

The 25 Greatest Hazards of Excavation

Michael Hayslip, Esq., CSP, PE
National Excavation & Safety
Training Institute (NESTI)
Dayton, Ohio

Eric Voight, CSP
Commerce Risk Control Services
Cherry Hill, New Jersey

Introduction

Excavation issues are always of importance to SH&E professionals in the construction industry. We will cover the essential elements of hazard identification as well as how hazards can be defined and then eliminated or controlled. By the end of our session every attendee should leave with a clear and practical picture of how to address various issues in the workplace.

Each year in the United States, an estimated 100 deaths occur and over 1,000 workers are injured in excavation accidents. Cave-ins pose the greatest risk and are much more likely than other excavation-related accidents to result in worker fatalities. This presentation describes the greatest hazards in the workplace as they relate to excavation and trenching operations performed in the construction industry. When we evaluate the need for safety during excavations, the prime responsibility is always the safety of our personnel.



Excavation Hazards

Soil

Soil is heavy. A cubic foot can weigh as much as 110 pounds, and a cubic yard can weigh between 3,000 and 4,000lbs.—a little more than a small Pickup Truck. 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 while heavier soils can crush

the body in a matter of seconds. And to know, for that moment you may never see your loved ones again.

The texture of the soil is a key to its stability. Cohesion is the ability of a soil to stick together instead of crumbling. The more cohesive a soil is, the safer. Soil is classified by its cohesive properties. With the exception of stable rock the soil types are A, B, and C. Type A soil is the most cohesive of the three soils. Clay, silty clay and clay loam are examples of type A. Type C is the least cohesive. Sand is type C soil. Sandy or loose grain soil have poor cohesive properties and are very dangerous and unstable. The cohesive property of type B lies between A and C.

Caution should be used when classifying soil. Other conditions may affect soil strength. Soil classification should be left up to the competent person. Moisture, vibration and load affect the stability of the soil. What may be safe at one time may not be safe at another. These changes occur often without sufficient warning to protect the workers.

Falls

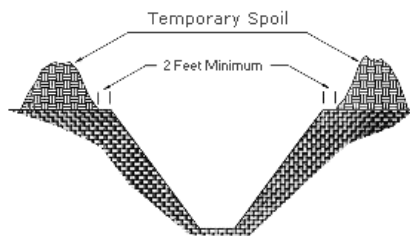
Guardrails, fences, or barricades must be provided on excavations adjacent to any walking/working surface or vehicle passageways. Warning lights or other illumination shall be maintained as necessary for the safety of the public and employees as needed.

All excavations must be effectively barricaded or covered and warnings posted as necessary to prevent unauthorized access. All temporary excavations of this type must be backfilled as soon as possible.

Where employees and the public are permitted to cross over excavations walkways/pedestrian bridges must be protected by standard guardrails. Where workers in the excavation may pass under these walkways or bridges, a standard guardrail and toe board must be used.

Falling Material

Keep soil, materials and equipment that might fall or slide into an excavation at least two feet from the edge of excavations; have restraining devices, or both. Alert equipment operators when they near the edge of an excavation.



If possible, keep the grade away from the excavation. Provide scaling to remove loose rock or soil or install protective barricades and other equivalent protection to protect from the hazard of falling rock, soil or materials. Do not work on the faces of sloped or benched excavations at levels above other workers unless the workers at lower levels are adequately protected.

At a minimum workers should wear personal protective clothing such as a hard hat. The hazard of falling, rolling or sliding material or equipment must be considered. Do not work under loads handled by lifting or digging equipment. To avoid being struck by spillage or falling materials, stand away from vehicles being loaded or unloaded.

Equipment

Vibrations are always present in excavating operations. Equipment and vehicles such as backhoes, excavators and dump trucks are frequently found in the area. Vibrations should be kept to a minimum where possible. The amount of vibration should be considered in the design of the excavation or trench.

When mobile equipment is operated adjacent to the edge of an excavation, a warning system will be used when the operator does not have a clear and direct view of the edge of the excavation. The warning system may consist of barricades, hand or mechanical signals.

Access & Egress

When workers are required to be in excavations four feet deep or more, adequate means of access and egress must be provided. This can be accomplished by a ladder, steps, ramp or other safe means.

All workers should be within twenty-five feet of a means of exit. Do not move a ladder or other device if it will increase the distance another worker must travel. If structural ramps are used by vehicles and used as a means of egress, they must be designed by a competent person.

Traffic

If exposed to vehicular traffic employees shall wear warning vests or reflective, highly visible clothing.

Traffic conditions may also causes vibration which can affect the trench.

Shielding

A shield, also known as a trench box, is a common protective system used by contractors. Trench boxes are not designed to prevent cave-ins, but rather serve to protect workers within the structure should a cave-in occur. The manufacturer should provide the method in which the shield is lowered into the trench, moved and the limits of protection while working inside the shield. 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. **Never** stack shields that are not designed for that purpose, and do not stack shields from different manufacturers, as they may not be compatible.
- 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.
- Shielding should always be used according to manufacturer's tabulated data.

