CITY OF SACRAMENTO REGULATORY COMPLIANCE PROGRAM
TOPIC: TRENCHING AND EXCAVATION SAFETY PROGRAM
EFFECTIVE DATE: 7/18/12
SUPERSEDES: N/A
SECTION: RCP #17

PURPOSE

The objective of the Trenching and Excavation Safety Program (TESP) is to establish requirements for practices and procedures to protect employees when working in trenches and excavations. To ensure compliance with the California Code of Regulations, including Title 8, §§ 1539-1542, this regulatory compliance program provides guidance to managers, supervisors, and employees of the City of Sacramento required to work in and/or around trenches and excavations.

RESPONSIBILITIES

1. Department and/or Division Managers are responsible for:

    a. Implementing the TESP throughout his or her departments;

    b. Requesting help from Environmental Health & Safety (EH&S) staff to study specific operations, facilities, and equipment to determine employee exposure as needed;

    c. Using engineering and/or administrative controls to reduce exposure to excavation hazards as required;

    d. Implementing specific worksite procedures for the use of protective devices in accordance with this TESP;

    e. Providing access to the regulations to all employees who are subject to the TESP;

    f. Ensuring that soil conditions are evaluated by a Competent person before the start of work, daily and throughout the job as conditions change; and

    g. Maintaining records of the excavation checklist for a minimum of three years.

2. **Competent persons are responsible for:**

    a. Knowledge of the provisions pertaining to excavations, trenches and earthwork;

    b. Knowledge of soil analysis as related to excavations, trenches and earthwork;

    c. Knowledge of the use of protective systems;

    d. Implementation of prompt corrective action on the job as conditions warrant; and

    e. Recognition of the potential and testing for hazardous atmospheres;

f. Inspection of trenches and excavations before the start of work, daily and throughout the day as conditions change.

3. Supervisors are responsible for:

a. Implementing the TESP within their work group;

b. Ensuring access to protective devices as deemed necessary by the Competent person;

c. Ensuring that soil classification is performed;

d. Assisting in selection of protective equipment;

e. Conducting evaluations of the workplace to ensure that the written TESP is being properly implemented;

f. Monitoring employees to ensure that they are using proper protective devices when necessary.

g. Ensuring proper documentation of inspections (Attachment A); and

h. Ensuring that training on trenching and excavation safety is provided to all exposed employees.

4. Site Supervisors/Lead Workers are responsible for:

a. Implementing TESP at the site;

b. Ensuring that soil classification is performed;

c. Ensuring appropriate protective devices are utilized according to design;

d. Ensuring that an "excavation Competent person" is designated; and

e. Assisting in providing training on trenching and excavation safety.

5. Excavation Competent person are responsible for:

a. Identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees;

b. Taking prompt corrective measures to eliminate hazards;

c. Knowing excavation safety standards including soil classification;

d. Knowing the proper use of protective systems and trench safety equipment; and

e. Documenting his or her experience and training.

6. **Employees are responsible for:**

a. Working in compliance with TESP; and

b. Never entering an excavation meeting the scope of this program until authorized by the Competent person.

7. Environmental Health and Safety Specialists are responsible for:

a. Providing technical support for excavation and shoring operations;

b. Assisting in atmospheric testing and equipment selection as needed;

c. Assisting in protection equipment selection;

d. Providing onsite evaluation to monitor use of safe work practices and procedures;

e. Assisting in providing training on trenching and excavation safety; and

f. Reviewing and updating TESP.

PROCEDURES

1. Utilities

Utilities must be located at least two days prior to excavation in accordance with the City's Underground Service Alert (USA) Program. Excavations must not endanger the underground installations, or the employees engaged in the work. Utilities left in place should be protected by barricades, shoring, suspension or other means as necessary to protect employees. City personnel discover or cause damage to subsurface installations, site personnel will immediately call emergency services (911), the owner of the installation, and the City EH&S Office.

2. Public Access

Excavations must be isolated from public access by substantial physical barrier. Barricades, lighting and posting shall be installed as needed prior to the start of excavation operations. All temporary excavations shall be backfilled as soon as possible.

