



**STREETER**  
ASSOCIATES

**SHARP MINDS. SUPERIOR CONSTRUCTION.**



# **TRENCHING and EXCAVATION SAFETY**



**TAB 6 ~ TRENCHING AND EXCAVATION**  
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## INTRODUCTION

### PURPOSE

Streeter Associates, Inc. has implemented this Excavation Program to assure the safety of employees who work in or around excavations as part of their job duties. This program is also designed to protect employees and the general public who work or travel in the vicinity of excavations.

### SCOPE

This program is designed to assist Streeter Associates, Inc. with establishing procedures to achieve workplace Safety Standards as established in the OSHA Excavation standard at 29 CFR 1926 Subpart P. The program establishes guidelines and procedures for use on excavations created on Streeter Associates, Inc. job sites.

### APPLICATION

This program applies to all work involving excavations on Streeter Associates, Inc. job sites.

### GENERAL PROGRAM REQUIREMENTS

- Employees who work in or around excavations must be provided training according to their work.
- The excavation or trench must either be sloped or supported as required to comply with OSHA requirements.
- Traffic around the site must be controlled, and barricades, signs, and/or flag persons used as needed to control both vehicular and pedestrian traffic.
- Utilities on the site must be protected and suitable precautions taken if any utility will be disturbed by the work.
- Employees must use required personal protective equipment (PPE).
- Each job site covered by this program must appoint one or more competent person(s) to ensure compliance with this program.
- Work conducted on or around electrical utility systems;
- Tagged out using procedures from the Lockout/Tag Out Program;



Excavation work may involve safety hazards not addressed by this program including:

- Work conducted in areas where hazardous atmospheres or gases could accumulate (e.g. landfills, manure pits, gas distribution lines, or hazardous materials storage locations) covered under the Confined Space Program;
- Work associated with electric power generation, transmission and distribution systems;
- Fall hazards covered under the Fall Protection Program.

## 2.0 RESPONSIBILITIES

Streeter Associates, Inc. will monitor the overall effectiveness of the program through audits and annual reviews. Streeter Associates, Inc will provide worker training and competent person training. Streeter Associates, Inc. will conduct an annual audit of the program and will maintain records relating to training and audits.

### COMPETENT PERSON

Each competent person is responsible for ensuring that procedures described in this program are followed including employee training, personal protective equipment, site inspections, tests, and record keeping.

### EMPLOYEES

Each employee has the responsibility to follow established procedures, enter an excavation only after receiving training, and must demonstrate a complete understanding of the safe work practices to be followed while working in an excavation. Employees must wear the required personal protective equipment.

## 3.0 COMPLIANCE

In order to comply with this program:

1. An initial inspection to evaluate site hazards must be conducted by a competent person.
2. If underground utilities have not been marked out, all underground utilities must be identified by a certified professional. Calling 811 before any excavation takes place will help avoid any accidents or incidents. Once all underground utilities are





marked and identified, these markings need to be maintained throughout the Project.

3. All hazards must be eliminated, controlled, or employees must be provided appropriate personal protective equipment.
4. Protection must be provided against potential cave-ins using either sloping or benching systems or support systems.
5. Inspections must be conducted daily or as conditions occur that may affect or create hazards.

#### 4.0 TRAINING

All personnel involved in excavation work must be trained in accordance with the requirements of this program. Training must be provided before the employee is assigned duties.

Retraining will be provided the lesser of every three years or as necessary to maintain knowledge or skills to safely work within or in the vicinity of excavations.

#### SITE WORKER

Personnel who conduct work within or in the vicinity of excavations must receive training prior to beginning work at the site. The training must include:

- Requirements of the OSHA Excavations standard;
- Requirements of STREETER ASSOCIATES, INC. Excavation Safety Program;
- Work practices;
- Hazards relating to excavation work;
- Methods of protection for excavation hazards;
- Use of Personal Protective Equipment;
- Procedures regarding hazardous atmospheres;
- Emergency and non-entry rescue procedures.