Job-built shields can be designed as described in tables found in the OSHA standard. The standard provides information on the design, type of material and size with respect to the depth of the trench. If these tables are not followed, the support system must be designed using tabulated data approved or prepared by a registered professional engineer.

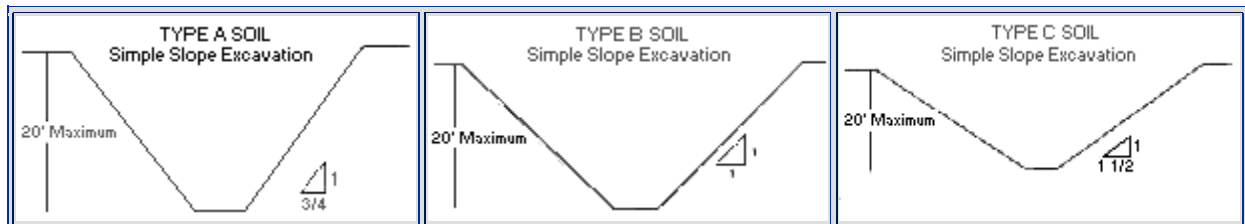
Shoring

Shoring refers to a structure installed against the walls of a trench or excavation. The structure can be hydraulic, pneumatic or a timber shoring system. It must be installed in a manner strong enough to resist the pressures surrounding the excavation and prevent cave-ins. It can be constructed from sheeting, tightly placed timber shores, bracing, trench jacks, piles or other approved materials. OSHA has developed guidelines for the construction and installation of shoring systems which must be followed. This information can be found in the appendices of 29 CFR 1926 Subpart P.

Sloping

Sloping is a method of protecting employees from cave-ins by cutting back the sides of an excavation so that they are inclined away. The angle of incline will vary with the type of soil, environmental conditions and the application of loads.

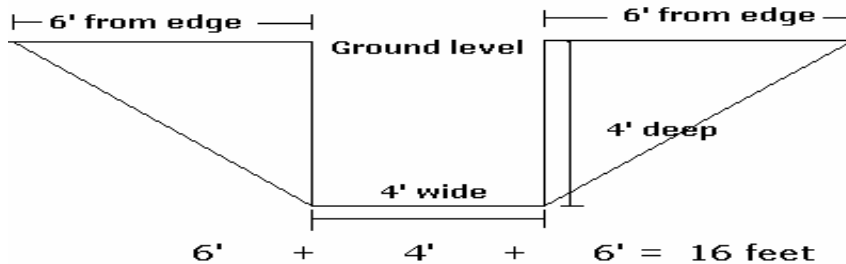
Benching is a method of protecting workers from cave-ins by excavating the sides to form one or a series of levels or steps. The surfaces between levels are usually vertical or near vertical. OSHA has specific guidelines that must be followed for sloping and benching operations.



There are very few applications where sloping and/or benching can be used because of the lack of available space. Many excavations are dug where the presence of other utilities and traffic become major considerations. If the location to be excavated has been previously disturbed, as is

frequent, 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.

Example of slope required for Type C soil



Weather

Rainfall, temperature change and even strong winds can affect the stability of the soil. The competent person must be notified of any changes due to the weather to allow a re-inspection. Soil that freezes after the operation begins can actually cause the soil to move. Water in the soil freezes and expands. The expansion pushes on the soil. If the soil was frozen when the operation began and it gets warmer, thawing will release water, causing the walls and bank to slide.

Installation and Removal of Protective Systems

The installation of the support system must be closely coordinated with the excavation of the trench. Shoring must be placed from the top down and removed from the bottom up to keep the workers in a protective system at all time.

The excavation should be backfilled as the protective system is dismantled. After the excavation has been cleared, workers should slowly remove the protective system from the bottom up, taking care to release members slowly.

When installing support systems, securely connect members of support systems. Never overload the members of a support system.

Do not excavate below the bottom members of a support system unless:

- the system is designed to resist the forces calculated for the full depth of the trench, and
- there are no indications of a possible cave-in below the bottom of the support system, and
- the work below does not exceed two feet in depth.

Competent Person

Regardless of the depth of the excavation, OSHA requires a **competent person to inspect conditions at the site on a daily basis. Inspections must be made 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 the trench.

The competent person shall conduct inspections:

- Daily and before the start of each shift.
- As dictated by the work being done in the trench.
- After every rain storm.
- After other events that could increase hazards, such as snowstorm, windstorm, thaw, earthquake, dramatic change in weather, etc.
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur.
- When there is a change in the size, location, or placement of the spoil pile.
- When there is any indication of change or movement in adjacent structures.

Adjacent Structures

All equipment, materials, supplies, permanent installations (e.g. buildings, roadways), trees, and other objects at the surface that could present a hazard to employees working in the excavation must be removed or supported, as necessary, to protect employees.

