EXCAVATION
&
TRENCHING

Steingass Mechanical Contracting, Inc.
754 Progress Drive
Medina, Ohio 44256
(330) 725-6090

EXCAVATION AND TRENCHING

INTRODUCTION

The Occupational Safety and Health Act under 29 CFR 1926 Subpart P establishes requirements relating to employee protection in excavations and trenches. In response to the regulatory mandate, Steingass Mechanical Contracting, Inc. has developed and will maintain the Excavation and Trenching Program to provide the proper and safe procedures for all applicable employees.

PURPOSE

This document is primarily intended to outline the methods of protecting and/or informing all applicable employees of the hazards associated with excavation and trenching operations. In addition, it is intended that Steingass Mechanical Contracting, Inc. will be in full compliance with 29 CFR 1926 Subpart P.

Due to the serious nature of this policy, Steingass Mechanical Contracting, Inc. intends to continually monitor this policy for its workability and identify and correct inadequacies or deficiencies.

RESPONSIBILITY

Steingass Mechanical Contracting, Inc. shall instruct all applicable employees in the safety significance of the Excavation and Trenching Program and/or procedures. In addition, Steingass Mechanical Contracting, Inc. considers these requirements to be of critical importance in helping to ensure that the applicable provisions of the Excavation and Trenching Program are known, understood, and strictly adhered to by all employees. Strict enforcement of this program is required as a condition of employment. Any variations from these set procedures will be considered a work rule violation and because of the serious nature of this program, disciplinary action will be taken in accordance with the disciplinary guidelines described in Steingass Mechanical Contracting, Inc.`s Safety Rules and Regulations.

DEFINITIONS

Accepted engineering practices: Means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum hydraulic shoring: Means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hold: 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 (benching system): Means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in: Means the separation of a mass of soil or rock material from the side of an excavation or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation , either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person: Means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces: Means the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the sides of which 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:*** Means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure: Means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere: Means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness or injury.

Kickout: Means the accidental release 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 or 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, and is 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 in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a registered professional engineer within the meaning of this standard when approving designs for manufactured protective systems or tabulated data to be used in interstate commerce.

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 (shield system): Means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either pre-manufactured or job-built provided it meets the requirements for a shield system. Shields used in trenches are usually referred to as trench boxes or trench shields.

Shoring (shoring system): Means a hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides: See Faces.

Sloping (sloping system): Means a method of protecting employees from cave-ins by excavating to form sides of an excavations that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock: Means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

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.

Tabulated data: Means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (trench excavation): Means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box: See Shield.

Trench shield: See Shield.

Uprights: Means 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: Means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

SPECIFIC REQUIREMENTS FOR EXCAVATIONS

A site specific safety plan for excavation and trenching shall be developed and include the following:

1. All surface encumbrances which are located to create a hazard to employees will be removed or supported to safeguard employees.

2. Underground installations:

    a. The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines or any other underground installations that reasonably may be expected to be encountered during excavation work, will be determined prior to opening an excavation.

    b. Utility companies or owners will be contacted within established or customary local response times, advised of the proposed work and asked to establish the location of the utility underground installations prior to the start of the excavation. When utility companies or owners cannot respond to a request to locate underground utility companies with 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, work may proceed, provided it is done with caution and detection equipment or other acceptable means to locate utility installations are used.

    c. When excavation operations approach the estimated location of underground installations, the exact location of the installations will be determined by safe and acceptable means.

    d. While the excavation is open, underground installations will be protected, supported or removed as necessary to safeguard employees.

3. **Access and egress.**

   a. Structural ramps:

      i. Structural ramps used solely by employees as a means of access or egress from excavations will be designed by a competent person. Structural ramps used as access or egress of equipment will be designed by a competent person qualified in structural design and will be constructed in accordance with that design.

      ii. Ramps and runways constructed of two or more structural members will have the structural members connected together to prevent displacement.

      iii. Structural members used for ramps and runways will be uniform thickness.

      iv. Cleats or other appropriate means used to connect runway structural members will be attached to the bottom of the runway or will be attached in a manner to prevent tripping.

      v. Structural ramps used instead of steps will be provided with cleats or other surface treatments on the top surface to prevent slipping.

   b. A stairway, ladder, ramp or other safe means of egress will be located in trench excavations that are 4 feet or more in depth and require no more than 25 feet of lateral travel for employees.