#### COMPETENT PERSON

In addition to site worker training, a job site competent person must also receive training to include:



- Methods of evaluating the site and conducting inspections according to this program;
- Evaluation and selection of protection methods;
- Ensuring compliance with this program;
- Requirements under additional applicable programs such as Confined Space and Fall Protection.

### HAZARDS

### SURFACE ENCUMBRANCES

All equipment, materials, supplies, permanent installations (e.g. buildings, roadways), trees, brush, boulders, 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.

### UNDERGROUND INSTALLATIONS

The location of sewer, telephone, fuel, electric, and water lines as well as any other underground installations that may be encountered during excavation work must be located and marked prior to opening the excavation. The Competent Person must make arrangements as necessary with the appropriate utility agency for the protection, removal, shutdown, or relocation of underground installations.

If it is not possible to establish the exact location of underground installations, the work may proceed with caution provided detection equipment or other safe and acceptable means (e.g. using hand tools) are used to locate the utility as the excavation is opened and each underground installation is approached.

Excavation work will 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 barricades, shoring, suspension, or other means as necessary to protect employees.

### ACCESS AND EGRESS

Stairs, ladders, or ramps must be provided where employees are required to enter trench excavations four feet or more in depth. Stairs, ladders, and ramps, where used, will be in accordance with the Stairways and Ladders Program. The maximum



distance of travel in an excavation to a means of egress will not exceed 25 feet.

### VEHICULAR TRAFFIC

Employees exposed to vehicular traffic must be provided with, and will wear, warning vests or other suitable garments marked with or made of reflective or high-visibility

### FALLING LOADS

No employee will be permitted underneath loads handled by lifting or digging equipment. Employees will be required to stand away from any vehicle being loaded or unloaded. Vehicle operators may remain in the cabs of vehicles being loaded or unloaded when the vehicle provides adequate protection for the operator during loading and unloading operations.

### MOBILE EQUIPMENT

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 must consist of barricades, hand or mechanical signals, or stop logs. If possible, the surface grade will slope away from the excavation.

### HAZARDOUS ATMOSPHERES

Atmospheric testing must be conducted in excavations over four feet deep where hazardous atmospheres could reasonably be expected to exist (e.g. landfill areas, near hazardous substance storage, gas pipelines).

Adequate precautions will be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen or other hazardous atmospheres. These precautions include providing appropriate respiratory protection or forced ventilation. Forced ventilation or other effective means will be used to prevent exposure to an atmosphere containing a flammable gas in excess of 10 percent of the lower flammable limit. Where needed, respiratory protection will be used in accordance with the Respiratory Protection Program.

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

Monitors will be maintained and calibrated in accordance with manufacturer's specifications.



### WATER ACCUMULATION

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

If water is controlled or prevented from accumulating by the use of water removal equipment, a person trained in the use of the equipment must monitor the water removal equipment and operation.

If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means will be used to prevent surface water from entering the excavation. Precautions will also be taken to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains must be re-inspected by the superintendent and competent person to determine if additional precautions should be taken.

### ADJACENT STRUCTURES

Support systems (such as shoring, bracing, or underpinning) will be used to assure the stability of structures and the protection of employees where excavation operations could affect the stability of adjoining buildings, walls, or other structures.

Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees will not be permitted except when:

- A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or
- The excavation is in stable rock; or
- A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or
- A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.
  
- Sidewalks, pavements and appurtenant structures will not be undermined unless a support system or other method of protection is provided to protect employees from the possible collapse of such structures.
  
- Where review or approval of a support system by a registered professional engineer is required, Streeter Associates, Inc. will secure this review and approval in writing before the work is begun.





## LOOSE ROCK OR SOIL

Adequate protection must be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection will consist of:

- Scaling to remove loose material;
- Installation of protective barricades, such as wire mesh or timber, at appropriate intervals on the face of the slope to stop and contain falling material; or
- Benching sufficient to contain falling material.

Excavation personnel will not be permitted to work above one another where the danger of falling rock or earth exists.

Employees must be protected from excavated materials, equipment or other materials that could pose a hazard by falling or rolling into excavations.

