OR-OSHA
Construction Depot
Spring 2005 *A newsletter for the construction industry* QUARTERLY

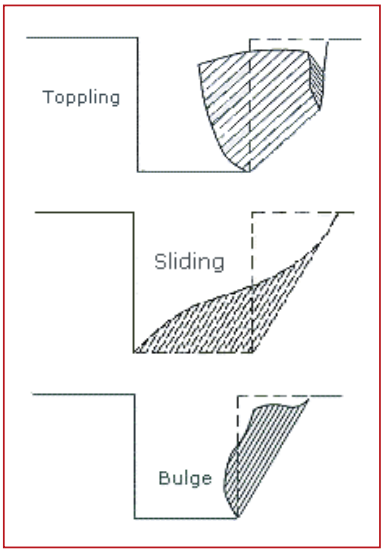
Never enter an unprotected trench!

Trench cave-ins can trap victims within seconds and kill them within minutes. A cave-in that contains three to five cubic yards of soil weighs 8,000 to 14,000 pounds — a victim can suffocate in less than three minutes. If the victim survives, the weight of the soil is likely to cause serious internal injuries. And cave-ins aren't the only trenching hazard. Lack of oxygen, toxic fumes, explosive gases, and buried power lines may also be present.

Unfortunately, many contractors who do trench work still think that safeguarding a trench is too expensive or takes too much time. They take the risks because they haven't experienced the consequences of a cave-in. They're playing trench roulette.

PHOTO: Central Pierce Fire & Rescue

What causes a cave-in?



Undisturbed soil stays in place because of the soil's opposing horizontal and vertical forces. When you create a trench, you remove soil that provides horizontal support. Soil behind the face of an unsupported trench will eventually move downward, into the excavation as shown in the figure, left. The longer the face remains unsupported, the more likely it is to cave in.

Soil and rock characteristics also affect the stability of a trench. A competent person must conduct visual and manual tests to determine the type of the soil at the trench site. The evaluation is critical in determining how to protect workers from a cave-in. OR-OSHA's Subdivision 3/P excavation requirements define four types:

- **Stable rock:** Natural solid mineral matter that can be excavated and remains intact while exposed.
- **Type A soil:** Cohesive soil that has an unconfined compressive strength of 1.5 tons per square foot or more. Unconfined compressive strength, the load at which soil will fail when it's compressed, can be determined by laboratory or field testing.
- **Type B soil:** Cohesive soil that has an unconfined compressive strength between 0.5 and 1.5 tons per square foot.
- **Type C soil:** Cohesive soil that has an unconfined compressive strength of 0.5 tons per square foot or less.

What's the difference between an excavation and a trench?

When you dig a hole, you make an excavation. Make the excavation narrow — deeper than wide — and not more than 15 feet wide at the bottom, and you create a trench as defined by OR-OSHA's Subdivision 3/P excavation requirements.

Planning: what to consider before you dig

Planning reduces the chance that something will go wrong and is a critical part of trench work. Consider the following before you dig a trench:

- **Surface debris.** Is there debris near the trench site that could create a hazard? If so, remove it.
- **Soil and rock characteristics.** What type of soil and rock will be removed to create the trench? A designated competent person needs to evaluate the soil to determine how workers will be protected from a cave-in.
- **Underground utility lines.** Where are the sewer, telephone, fuel, electric, and water lines located? 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.
- **Vehicle traffic.** Is the trench near a public road? Workers must wear high-visibility clothing if exposed to traffic.
- **Stability of adjacent structures.** Are there buildings, walls, or other structures that the trench work could make unstable? They'll need to be supported

... continued on Page 2

so that they don't endanger workers. Never excavate under the base or footing of a foundation unless the foundation is properly supported, the excavation is in solid rock, or a registered professional engineer approves the work.

