

**Excavation, Trenching and Shoring Safety
and
OSHA's Excavation Standard**

AFSCME Training and Education Institute Manual

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INTRODUCTION

Construction work is dangerous-and work involving trenching and excavating activities tends to be the most hazardous in the industry. Yet, we see trenching and excavating work going on all around us. Excavations are needed for the installation and repair of utility lines, replacement of water and sewer lines, swimming pool construction, even grave digging. Excavation projects vary considerably, each with its own set of unique problems.

In 1971, OSHA issued its first standard related to excavations and trenching. Since that time, OSHA has changed the standard in a effort to reduce injuries and fatalities. Despite these efforts, accidents related to excavations and trenching activities continue to occur at a high rate: over one hundred deaths and many more times that amount in disabling accidents occur every year. You don't have to lose your life to lose your livelihood. Accidents of this kind are most prevalent in small to medium size businesses and municipal and county governments. These high death and accident rates prompted OSHA to sponsor a National Emphasis Program (NEP) to address the hazards.

Many who work in the construction industry will tell you that accidents should be expected -"its just the cost of doing business". This is not acceptable. We must ask the question, "Why do these accidents continue to occur?" The answer can only be that the message is not getting out to those who need it most-the workers involved in trenching and excavation activities. Only an informed and fully trained worker can recognize dangerous situations and therefore protect himself. This workbook attempts to do just that-inform and educate those who must work in excavations and trenches about the dangers they face and the safe work practices that must be followed for their protection.

CHAPTER 1

The Hazards of Excavations

There are many potential hazards when working in excavations and trenches. Probably the most common hazard at any worksite is the threat of *cave-in*. A cave-in occurs when walls of an excavation collapse.

Why do cave-ins occur? Undisturbed soil is kept in place by natural horizontal and vertical forces of the adjacent soil. When earth is removed to create an excavation, these natural forces are no longer able to hold back the soil left behind forming the trench wall. With no support, eventually the laws of gravity take over, and the soil from the trench walls will eventually move downward and inward into the excavation. The result is a cave-in. Cave-ins occur suddenly-usually too quickly for a worker to react. Cave-ins are more likely to occur in unprotected excavations where:

- The excavation is dug in unstable or previously disturbed soil;
- Excessive vibration from construction equipment or vehicle traffic around the excavation is present;
- A surcharge of loads are present near the sides of an excavation, most frequently from equipment or the excavated material too near to the edge;
- An accumulation of water in the excavation;
- Changes in weather conditions (freezing, melting, sudden heavy rain, etc.)

These conditions can be controlled by :

- Re-routing traffic when possible, and keeping only the heavy construction equipment required near the excavation;
- Keeping the spoil pile at least 2 feet back from the edge of the excavation;
- Pumping water out of the excavation before anyone enters it;
- Using protective systems when required.
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Other hazards to be considered when working around excavations and trenches include *accidental contact with utility lines*, crushing and striking hazards posed by *mechanized equipment*, and *hazardous atmospheres*. All of these hazards, however, can be kept to a minimum with thorough planning. A pre-job survey allows contractors and owners the opportunity to avoid costly changes after the work has begun.

CHAPTER TWO

What OSHA's Standard Requires

The standard covering excavation safety is Title 29 Code of Federal Regulations, Part 1926.650-652, (Subpart P), OSHA's Rules and Regulations for Construction Employment. A copy of the complete standard is found in Appendix A of this workbook. The standard covers all excavations made in the earth's surface, including trenches, and the requirements for protective systems to be used. OSHA defines an **excavation** as any man-made cut, cavity, trench, or depression in the earth's surface as formed by earth removal. This can include anything from excavations for home foundations to a new highway. A **trench** refers to a narrow excavation made below the surface of the ground in which the depth is greater than the width-and the width does not exceed 15 feet. Trenching is common in utility work, where underground piping or cables are being installed or repaired.

If an excavation is more than 5 feet in depth, there must be a **protective system** in place while workers are present in the excavation. Excavations more than 4 feet in depth must have a way to get in and out, usually a ladder, for every 25 feet of horizontal travel.