Guardrails, fences or barricades should be installed around excavations adjacent to walkways, roads paths or other traffic areas. Use of barricade tape alone is not a sufficient method of isolation when the excavation is unattended. Warning lights or other illumination shall be used as necessary for the safety of the public at night. Wells, holes, pits and similar excavations must be effectively barricaded and/or covered and posted if unattended. Walkways or bridges used by the general public, employees or equipment to cross excavations must be equipped with standard guardrails with the vertical height of the top rail within the range of 42 to 45 inches.

3. Surface Encumbrances

All equipment, materials, supplies, buildings, roadways, trees, utility vaults, boulders, etc., that could present a hazard to employees working in the excavation, must be removed or supported as necessary to protect employees.

4. Soil Classification

The competent person in charge of the excavation is responsible for determining the soil type. All previously disturbed soil is automatically considered Type C soil. Soil may be classified as Type C by default and no additional tests are required. To classify a soil as Type B the Competent person shall use a visual test coupled with one or more manual tests as described in Attachment B.

5. Protective Systems

Each employee required to work in an excavation of five feet deep or more must be protected from cave-ins by shoring and/or sloping. Excavations of less than five feet in depth are excluded from this requirement only if they are in solid rock or a Competent person has inspected and finds no indication of a potential cave-in. If there is a possibility of soil movement, protective systems are required for trenches and excavation of less than five feet.

Acceptable protective methods include sloping, benching, shielding and shoring. Excavations under the base of the footing for a foundation or wall, or greater than 20 feet in depth, require support systems designed by a registered professional engineer.

Sidewalks, pavement, utility vaults or other similar structures shall not be undermined unless a support system or another method of protection is provided to protect employees from possible collapse. Sloping or benching are often preferred methods of protection; however, shoring or shielding can be used when the location of the excavation makes sloping or benching to the allowable angle impractical. See Attachment C for commonly used examples of sloping and benching protective systems. For detailed information refer to Requirements for Protective Systems in Title 8, Section 1541.1 of the California Code of Regulations (T8 CCR 1541.1), including Appendices A through F.

6. Sloping

Maximum allowable slopes for excavations of less than 20 feet are based on soil type and angle to the horizontal are as follows:

a. Stable Rock can have vertical walls with an angle of 90-degrees

b. Type A soil must have walls sloped to a maximum angle of 53-degrees (0.75:1 slope) from horizontal in all directions.

c. Type B soil must have walls sloped to a maximum angle of 45-degrees (1:1 slope) from horizontal in all directions.

d. Type C soil must have walls sloped to a maximum angle of 34-degrees (1.5:1 slope) from horizontal in all directions. (See Attachment C, Figures 1 & 2 for examples).

7. Shielding

Trench boxes or trench shields are intended to protect workers from cave-ins and similar incidents. The trench shield is lowered into the excavation and workers may then enter only the protected area within the shield. When shielding is used in conjunction with sloping, the shielding must extend a minimum of 18 inches above the top vertical side. (See Attachment C, Figure 4 for examples).

On vertical cut trenches the shielding must extend to at least the top of the excavation. As much as two feet of earth material can extend below the shielding, only if 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.

8. Access and Egress

Structural ramps that are used solely by employees as a means of access or egress from excavations, shall be designed by a Competent person. Structural ramps used for access or egress of equipment shall be designed by a Competent person qualified in structural design and shall be constructed in accordance with the design.

Means of safe egress from trench excavations such as a stairway, ladder, or ramp shall be located in trench excavations that are four feet or more in depth at a frequency that requires no more than 25 feet of lateral travel for all employees.

9. **Adjacent Structures**
   Where the stability of adjoining buildings, walls, sidewalks or other structures are endangered by excavation operations, support systems such as shoring, bracing or underpinning shall be provided. Undermining the surface of adjacent structures without an engineered support system is prohibited.

10. **Subsurface Installations**
    Hand excavation only is required within two feet of subsurface installations to determine the exact location of the installation before using any power- operated or power-driven excavating or boring equipment, except for the removal of any existing pavement if there are no subsurface installations contained in the pavement.