- **Access.** How will workers get in and out of the trench? Workers must use ladders, stairs, or ramps for trenches that are four or more feet deep. Use wood or fiberglass ladders if there's a risk of contacting electrical lines.
- **Onsite vehicles and mobile equipment.** Will vehicles operate near the trench? Workers in the trench must stay away from any vehicle being loaded or unloaded. And mobile equipment operators must have an effective way of knowing when they are too close to the trench.
- **Atmospheric hazards.** Could workers be exposed to atmospheric hazards or low oxygen levels when they are in the trench? Such hazards must be controlled before workers enter and appropriate rescue equipment must be available.
- **Water accumulation.** Could water accumulate in the trench from nearby streams, heavy rains, or a high water table? Workers can't enter a trench in which water has accumulated unless the condition has been controlled.
- **Fall protection.** Will people be walking near the trench? Walkways over trenches that are more than six feet deep must have standard guardrails.
- **Loose rock and soil.** How will workers in the trench be protected from falling rock or soil? Remove or contain material in the trench that poses a hazard. Keep soil and other material at least two feet away from the edge of the trench.
- **Emergencies.** What emergencies could happen at the site? Determine how to respond to them and ensure that the necessary rescue equipment will be available.

The role of the competent person

The competent person — who must have training in soil analysis, trench protection methods, and OR-OSHA's Subdivision 3/P excavation requirements — is responsible for classifying soil, determining the method to protect workers from cave-ins, testing for atmospheric hazards, and inspecting the trench. The competent person must inspect the trench and the protective system at least once a day for instability, damage, or other hazards. Inspections are also necessary after heavy rain or activities such as blasting that may increase the risk of cave in. The competent person has authority to immediately correct hazards and to order workers to leave the trench until the hazards have been corrected.

Getting in and out of a trench

A trench that has a depth of four feet or more must have a stairway, ladder, or ramp that is within 25 feet of workers; if conditions in a trench become hazardous, workers' safety may depend on how quickly they can climb out.

A competent person must design any structural ramps that are used to enter and exit the trench. Structural ramps used in place of steps must have a non-slip surface. A competent person must also evaluate earthen access ramps that workers use to enter and exit the trench.

Keep in mind

- Workers in excavations five or more feet deep must be protected by appropriate sloping, shoring, or shielding.
- Workers in any excavation more than 20 feet deep must be protected by a system dexigned by a registered professional engineer.

Materials and mobile equipment

Excavated soil, called spoils, can cause a cave-in when piled too close to the edge of a trench. So can heavy equipment. Keep spoils and equipment at least two feet away from the edge. When possible, use vertical shores or shields that extend above the top of the trench to restrain spoils. When it's not possible to meet the two-foot setback, move spoils and equipment to another location.

Keep workers off the faces of benched excavations when other workers are below them unless the workers are protected from rocks, soil, or other falling objects.

Workers in the trench must stay away from raised loads and from vehicles being loaded or unloaded. And mobile equipment operators must have an effective way of knowing when they are too close to the trench; OR-OSHA's Subdivision 3/P Excavation requirements suggest barricades, hand or mechanical signals, stop logs, or grading away from the excavation.

Hazardous atmospheres

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

Trenches that contain hazardous atmospheres must be ventilated so that they are safe to enter or workers must wear appropriate respirators. OR-OSHA's ventilation requirements are in Subdivision 3/D [1926.57]; respiratory protection requirements are in Subdivision 3/E [1926.103]. Emergency rescue equipment must also be readily available at the site.

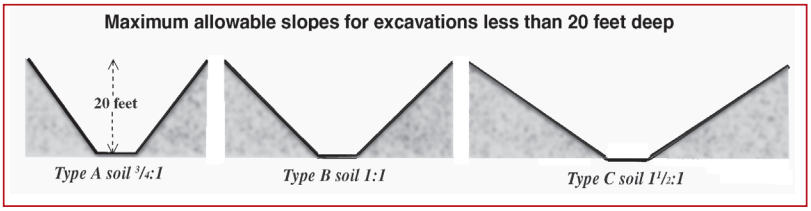
Water accumulation

Water makes soil unstable. Workers can't enter trenches when water has built up unless they are protected from the increased risk of a cave-in. Protection methods include specialized support systems and water-removal equipment. A competent person must inspect the trench and monitor methods used to control water accumulation.

