SECTION 12

EXCAVATION, TRENCHING, and SHORING
Policy & Procedures

1. **EXCAVATION, TRENCHING AND SHORING POLICY and PROCEDURE:** An excavation, as defined by OSHA 29 CFR 1926.650, means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. All excavation work performed by Maul Electric, Inc., as the contractor or sub-contractor, will conform to the guidelines of this policy, the above referenced OSHA standards. If the client's procedures and policies meet or exceed this document, the client policy and procedures will be used. **THIS POLICY AND PROCEDURE IS LIMITED TO EXCAVATIONS OF LESS THAN 20 FEET IN DEPTH. EXCAVATIONS THAT EXCEED 20 FEET REQUIRE SHORING SYSTEMS DESIGNED BY A QUALIFIED PROFESSIONAL ENGINEER.**

A. **OSHA Reference**: 29 CFR 19.26(f), 29 CFR 1926.650,29 CFR 1926.651, 29 CFR 1926.652, 29 CFR 1926.653

B. **Definitions:**

1. **Accepted Engineering Practices** are those requirements, which are compatible with standards of practice required by a registered professional engineer.

2. **Aluminum Hydraulic Shoring** is a pre-engineered shoring system comprised aluminum hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (whalers). The system is designed specifically to support the sidewalls of an excavation and prevent cave-ins.

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

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

5. **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 by falling or sliding in a quantity that may be sufficient to entrap, bury, or injure and immobilize a person.

6. **Competent Person** is one who is capable of identifying existing and predictable hazards in the surroundings or working conditions, which are unsanitary, hazardous, or dangerous to employees. A competent person has the ability and authority to take prompt corrective measures to eliminate the previously mentioned conditions.

7. **Cross Braces** are the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or Wales.

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

9. **Failure** is the breakage, displacement, or permanent deformation of a structural member or connection that would reduce its structural integrity and its support capabilities.

10. **Hazardous atmosphere** is an atmosphere that may be harmful, cause death, illness, or injury by being explosive, poisonous, flammable, corrosive, oxidizing, irritating, or toxic.

11. **Kick out** is the accidental release or failure of a cross brace.

12. **Protective system** is a method of protecting employees from cave ins, materials that could roll or fall into the excavation or excavation face, collapse of adjacent structures. They include support systems, sloping and benching systems, shield systems, and other systems, which provide the necessary protection.

13. **Ramp** means an inclined walking or working surface used to gain access to one point from another and is constructed from earth or structural materials like wood or steel.

14. **Registered Professional Engineer** is a professional engineer registered in the state where the work is to be performed.

15. **Sheeting** is the member of a shoring system that retains the earth in position and is supported by other members of the shoring system.

16. **Shield (Trench Box, Trench Shield)** is a structure that is able to withstand the forces of a cave-in. Shields can be permanent structures that can be designed to be portable and moved along as the work progresses, pre-manufactured, or job-built in accordance with 1926.652 (c)(3).

17. **Shoring (Shoring System)** is a structure such as a metal hydraulic, mechanical, or timber shoring system that supports the sides of an excavation and is designed to prevent cave-ins.

18. **Sloping (Sloping System)** excavation to form sides of an excavation that are inclined away from the excavation. The angle of incline required to prevent a cave-in varies with differences in factors such as the soil

type, environmental conditions of exposure, and application of surcharge loads.

19. **Stable Rock** is a solid mineral material that can be excavated with vertical sides and will remain intact while exposed. (See the standard for methods of converting unstable rock to stable rock.)

20. **Structural Ramp** is a ramp made of steel or wood and usually used for vehicle access. Soil or rock ramps are not considered structural.

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

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

23. **Trenches** are a narrow excavation, in relation to length, made below the surface of the ground. Generally, 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 and reduce the dimension from the structure to the side to 15 feet or less the excavation is considered a trench.

24. **Uprights** are vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not come in contact with each other. Uprights in contact with each other are sheeting.

25. **Wales** are 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.

26. **Confined space** for the purpose of the excavation standard is defined as one having: (refer to Section 6 for more specific information)

    a) Limited access and egress.
    b) Ventilation, which could produce or contain a hazardous atmosphere.
    c) Is not designed for continuous human occupancy.
    d) Is deeper than four (4) feet.

