps made from soil or rocks are not considered structural ramps.

Support system	A system that supports an adjacent structure, underground installation, or the face of an excavation.
Surcharge	A load exerted on ground adjacent to an excavation.
Tabulated data	Tables and charts, approved by a registered professional engineer, used to design and construct a protective system. At least one copy of the data and the name of the engineer who approved it must be kept at the site while the system is constructed.
Trench	An excavation that is longer than wide. In general, the depth is greater than the width but the width measured at the bottom of the trench is not greater than 15 feet.
Upright	Vertical member of a shoring system.

Excavation requirements

Subdivision 3/P (Excavations) of OR-OSHA's safety and health standards has the following requirements for the construction industry, which apply to all open excavations.

- 1926.650 — Scope, application, and definitions
- 1926.651 — Specific excavation requirements
- 437-003-0096 — Underground installations
- 1926.652 — Requirements for protective systems
- Appendix A — Soil classification
- Appendix B — Sloping and benching
- Appendix C — Timber shoring for trenches
- Appendix D — Aluminum hydraulic shoring for trenches
- Appendix E — Alternatives to timber shoring
- Appendix F — Selection of protective systems

Safe practices checklist

All your answers should be Yes!	Yes	No
1. A designated competent person at the excavation site understands visual and manual test methods, use of protective systems, the hazards of excavation work, and the requirements of OR-OSHA's excavation standards.	☐	☐
2. A designated competent person inspects the excavation, adjacent areas, and protective systems daily before work begins, as necessary throughout the shift, and after rain or other conditions that could increase the risk of a hazard.	☐	☐
3. A designated competent person has authority to immediately correct hazards and to order employees to leave the excavation until the hazards have been corrected.	☐	☐
4. Sewer, telephone, fuel, electric, or water lines near the site have been located and clearly marked. Contact the Oregon Utility Notification Center for help in locating underground utility lines. In the Portland metro area: (503) 246-6699. Outside the Portland metro area: (800) 332-2344.	☐	☐
5. Hard hats are required whenever there are overhead hazards.	☐	☐
6. Debris and other unnecessary material have been cleared from the site.	☐	☐

		Yes	No
7.	Employees who are exposed to highway traffic are provided with and wear high-visibility garments.	☐	☐
8.	Excavations at remote sites have appropriate warning barriers.	☐	☐
9.	Employees are protected from loose rock or soil that could fall into the excavation.	☐	☐
10.	Employees are prohibited from working or standing under suspended loads.	☐	☐
11.	Employees are required to stand away from vehicles that are being loaded or unloaded.	☐	☐
12.	Employees are prohibited from working on the faces of sloped or benched excavations when other employees are below them.	☐	☐
13.	Mobile equipment operators have an effective way of knowing when they are too close to the edge of an excavation. Examples include barricades, hand or mechanical signals, stop logs, or grading away from the excavation.	☐	☐
14	Spoils, equipment, and tools are at least 2 feet from the edge of the excavation.	☐	☐
15.	Walkways that cross over excavations more that 6 feet deep and 30 inches wide have standard guard rails and toe boards.	☐	☐

		Yes	No
16.	Underground installations are protected, supported, or removed when the excavation is open.	☐	☐
17.	Excavations that have a depth of 4 feet or more have ladders or other means of safe access within 25 feet of employees.	☐	☐
18.	Ladders are secured and extend 3 feet above edge of the excavation.	☐	☐
19.	A designated competent person designs the structural ramps that employees use to enter and exit the excavation.	☐	☐
20.	Structural ramps have nonslip surfaces.	☐	☐
21.	Employees are prohibited from entering an excavation that shows signs of water accumulation unless they are protected from the risk of a cave-in.	☐	☐
22.	A competent person monitors the methods used to control water from accumulating in an excavation.	☐	☐
23.	Surface water or runoff is diverted away from the excavation.	☐	☐
24.	The atmosphere in an excavation is tested when the possibility of a hazardous atmosphere exists.	☐	☐
25.	Employees are protected from hazardous atmospheres or atmospheres containing less than 19.5 percent oxygen.	☐	☐