4. Employees exposed to public vehicular traffic will be provided and wear warning vests (or other suitable garments) marked with or made of reflectorized or high-visibility material.

5. No employee will be permitted underneath loads handled by lifting or digging equipment. Employees will be required to stand away from vehicles being loaded or unloaded to avoid being struck by spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when vehicles are equipped with a cab shield and/or canopy adequate to protect the operator from shifting or falling objects.

6. When mobile equipment is operated adjacent to an excavation, or when the equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system will be utilized such as barricades, hand or mechanical signals, or stop logs. If possible the grade will be away from the excavation.

7. Hazardous atmospheres

a. To prevent exposure to harmful levels of atmospheric contaminants, the following requirements will apply:

i. Where oxygen deficient (atmospheres containing less than 19.5% oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, i.e., excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation will be tested before employees enter excavations greater than 4 feet in depth.

ii. Adequate precautions will be taken to prevent employee exposure to atmospheres containing less than 19.5% oxygen and other hazardous atmospheres. These precautions include providing respiratory protection and/or ventilation.

iii. Adequate precaution will be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20% of the lower flammable limit of the gas.

iv. When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing will be conducted as often as necessary to ensure that the atmosphere remains safe.

b. Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, will be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment will be attended when in use.

c. Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, will wear a harness with a lifeline securely attached to it. The lifeline will be separate from any line used to handle materials and will be individually attended at all times while the employee wearing the lifeline is in the excavation.

8. Hazards associated with water accumulation.

   a. Employees will not work in excavations in which there is accumulated water, or in excavations, in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately will vary, but include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use a safety harness and lifeline.

   b. If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations will be monitored by a competent person to ensure proper operation.

   c. 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 and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person.

9. Where the stability of adjoining buildings, walls or other structures is endangered by excavation operations, support systems such as shoring, bracing or underpinning will be provided to ensure the stability of such structures for the protection of employees.

10. An excavation below the level of the base or footing of any foundation or retaining wall will not be permitted except when:
    a. A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

    b. The excavation is in stable rock; or

    c. A registered profession engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

    d. A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

11. Sidewalks, pavements and appurtenant structure will not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

12. Employees will be protected from the hazards associated with loose rock and soil by the following means:

    a. Adequate protection will 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 remove loose material; installation of protective barricades at intervals on the face to stop and contain falling material; or other means that provide equivalent protection.

    b. Employees will be protected from excavated or other material or equipment that could pose a hazard by falling or rolling into excavations. Protection will be provided by placing and keeping such materials or equipment at least 2 feet from the edge of the excavations, or by use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both.

13. Steingass Mechanical Contracting, Inc.'s competent person will have the responsibility to conduct daily inspections of excavations, the adjacent area and protective systems prior to the start of work and throughout the shift after every rainstorm or other hazard increasing occurrence. These inspections will be made to look for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions.

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

15. Adequate fall protection shall be provided where employees are exposed to walking/working surfaces greater than 6 feet or more above lower levels. Walkways with guardrails will be provided where employees or equipment are required or permitted to cross over excavations.

16. Attractive Nuisances. Steingass Mechanical Contracting, Inc.'s competent person shall have the responsibility to ensure adequate barrier protection for remotely located excavation is in place.

PROTECTIVE SYSTEMS

Each employee in an excavation will be protected from cave-ins by an adequate protective system (i.e. sloping and benching system or a shield systems) except when excavations are made entirely in stable rock or excavations are less than 5 feet in depth ***and*** examination by the competent person provides no indication of a potential cave-in. Protective systems will have the capacity to resist without failure all loads that are intended or expected to be applied or transmitted to the system.

CRITERIA FOR DESIGN OF SLOPING AND BENCHING SYSTEMS

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

1. ***Option 1 - Allowable configurations and slopes***
   a. Excavations will be sloped at an angle not steeper than 1½ horizontal to 1 vertical, unless one of the other options listed below are used.

   b. Slopes will be excavated to form configurations that are consistent with the slopes shown in Appendix B for Type C soil.

2. ***Option 2 - Determination of slopes and configurations using Appendices A and B***

   Maximum allowable and allowable configurations for sloping and benching systems, will be determined with the conditions and requirements in Appendices A and B.

3. ***Option 3 - Designs using other tabulated data.***
   a. Designs of sloping and benching systems will be selected from and be in accordance with tabulated data, such as tables and charts.
   b. The tabulated data will be in written form and will include the following:
      i. Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

ii. Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;
iii. Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

c. At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, will be maintained at the job site during construction of the protective system. After that time the data may be stored off the job site, but a copy of the data will be made available upon request.