Nearby structures can impact the stability of the soil. They create additional forces on the soil. Unsupported structures may even fall into the trench. Structures such as trees, traffic signs or poles are considered surface encumbrances. Surface encumbrances must be removed or secured to eliminate the hazard.

Support systems shall be used to ensure the stability of structures and the protection of employees where excavation operations could affect the stability of adjacent buildings or other structures.

Sidewalks and pavements shall not be undermined unless a support system or other method of protection is provided to protect employees from the possible collapse.

Where review or approval of a support system by a registered professional engineer is required documentation shall be provided to the competent person prior to work commencing.

Utilities

Overhead and underground utilities create hazards. Contractors must have their states One-Call determine the estimated location of utility installations (sewer, telephone, electric, water lines or underground installations). The utility companies or owners must be contacted. They are asked to find the exact location of underground installations. If the utility company cannot respond within 72 hours (State laws may be different) or cannot find the exact location of the utility, the contractor must proceed with caution.

Excavation work must be conducted in a manner that does not endanger underground installations or employees engaged in the work. Utilities left in place must be protected by any means necessary to protect employees.

Water

Surface water, ground water and the level of the water table are important factors. Anyone watching children play in the mud knows that water has a dramatic impact on the soil. Too little or too much water can make soil unstable. If water can accumulate in the trench it must be removed.

The amount of water in soil can change. Ditches, dikes or other suitable means must be used to prevent surface water from entering an excavation. The competent person must inspect excavations subject to runoffs from rains. If water accumulates, it must be drained before the excavation is occupied. If water removal equipment is used to control or prevent water build up, the equipment and operation of the equipment must be monitored by the competent person.

Employees will not work in excavations that contain or are accumulating water unless precautions have been taken to protect employees from hazards posed by water accumulation. The precautions taken could include, for example, special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of safety harnesses and lifelines.

If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operation must be monitored by the competent person.

Heavy Loads

Heavy loads including excavated soil near the face of the excavation can create a dangerous situation. Material shall be kept back from the edge at least two feet. Utilize cribbing for equipment to distribute the weight evenly. For mobile equipment make sure a warning system is used to identify the location of the trench. Observe these warnings.

Atmospheric Conditions

Excavations may be treated as Confined spaces. Atmospheric testing must be conducted in excavations over four feet deep where hazardous atmospheres could reasonably be expected to exist (e.g. natural gas lines, landfills or hazardous process areas).

Adequate precautions must be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen or other hazardous/toxic atmospheres. These precautions may include providing appropriate respiratory protection or positive ventilation.

Atmospheric monitoring shall be performed using a properly calibrated direct reading instrument with audible and visual alarms. Monitoring must be continuous where controls are being used to reduce the level of atmospheric contaminants.

If there is any possibility that the trench or excavation could contain a hazardous atmosphere, atmospheric testing must be conducted prior to entry as would be the case with Permit Required Confined Space.

Bibliography

OSHA Technical Manual

29 CFR 1926 Subpart P, Excavations

Excavation Safety: Available online from <http://www.esafetyline.com/>

OSHA TECHNICAL MANUAL SITE ASSESSMENT QUESTIONS

During first and subsequent visits to a construction or facility maintenance location, the compliance officer (or the site's safety officer or other competent person) may find the following questions useful.

1. Is the cut, cavity, or depression a *trench* or an *excavation*?
2. Is the cut, cavity, or depression more than 4 ft (1.2 m) in *depth*?
3. Is there *water* in the cut, cavity, or depression?
4. Are there adequate means of *access* and *egress*?
5. Are there any *surface encumbrances*?
6. Is there exposure to *vehicular traffic*?
7. Are *adjacent structures* stabilized?
8. Does *mobile equipment* have a *warning system*?
9. Is a *competent person in charge* of the operation?
10. Is *equipment operating* in or around the cut, cavity, or depression?
11. Are procedures required to monitor, test, and *control hazardous atmospheres*?
12. Does a competent person *determine soil type*?
13. Was a *soil testing device* used to determine soil type?
14. Is the *spoil* placed 2 ft (0.6 m) or *more from the edge* of the cut, cavity, or depression?
15. Is the *depth* 20 ft (6.1 m) or *more* for the cut, cavity, or depression?
16. Has a *registered professional engineer* approved the procedure if the depth is more than 20 ft (6.1 m)?
17. Does the procedure require *benching* or *multiple benching*? *Shoring*? *Shielding*?
18. If provided, *do shields extend at least 18 in (0.5 m) above* the surrounding area if it is sloped toward the excavation?
19. If shields are used, is the depth of the cut *more than 2 ft (0.6 m) below the bottom of the shield*?
20. Are any required *surface crossings* of the cut, cavity, or depression the *proper width and fitted with hand rails*?
21. Are means of *egress* from the cut, cavity, or depression *no more than 25 ft (7.6m) from the work*?
22. Is *emergency rescue equipment* required?
23. Is there *documentation of the minimum daily excavation inspection*?