OSHA requires that regardless of the depth on an excavation, a **competent person must inspect conditions at the site on a daily basis and as frequently as necessary during the progress of work to assure that the hazards associated with excavations are eliminated before workers are allowed to enter.** A competent person has the following qualifications:

- Thorough knowledge of the OSHA standard 29 CFR 1926.650-652 /Subpart P
- Understands how to classify soil types
- Knows the different types and proper use of excavation safety equipment (e.g. protective systems)
- Has the ability to recognize unsafe conditions, the **authority to stop the work** when unsafe conditions exist, the knowledge of how to correct the unsafe conditions, **and does!** If someone has to be called in order to stop the work, or the designated competent person does not stop unsafe acts and conditions, the person is not acting "competently" within the meaning of the standard.

It is the responsibility of the competent person is to conduct daily inspections prior to the start of any work and as needed throughout the shift. He/she may use a checklist to ensure all operations are reviewed. Part of this inspection process includes determining the soil classification. OSHA has included in Appendix A of its excavation standard methods

to make it easier for a competent person to classify soils. (See Chapter 3 for details on soil classification.)

The competent person determines what soil types are present by using both **manual** and **visual** methods. The ability to determine soil type correctly is critical, because soil type is one of the determining factors in specifying protective systems.

A protective system must be used if an excavation is 5 feet or greater in depth. The three most commonly used kinds of protective systems are: *shoring, shielding, and sloping*. Shoring, whether the traditional timber shores or the modern hydraulic shores, brace against and hold up the walls of an excavation, preventing cave-ins. Shielding devices, commonly called trench boxes, shields, or coffins, are not designed to prevent a trench wall from collapsing, but rather serves as a “shield” to the workers within the structure should a cave-in occur. With both shoring and shielding, the workers are only protected as long as they stay within the protective confines of the systems. Sloping refers to the cutting back of the trench walls at such an angle that there is little chance for collapse. Each of these protective systems are acceptable to OSHA; it is up to the competent person to determine which method will be most effective for the job at hand. The competent person must inspect these systems regularly to ensure that they are functioning properly.

CHAPTER THREE

What is Soil?

Soil is a mixture of sand, gravel, silts, clay, water, and air. It is the amounts of these ingredients which determine its “cohesiveness”, how well a soil will hold together. *Cohesive soil* does not crumble. It can be molded easily when wet, and is hard to break up when dry. Clay is a very fine grained soil, and is very cohesive. Sand and gravel are coarse grained soils, having little cohesiveness and often called *granular*. Generally speaking, the more clay that is in the soil being excavated, the better the trench walls will hold up.

Another factor in soil cohesiveness is water. Soil that is filled with water is termed *saturated*. Saturated soil does not hold together well, and is particularly dangerous in excavation work. However, the opposite can also be true. Soil that is void of water, or *oven-dry*, can crumble easily, and will not hold together when excavated.

OSHA classifies soils into four categories: Solid Rock, Type A, Type B, and Type C. Solid Rock is the most stable, and Type C soil is the least stable. . Soils are typed not only by how cohesive they are, but also by the conditions in which they are found. Stable rock is practically unachievable in the excavation of a trench. The excavation of rock typically requires drilling and blasting, which fractures the rock, making it less stable. Type A soil can be clay, silty clay, or sandy clay. A soil cannot be considered Type A if it is fissured or other conditions exist that can adversely effect it, such as:
being subject to vibration from heavy traffic, pile driving, or similar effects
having been previously disturbed/excavated
where it is part of a layered system, where less stable soil is near the bottom of the excavation, with the more stable soils on top.
subject to other factors which would make it unstable-such as the presence of ground water, or freezing and thawing conditions.

Many OSHA compliance personnel believe that construction equipment at the site create enough vibrations to prevent any soil from being typed as “A”. If vibrations can be felt while standing next to an excavation, the competent person should consider downgrading Type A soil to Type B or C.

Type B soils include both cohesive and non-cohesive soils. They include silts, sandy loams, medium clays, and unstable rock. Soils that might be classified as A, but have fissures, or are subject to vibration, may also be classified as “B” soils

Type C soils are the most unstable (and therefore most dangerous) of the four soil types. They are easily recognized by the continual sloughing of the sides of the walls of excavation. If soil is submerged, or water is seeping from the sides of an excavation, it's very probably "C" soil. Soil may be classified as Type C if an excavation is dug in "layered" soils, where different soil types lay on top of each other. If an unstable soil type is underneath a stable soil type, you should always consider the "weakest link". Because of where we dig, it's important to understand that once soil has been excavated, it will never be returned to the composition as it was naturally formed.