C. Pre Excavation Checks:

1. Hidden obstructions or hazards may be identified by obtaining and checking site plans identifying underground pipes or utilities in the area of

the excavation. Care should be used as these plans and records may not be up-to-date or accurate.

2. Check the area for previously disturbed ground.

a) Excavations in previously disturbed ground may require additional bracing and shoring.

b) Previously disturbed ground near a new excavation may also require use of bracing and shoring in the new excavation.

D. Shoring Use:

1. All trenches over 5 feet in depth must be shored, sloped, or shield provided to protect workers.

2. Excavations shallower than 5 feet must also be sloped or shored if they are in unstable soil.

3. The depth of an excavation must be measured at its greatest vertical dimension.

4. Spoil piles, located close to the edge of an excavation will affect the vertical depth.

NOTE: Workers kneeling in a trench less than 5 feet can still be exposed to the hazards of cave-ins or hazardous environments.

E. Sloping: There are three methods of sloping a trench to protect workers.

1. Sloping is cutting back the trench walls to the proper angle of repose. Refer to Table B-1 of 29CFR 1926 subpart P)

2. Angles of repose are dependent upon soil classification, water conditions, previous soil disturbances, etc.

3. The proper angle should be independently determined by a qualified person for each site and if conditions require each trench at the same site.

4. Where the excavation has water conditions, silty material, loose boulders, and areas where erosion, deep frost action, and slide planes appear, the angle of repose must be flattened.

F. Shoring Of Trenches: Trench shoring is installed to resist or replace the force on the excavation face.

1. Shoring of a trench may be accomplished with the use of wood timbers, screw jacks, hydraulic rams, or combinations of all of these methods.

2. Timbers must be in sound condition and free of major defects.They must be equal to the grade size specified. Workers must be alert for warning signs of splintering or separating wood fibers. **FAILURE OF THE SHORING IS EMINENT WHEN THESE SIGNS ARE DETECTED AND WORKERS MUST EVACUATE THE EXCAVATION.**

3. Steel shoring components provide little warning before failure and workers must check and be alert for bent or damaged members.

4. Pressure Gauges, cylinders, and rails must all be in good condition if hydraulic shoring is used. Signs of fluid leakage must be detected and repaired.

G. **Trench Shoring Methods:** The type of shoring to be used is determined by the soil type and soil conditions. Ground water and water intrusion can weaken the soil face and add weight, adding additional force on the shores. If the excavation is below the water line, the shoring should be driven below the bottom of the surface of the trench to prevent undermining.

1. Tight sheeting must be provided where seepage occurs. The excavation should be kept dry 24 hours per day to avoid the possibility of saturation and possible failure of the excavation wall.

2. Shoring in Hard Compact Soil is commonly accomplished by open sheeting or "skip shoring".

a) Struts must be placed in a true horizontal position and square to the sides of the trench at a maximum vertical spacing not to exceed OSHA 29CFR 1926 Subpart B Tables C1.1- C1.3, C2.1- C2-3, D1-1- D1.3 or the manufacturer’s tabulated data.

b) The ends must be secured to prevent slippage or kick outs.

c) The lateral spacing between struts must not exceed OSHA Tables C1.1 to C1.3, C2.1-C2.3, D1.1-D1.3 or manufacturers tabulated data or a professional engineer’s specification.

d) Struts must be inspected daily for movement or decreased bearing pressure. Repairs, replacement, or reinstatement must be accomplished before workers are allowed into the excavation or around the upper edges.

3. Shoring in loose unstable soil can be considerably greater than in stable soil, due to the pressure exerted on shoring.

a) Increased strut size and or decreased strut spacing is required.
b) Very Loose soil will require closed sheeting with tight edge- to edge contact.
c) Wood or locking steel sheeting may be used when joints must be watertight.

H. Mandatory Shoring Protection:

1. All workers working in a trench with a depth that exceeds 5 feet must be protected by a shoring system or shield.

2. The placement of shores must be accomplished prior to any worker entering the trench.

3. A registered professional engineer must design all shoring systems used in an excavation below 20 feet in depth.

4. In trenches or excavations where a hazardous condition may exist, the space must be treated as a permit required confined space and Section 6 of this manual must be followed.

5. All workers in the excavation or trench must be provided with Personal Protective Equipment as specified in this manual, OSHA and client standards.