11. **High Priority Subsurface Installations**
    When the excavation is proposed within ten feet of a high priority subsurface installation, an onsite meeting is required between the excavator and the subsurface installation owner/operator's representative at a mutually agreed upon time to determine the action or activities required to verify the location of such installations. High priority subsurface installations include high pressure natural gas lines, petroleum pipelines, pressurized sewage pipelines, conductors or cables that have a potential to ground of 60,000 volts or more, or pipelines that are potentially hazardous to employees, or the public, if damaged.

12. **Loose rock or Soil**
    Employees shall be protected from loose rock or soil that could pose a hazard by falling or rolling from the excavation face. Such protection shall consist of scaling to remove loose material and/or installation of protective barricades at necessary intervals along the face to stop and contain falling material. Other means that provide equivalent protection are also acceptable.

    Employees shall be protected from excavated materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least two feet from the edge of excavations using retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations.

13. **Hazardous Atmosphere**
    Where oxygen deficiency (atmospheres containing less than 19.5% oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, the atmosphere inside the evacuation shall be tested before employees enter excavations greater than four feet in depth. Atmospheric monitoring will be conducted in accordance with the City's Confined Space Entry Program, RCP #6. Adequate precautions shall be taken to prevent employee exposure to hazardous atmospheres including ventilation and/or respiratory protection. When a hazardous atmosphere exists, or may be reasonably expected to develop, operations will be conducted as permit-required confined space entries in addition to compliance excavation requirements.

14. **Water Accumulation**
    Employees shall not work in excavations in which there is accumulated water or in excavations in which water is accumulating, unless adequate protective precautions are taken. The precautions may include support or shield systems, water removal procedures, or use of safety harness and lifeline. Water removal equipment and operations shall be monitored by a Competent person.

15. Vehicle and Equipment Hazards

Employees exposed to vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

Employee shall not be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with Title 8, Section 1591(e) of the California Code of Regulations, to provide adequate protection for the operator during loading and unloading operations.

When mobile equipment is operated adjacent to an excavation, or when such 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 shall be utilized such as barricades, hand or mechanical signals or stop logs. If possible, the grade should be away from the excavation.

16. Inspections

Excavations, areas adjacent to excavations and protective systems shall be inspected daily by a Competent person for circumstances that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions. An inspection shall be conducted by the Competent person prior to the start of work and as needed throughout the shift.

Inspections shall also be made after every rain storm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated. 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 shall be removed from the hazardous area until the necessary precautions have been taken to ensure his or her safety.

PERSONAL PROTECTIVE EQUIPMENT

Employees who are working in or around excavations shall wear the following personal protective equipment (PPE) at a minimum:

a. ANSI 107 compliant Class 2 or higher high visibility clothing;

b. ANSI Z-89 compliant hard hat;

c. ANSI Z-87 compliant safety glass; and

d. Approved work uniform.

TRAINING

Employees will be trained in the hazards of working in and around excavations prior to exposure and periodically if work practices change. All supervisors and site supervisors will be trained and qualified as excavation Competent persons.

RECORDKEEPING

a. Written Program
Update and maintain TESP in accordance with applicable regulations and industry best practices.

b. Excavation Checklists and Inspections
Maintain records for three years.

c. Employee Training Records
Maintain records for duration of employment plus three years.

Daily Trench/Excavation Inspection Form (Attachment A)

In accordance with Cal-OSHA regulations, trenches/excavations are to be inspected for hazardous conditions prior to entry and continuously throughout the work by a Competent person. The Competent person must inspect the following items and **sign** that the inspection has been completed. Make comments as appropriate and retain inspection form on file for three years. If there is a deficiency, inform your supervisor immediately. Work is not to proceed until the hazardous condition is mitigated or controlled.