- Protection will be provided by keeping such materials or equipment at least 2 feet from the edge of excavations, by the use of restraining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

Materials and equipment may, as determined by the competent person, need to be stored further than 2 feet from the edge of the excavation if a hazardous loading condition is created on the face of the excavation.

Materials piled, grouped or stacked near the edge of an excavation must be stable and self-supporting.

## FALL PROTECTION

Barricades, walkways, lighting and posting must be provided as necessary prior to the start of excavation operations.

Guardrails, fences, or barricades must be provided on excavations adjacent to walkways, driveways, and other pedestrian or vehicle thoroughfares. Warning lights or other illumination must be maintained as necessary for the safety of the public and employees from sunset to sunrise.

Wells, holes, pits, shafts, and all similar excavations must be effectively barricaded or covered and posted as necessary to prevent unauthorized access. All temporary excavations of this type will be backfilled as soon as possible.

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



The competent person will conduct daily inspections of excavations, adjacent areas, and protective systems for evidence of a situation that could result in possible cave-ins, failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection will be by the competent person prior to the start of work and as needed throughout the shift. Inspections will also be made after each hazard-changing event (e.g. rainstorm). These inspections are required when the excavation will be or is occupied by employees.

A sample inspection checklist is included in Section 9.0

Where the competent person finds evidence of a situation that could result in a possible cave-in, failure of protective systems, hazardous atmosphere, or other hazardous conditions, exposed employees will be removed from the hazardous area until precautions have been taken to assure their safety.

The competent person will maintain a written log of all inspections conducted. This log will include the date, work site location, results of the inspection, and a summary of any action taken to correct existing hazards.

## 7.0 PROTECTION

Each employee in an excavation will be protected from cave-ins by using either an adequate sloping and benching system or an adequate support or protective system.

Exceptions to this are limited to:

- Excavations made in stable rock; or
- Excavations less than four feet in depth where examination of the ground by a Competent Person provides no indication of a potential cave-in.

Protective systems will be capable of resisting all loads that could reasonably be expected to be applied to the system.

Section 10 provides a flowchart to assist with the selection of protection systems.

### SLOPING AND BENCHING

The slope and configuration of sloping and benching systems will be selected and constructed by the Competent Person in accordance with Section 11.

Employees will not be permitted to work above other employees on the faces of sloped or benched systems except when employees at the lower levels are protected from the hazard of falling, rolling, or sliding material or equipment.



## SUPPORT SYSTEMS

The design of support systems, shield systems, and other protective systems will be selected and constructed by the Competent Person in accordance with the requirements of Section 14.

## 8.0 GLOSSARY

**Accepted Engineering Practices** means the standards of practice required by a registered professional engineer.

**Adjacent Structure Stability** refers to the stability of the foundation of adjacent structures whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the failure zone of the excavation.

**Aluminum Hydraulic Shoring** means a manufactured shoring system consisting of aluminum hydraulic cylinders (cross braces) used with vertical rails (uprights) or horizontal rails (wales). Such system is designed to support the sidewalls of an excavation and prevent cave-ins.

**Bell-bottom Pier Hole** means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

**Benching or Benching System** is a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or more horizontal steps, usually with vertical or near-vertical surfaces between levels.

**Cave-in** means the movement of soil or rock into an excavation, or the loss of soil from under a trench shield or support system, in amounts large enough to trap, bury, or injure and immobilize a person.

**Competent Person** means one who has been trained to identify hazards in the workplace, or working conditions that are unsafe for employees, and who has the authority to have these hazards eliminated or controlled.

**Cross Braces** mean the horizontal members of a shoring system installed from side to side of the excavation. The cross braces bear against either uprights or wales.

**Excavation** means any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal.

**Faces or Sides** mean the vertical or inclined earth surfaces formed as a result of excavation work.

**Failure** means the movement or damage of a structural member or connection that makes it unable to support loads.



**Hazardous Atmosphere** means an atmosphere that is explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, that may cause death, illness, or injury.