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

a. Sloping and benching systems not utilizing Options 1, 2 or 3 will be approved by a registered professional engineer.

b. Designs will be in written form and will include at least the following:
i. The magnitude of the slopes that were determined to be safe for the particular project;
ii. The configurations that were determined to be safe for the particular project; and
iii. The identity of the registered professional engineer approving the design.

c. At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, will be maintained at the job site during construction of the protective system. After that time the data may be stored off the job site, but a copy of the data will be made available upon request.

MATERIALS AND EQUIPMENT

1. Materials and equipment used for protective systems will be free from damage or defects that may impair their proper function.

2. Manufactured materials and equipment used for protective systems will be used and maintained in a manner that is consistent with the manufacturer's recommendations and will prevent employee exposure to hazards.

3. Material or equipment used for protective systems is damaged; the competent person will examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is suitable for safe use, the material or equipment will be removed from service, and will be evaluated and approved by a registered professional engineer before being returned to service.

INSTALLATION AND REMOVAL OF SUPPORT SYSTEMS

1. Members of support systems will be securely connected together to prevent sliding, falling, kickouts or other predictable failure.

2. Support systems will be installed and removed in a manner to protect employees from cave-ins, structural collapses or from being struck by member of the supports system.

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

4. Prior to temporary removal of individual precautions will be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

5. Removal will begin at and progress from the bottom of the excavation. Members will be released slowly to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

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

7. Excavation of material to a level no greater than 2 feet below the bottom of the members of a support system will be permitted provided the system is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

8. Installation of a support system will be closely coordinated with the excavation of trenches.

SHIELD SYSTEMS

1. Shield systems will not be subjected to loads exceeding those which the system was designed to withstand.

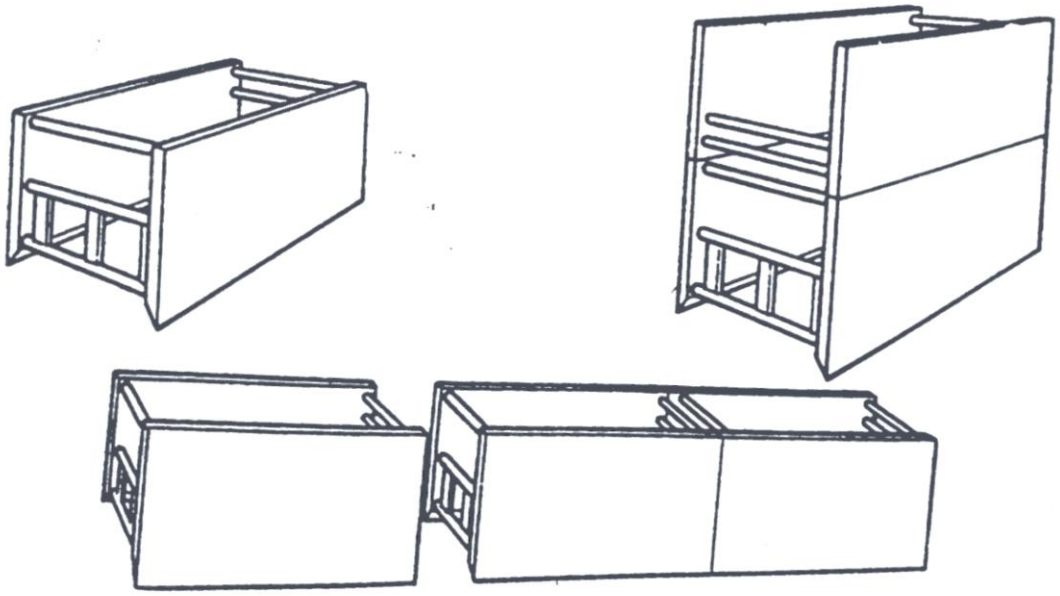
2. Shields will be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

3. Employees will be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

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

5. Excavations of earth material to a level not greater than 2 feet below the bottom of the shield will be permitted provided the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

Examples of Trench Shields



APPENDIX A - SOIL CLASSIFICATION

This appendix 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. The appendix contains definitions, sets forth requirements and describes acceptable visual and manual tests for use in classifying soils.

This appendix will apply when a sloping or benching system, timber shoring and other protective systems are designed as a method of protection for employees from cave-ins where data is used based upon the use of the soil classification system.