I. Installation of Shoring Systems: All installation should be in a top down method.

1. Struts must be in a true horizontal position with the ends secured to prevent slippage or sliding.

2. The uppermost shores must be placed first.

3. If possible, the workers should not be in the trench when the shores are lowered.

4. To prevent slough off and greater risk of cave-in, the shoring work should follow the trenching and excavation work as closely as possible.

J. REMOVAL OF SHORING SYSTEMS: Removal of shoring should be in a bottom to up method. Hydraulic shoring, however, may be removed from above.

1. Workers removing shoring must remain in a protected zone.

2. Premature removal of shoring will expose workers to an unnecessary hazard.

3. Timer or steel jacks are usually removed while inside the trench.

4. Before removal, some force must replace the force exerted by the shores against the trench face. e.g., bottom and intermediate struts should not be removed until they have been effectively replaced by backfill.

K. Hazards Affecting Trench Safety:

1. Weather conditions can affect the water content of the soil through excess water from rain or melting ice and snow. Watercan liquefy firm soil and increase pressure on the shores.

2. Freezing of the ground and quick thaw can undermine a shoring system and cause failure.

3. Soils can change properties from exposure to the air. Air slaking can turn hard solid soil, to soft slippery soil.

4. Vibrations from machinery, roadways, railroad tracks, explosives, flares, etc. will cause increased loads on a shoring system and extra sheeting and shoring may be needed.

5. The location of the Spoil Bank may also affect the pressure on a shoring.

6. Spoil Piles should be kept no closer than 2 feet from the trench and distances increased when site conditions warrant.

7. The edges of all open trenches must be protected. Barricades must be erected to prevent accidental entry, and, if possible, bumpers should be provided to prevent equipment from falling into the excavation.

8. All tools, equipment, and supplies must be kept back from the excavation edge to prevent accidental slippage into the site.

9. Hydrocarbon vapors are heavier than air. In locations where hydrocarbon vapors may be present atmospheric monitoring and confined space procedure are required.

10. All welding and cutting torches must be shut down at the source when workers depart the excavation or trench.

L. Excavation Equipment:

1. Excavation equipment must be operated by trained and qualified personnel only.

2. Workers in the excavation will not place themselves below a load being lifted overhead.

3. Equipment must be shut down when the operator dismounts the equipment.

4. Refueling of equipment must not take place in the immediate vicinity of the site.

5. Knowledgeable Signal Person must be in place when equipment operators cannot see the bottom of the excavation.

M. Daily Inspections of The Excavation And Shoring.

1. Daily inspections of the excavation and shoring equipment shall be made by a competent person and documented on the Excavation Inspection Form (at the end of this of this section).

2. Should an unsafe condition be discovered, work must stop immediately in the affected area and corrective action taken.

3. Inspections must also be accomplished after rainstorms, snowstorms, or any other occurrence that may alter the condition and hazard of the site.

N. **Competent Persons:** The OSHA Standards require that the competent person must be capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and have authorization to take prompt corrective measures to eliminate them and, if necessary, to stop the work. Maul Electric, Inc. is responsible for the designation of a competent person at excavation sites. Maul Electric, Inc. reserves the right to review the qualifications of any client or sub-contractor furnished competent person.

O. A competent person is required to:

1. Have a complete understanding of the applicable safety standards and any other data provided.

2. Assure the proper locations of underground installations or utilities, and that the proper utility companies have been contacted.

3. Conduct soil classification tests and reclassify soil after any condition changes.

4. Determine adequate protective systems (sloping, shoring, or shielding systems) for employee protection.

5. Conduct all air monitoring for potential hazardous atmospheres. Conduct daily and periodic inspections of excavations and trenches.

6. Approve design of structural ramps, if used.

P. **Access and Egress:** A means of access and egress (usually ladders) must be provided within 25 feet of every worker.

1. Ladders must be in good condition, extend 3 feet over the top of the trench and secured in such a manner as to prevent movement while in use.

2. Access and egress must be provided for all excavations in excess of 4 feet in depth.

3. Walkways, runways, and sidewalks must be kept clear of excavated material or other obstruction.

4. No sidewalk, ramp walkway, etc., shall be undermined unless properly shored.

2. **Classification of Soil and Rock Deposits:** Each soil and rock deposit must be classified by a competent person as one of the following: Stable Rock, Type A, Type B, or Type C in accordance with the following definitions.

A. **Definitions:**

1. **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.

2. **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 side slopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soil includes clayey silt, sandy clay, silty clay, clay, and organic clay.

