

Cave-Ins Happen: 5 Simple Steps to Protect Your Workers

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Working in trenches and excavations is potentially one of the most hazardous types of work in the construction and utility industries. Across the U.S., as many as 400 workers are killed, and several thousand are injured, each year. And it's not surprising that most of the workers who are injured or killed have received no trenching and excavation safety training. What **is** surprising is that most of the trenches involved are relatively shallow (5 to 15 feet deep).

Many construction people don't appreciate the enormous weight of soil. One cubic foot of soil weighs between 90 and 140 pounds. Therefore, a cubic yard of soil can weigh almost 4,000 pounds. As a result, when a trench cave-in occurs it usually means a very serious injury or a death.

Step 1 Make Sure You Have a Trained "Competent Person" on the Site

In an attempt to reduce the number of deaths and serious injuries that occur each year in trenches and excavations, the federal Occupational Safety & Health Administration (OSHA) requires that a "Competent Person" be on site whenever workers are exposed in an excavation. OSHA defines the Competent Person as one who:

- Is capable of identifying existing or predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and
- Has the authority to take prompt corrective measures to eliminate them.

OSHA goes on to stipulate that the Competent Person on a trenching and excavation site

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must have specific training in — and be knowledgeable of — the requirements of the OSHA Standard (29 CFR 1926, Subpart P), soils analysis, the use of protective systems.

Regular, ongoing inspections on-site are particularly important, so much so that I have included the topic in its own section, Step 5.

A number of trade associations and private consultants offer Competent Person training, with classes usually lasting about eight hours. OSHA and most safety professionals also encourage periodic “refresher” training.

The on-site presence of the “Competent Person” is crucial to helping maintain a safe working environment. When cave-ins occur, there are often one or more very serious injuries deaths. To complete trenching and excavation work safely, contractors and utilities need a person on site who has the knowledge of how to carry out the

work safely, who regularly inspects the trenches or excavations, and who has the authority to take immediate action to insure the safety of all workers.



Just imagine the outcome of this collapse if the workers in the trench had not been protected by the steel trench box.

OSHA is very specific about the responsibilities of the Competent Person. Those responsibilities include:

- Having the authority to stop work,
- Inspecting of trenches or excavations,
- Testing for hazardous atmospheres when such atmospheres exist or could be reasonably expected to exist,
- Inspecting of materials or equipment if damaged, to determine if usable,
- Monitoring of water-removal equipment and operations, and
- Visual and manual testing of the soil.



Step 2

Follow OSHA's General Requirements

The General Requirements section of OSHA's 29 CFR 1926, Subpart P – Excavations, addresses a number of “common sense” items related to trenches and excavations.

SURFACE ENCUMBRANCES

These are described as telephone poles, trees, fire hydrants, street signs, sidewalks, curbs and gutters, and similar objects adjacent to an excavation. They should be removed or supported, to insure their stability and to safeguard workers.

UNDERGROUND INSTALLATIONS

These include underground utilities such as sewer, gas, water, and telephone and electric lines. Utility companies must be contacted with adequate, established, or customary local lead times, advised of the proposed work, and asked to determine the location of the utilities prior to the start of actual excavation work. All underground utilities must be protected, supported, or removed to protect workers.



Surface encumbrances and underground utilities are just two of the items that must be properly dealt with in excavation work.

ACCESS & EGRESS

These are just fancy words for entering or exiting an excavation. Trenches and excavations deeper than four feet require a means of access and egress. Also, each worker must be within 25 feet of a ladder, ramp, or stair. Each means of access and egress must be within a protected area.

VEHICULAR TRAFFIC

Workers exposed to traffic must be provided with, and must wear, warning vests or other highly visible garments. Signs, signals, barricades, and/or flagmen may also be required.

FALLING LOADS

Workers are not permitted underneath overhead loads. In addition, employees must stand away from equipment being loaded or unloaded from vehicles.

WARNING SYSTEMS FOR MOBILE EQUIPMENT

When mobile equipment is operated near the edge of an excavation, and the operator does not have a clear and direct view of that edge, warning systems — such as barricades, spotters, or stop logs — are required.

HAZARDOUS ATMOSPHERES

This section of the OSHA Standard is designed to protect workers from so-called “bad air.” Concerns include there being:

- too little oxygen,
- too much oxygen,
- flammable gases (such as methane and natural gas), and
- toxic gases such as hydrogen sulfide and carbon monoxide.

Testing, along with the use of ventilation equipment, are two of the most common, and important, methods of addressing hazardous or potentially hazardous atmospheres.