DEFINITIONS

The definitions and examples given below are based on, in whole or in part, the following:

- American Society for Testing Materials (ASTM) Standard D653-85 and D2488;
- The Unified Soils Classification System;
- The U. S. Department of Agriculture (USDA) Textural Classification Scheme;
- The National Bureau of Standard 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 handsize sample cannot be crushed into powder or individual soil particles 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 sheer vane.

Soil classification system: Means,for the purpose of this program, 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 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 soil with an unconfined compressive strength of 1.5 ton per square foot (tsf) or greater. Examples of cohesive soil 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:

i. The soil is fissured: or
ii. The soil is subject to vibration from heavy traffic, pile driving or similar effect; or
iii. The soil has been previously disturbed; or
iv. 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 or greater; or
v. The material is subject to other factors that would require it to be classified as a less stable material.

Type B: Means

i. Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf; or
ii. 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.
iii. Previously disturbed soils except those which would otherwise be classed as Type C. soil.
iv. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
v. Dry rock that is not stable; or
vi. Material that is part of a sloped, layered system where the layers dip into the excavation of a slope less steep than four horizontal to one vertical, but only if the material would otherwise be classified as Type B.

Type C: Means

i. Cohesive soil with an unconfined compressive strength of .5 tsf or less; or
ii. Granular soils including gravel, sand and loamy sand; or
iii. Submerged soil or soil from which water is freely seeping; or
iv. Submerged rock that is not stable, or
v. Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical 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

1. Each soil and rock deposit will be classified by a competent person as Stable Rock, Type A, Type B or Type C.

2. 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 the competent person using tests as outlined 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.

3. The visual and manual analyses 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.

4. 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.

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

VISUAL SOIL CLASSIFICATION 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.

1. 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.

2. 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.

3. 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 spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

4. 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.

5. 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.

6. 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.

7. 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.

1. ***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 diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two- inch length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

2. ***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 and there is no visual indication the soil is fissured, the soil may be considered un-fissured.

3. ***Thumb penetration.*** The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils.

- Type A soil 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.

4. ***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.

5. ***Drying test.*** The basic purpose of the drying test is to differentiate between cohesive material with fissures, un-fissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick and six inches in diameter until it is thoroughly dry:

   a. If the samples develop cracks as it dries, significant fissures are indicated.

   b. 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 un-fissured cohesive material and the unconfined compressive strength should be determined.

   c. If a samples 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.

APPENDIX B - SLOPING AND BENCHING

This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins.

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 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 ravelling, 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 ration 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 FOR SLOPING AND BENCHING SYSTEMS

1. Soil and rock deposits will be classified in accordance with Appendix A of the Trenching and Excavation Program.

2. The maximum allowable slope for a soil or rock deposit will be determined by the following Table B-1:

Soil or Rock Type	**Maximum allowable slopes (H:V)[1] for excavation less than 20 feet deep[3]**
Stable rock	Vertical (90^0)
Type A[2]	3/4:1 (53^0)
Type B	1:1 (45^0)
Type C	1½:1 (34^0)

[1] Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

[2] A short-term maximum allowable slope of ½H:1V (63^0) is allowed in excavation in Type A soil that are 12 feet or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet in depth will be _H:1V (53^0).

[3] Sloping and benching for excavations greater than 20 feet deep will be designed by a registered professional engineer.

3. The actual slope will meet the following requirements:

   a. The actual slope will not be steeper than the maximum allowable slope.

   b. The actual slope will be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope will be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

   c. When surcharge loads from stored material or equipment, operating equipment or traffic are present, the competent person will determine the degree to which the actual slope must be reduced below the maximum allowable slope, and will assure that such reduction is achieved. Surcharge loads from adjacent structures will be evaluated.

SLOPE CONFIGURATIONS

Configurations of sloping and benching systems will be in accordance with Figure B-1. All slopes stated below are in the horizontal to vertical ratio.

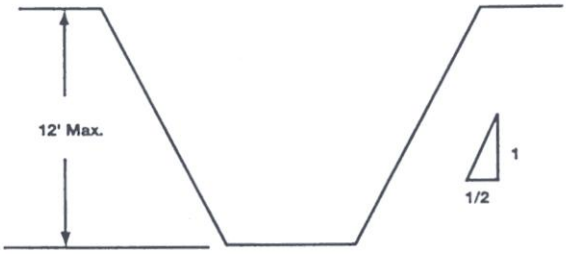
Figure B–1
Slope Configurations
(All slopes stated below are in the horizontal to vertical ratio)

B—1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.