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

4. **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.

5. **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.

6. **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.

7. **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.

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

9. **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.

10. **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 environmental conditions of exposure.

11. **Stable Rock:** means natural solid mineral matter that can be excavated with vertical sides and remain in tact while exposed.

12. **Submerged Soil:** means soil, which is underwater or is free seeping.

13. **Type A Soil: means;**

    a. Cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (psf) 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 considered Type A. However, no soil is Type A if:
    b. The soil is fissured or
    c. The soil is subject to vibration from heavy traffic, pile driving, or similar effects

d. The soil has been previously disturbed; or
e. 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:IV) or greater; or
f. The material is subject to other factors that would require it to be classified as a less stable material

14. Type B Soil: means;

a. Cohesive soil with an unconfined compressive strength greater than 0.5 tons per square foot (psf); or
b. 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.
c. Previously disturbed soils except those which would otherwise be classed as Type C soil.
d. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
e. Dry rock that is not stable; or
f. Material that is part of a sloped, layered system where the
g. Layers dip into the excavation on a slope less steep that four horizontal to one vertical (4H: IV), but only if the material would be otherwise classified Type B.

15. Type C Soil: means:

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

16. 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 or other methods.

17. 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.

18. Visual And Manual Analysis: The visual and manual analysis, such as those noted as being acceptable, 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.

B. **Layered System:** In a layered system, the system shall be classified in accordance with its weakest layer.

C. **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.

3. Acceptable Visual And Manual Tests:

A. **Visual Test**: Visual analysis is conducted to determine **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 the excavated material.

1. Check samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of 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 fall off a vertical side, the soil could be fissured. Small falls 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.

6. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

7. 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.

8. 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.

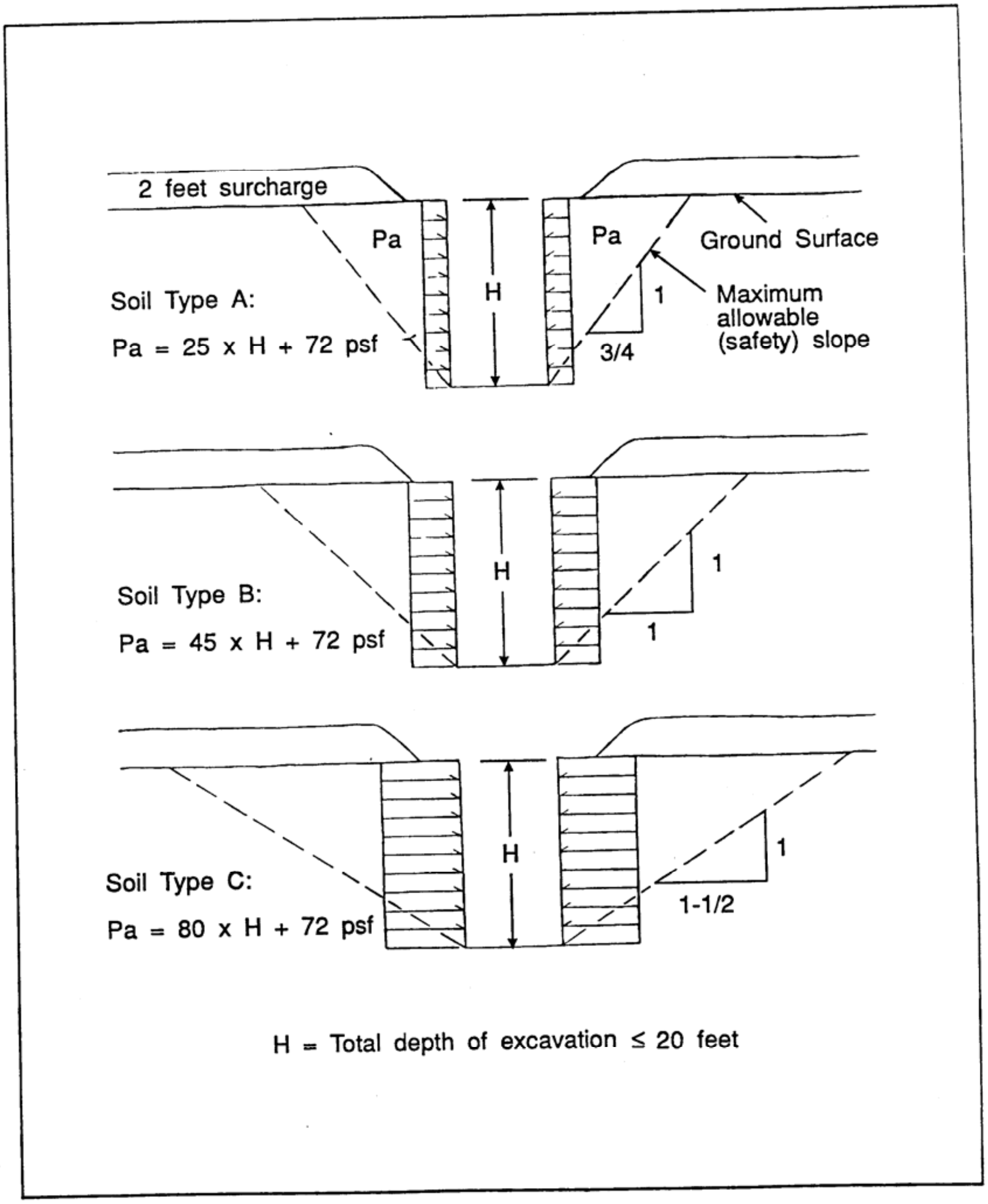
B. **Manual Tests**: Manual analysis of soil samples is conducted to determine the quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