**Ingress and Egress** mean "entry" and "exit" respectively, and refer to the safe means for employees to enter or exit.

**Kickout** means the accidental movement or failure of a cross brace.

**Protective System** means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

**Ramp** means an inclined walking or working surface that is used to gain access to one point from another. A ramp may be constructed from earth or from structural materials such as steel or wood.

**Registered Professional Engineer** means a person who is registered as a professional engineer.

**Sheeting** means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

**Shield or Shield System** means a structure used in an excavation to withstand cave-ins and which will protect employees working within the shield system. Shields can be permanent structures or portable units moved along as work progresses.

**Shoring or Shoring System** means a structure that is built or put in place to support the sides of an excavation to prevent cave-ins.

**Sides** See "Faces."

**Sloping or Sloping System** means sloping the sides of the excavation away from the excavation to protect employees from cave-ins. The required slope will vary with soil type, weather, and surface or near surface loads that may affect the soil in the area of the trench (such as adjacent buildings, vehicles near the edge of the trench and so forth).

**Stable Rock** means natural solid mineral material that can be excavated with vertical sides that will remain intact while exposed.

**Structural Ramp** means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

**Support System** means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.



**Surface Encumbrances** include underground utilities, foundations, streams, water tables, transformer vaults, and geologic anomalies.

**Surcharge** means an excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect stability.

**Tabulated Data** means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

**Trench** means a narrow excavation (in relation to its length) made below the surface of the ground.

**Trench Box** See "Shield".

**Unconfined Compressive Strength** is the load per unit area at which soil will fail in compression.

**Underground Installations** include, but are not limited to, utilities, tunnels, shafts, vaults, foundations, and other underground fixtures or equipment that may be encountered during excavation work.

**Uprights** mean the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

**Wales** are horizontal members of a shoring system placed in the direction of the excavation face whose sides bear against the vertical members of the shoring system or earth (the uprights or sheeting).





## **INSPECTION CHECKLIST**

### **SURFACE CONDITIONS**

- Cracks or Cracking
- Spoil piles set back 2 feet from edge
- No equipment or materials stored near edge
- No standing water in excavation
- No sources of vibration

### **BANKS AND SIDES OF SLOPE OR BENCH**

- Cracks or Cracking
- Spalling
- Change in soil type
- Slope adequate for soil
- SHORING AND SHIELDING
- In place and functioning properly
- No leakage from hydraulic cylinders
- Wedges tight

### **ACCESS AND EGRESS**

- Access every 25 feet
- Stairs, ladders, and ramps set properly

### **EXISTING UTILITIES**

- Support adequate
- Loose materials
- Utilities identified and protected
- WEATHER
- Overnight freezing
- Rain

### **PERSONAL PROTECTIVE EQUIPMENT**

- Reflective or Hi-visibility vests in vehicular areas
- Hard hats, steel-toe shoes, etc. being used as specified



## 10.0 PROTECTION SYSTEMS

Use the following guideline to determine whether protection systems are needed.

1. If the excavation is less than 4 feet deep, a protection system is needed that meets the requirements under Section 11 – Sloping and Benching or Section 14 – Support Systems, unless the site excavation competent person determines that there is no risk for cave-in.
2. If the excavation is between 4 and 20 feet deep, a protection system that meets the requirements under Section 11 – Sloping and Benching or Section 14 – Support Systems must be installed and utilized in all occupied areas of the excavation.
3. If the excavation is greater than 20 feet, a protection system designed by a registered engineer must be installed and utilized in all occupied areas of the excavation.

## 11.0 SLOPING AND BENCHING SYSTEMS

The slope and configuration of sloping and benching systems must be selected and constructed by the Competent Person in accordance with one of the following:

### **Option 1 - ALLOWABLE CONFIGURATIONS AND SLOPES.**

Excavations must be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the Competent Person uses one of the other options listed below.

The slopes used must be excavated in accordance with the slopes shown for Type C soil in Section 12 - Sloping and Benching.