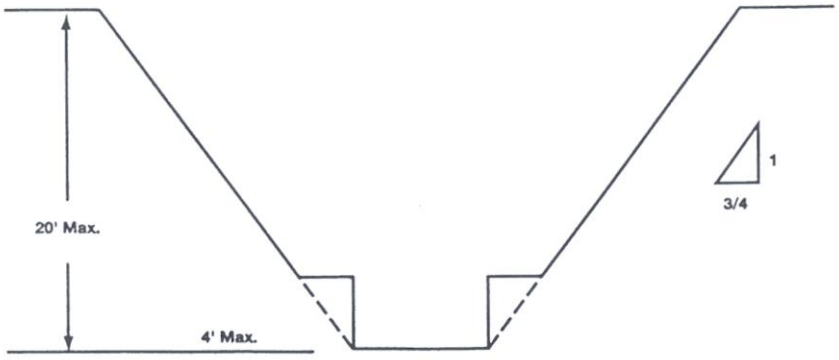
SIMPLE SLOPE—GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

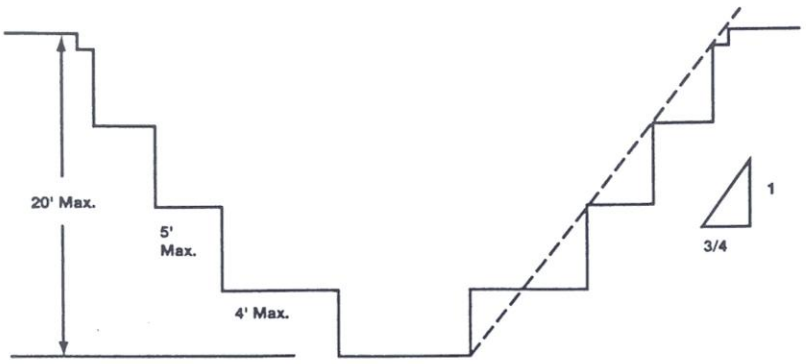


SIMPLE SLOPE—SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and a maximum bench dimentions as follows:

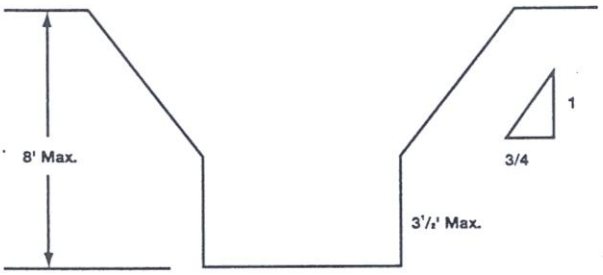


SIMPLE BENCH



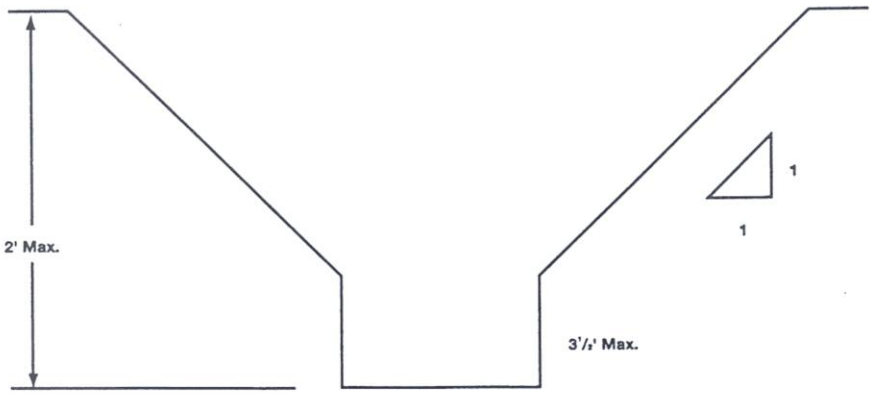
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