Project: _____ Department: _____

Date: _____ Time: _____ Weather: _____

Soil Type: _____Trench Depth: _____ Length: _____Width: _____

Type of Protective System: _____ USA Ticket #: _____

Excavation	**Yes**	**No**	**N/A**	
Warning system established and used when mobile equipment is operating near edge of excavation.				
Emergency Action Plan established and communicated to crew.				
Means of Access and Egress	**Yes**	**No**	**N/A**	**Comments**
Travel distance to means of egress no greater than 25 feet in excavations four (4) feet or more in depth.				
Straight ladders used in excavations extend at least three (3) feet above the edge of trench				
Ramps being used by the employee access have been designed by Competent person.				
Employees protected from cave-ins when entering or exiting the excavation.				
Wet Conditions	**Yes**	**No**	**N/A**	**Comments**
Precautions taken to protect employees from water accumulation.				
Water removal equipment monitored by Competent person.				
Surface water or runoff controlled or diverted to prevent accumulation in excavation.				
Inspection made by Competent person after each rainstorm or other hazard-increasing occurrence.				
Utilities	**Yes**	**No**	**N/A**	
Utility companies contacted and/or utilities located.				
Exact location of utilities marked when near excavation.				
Prior to use of equipment, underground utilities have been located by hand digging.				
Underground installations protected, supported or removed when excavation is open.				

Excavation	Yes	No	N/A	Comments
Is excavation less than five feet in depth?				
Is there a potential for a cave-in? **(If YES, excavation must be sloped, shored or shielded)**				
Is excavation five feet or deeper than five feet in depth?				
Is sloping used as your protective system?				
Excavations, adjacent areas & protective systems inspected by Competent person daily and before the start of work.				
Competent person has authority to remove workers from excavation immediately.				
Surface encumbrances supported or removed.				
Employees protected from loose rock or soil.				
Hard hats and safety glasses worn by all employees.				
Spoils, materials and equipment set back a minimum of two (2) feet from edge of excavation.				
Adequate barriers provided at all excavations, wells, pits, shafts, etc.				
Walkways and bridges over excavations six (6) feet or more in depth and more than thirty (30) inches wide equipped with guardrails.				
High visibility clothing worn by all employees.				
Employees prohibited from working or walking under suspended loads or booms.				
Employees required to stand away from vehicles being loaded or unloaded.				
Employees prohibited from working on faces of sloped or benched excavations above other employees.				
Safety harness and life line individually attended when employees enter deep confined excavations.				

	REQUIRED TESTS OF AIR IN THE CONFINED SPACE							**REQUIRED TESTS OF AIR IN THE CONFINED SPACE**					
					OTHER[1]							OTHER[1]	
TIME	LEL %	OXY %	H_2S PPM	CO PPM	PPM	PPM	TIME	LEL %	OXY %	H_2S PPM	CO PPM	PPM	PPM
Permit Required if :	Is > 10%	Is not 19.5 – 23.5%	Is not < 10 ppm	Is not < 25 ppm				Is > 10%	Is not 19.5 – 23.5%	Is not < 10 ppm	Is not < 25 ppm		

Support Systems	Yes	No	N/A	Comments
Materials and/or equipment for support systems selected based on soil analysis, trench depth, and expected loads.				
Materials and equipment used for protective systems inspected and in good condition.				
Materials and equipment not in good condition have been removed from service.				
Protective systems installed without exposing employees to the hazards of cave-ins, collapses, or threat of being struck by materials or equipment.				
Members of support system securely fastened to prevent failure.				
Support systems provided to ensure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.				
Excavations below the level of the base of a footing have been approved by a Registered Professional Engineer.				
Removal of support systems progresses from the bottom and members are released slowly so you can note any indication of possible failure.				
Backfilling progresses with removal of support system.				
Excavation of material to a level no greater than two (2) below the bottom of the support system and only if system is designed to support the loads calculated for the full depth.				
Shield system placed to prevent lateral movement.				
Employees are prohibited from remaining in shield system during vertical movement.				

Training	Yes	No	N/A	Comments
All employees have had excavation safety awareness training.				

_____ _____ _____

Name of Competent person (Please Print) Signature of Competent person Date

Soil Classification Requirements Definitions (Attachment B)

Cemented soil
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
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 side slopes, 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: Soil that does not exhibit visible signs of moisture content.

Fissured soil
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
A 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
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
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
A property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil
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
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
Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil
Soil which is underwater or is free seeping.

Type A soil
Cohesive soils with an unconfined, compressive strength of 1.5 tons per square foot (tsf) or greater. Examples of cohesive soils are as follows: 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:

1. The soil is fissured;
2. The soil is subject to vibration from heavy traffic, pile driving, or similar effects;
3. The soil has been previously disturbed;
4. 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;
5. The material is subject to other factors that would require it to be classified as a less stable material.