WATER ACCUMULATION

Workers must not work in trenches or excavations where there is accumulated water, or where water is accumulating, unless adequate precautions are taken. If the excavation work interrupts the natural flow of surface water, then diversion ditches, dikes, or other means may be required to keep water out.

ADJACENT STRUCTURES

The stability of sidewalks, streets, adjoining buildings, walls, and other structures can be reduced by excavation operations. Specialized shoring systems, bracing, and/or underpinning may be required to ensure the stability of these structures, and to protect workers.

LOOSE SOIL OR ROCK

Spoil piles (and equipment) must be set back at least two feet from the edge of a trench or excavation.

FALL PROTECTION

Walkways with standard guardrails are required when employees or equipment cross over excavations. Wells, pits, shafts, etc., must be barricaded or covered.

Paying close attention to each of these important potential dangerous circumstances will help insure worker safety, as well as help contractors and utilities “stay legal” with OSHA.



Step 3

Carefully Analyze the Soil

An important responsibility for the “Competent Person” (discussed in Step 1) is soil analysis and classification. It is the first step in choosing a protective system, and the law requires it. Even if a soils engineering service has been identified for a project, the “Competent Person” is still required to classify the soil.

There are hundreds (maybe thousands) of different types of soil. OSHA is concerned with just four types:

STABLE ROCK

Defined as natural, solid mineral matter that can be excavated with vertical sides that will remain intact while exposed. Stable rock is extremely rare. In fact, less than two percent of the soil in the U.S. is classified as Stable Rock. In addition, the process of excavating with saws, breakers, dynamite, etc., will likely fracture and de-stabilize rock that was initially considered stable.

TYPE A

Defined as cohesive soil with an unconfined compressive strength of 1.5 tons per square foot or greater. As a practical matter, Type A soil is also rare because previously disturbed soils, or soils subject to vibration from construction equipment, traffic, railways, etc., are disqualified as being “Type A.”

TYPE B

Defined as moderately cohesive soil. Not as good as Type A, but not as bad as Type C soil.

TYPE C

Defined as the least cohesive soils, having an unconfined compressive strength less than .5 tons per square foot. This includes wet, granular, or loose soils. The best way to remember Type C is to think of the “C” as standing for “crummy.” It is the least stable type of material. And there is a lot of Type C soil throughout the U.S.



Soil that “flows” out of the excavator bucket is granular, wet, or loose material, and is classified as “Type C” soil.

The “Competent Person” is required to perform at least one visual and one manual test of the soil.

VISUAL TEST

To make a visual test, the Competent Person observes soil as it is being excavated. Soil that remains in large clumps is cohesive, and is probably Type A or Type B soil (depending upon other factors). Soil that flows out of an excavator bucket is granular, loose, or wet, and is probably Type C. The Competent Person should also check the sides of the excavation for layered systems, water, utilities, and signs of previously disturbed soils. Likewise, the Competent Person must be vigilant for sources of vibration.

MANUAL TESTS

There are a number of different manual tests included in the OSHA Standard.

The **Dry Strength, Thread, or Ribbon Tests** can be used to determine if a soil is cohesive or granular.

The **Thumb Penetration Test** relies heavily upon the experience of the person performing the test. In the

Thumb Penetration Test, the Competent Person gathers a handful of freshly excavated soil and presses his/her thumb into the material. Type A soils require a great deal of effort to indent the soil. Type B soils can be indented with moderate pressure. Type C soils require little or no effort.

Pocket Penetrometers and Shearvanes can be used to determine the approximate unconfined compressive strength of soils.



A Pocket Penetrometer is an instrument that can be used to estimate the unconfined compressive strength of cohesive soils. This is an example of a “manual” test of the soil.

There is one method of Soil Classification that the Competent Person can employ to avoid all these tests: Namely, assume the “worse case” scenario and classify all soil as Type C. Then sloping, shoring, or shielding can be used for the trench or excavation accordingly. In fact, many contractors and utilities take the position that every soil they work in is Type C. That greatly simplifies the entire trenching and excavation safety process.



Step 4 Use a Protective System

With just one exception, OSHA requires the use of protective systems in all trenches and excavations that are deeper than five feet. (The one exception involves trenches or excavations in stable rock. In those situations, it is “legal” to work with vertical walls. But beware: Stable rock is very rare.)

If a trench or excavation is less than five feet deep, a protective system may be required, if there is a potential for a cave-in. (Note: In some states, laws may require use of protective systems for trenches and excavations that are only 4 feet or more deep. Always check with your state regulations).