In many construction projects, the soil that is being excavated has been *previously disturbed*. This means the soils has been excavated or moved in the past. This is another factor a competent person must consider when typing soils. Previously disturbed soils are rarely as strong as undisturbed soils, and are usually typed as "C" soil. Previously disturbed soil is commonly found above existing utilities, such as water, sewer, electrical and gas lines. This makes work around these utilities more dangerous due to the unstable nature of the soil. Much of the work we perform in excavations are along right-of-ways, where the soil is almost always likely to be Type C.

Note: If you are uncertain of the soil type, ALWAYS assume Type C soil!

A competent person must type soils by using at least one *visual* and one *manual* test. A visual test can include inspecting the soil as it is being removed, and examining the spoil pile and the color and make-up of the remaining excavation walls. A manual test means working with the soil with either your hands or with an instrument designed to measure soil strength. For example, if you can manipulate the soil into a long "worm" or ribbon, the soil is cohesive and may be classified as A or B, depending on other conditions. One useful instrument for measuring soil strength is a *penetrometer*. (*need picture*) When you press this instrument into a soil sample, it measures its unconfined compressive strength in tons per square foot (tsf).

Soil is heavy. A cubic foot can weigh as much as 114 pounds, and a cubic yard can weigh over 3,000 lb. - as much as a pick-up truck! Most workers don't realize the force that will hit them when a cave in occurs. A person buried under only a few feet of soil can experience enough pressure in the chest area to prevent the lungs from expanding. Suffocation can take place in as little as three minutes. Heavier soils can crush and distort the body in a matter of seconds. It's no wonder trench accidents involve so many deaths and permanently disabling injuries.

CHAPTER FOUR

Protective Systems

Protective systems are methods of protecting workers from cave-ins of material that can fall or roll into an excavation, or from the collapse of adjacent structures. As mentioned in earlier chapters, if an excavation is less than 5 feet deep, OSHA does not require a protective systems **unless the competent person sees signs of a potential cave-in.** (It is important to remember that a wall collapse in a trench four and 1/2 feet deep can still have serious results!) For trenches between 5 feet and 20 feet deep, **shoring and sheeting, shielding, sloping and benching** are all acceptable protective measures. It is up to the planners of the construction project and the competent person on site to determine which systems are most appropriate. If an excavation is greater than 20 feet deep, a **registered professional engineer** must design the protective system.

Shoring systems are structures of timber, mechanical, or hydraulic systems that support the sides of an excavation and which are designed to prevent cave-ins. **Sheeting** is a type of shoring system that retains the earth in position. It can be driven into the ground or work in conjunction with a shoring system. Driven sheeting is most frequently used for excavations open for long periods of time. Another type of sheeting, in which plates or shoring grade plywood is used in conjunction with strutted systems such as hydraulic or timber shoring. These strutted systems are also referred to as **active systems**. The most frequently used strutted system involves **aluminum hydraulic shores** which are lightweight, re-usable and installed and removed completely from above ground.

A **shield**, often referred to a trench box is another common protective system used by contractors, an excellent choice when continuous horizontal installations are contemplated. It's placed in the trench and dragged along with the progress of the work. A few important points about shields:

Personnel should be out of the box and above ground when the shield is being moved.
You could be caught between the moving box and fixed object(s);

The top of the shield should extend at least eighteen (18) inches above the level of any materials that could cave or roll into the trench;

Some shields are designed to be stacked, one on top of another. The forces of a cave-in can literally push a box sideways, causing a crushing hazard. After a box is positioned for the work, the voids between the box and the trench wall should be filled with excavated material to prevent displacement caused by a cave-in.

Sloping and benching are another means of protecting workers from cave-in hazards. Sloping is a method of excavating in which the walls of an excavation are laid back to an “angle of repose” suitable to the type of soil.

Insert diagram of simple slope.

Benching is a process of stepping off the earthen walls of an excavation.

Insert simple benching diagram.