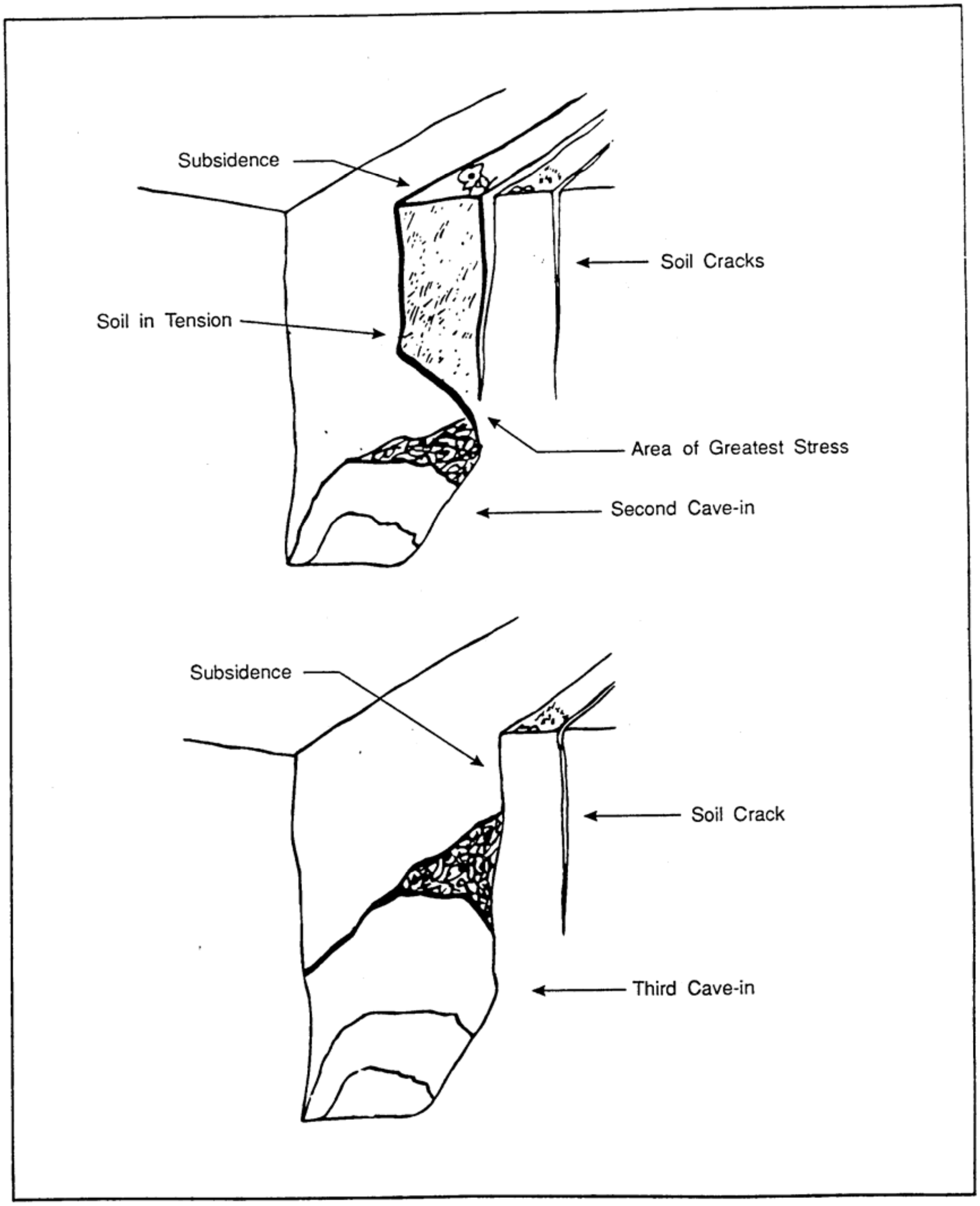
1. Plasticity: Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8 inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two-inch (50mm) length of 1/8-inch thread can be held on one end without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