Type B soil

1. Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf;
2. 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;
3. Previously disturbed soils except those which would otherwise be classed as Type C soil;
4. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration;
5. Dry rock that is not stable;
6. 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 soil

1. Cohesive soil with an unconfined compressive strength of 0.5 tsf or less;
2. Granular soils including gravel, sand, and loamy sand;
3. Submerged soil or soil from which water is freely seeping;
4. Submerged rock that is not stable;

5. Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H: 1V) or steeper.

Unconfined compressive strength
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
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. **Classification of soil and rock deposits**

   Each soil and rock deposit shall be classified by a Competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth above.

2. **Basis of classification**

   The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a Competent person using tests described in the acceptable visual and manual tests section below, or in other approved 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. **Visual and manual analyses**

   The visual and manual analyses, such as those noted as being acceptable in the visual and manual tests section of this Appendix, shall 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. **Layered systems**

   In a layered system, the system shall 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. **Reclassification**

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

Acceptable Visual and Manual Tests

1. 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.

a. 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;

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

c. 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;

d. 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;

e. 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;

f. 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;

g. 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.

2. Manual Tests

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

a. 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 length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive;

b. 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 un-fissured;

c. Thumb Penetration - The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. 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 (rain, flooding), the classification of the soil must be changed accordingly;

d. 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;

e. 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 and six inches in diameter until it is thoroughly dry:

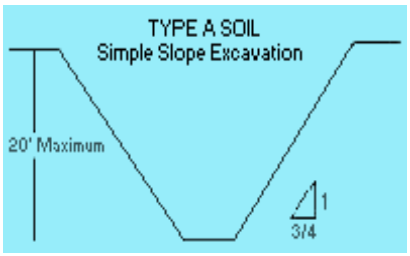
1. If the sample develops cracks as it dries, significant fissures are indicated;

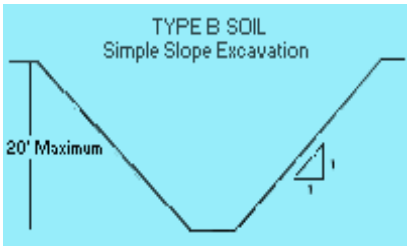
2. Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as an un-fissured cohesive material and the unconfined compressive strength should be determined;

3. 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.

Excavation Diagrams
(Attachment C)

Figure 1 illustrations of simple slope trenching in A, B and C type soils.





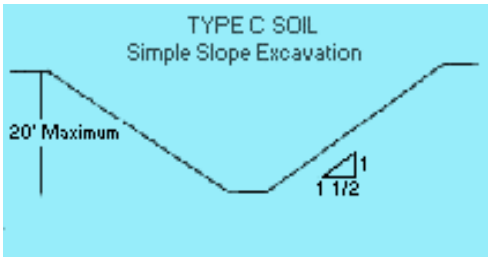
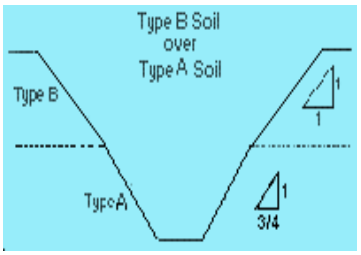
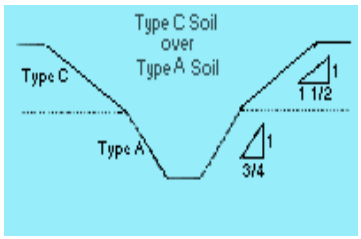
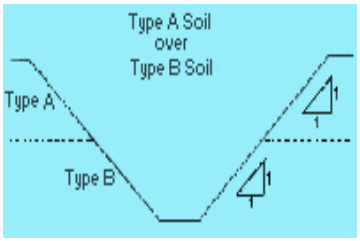
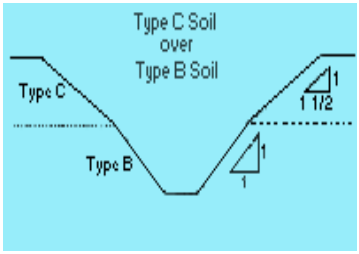


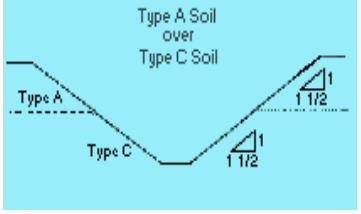
Figure 2 illustrations of slope configurations in layered soils.