Use appropriate protection to prevent cave-ins

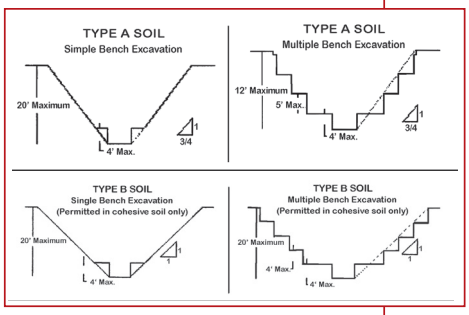
There are three basic methods for protecting workers from cave-ins: ***Sloping and benching, shoring,*** or ***shielding***. The correct method depends on factors such as soil type and water content, trench depth and width, the nature of the work, and activities outside the trench that could increase the risk of a cave in. The competent person has the responsibility for considering these factors and for determining appropriate protection.

Sloping and benching reduce the risk of cave-in by excavating the sides of the trench at an angle. The flatter the angle, the greater the protection. The maximum allowable slopes for excavations less than 20 feet deep depends on the soil type, shown in the figure below.



A registered professional engineer must determine slopes in trenches that are deeper than 20 feet.

Benches are cuts in the slope that give it a stair-step appearance. There are two types of benches: simple and multiple. Soil type also determines the angle of benched slopes. Usually the bottom vertical height of the trench must not exceed four feet for the first bench. Benched slopes are permitted only in ***Type A and Type B soils*** as shown in the figure, below.



Shores are vertical or horizontal supports that prevent the trench from collapsing. Nowadays most manufactured shores consist of two rails connected by hydraulic cylinders, which are pressurized by a hand pump. The force of the pressurized cylinders against the rails compresses the soil and keeps it in place.

Vertical shores are also called ***uprights***. Easy to install and relatively inexpensive, they're used most often in relatively stable soil, and in shallow trenches that have parallel faces. Vertical shores must be sized and spaced for the trench's dimensions and soil type. Plywood sheeting or Finform — a special type of plywood made in Finland — may also be necessary to prevent soil from sliding into the trench. The competent person needs to make these decisions after reviewing the manufacturer's instructions and OR-OSHA's Subdivision 3/P excavation requirements.

PHOTO: Speedshore Corporation

Vertical shore

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 trench. Horizontal shores are lightweight and easy to install but, like vertical shores, they must be sized and spaced for the trench's dimensions and soil type. The competent person must also make these decisions.

PHOTO: Speedshore Corporation

Waler system

Shields are made in two-sided and four-sided solid-sheeted exteriors. They're available from manufacturers in a variety of dimensions, usually aluminum or steel. Shields can also be built onsite if they meet OR-OSHA's Subdivision 3/P requirements for protective systems. Shields are well suited for utility work, laying pipe, and work in pits and shafts. Shields don't prevent a trench from collapsing but "shield" workers if a face does collapse.

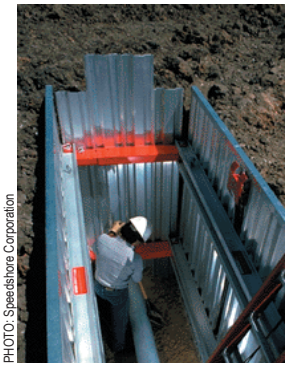
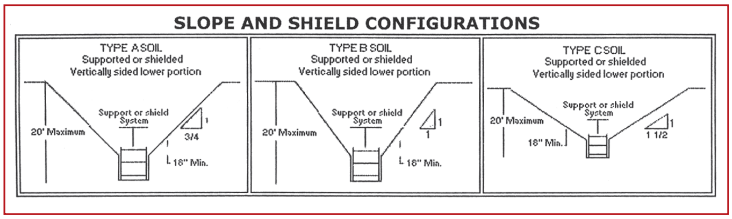


PHOTO: Speedshore Corporation

Shoring shield

The typical height of a trench shield is eight feet; however they can be stacked to increase height. Shields can also be used in properly sloped or benched trenches, as shown in the figure below.



The competent person will determine the type of shield used at a site by considering factors including the nature of the work, the trench dimensions, soil characteristics, and equipment such as backhoes or track-type excavators to lower or position the shield.

OR-OSHA
Construction Depot
A newsletter for the construction industry QUARTERLY

OR-OSHA Construction Depot is published quarterly by the Oregon Occupational Safety and Health Division of the Department of Consumer and Business Services.