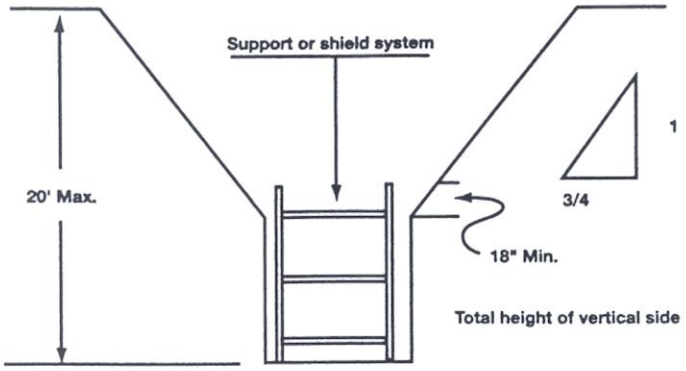
UNSUPPORTED VERTICALLY SIDED LOWER PORTION — MAXIMUM 8 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION — MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾ :1. The support or shield system must extend at least 18 inches above the top of the vertical side.

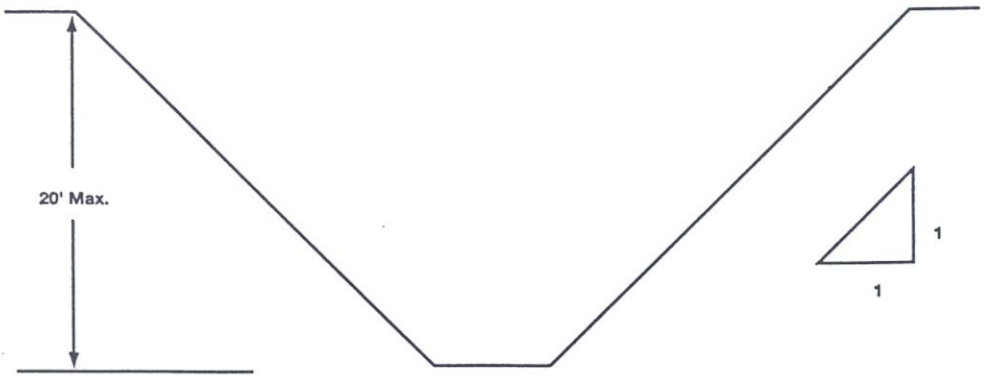


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under §1926.652(b).

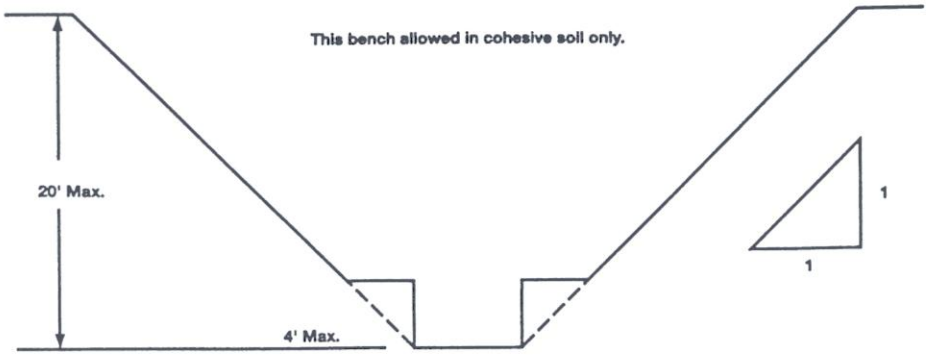
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