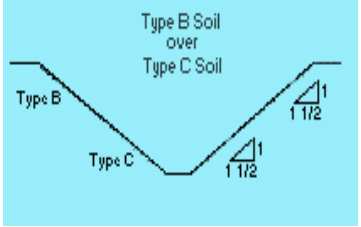
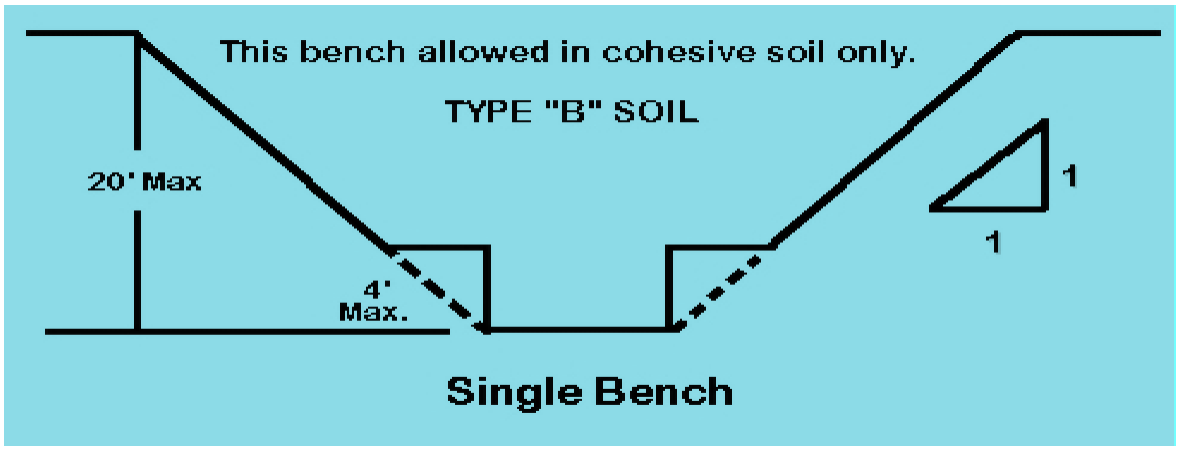
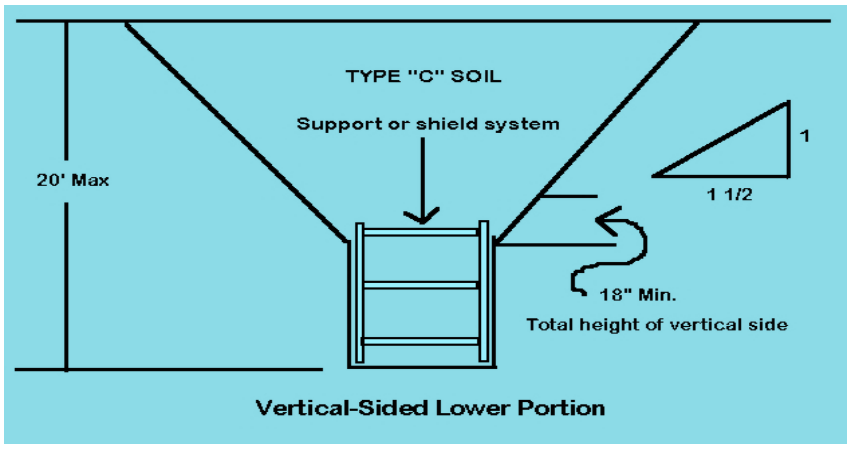


Figure 3
All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1. Benching is not allowed in type C soil.