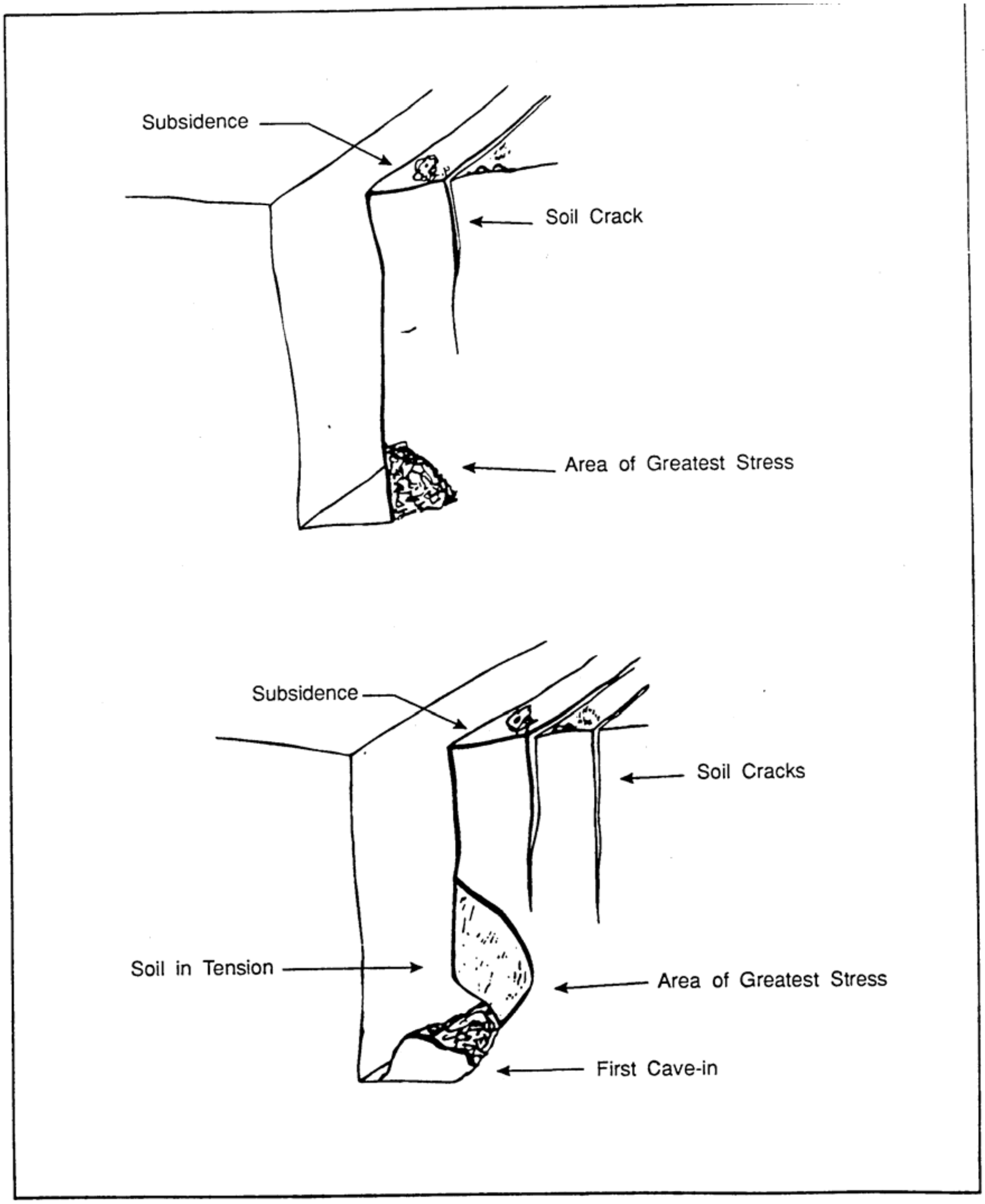
2. Dry Strength: If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination or gravel, sand, or silt). If the soil is dry and falls into clumps that break up into smaller clumps, but the smaller clumps can only be broken 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.