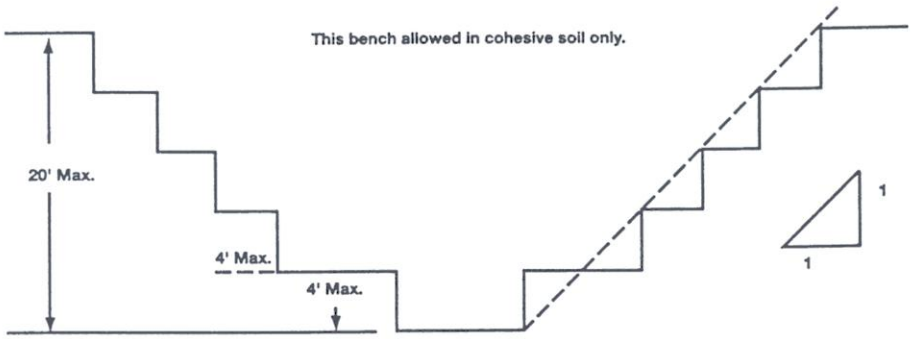


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

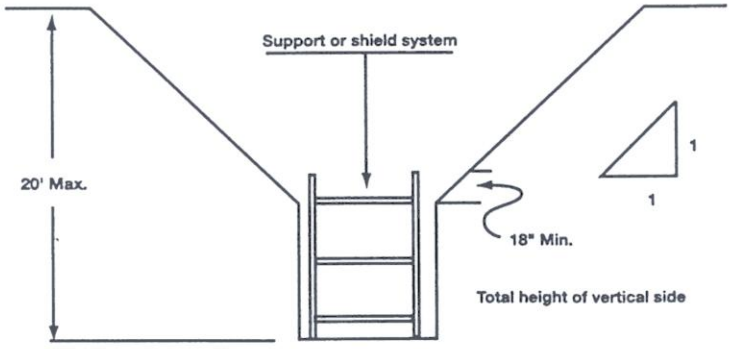


SINGLE BENCH



MULTIPLE BENCH

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

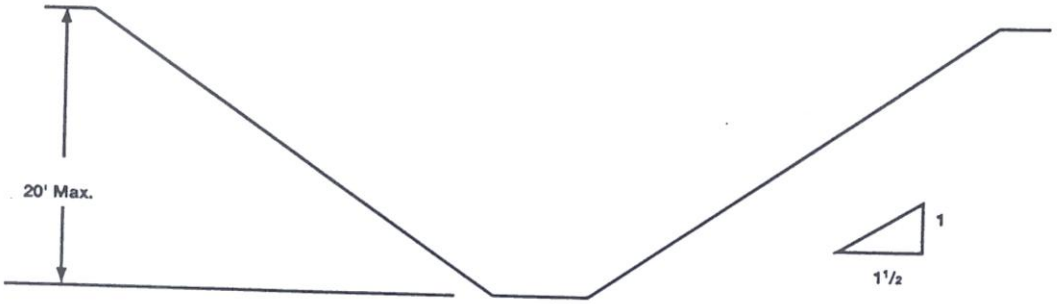


VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

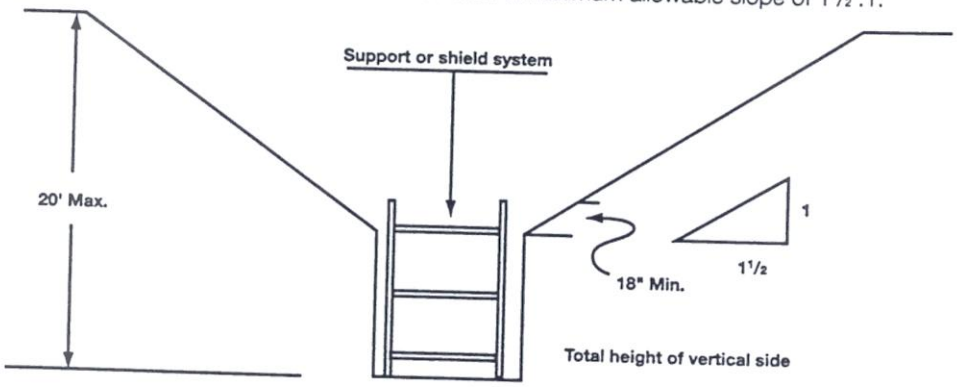
B—1.3 Excavations Made in Type C Soil.

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½ :1.

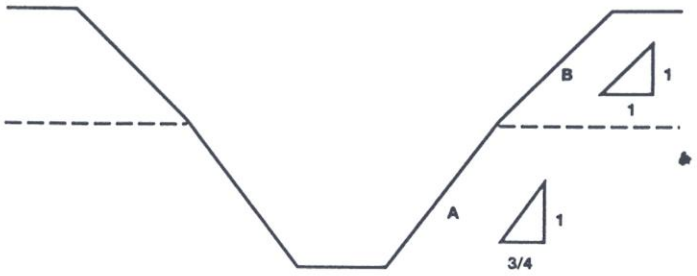


VERTICALLY SIDED LOWER PORTION

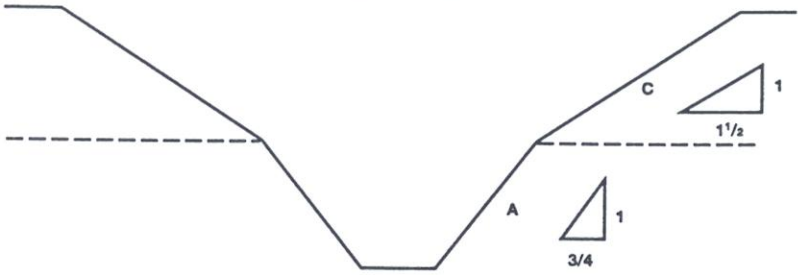
3. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