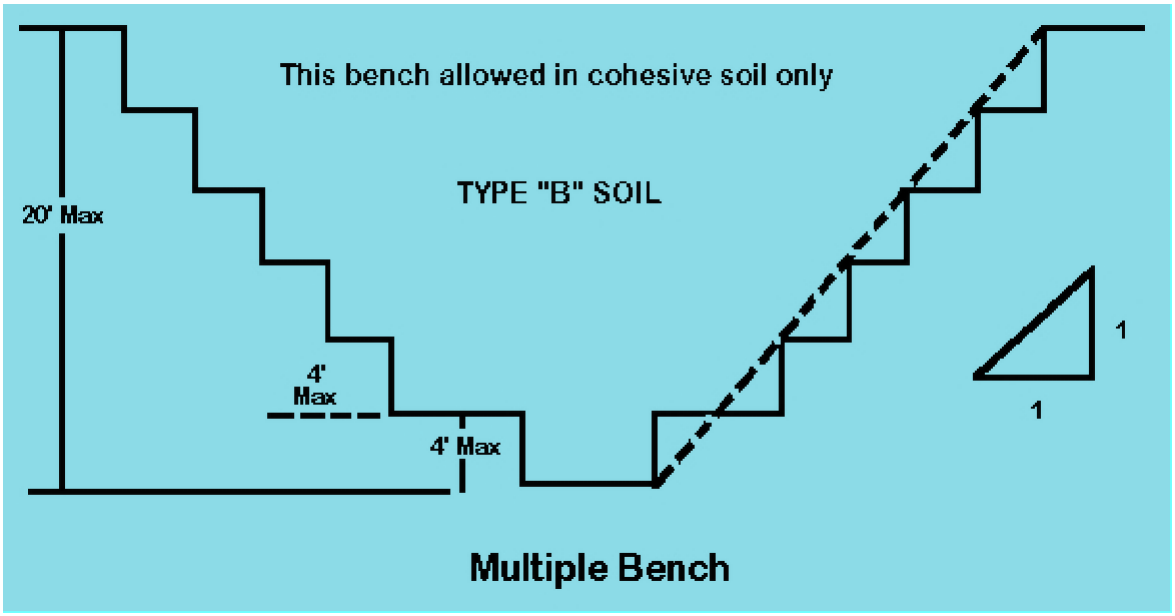


Figure 4 illustrations of shielding systems in B and C type soils.

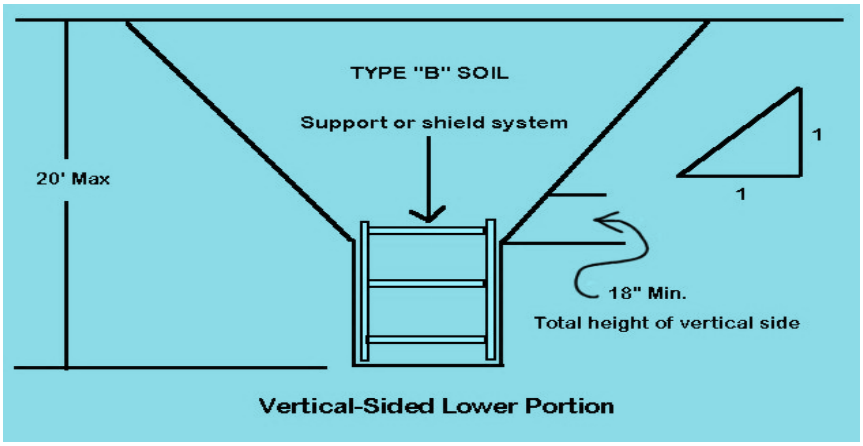
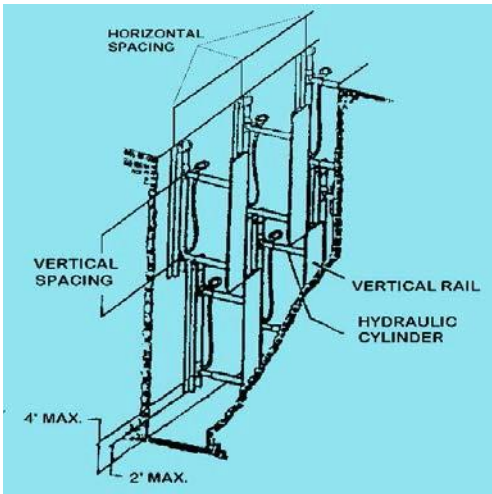


Figure 5 illustrations of Aluminum hydraulic shoring systems.

Vertical Stacked



Waler System