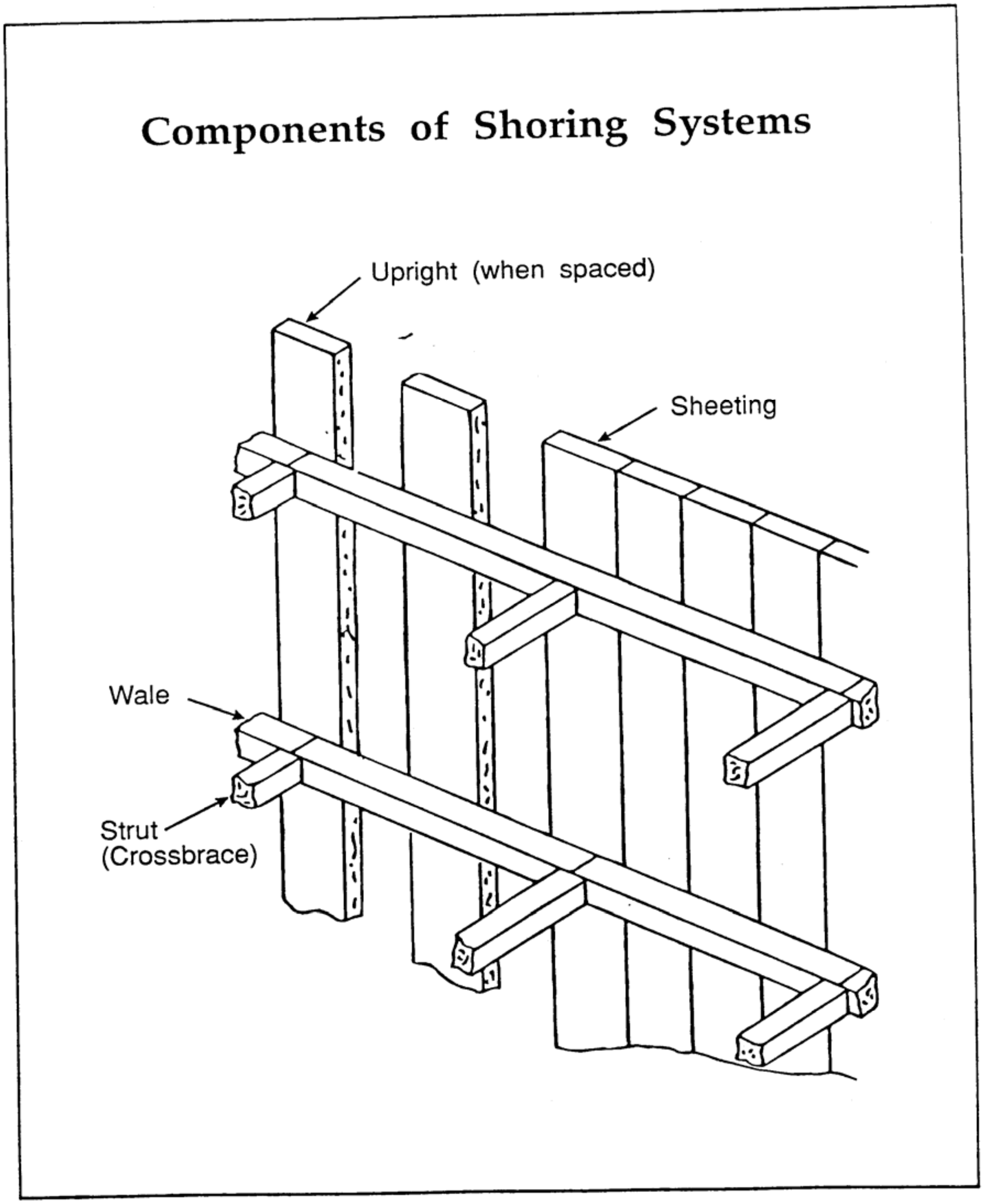
3. Thumb Penetration: The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. Type A soils with an unconfined compressive strength of 1.5 psf can be readily indented by the thumb; however, only with very great effort. Type C soils with an unconfined compressive strength of 0.5 psf can be easily penetrated several inches by the thumb and can be molded by light finger pressure. This test should be conducted on undisturbed soil sample, such as a large clump of spoil, as soon as practical after excavation to keep to a minimum the effects of drying.