5 Protective System Options

There are five options for providing a protective system:

OPTION #1 – SLOPING AND BENCHING

This procedure calls, first, for classifying the soil, then referring to the charts and illustrations in the OSHA Standard to determine the correct angle of the sloping or benching.

From the OSHA Standard:

Type Soil	Angle of Bank
Stable Rock	Vertical wall
Type A Soil	$\frac{3}{4}$ to 1 (H to V), or 53 degrees
Type B Soil	1 to 1 (H to V), or 45 degrees
Type C Soil	1 ½ to 1 (H to V), or 34 degrees

OPTION #2 – TIMBER SHORING

This is a system of wooden walers, cross braces, and uprights that support the walls of a trench or excavation. The OSHA Standard specifies the sizes of timbers, based on the various types of

soil, the depth of the trench or excavation, and the type of timber used to build the structure (oak or Douglas fir). Today, few contractors or utilities use timber shoring. And there are a number of practical reasons, including limited availability of timber, the need for skilled carpenters to build such systems, the building time required, safety issues, and, probably the biggest reason, the easy availability of other more cost-effective systems.

professional engineer must design a system specifically for the job. The engineer has to be registered in the state where the system will be used, and will have to “stamp” the design. There are additional requirements, as well, all of which are covered in the OSHA Standard.



OPTION #3 – ALUMINUM HYDRAULIC SHORING

Hydraulic shoring systems have replaced a lot of timber shoring. Developed in California in the late 1950s, there are two main types of hydraulic shoring systems: vertical shores and horizontal walers. Both employ aluminum rails and hydraulic cylinders that apply pressure to the walls of a trench, creating an “arching effect” in the adjacent soil that prevents the walls from collapsing.

OPTION #4 – TRENCH SHIELDS

Trench shields are aluminum or steel structures designed to protect workers by withstanding the forces imposed by a cave-in. Regardless of the material they are made of, the principles are the same.

OPTION #5 – SITE-SPECIFIC ENGINEERED SYSTEMS

Occasionally the charts in the OSHA Standard for sloping and benching, or timber shoring, as well manufactured systems such as aluminum hydraulic shoring or trench shields, are not appropriate. There may exist job-site conditions or other factors that prevent the use of all these systems. In these situations, a registered



Five protective-system options exist. A steel trench box such as this one may be the best solution to protect workers in certain excavation situations.

Step 5 Inspect the Excavation

The properly trained and authorized Competent Person must inspect daily:

- for indications of possible cave-ins,
- for failure of protective systems,
- for hazardous atmospheres, and
- for other hazardous conditions.

The inspections need to be conducted prior to the start of work, and also as needed throughout the shift, after rainstorms, and after other potential hazard-increasing events. The Competent Person must also check adjacent areas and protective systems (before and during use), and look always for indications of possible cave-ins and hazardous or potentially hazardous conditions.



An Inspection Checklist can greatly aid the Competent Person in making thorough inspections. This checklist is available as a FREE download from the "Useful Information" section of TrenchSafety's web site, www.TrenchSafety.com

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Trenching & Excavation Safety Checklist

Site Location: _____ Date: _____ Time: _____ a.m. p.m.

GENERAL INSPECTION

- Has the "Competent Person" had specific training in—and is knowledgeable about—soil analysis, use of protective systems, and the requirements of 29 CFR 1926 Subpart P? Excavations and Trenching? YES NO N/A
- Does the "Competent Person" have the authority to remove workers from the excavation immediately? YES NO N/A
- Are excavations, adjacent work, and protective systems inspected by a Competent Person:
 - A. Daily prior to the start of work. B. As needed throughout the shift, and C. After every rainstorm or other occurrence that could increase the hazard? YES NO N/A
- Are ALL surface encumbrances removed or supported? YES NO N/A
- Are ALL employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation? YES NO N/A
- Are hard hats worn by ALL employees? YES NO N/A
- Are spoils, materials, and equipment set back at least 2 feet from the edge of the excavation? YES NO N/A
- Are barriers provided at all readily located excavations, wells, pits, shafts, etc.? YES NO N/A
- Are walkways and bridges over excavations 4 feet or more in depth and 30 inches or more in width equipped with standard guard rails and toe boards? YES NO N/A
- Are warning vests or other highly visible clothing provided and worn by all employees exposed to vehicular traffic? YES NO N/A
- Are employees required to stand away from vehicles being loaded or unloaded? YES NO N/A
- Are warning systems established and used when mobile equipment is operating near the edge of an excavation? YES NO N/A
- Are employees prohibited from going under suspended loads? YES NO N/A
- Are employees prohibited from working on the faces of sloped or benched excavations above other employees? YES NO N/A