### **Option 2 - DETERMINATION OF SLOPES AND CONFIGURATIONS.**

Maximum allowable slopes, and allowable configurations for sloping and benching systems, must meet the requirements of Section 12 - Sloping and Benching and Section 13 - Soil Classification.

### **Option 3 - DESIGNS USING OTHER TABULATED DATA.**

The design of sloping or benching systems may be selected from, and must be constructed in accordance with, other tabulated data, such as tables and charts. The tabulated data used must be in written form and include all of the following:



- Identification of the factors that affect the selection of a sloping or benching system;
- Identification of the limits of use of the data, including the maximum height and the angle of the slopes determined to be safe;
- Other information needed by the user to make correct selection of a protective system.
- One copy of the tabulated data that identifies the registered professional engineer who approved the data must be maintained at the jobsite during construction of the protective system.

#### **Option 4 - DESIGN BY A REGISTERED PROFESSIONAL ENGINEER:**

Sloping and benching systems not utilizing Option (1), Option (2) or Option (3) above must be approved by a registered professional engineer.

Designs must be in written form and must include at least the following:

- The maximum height and angle of the slopes that were determined to be safe for the particular project;
- The identity of the registered professional engineer approving the design.

At least one copy of the design must be maintained at the jobsite while the slope is being constructed.

## 12.0 SLOPING AND BENCHING

### SCOPE AND APPLICATION

This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this Section apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in Section 11 – Sloping and Benching Systems Option 2.

### DEFINITIONS

**Actual slope** means the slope to which an excavation face is excavated.

**Distress** means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the



face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

**Maximum allowable slope** means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

**Short term exposure** means a period of time less than or equal to 24 hours that an excavation is open.

## REQUIREMENTS

### Soil classification

Soil and rock deposits must be classified in accordance with the Section 13 – Soil Classification Procedures.

*Maximum allowable slope table on next page*



Maximum allowable slope

The maximum allowable slope for a soil or rock deposit must be determined from Table C2-1.

**Table C2-1: Maximum Allowable Slopes for Excavations Less Than 20 Feet**

Soil or Rock Type	Maximum Slope (H:V)	Maximum Slope (Degrees)
Stable Rock	Vertical	90
Type A	.75:1	53
Type B	1:1	45
Type C	1.5:1	34

*Footnote(1) Numbers shown in Max Slope (degrees) are angles expressed in degrees from the horizontal. Angles have been rounded off.*

*Footnote(2) A short-term maximum allowable slope of 1/2H:1V (63 degrees) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth will be 3/4H:1V (53 degrees).*

*Footnote(3) Sloping or benching for excavations greater than 20 feet deep will be designed by a registered professional engineer.*





Actual slope

The actual slope must not be steeper than the maximum allowable slope.

The actual slope must be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope must be cut back to an actual slope which is at least 1/2 horizontal to one vertical (1/2H:1V) less steep than the maximum allowable slope.

When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person must:

- determine the degree to which the actual slope must be reduced below the maximum allowable slope, and
- assure that such reduction is achieved.

Surcharge loads from adjacent structures must be evaluated in accordance with this program.

Configurations

Configurations of sloping and benching systems must be in accordance with the table and figures below.