		Yes	No
26.	Emergency rescue equipment is available when hazardous atmospheres could exist in an excavation.	☐	☐
27.	Employees who work in excavations are trained to use appropriate personal protective equipment.	☐	☐
28.	A designated competent person has classified soil at the excavation site with at least one manual test and one visual test.	☐	☐
29.	Materials and equipment used for protective systems at the excavation site are chosen based upon soil analysis, excavation depth, and expected loads.	☐	☐
30.	Materials and equipment used for protective systems are inspected regularly and in good condition.	☐	☐
31.	Damaged equipment is removed from service immediately.	☐	☐
32.	Protective systems are installed without exposing employees to the risk of cave-ins.	☐	☐
33.	Structures, roadways, and sidewalks adjacent to the excavation are adequately supported.	☐	☐
34.	Excavations are backfilled when protective systems are removed.	☐	☐

		Yes	No
35.	Appropriate sloping, shoring, or shielding protects employees who work in excavations 5 or more feet deep.	☐	☐
36.	A designated competent person determines the type of shield used at a site by considering factors such as the nature of the work, excavation dimensions, soil characteristics, and equipment used to lower or position the shield.	☐	☐
37.	Employees in excavations more than 20 feet deep are protected by a system designed by a registered professional engineer.	☐	☐
38.	Shields are installed so that they do not move laterally.	☐	☐
39.	Employees are not allowed in shields that are moved vertically.	☐	☐

Oregon OSHA Services

OR-OSHA offers a wide variety of safety and health services to employers and employees:

Consultative Services

- Offers no-cost on-site safety and health assistance to help Oregon employers recognize and correct workplace safety and health problems.
- Provides consultations in the areas of safety, industrial hygiene, ergonomics, occupational safety and health programs, assistance to new businesses, the Safety and Health Achievement Recognition Program (SHARP), and the Voluntary Protection Program (VPP).

Enforcement

- Offers pre-job conferences for mobile employers in industries such as logging and construction.
- Provides abatement assistance to employers who have received citations and provides compliance and technical assistance by phone.
- Inspects places of employment for occupational safety and health hazards and investigates workplace complaints and accidents.

Appeals, Informal Conferences

- Provides the opportunity for employers to hold informal meetings with OR-OSHA on concerns about workplace safety and health.
- Discusses OR-OSHA's requirements and clarifies workplace safety or health violations.
- Discusses abatement dates and negotiates settlement agreements to resolve disputed citations.

Standards & Technical Resources

- Develops, interprets, and provides technical advice on safety and health standards.
- Provides copies of all OR-OSHA occupational safety and health standards.
- Publishes booklets, pamphlets, and other materials to assist in the implementation of safety and health standards and programs.
- Operates a Resource Center containing books, topical files, technical periodicals, a video and film lending library, and more than 200 databases.

Public Education & Conferences

- Conducts conferences, seminars, workshops, and rule forums.
- Coordinates and provides technical training on topics such as confined space, ergonomics, lockout/tagout, and excavations.
- Provides workshops covering management of basic safety and health programs, safety committees, accident investigation, and job safety analysis.
- Manages the Safety and Health Education and Training Grant Program, which awards grants to industrial and labor groups to develop training materials in occupational safety and health for Oregon workers.

For more information, call the OR-OSHA office nearest you. *(All phone numbers are voice and TTY.)*

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Bend, OR 97701-4374
(541) 388-6066
Consultation: (541) 388-6068

Medford
1840 Barnett Road, Ste. D
Medford, OR 97504-8250
(541) 776-6030
Consultation: (541) 776-6016

Pendleton
721 SE Third St., Ste. 306
Pendleton, OR 97801-3056
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