B—1.4 Excavations Made in Layered Soils

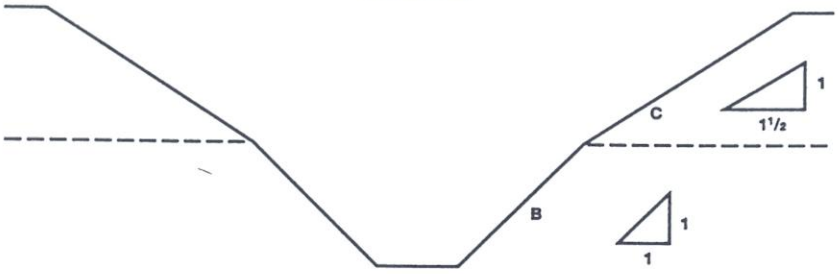
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



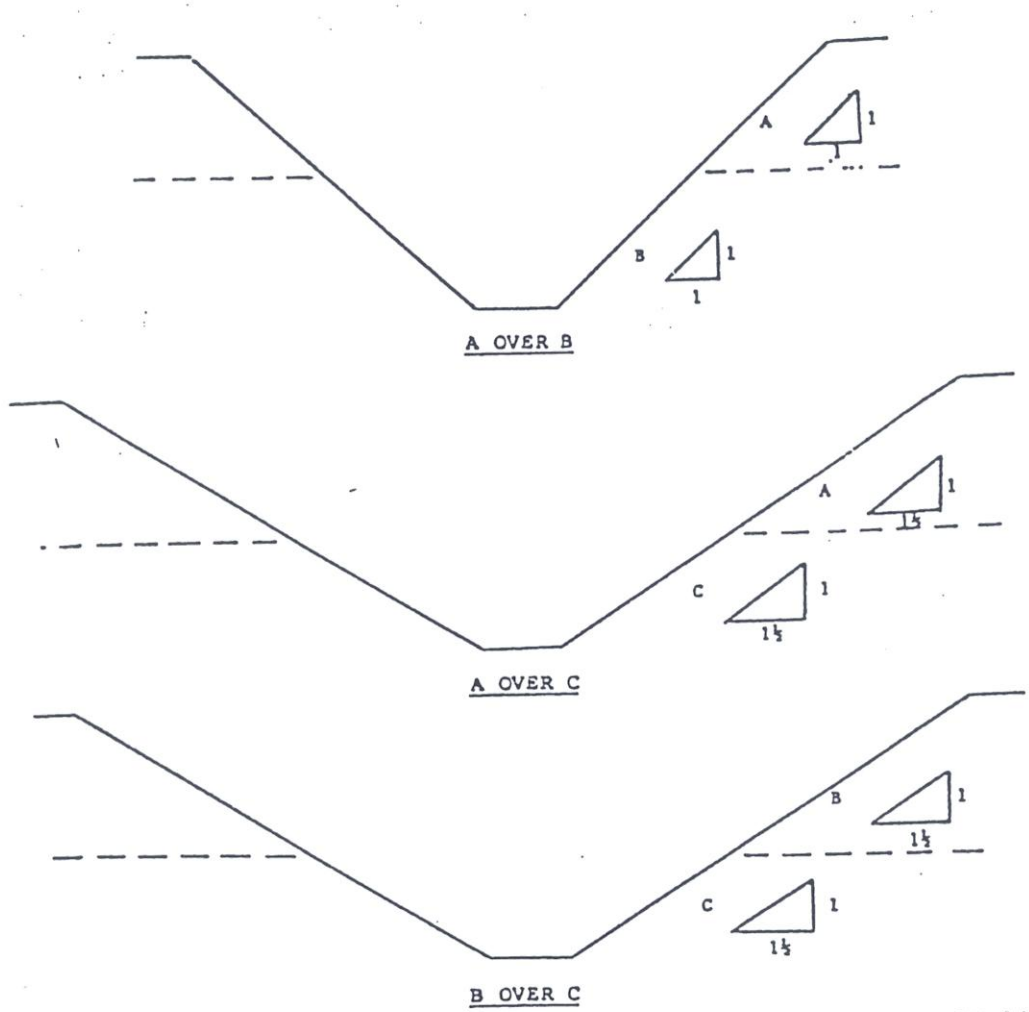
B OVER A



C OVER A



C OVER B



2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).