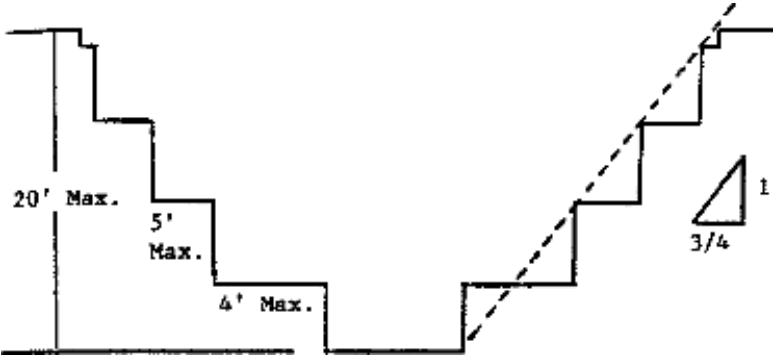
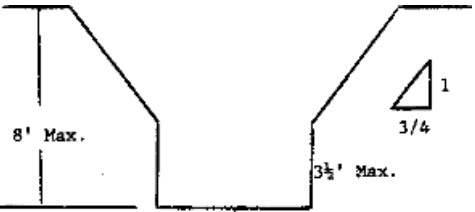
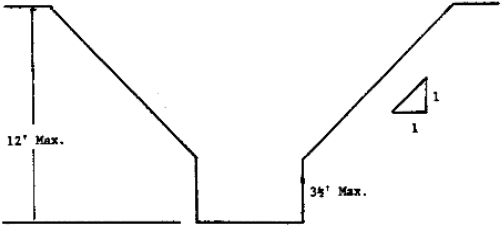
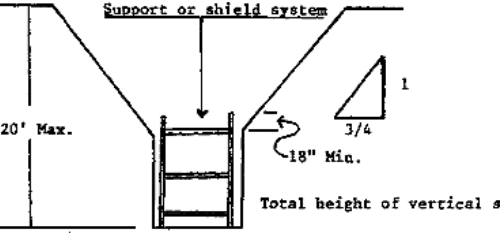
**Figures: Slope Configurations**

All slopes stated below are in the horizontal to vertical ratio.

Excavations made in Type A soil

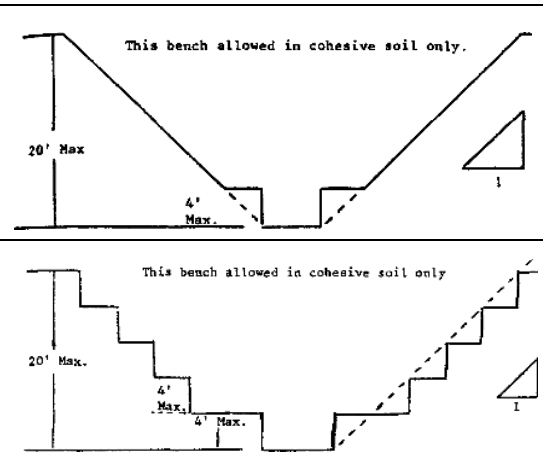
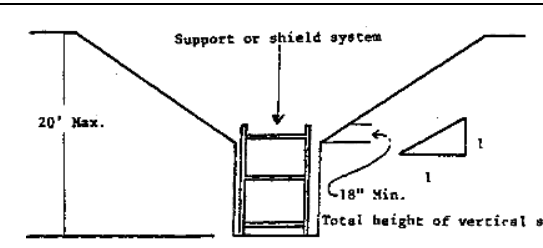
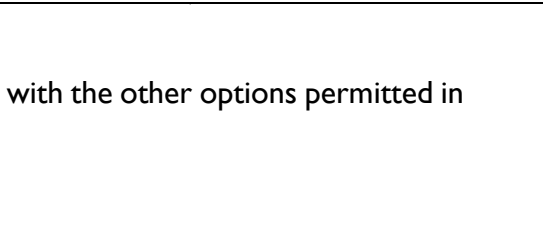
<p>All simple slope excavations 20 feet or less in depth will have a maximum allowable slope of 3/4:1.</p>	
<p>All benched excavations 20 feet or less in depth will have a maximum allowable slope of 3/4 to 1 and maximum bench dimensions as indicated.</p>	



	
<p>All excavations 8 feet or less in depth which have unsupported vertically sided lower portions will have a maximum vertical side of 3 1/2 feet.</p>	
<p>All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions will have a maximum allowable slope of 1:1 and a maximum vertical side of 3-1/2 feet</p>	
<p>All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded will have a maximum allowable slope of 3/4:1. The support or shield system must extend at least 18 inches above the top of the vertical side.</p>	