UTILITIES

- Are utilities companies contacted and/or utilities located as required by local, state, and federal law? YES NO N/A
- Are the exact locations clearly marked? YES NO N/A
- Are underground installations protected, supported, or removed when an excavation is open? YES NO N/A

ACCESS & EGRESS

- Are ladders or other means of access and egress in place in all trenches 4 feet or more deep? YES NO N/A
- Are the ladders that are used in excavations secured and extended 3 feet above edge of the excavation? YES NO N/A
- Are ALL structural ramps used by employees designed by a "Competent Person"? YES NO N/A
- Are ALL structural ramps used for equipment designed by a Registered Professional Engineer? YES NO N/A
- Are ALL ramps constructed of materials of uniform thickness, closed together, equipped with non-slip surfaces? YES NO N/A
- Are employees protected from cave-ins when entering or exiting excavation? YES NO N/A

WET CONDITIONS

- Are precautions taken to protect employees from water accumulation? YES NO N/A
- Is water removal equipment monitored by "Competent Person"? YES NO N/A
- Is surface water or runoff diverted after every rainstorm or other hazard-increasing occurrence? YES NO N/A

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HAZARDOUS ATMOSPHERES

- Is the atmosphere within ALL excavations tested when there is a reasonable possibility of an oxygen-deficient, oxygen-enriched, combustible, toxic, or other harmful contaminant? YES NO N/A
- Are adequate precautions taken to protect employees from exposure to an atmosphere containing less than 19.5% oxygen and/or other hazardous atmosphere? YES NO N/A
- Is verification provided to protect employees from an atmosphere containing flammable gas? YES NO N/A
- Is emergency equipment available when hazardous atmospheres could or do exist? YES NO N/A
- Are employees trained to use personal protective equipment and other rescue equipment? YES NO N/A
- Are safety harnesses and lifelines used and individually attended when workers enter bell-bottom pits, holes or other deep confined excavations? YES NO N/A

SOILS

- Has the Competent Person classified the soil using one manual test and one visual test, as specified by the standard? YES NO N/A

Visual Test (RPR): _____ Manual Test (Type): _____
 Soil Classified as: Solid Rock Type A Type B Type C

SUPPORT SYSTEMS

3 Primary Options are Available

Note: If an excavation is deeper than 5 feet (6 feet in some states), a support system is required by federal law, except for excavations entirely in stable rock (see 1910.261). If an excavation is less than 5 feet deep (6 feet in some states), a support system is required if there is a potential for a cave-in, as determined by the "Competent Person."

Option #1 - Sloping (For excavations less than 20 feet deep.) Option #2 - Shoring (Shoring must be installed according to charts in the OSHA Appendix or the manufacturer's published data, and the data must be on site.) Option #3 - Shielding (Shielding must be installed according to the manufacturer's published data, and the data must be on site.)

SOIL TYPE	MAXIMUM ALLOWABLE SLOPE (H:V)
Stable Rock:	Vertical or 90°
Type A:	3:1 or 5:1
Type B:	1:1 or 4:5
Type C:	1:1 or 3:4

A 4th option always available is a system designed by a Registered Professional Engineer (RPE) that meets OSHA equipment, and must be on site.

- Are materials and/or equipment checked (based upon soil analysis, trench depth and expected loads)? YES NO N/A
- Are materials and equipment that are used for protective systems inspected and in good condition? YES NO N/A
- Are damaged materials and equipment immediately removed from service? YES NO N/A
- Are damaged materials and equipment inspected by a Registered Professional Engineer after repairs are made and before being placed back in service? YES NO N/A
- Are protective systems installed without exposing employees to hazards of cave-ins, collapses, or threat of being struck by materials or equipment? YES NO N/A
- Are ALL members of support systems securely fastened together to prevent failure? YES NO N/A
- Are support systems provided to insure stability of adjacent structures, buildings, roadways, sidewalks, etc.? YES NO N/A
- Are excavations below the level of the base or footing supported, and approved by a Registered Professional Engineer? YES NO N/A
- Are backfilling operations with the removal of the support system? YES NO N/A
- Is a shield system installed to prevent lateral movement? YES NO N/A
- Are employees prohibited from remaining in a shield system during vertical movement? YES NO N/A

Inspected by: _____

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To summarize, by having a properly trained and authorized Competent Person on site, by following the General Requirements section of the OSHA Standard, by carefully classifying the soil, by utilizing protective systems, and by rigorously and repeatedly inspecting every excavation, you and your employees can work safely in trenches and excavations.

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