Sloping can be used as a system by itself or in conjunction with benching.

Insert simple diagram of slope and bench configuration from appendix.

In the real world, there are very few applications where sloping and/or benching can be used. Why? Most often, the luxury of available space is the first consideration. Many excavations are dug in right-of-ways where other the presence of other utilities and traffic become major considerations. Moreover, for every cubic yard of soil that is removed, it is very likely that nearly the same amount of material must be put back, *and compacted as well.*

Insert diagram of type c slope

If the location to be excavated has been previously disturbed, as it frequently is along a right-of-way, the soil type will very likely be classified as “C”. With Type C soil, the excavation walls must be sloped back on each side of the excavation one and one half feet for every foot of depth.

Add all these factors up and it soon becomes clear: sloping, even in conjunction with benching may be desirable but not always very practical and economical.

A competent person must be conversant with the various sloping and benching configurations available, should that be the choice for protecting workers. In sloping and benching, the important points to remember is the “weakest link” when determining what type of soil is supporting what type of soil. If type C is supporting type B or any other type of combination, the sloping and benching configuration chosen must be in accordance with the OSHA standard. Refer to Appendix A of this workbook for the various conditions in which sloping and/or benching can be used.

Chapter 5

Materials Handling and Mechanized Equipment

Construction, by its nature is an ever-changing environment and involves a constant movement of personnel and materials. The use of mechanized equipment in that process poses significant crushing and striking hazards, particularly in excavation work. Cordon off areas around the swing radius of digging equipment and move the barriers with the progress of the work. This is particularly important when the back-hoe is operating in close proximity to trees and other solid objects such as sections of pre-cast. Most track-type back-hoes have a serious blind-spot - that's usually the rear of the machine on a diagonal to the operator's position.

Remember that loaders and backhoes are primarily earth-moving equipment. Traveling with material suspended from buckets poses a special hazard. Swinging loads may catch a worker between the suspended load and the machinery or the worker may trip on uneven grade and be run over by the equipment.

Back-up alarms and other warning devices tend to be tuned out over time. Many pieces of equipment have only partially unobstructed vision to the rear. Still other types of equipment, such as track equipment and skid-steer loaders make it difficult for an operator to turn completely around when backing up. Don't rely on back-up alarms as the sole warning of which direction a machine is going to move. Always make sure the operator is aware of your position.

You may not be working next to an active motor way but reflective vests or clothing are still a good idea. Don't assume an equipment operator can see you. When any load is brought under tension, regardless of the equipment being used to hoist it, stay away! The load should be controlled with a tag line while aloft and only after being positioned in the location of placement should workers be anywhere near it. No one should have any portion of their body under any portion of a suspended load.

Chapter 6

Hazardous Atmospheres

Hazardous atmospheres frequently go unrecognized by workers until it's too late. Then personnel dive in to rescue and often become the victims as well. Indeed, 60% of all workers who die from such atmospheres are the rescuers themselves. Planners who perform pre-construction site surveys evaluate conditions for potential atmospheric hazards as well as the physical conditions that lend themselves to cave-ins. The competent person understands and uses direct reading instrument(s) that can detect the most common atmospheric hazards found in excavations almost instantaneously.

Hazardous atmospheres include oxygen deficient environments, flammable/combustible/explosive environments and toxic environments. Here are a few examples of the most common sources for hazardous atmospheres in excavations:

Oxygen deficient atmospheres:

Rain water passing over limestone, causing an acidity reaction, in turn causing the development of carbon dioxide. Carbon dioxide is a simple asphyxiant which depletes oxygen and can result in death.

Flammable/Combustible/Explosive Atmospheres:

Volatile organic compounds found in petroleum products can move through voids in soils and accumulate in excavations. Such accumulations can create both a fire and toxic hazard. Adjacent buried tanks are a common source.

Toxic Atmospheres:

Carbon monoxide from vehicles or equipment too near the excavation can accumulate and create a toxic environment for the workers. Important in dealing with potential hazardous environments is their early recognition. Testing equipment for atmospheric hazards in today's world is easily used, compact and one instrument can be purchased to detect the three most common atmospheric hazards found in excavations. Continuous monitoring is always advisable because of the changing conditions that can occur.