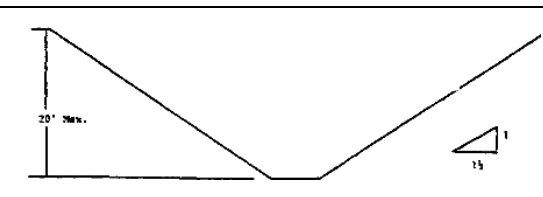
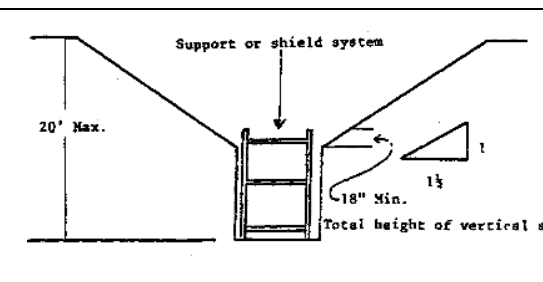
All other simple slope, compound slope, and vertically sided lower portion excavations will be in accordance with the other options described in Section 11 – Sloping and Benching Systems.



<p>All benched excavations 20 feet or less in depth will have a maximum allowable slope of 1:1 and maximum bench dimensions as indicated.</p>	
<p>All excavations 20 feet or less in depth which have vertically sided lower portions will be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations will have a maximum allowable slope of 1:1.</p>	
<p>All excavations 20 feet or less in depth which have vertically sided lower portions will be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations will have a maximum allowable slope of 1:1.</p>	

All other sloped excavations must be in accordance with the other options permitted in Section 11 – Sloping and Benching Systems.

Excavations Made in Type C Soil

<p>All simple slope excavations 20 feet or less in depth will have a maximum allowable slope of 1 1/2:1.</p>	
<p>All excavations 20 feet or less in depth which have vertically sided lower portions will be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations will have a maximum allowable slope of 1 1/2:1.</p>	

All other sloped excavations must be in accordance with the other options described in Section 11 – Sloping and Benching Systems.



Excavations Made in Layered Soils

All excavations 20 feet or less in depth made in layered soils will have a maximum allowable slope for each layer as set forth below.

Type B over Type A	
Type C over Type A	
Type C over Type B	
Type A over Type B	
Type A over Type C	
Type B over Type C	

All other sloped excavations must be in accordance with the other options described in Section 11 – Sloping and Benching Systems.



### 13.0 SOIL CLASSIFICATION

#### SCOPE AND APPLICATION

##### SCOPE

This Section describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. This appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

##### APPLICATION

This Section applies when a sloping or benching system is designed in accordance with the requirements set forth in 1926.652(b)(2) as a method of protection for employees from cave-ins. This Section also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with Section 14. This Section also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in 1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

##### DEFINITIONS

The definitions and examples given below are based on, in whole or in part, the following; American Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System; The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

**Cemented soil** means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

**Cohesive soil** means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

**Dry soil** means soil that does not exhibit visible signs of moisture content.

**Fissured** means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.





**Granular soil** means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

**Layered system** means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

**Moist soil** means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

**Plastic** means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

**Saturated soil** means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or shear vane.

**Soil classification system** means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the characteristics of the deposits and the environmental conditions of exposure.

**Stable rock** means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

**Submerged soil** means soil which is underwater or is free seeping.

**Type A** means cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
- The soil has been previously disturbed; or
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or



- The material is subject to other factors that would require it to be classified as a less stable material.

**Type B** means:

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
- Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
- Previously disturbed soils except those which would otherwise be classed as Type C soil.
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
- Dry rock that is not stable; or
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

**Type C** means:

- Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or
- Granular soils including gravel, sand, and loamy sand; or
- Submerged soil or soil from which water is freely seeping; or
- Submerged rock that is not stable, or
- Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

**Unconfined compressive strength** means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

**Wet soil** means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.



## REQUIREMENTS

### Classification of soil and rock deposits

Each soil and rock deposit will be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in this appendix.

### Basis of classification

The classification of the deposits will be made based on the results of at least one visual and at least one manual analysis. Such analyses will be conducted by a competent person using tests described below, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

### Visual and manual analyses

The visual and manual analyses, such as those noted as being acceptable in this appendix, will be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

### Layered systems

In a layered system, the system will be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

### Reclassification

If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, a competent person will evaluate the changes. The deposit will be reclassified as necessary to reflect the changed circumstances.