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.


2 feet surcharge
Pa
Pa
Ground Surface
H
1
Maximum allowable (safety) slope
3/4
Soil Type A:
Pa = 25 x H + 72 psf
H
1
1
Soil Type B:
Pa = 45 x H + 72 psf
H
1
1-1/2
Soil Type C:
Pa = 80 x H + 72 psf
H = Total depth of excavation ≤ 20 feet

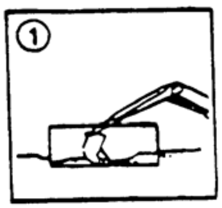

Subsidence
Soil Cracks
Soil in Tension
Area of Greatest Stress
Second Cave-in
Subsidence
Soil Crack
Third Cave-in


Subsidence
Soil Crack
Area of Greatest Stress
Subsidence
Soil Cracks
Soil in Tension
Area of Greatest Stress
First Cave-in

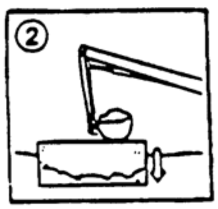

Components of Shoring Systems
Upright (when spaced)
Sheeting
Wale
Strut
(Crossbrace)

Shield Installation and Movement

By excavating inside the shield in Type B and Type C soils, contractors are able to greatly reduce the amount of soil removed. This technique is also used on narrow street work as it helps to minimize environmental damage and restoration costs.

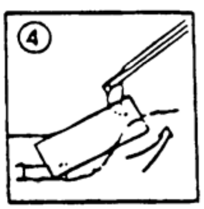


Place the shield in-line and dig from within

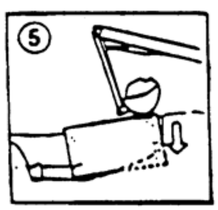


. . . tamping the shield down after each bucketful

When the shield attains grade, install pipe.



Then, pull the shield forward and up approximately 45 degrees.

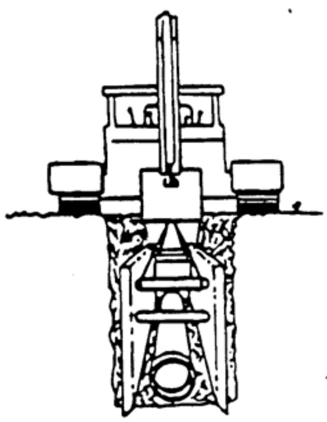


. . . and continue excavating inside, tamping the front of the shield again to grade for setting the next length of pipe.

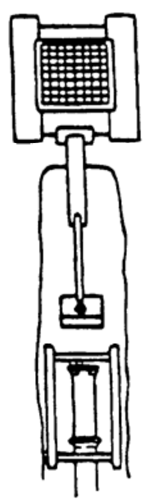
As you continue this process, backfilling can proceed at the rear.

Shield Installation and Movement

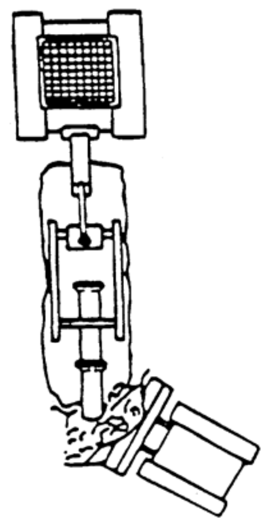
In Type A soil (when the trench walls hold) most contractors prefer to excavate ahead of the trench shield, beginning with an open cut to pipe grade level, then . . .



. . . lowering the shield into the trench for installing pipe . . .



. . . excavating ahead of the shield for the next length of pipe



. . . and pulling the shield forward into the new excavation while backfilling at the rear.