DEPARTMENT OF CONSUMER & BUSINESS SERVICES
Oregon Occupational Safety & Health Division

Department of Consumer and Business Services director
Cory Streisinger

Oregon OSHA administrator
Peter De Luca

Construction Depot editor
Ellis Brasch

Designer and illustrator
Patricia Young

DCBS editor
Dian Cox

Reprinting, excerpting or plagiarizing any part of this publication is fine with us! Please send us a copy of your publication or inform the **Construction Depot** *editor as a courtesy.*

If you have questions about the information in **Construction Depot**, *please contact Ellis Brasch ellis.k.brasch@state.or.us or call (503) 947-7399.*

For general information, technical answers or information about Oregon OSHA services, please call (503) 378-3272 or toll-free within Oregon, (800) 922-2689.

Did you know? The American Society of Safety Engineers recently published a revised ANSI/ASSE standard for excavation safety — *ANSI/ASSE a10.12-1998 (R2005), Safety Requirements for Excavation*. For more information, contact the American Society of Safety Engineers, **www.asse.org**.

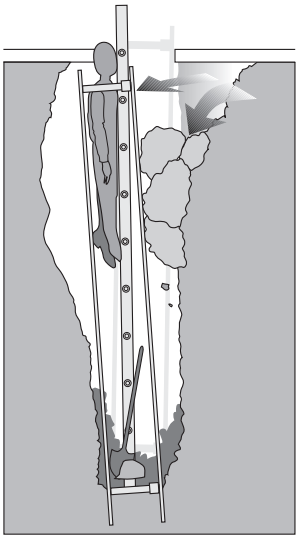
OR-OSHA 440-3351 (4/05)

For a color version of *Construction Depot* and related occupational-safety-and-health information, visit the OR-OSHA Web site, www.orosha.org.

OR-OSHA
Construction Depot
Spring 2005 *A newsletter for the construction industry* QUARTERLY

This issue of the **Construction Depot** *focuses on the basics of trench safety. Trench cave-ins happen with little or no warning and victims are often unprotected or using the wrong methods of protection. Some contractors still think that safeguarding a trench is too expensive or takes too much time.* ***In this issue:***

■ What causes a cave-in? ■ Planning: what to consider before you dig ■ The role of the competent person ■ Getting in and out of a trench ■ Materials and mobile equipment ■ Hazardous atmospheres ■ Water accumulation ■ Preventing cave-ins



Fatality Report

Accident type.....**Crushing**
Industry.....**Water and sewer excavation**
Employee job title.....**Laborer**

Description of accident

A small excavation company that consisted of an owner and two employees had been hired to run a sewer line from the main line in the street to a developed lot. The job involved excavation of a trench with a backhoe. The company owner, who always worked with his crew and was the "competent person" on site, was operating the backhoe. When the excavation was 11 feet deep, the backhoe operator "felt" the main. At the same time, one side of the trench partially collapsed. The owner was about to send one of the crew, who had been with this company for seven months, into the trench with a shovel to hand-dig the rest of the way to the main.

The backhoe operator positioned a trench shield in the trench and an aluminum ladder was dropped down one side of the trench for the man with the shovel to descend. As he did so, the other side of the trench collapsed, and the shield shifted with the lateral pressure from the opposite side of the trench. The victim's head was even with the concrete edge of the street surface when the shifting shield pinned his head between the edge of the street surface and the ladder. It was necessary to move the trench shield with the backhoe to free the victim. The owner did this, and the victim fell to the bottom of the trench. The crew called 911 and administered CPR, but the accident victim was dead when the Portland Fire Department arrived.

Investigation findings

One face of the trench had partially collapsed before the trench shield was placed. The owner placed the trench shield incorrectly, positioning it vertically rather than horizontally in the trench. The 3,000-lb. shield, placed vertically in the trench, did not extend a sufficient distance above the top of the trench to be stable in the event of lateral pressure. When lateral pressure was applied with the collapse of the other side of the trench, the shield shifted, and its movement trapped the victim's head between the ladder and the road's edge.The trench shield was also missing midsection bracing.