## ACCEPTABLE VISUAL AND MANUAL TESTS

### Visual tests

Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes.



Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spill off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

#### Manual tests

Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

**Plasticity.** Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

**Dry strength.** If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.



Thumb penetration. The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488 - "Standard Recommended Practice for Description of Soils (Visual - Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

Other strength tests. Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

Drying test. The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

If the sample develops cracks as it dries, significant fissures are indicated.

Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as an unfissured cohesive material and the unconfined compressive strength should be determined.

If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

#### 14.0 SUPPORT SYSTEMS

The design of support systems, shield systems, and other protective systems will be selected and constructed by the Competent Person in accordance with one of the following options.

##### **Option I - Designs using OSHA Criteria.**

Timber shoring and aluminum hydraulic shoring must be utilized in accordance with OSHA criteria.



### **Option 2 - Designs using manufacturers tabulated data.**

Support systems, shield systems, or other protective systems (e.g. trench boxes) drawn from manufacturer's tabulated data will be constructed and used in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer will only be allowed after the manufacturer issues specific written approval.

Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations will be kept in written form at the jobsite during construction of the protective system.

### **Option 3 - Designs using other tabulated data.**

Designs of support systems, shield systems, or other protective systems will be selected from and be constructed in accordance with tabulated data, such as tables and charts.

The tabulated data will be in written form and include all of the following:

- Identification of the factors that affect the selection of a protective system drawn from such data;
- Identification of the limits of use of the data;
- Information needed by the user to make a correct selection of a protective system from the data.
- At least one copy of the tabulated data, identifying the registered professional engineer who approved the data, will be maintained at the jobsite during construction of the system.

### **Option 4 - Design by a registered professional engineer.**

Support systems, shield systems, and other protective systems not using the options detailed in options 1, 2, or 3 above will be approved by a registered professional engineer.

Designs will be in written form and will include the following:

- A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and
- The identity of the registered professional engineer approving the design.



At least one copy of the design will be maintained at the jobsite during construction of the protective system.

#### MATERIALS AND EQUIPMENT

Materials and equipment used for protective systems will be free from damage or defects that might affect their proper function.

Manufactured materials and equipment used for protective systems will be used and maintained in accordance with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

When material or equipment used for protective systems are damaged, the Competent Person will ensure that these systems are examined by a competent person to evaluate its suitability for continued use. If the competent person can not assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment will be removed from service. These materials or equipment will be evaluated and approved by a registered professional engineer before being returned to service.

#### INSTALLATION AND REMOVAL OF SUPPORT

Members of support systems will be securely connected together to prevent sliding, falling, kickouts, or other potential hazards.

Support systems will be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

Individual members of support systems will not be subjected to loads exceeding those which those members were designed to support.

Before temporary removal of individual support members begins, additional precautions will be taken as directed by the Competent Person to ensure the safety of employees.

These precautions could include, for example, the installation other structural members to carry the loads imposed on the support system.

Removal of support systems will begin at, and progress from, the bottom of the excavation. Members will be released slowly. If there is any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation the work will be halted until it can be examined by the competent person.





Backfilling will progress together with the removal of support systems from excavations.

Additional requirements for support systems for trench excavations:

- Excavation of material to a level no greater than 2 feet below the bottom of the members of a support system is allowed, but only if the system is designed to resist the forces calculated for the full depth of the trench. There will be no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.
- Installation of a support system will be closely coordinated with the excavation of trenches.

### SHIELD SYSTEMS

Shield systems will not be subjected to loads that are greater than those they were designed to withstand.

Shields will be installed in a manner that will restrict lateral or other hazardous movement of the shield that could occur during cave-in or unexpected soil movement. Employees will be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

Employees will not be allowed in shields when shields are being installed, removed, or moved vertically.

In trench excavations, excavation of material to a level no greater than 2 feet below the bottom of the shield system is allowed, but only if the system is designed to resist the forces calculated for the full depth of the trench. There will be no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield system