TD-4621M, Rev. 1

Excavation Safety Manual

Gas Operations

For Reference Use

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TD-4621M, Rev. 1

Excavation Safety Manual

Pacific Gas and Electric Company
Gas Technical Document Management
GasTDMMail@pge.com

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This excavation safety manual is in compliance with TD-4621S, which fulfills the regulatory requirements for excavation safety of the following regulations:

- Code of Federal Regulations (CFR) Title 29—Labor, Subtitle B—Regulations relating to labor (continued), Chapter XVII—Occupational Safety and Health Administration, Department of Labor (continued), Part 1926—Safety and health regulations for construction, Subpart P, Excavations.
- 29 CFR § 1926.800, Underground construction.
- 29 CFR § 1926.956, Underground lines.
- California Code of Regulations (CCR) Title 8, Sections 1540, “Excavations,” 1541, “General Requirements,” and 1542, “Shafts.”

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Preface

Excavation Safety

Excavating is recognized as one of the most hazardous construction operations. Prevention of trench wall cave-in and soil movement is a primary worker safety precaution in underground construction activities. Serious injury or death can occur to crew members if appropriate measures are not taken. The key components of excavation safety are responsibility and compliance.

Responsibility

Shoring vendors provide shoring materials and technical (tabulated or tab) data. Vendors often recommend shoring systems for particular applications in the field. The vendor's recommendations do not relieve the Competent Person, a Pacific Gas and Electric Company (Company) employee, of sole accountability and responsibility for selecting and properly installing appropriate excavation safety systems.

The Company Competent Person is always responsible and accountable for excavation safety.

Compliance

The contents of this manual are based on a thorough analysis of soil by registered Professional Engineers (P.E.). The manual includes specific safety information and requirements for working in different soil types. When used with the other Company safety rules and requirements for the workplace, information contained in this manual meets or exceeds state and federal safety requirements.

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Part 1
Introduction

1 About this manual

TD-4621M, the Excavation Safety Manual, has been updated, reformatted, and renumbered from the 2006 version. The form of the manual is smaller and sturdier for more practical use in the field. New content integrates end-user feedback, best practices, and improved compliance with the following regulations:

- Code of Federal Regulations (CFR) Title 29—Labor, Subtitle B—Regulations relating to labor (continued), Chapter XVII—Occupational Safety and Health Administration, Department of Labor (continued), Part 1926—Safety and health regulations for construction, Subpart P, Excavations.
- 29 CFR § 1926.800, Underground construction.
- 29 CFR § 1926.956, Underground lines.
- California Code of Regulations (CCR) Title 8, Sections 1540, “Excavations,” 1541, “General Requirements,” and 1542, “Shafts.”

This manual, in its entirety, must be kept at every jobsite where excavations are being performed.

1.1 Scope

This manual explains what employees must do to safely evaluate excavations and to use a cave-in prevention system. This manual describes how to properly protect that excavation from caving in.

Any employees using a cave-in prevention system not covered by the manual must consult a registered Professional Engineer (P.E.) for assistance. See Part 2, Section 5, for a list of special excavation conditions that also require consultation with a registered P.E.

1.2 Excavation plans

This manual plus any manufacturer’s tabulated data for cave-in prevention systems on the job site make up the excavation plan. According to regulations enforced by the California Division of Occupational Safety and Health (Cal/OSHA), such an excavation plan must be kept at every excavation job site.

2 Key contacts

2.1 Contact numbers during business hours

Table 1-1. Contact numbers during business hours

CONTACT REASON	CONTACT NUMBER
Report incident, accident, or injury	Safety Department Helpline (415) 973-8700
Request cave-in rescue	**Dial 911 for emergency rescue**
Engineering, soil analysis, and special cases	PG&E Geosciences (415) 973-5291
Report a Cal/OSHA **investigation** at the jobsite **Note:** Notify the supervisor. The supervisor must contact the Company Legal Department. See Appendix B, "Foreman's Guide for Briefing Cal/OSHA a Cal/OSHA investigation.	Safety Department Helpline (415) 973-8700
Report a Cal/OSHA **inspection** at the jobsite **Note:** See Appendix B for procedures to use during a Cal/OSHA inspection.	Safety Department Helpline (415) 973-8700
Safety issues or questions	Safety, Health and Claims Helpline (415) 973-8700

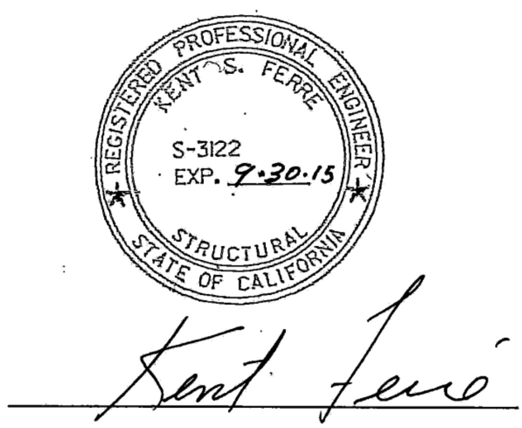
2.2 Contact numbers during non-business hours

Table 1-2. Contact numbers during non-business hours

CONTACT REASON	CONTACT NUMBER
Report incident, accident, or injury	Safety Department Helpline (415) 973-8700
Request cave-in rescue	**Dial 911 for emergency rescue**
Safety issues requiring immediate attention	Safety Department Helpline (415) 973-8700

3 Content certification

I hereby certify that this manual meets the requirements of California Code of Regulations (CCR) Title 8, Industrial Relations, Division 1, Department of Industrial Relations, Chapter 4, Division of Industrial Safety, Subchapter 4, Construction Safety Orders, Article 6, Excavations, § 1540, “Excavations.”



Kent Ferre, S. E.

Manager

California Registration Number 3122

Date 3/14/2014

4 Definitions

Definitions marked with an asterisk (*) are quoted directly from the the California Code of Regulations (CCR), Title 8, Section 1540, (b) Definition of terms for excavations, or 8 CCR § 1541.1, Appendix A, (b) Definition of terms for soil classifications.

***Accepted engineering practices:** Requirements which are compatible with the standards of practice required of a registered professional engineer.

Access and egress: Entry and exit, respectively. In trenching and excavation operations, these terms refer to the provision of safe means for employees to enter or exit an excavation or trench.

Adjacent structures stability: The stability of the foundation(s) of structures adjacent to the excavation, whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the failure zone of the excavation or trench.

***Aluminum hydraulic shoring:** A pre engineered shoring system comprised of aluminum hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). This system is designed specifically to support the side walls of an excavation to prevent cave-ins.

***Benching (benching system):** 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.

CCR: California Code of Regulations. The citations in this manual can be found on http://www.dir.ca.gov/Title8/1540.html.

Caliche: A silt or sand that is cemented with calcium carbonate. The calcium carbonate is deposited by the evaporation of ground water brought to the ground surface by capillary action.

Cal/OSHA: California Division of Occupational Safety and Health.

Caution: Information about an operating procedure, technique, etc., which could result in damage to equipment or interruption of service to customers if not carefully followed.

***Cave-in:** 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 or immobilize a person.

***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.

NOTE
Competent Person is defined in
CCR Title 8, Subchapter 4, §1504 (a).

***Competent Person:** Person 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.

Confined space: A space that, by design and/or configuration, has limited openings for entry and exit and unfavorable natural ventilation, may contain or produce hazardous substances, and is not intended for continuous employee occupancy.

***Cross braces:** The horizontal members of a shoring system that are installed perpendicular to the sides of the excavation the ends of which bear against either the uprights or the wales.

Egress: See *Access and egress*.

Employee crossing: See *Safe crossing*.

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

Excavation safety system: See *Protective system*.

***Faces (sides):** The vertical or inclined earth surfaces formed as a result of excavation work.

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

Fed/OSHA (OSHA): United States Department of Labor Occupational Safety and Health Administration.

***Fissured:** 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.

H:V: Ratio of horizontal to vertical or run to rise.

Hazardous Atmosphere: 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. This includes atmospheres with an oxygen content of less than 19.5% or greater than 23.5%, and/or containing gas levels greater than 1% gas in air.

***Kickout:** The accidental release or failure of a cross brace.

Loam: A mixture of clay, sand, and silt. The stability of loam depends on the moisture content and the proportions of each of the components. Loams are often named by their major component, so a sandy loam has a large sand component, a clay loam has a large clay component, etc.

***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. Layered soil systems are classified on the basis of the weakest soil layer.

Nominal thickness of wood products: Nominal thickness is a term for the unfinished or unplaned dimensions of the wood before final finishing. For example, although a two-by-four has a nominal thickness of 2" x 4", the material normally used actually measures approximately 1½" x 3½".

Qualified worker: Any worker who has some special skill, knowledge, or (usually acquired) ability in their work.

Previously disturbed soil: Soil moved from its native (original) location. Example: dug and backfilled excavations and fill locations.

***Protective system:** 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 necessary protection.

Public crossing: A location where the public crosses trenches or other excavations.

***Ramp:** 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.

NOTE
To consult with a registered Professional Engineer (P.E.), contact the Geosciences department or a shoring vendor.

***Registered professional engineer:** 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” used in interstate commerce.

Safe crossing: A secured wood walkway built with 2"-thick planks, 1⅛"-thick plywood, or a material of equivalent strength that is at least 24" wide.

***Sheeting:** The members of a shoring system that hold the earth in position and in turn are supported by other members of the system.

***Shield (shield system):** A structure that is able to withstand the forces imposed on it by a cave-in and thereby protects 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 built on the job.

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

***Sides:** See *Faces*.

Slide rail shoring system: A modular shoring system installed to the required depth in successive steps. The system consists of interlocking panels and posts installed by backhoe or excavator. The system is assembled at the surface from a pilot hole. It is subsequently deepened by digging inside the slide rail system, pushing the slide rail system down and adding more panels to deepen the shoring system.

***Sloping (Sloping system):** A method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation 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.

Special case: Any situation not specifically described in this manual.

Spoil: The material (e.g., rocks and soil) removed from an excavation.

NOTE

The Company requires that rock be solid and unfractured to be considered stable rock. Rock that is fractured, cracked, splintered or otherwise broken is not stable rock.

***Stable rock:** 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:** A ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Superimposed loads: Any item or material that exerts additional forces on the soil in the area of the excavation (e.g., the spoil pile or equipment placed close to the edge of the excavation). See also *Surcharge*.

***Support system:** A structure such as underpinning, bracing, or shoring that provides support to an adjacent structure, underground installation, or the sides of an excavation.

Surcharge: Excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect trench stability. See also *Superimposed loads*.

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

***Trench (trench excavation):** 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 the 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*.

Type A soil: See Part 2, Section 2, and Table 2-1 for a description of Type A soil.

Type B soil: See Part 2, Section 2, and Table 2-1 for a description of Type B soil.

Type C soil: See Part 2, Section 2, and Table 2-1 for a description of Type C soil.

Underpinning: A method of providing support underneath an undermined structure.

Underground installations: Include, but are not limited to, utilities (sewer, telephone, fuel, electric, water, and other product lines), tunnels, shafts, vaults, foundations, and other underground fixtures or equipment that may be encountered during excavation or trenching work.

Unconfined compressive strength: The load per unit area at which soil will fail in compression. This measure can be determined by laboratory testing, or it can be estimated in the field using a pocket penetrometer, thumb penetration tests, or other methods.

***Uprights**: The vertical members of a trench shoring system that are placed in contact with the earth and are 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:** Horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or the earth.

Warning: Information about an operating procedure, technique, etc., that could result in personal injury or loss of life if not carefully followed.

Zone of shoring: The area within an excavation where employees are protected from the danger of cave-in. See Part 3, Section 3 for more information.

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Part 2
Planning for Safety

The crew leader and Competent Person must plan each excavation to protect crew members and other workers from multiple hazards. To ensure safety, the Competent Person must decide:

1. Whether shoring, benching, or sloping is required.
2. What the soil type is.
3. Whether any special hazards are present that require the consultation of a registered Professional Engineer (P.E.) (Geosciences or a shoring vendor).
4. What cave-in prevention system will be used.

This part describes the process of evaluating and planning an excavation for safety.

1 Determining need for shoring, shielding, sloping, or benching

CAUTION
Damage to underground facilities may occur if excavations are performed without a current USA ticket. USA tickets are REQUIRED and valid for 28 days from the date issued.

1.1 Competent Person

A Competent Person must be on site at all times personnel are in the excavation to ensure that conditions have not changed and created a hazard for personnel.

To be a Competent Person, one must satisfy the criteria in Table 2-1 on page 2-2.

Table 2-1. Competency requirements

EITHER	OR
Successful completion of a Company-approved course in excavation safety training for the Competent Person	Pass an approved Competent Person certification examination
AND	
▪ Be designated as the Competent Person, **and** ▪ Demonstrate ability to appropriately classify soil and select protective systems	

Source: TD-4621S, Attachment 1, "Excavation Safety Guide."

The Competent Person:

- Evaluates all environmental conditions.
- Identifies on-site hazards requiring a registered P.E. or stamped tabulated data.
- Selects the appropriate type of worker protection.
- Inspects the excavation at the beginning of each shift and any time conditions change.

The Competent Person may choose from several protective options, as needed:

- Sloping or benching according to allowable configurations.
- Using a registered P.E. to design a sloping, benching, shielding, or shoring system.
- Using support systems in accordance with this manual or tabulated data.
- Purchasing or renting an engineered protective system (e.g., trench box, shield, cage).

The types of protection selected for the excavation depend on several factors, including:

- Size and shape of excavation.
- Type of soil.
- Availability of materials.
- Length of time excavation needs to be secured.

1.2 Is shoring, benching, shielding, or sloping necessary?

Unless specified by a registered P.E. or stamped tabulated data, existing unshored subsurface walls or structures are **not** acceptable means to ensure safety.

As with an unprotected trench end, any excavation into a hill or bank resulting in a 5′ or greater wall must be sloped or benched, or personnel must remain back a distance equal to the height with a barrier (visual or physical) present.

A cave-in prevention system is always required if any of the following conditions exist:

- The sides of the excavation are unstable and the work cannot be performed safely.
- The excavation is at least 5′ deep at any point and someone will enter the excavation.

Use the following flow chart to determine whether cave-in protection (sloping, benching, shoring, or a box/shield) is required.

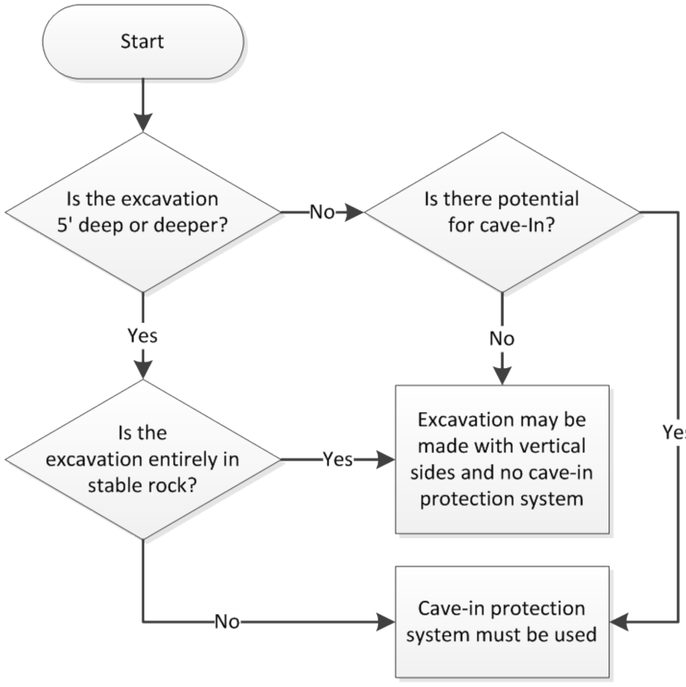

Figure 2-1. Excavation safety decision process

Pre-construction meetings

Excavation Safety should be a topic of conversation at all pre-construction meetings. Conversation should cover the following areas.

1. Verifying that essential permits were obtained.
2. Discussing the Excavation Plan.
3. Discussing the Cave-In Emergency Plan.
4. Resolving schedules.
5. Verifying USA Ticket.
6. Scheduling required inspections.
7. Verifying that essential variances from local codes or ordinances were obtained.

Permitting

The Company is exempt from obtaining a Cal/OSHA excavation permit before starting excavation work. However, other government agencies (counties, cities, municipalities, etc.) may require various permits before the Company begins earthwork activities. These local regulations may require the Company to contact the appropriate local authority to determine its permit requirements as far in advance of the anticipated start date as practical. Ensure that all needed permits are issued before work begins.

Bell holes

Provide employees with adequate room to work in the bell hole. Use the same protective measures in bell holes that are required for all other excavations.

2 Classifying the soil

2.1 Soil classifications

WARNING
Low-strength Type C Soil is a special case and always requires either assistance from a registered P.E. or the use of stamped tabulated data **before** excavating. See Part 1, Section 1.2 for phone numbers.

There are 5 main types of soil:

- **Rock:** Rock is the most stable type of soil. **Never** assume the soil is rock and **always** assume there are fissures in any rock.
- **Cemented soil:** This is soil that has constituents of rock (such as limestone) dissolved and bound into the soil, making it harder.
- **Cohesive soils:** These are typically clays which bind together, but not as strongly as cemented soils.
- **Granular soils:** The size of the aggregates defines whether this soil is gravel, sand or silt.
- **Loams:** Loams are mixtures of sand, silt, and clay. Their stability depends on the proportions of the three and the moisture.

For more information on soil mechanics, see Appendix A, "Soil Mechanics."

Classification for excavation

To classify soil for excavations, the Company uses the soil classification system outlined in Table 2-2 on page 2-6.

Table 2-2. Soil classification system

TYPE	CHARACTERISTICS
Stable Rock	Natural solid mineral matter which can be excavated with vertical sides and remain intact while exposed.
A	Cohesive with an unconfined compressive strength of 1.5 tons per square foot (TSF) or greater. Can be: • Clay • Silty clay • Sandy clay • Clay loam • Cemented soil
	Soil CANNOT be classified as Type A if ANY destabilizing factors are present, such as: • Soil is fissured • Vibrations have been or may be present • Soil has been previously disturbed • Soil is sloped or layered on a slope of 4:1 H:V or steeper. See Figure 2-4 for more information. Other factors may also bar soil from classification as Type A.
B	Cohesive with an unconfined compressive strength greater than 0.5 TSF but less than 1.5 TSF. Examples of Type B soil are: • Granular cohesionless soil (crushed rock, silt loam, sandy clay loam) • Previously disturbed soil not classified as type C • Type A soil that is fissured or subject to vibration • Dry rock that is not stable
C	Cohesive soil with an unconfined compressive strength of 0.5 TSF or less. Examples of Type C are: • Granular soil • Submerged rock that is not stable • Moist cohesive or moist dense granular • Soil that can be cut near-vertical and stand long enough to allow shoring and sheeting to be properly installed • NOT flowing or submerged
Low-strength C	These soils require assistance from a registered P.E. Examples of low-strength C are: • Granular soil including gravel, sand • Submerged soil • Soil from which water is freely seeping • Soils not meeting the classifications outlined above • Anywhere water is present Vendors may refer to low-strength C as “C-80.”

2.2 Classification test methods

A **minimum of two** soil classification tests (one visual and one manual) must be performed by the Competent Person. Soil reports prepared by an engineer are helpful, but the Competent Person is responsible for testing and classifying the soil in the excavation.

WARNING
Do not enter an unprotected excavation to collect samples or conduct soil tests. Use fresh samples removed from the excavation.

Visual tests

A visual test is a qualitative evaluation of soil conditions in the entire excavation site, including soil adjacent to the site and soil being excavated. Visual tests are listed below.

Soil grain size

- If you see individual grains **and** few clumps, which are easily crushed, soil is granular.
- If individual grains are **not** visible and the soil stays in clumps when excavated, the soil is cohesive.

Checking the trench sides

- Cracks or chunks of soil spalling from a vertical wall indicate fissured ground and a potentially hazardous situation.
- If soil is layered, review the slope by comparing the depth on one side of the trench to the layer depth on the alternate side. See Part 2, Section 5.7 for more details.

Checking the area for previous disturbance

- Clear ground vegetation to look for cracks in the soil around the excavation.
- Look for evidence (811 markings or other surface indicators) of existing underground or aboveground infrastructure which indicate the ground had been previously disturbed.

Checking for water

- Trench side bulging, boiling, sloughing or water seeping from trench sides from the groundwater table classify the soil as low-strength Type C. Contact a registered P.E.

Manual tests

A manual test is a manual analysis of soil sample conducted to provide more information to enable proper classification of the soil. After the visual test, at least one manual test is required to classify the soil. Examples of manual tests follow.

Plasticity test

Soil is cohesive if a fresh, moist, or wet soil sample can be rolled into threads ⅛" in diameter approximately 2" long without crumbling.

Drying test

Thoroughly dry a sample of soil approximately 1" thick by 6" in diameter and assess according to Table 2-3, below.

Table 2-3. Drying test

<table>
<tr><th colspan="2">IF…</th><th>THEN THE SAMPLE…</th></tr>
<tr><td colspan="2">Sample develops cracks as it dries.</td><td>Has significant fissures.</td></tr>
<tr><td colspan="2">Considerable hand force is required to break samples that dry without cracking.</td><td>Is unfissured cohesive material. The unconfined compressive strength should be determined.</td></tr>
<tr><td rowspan="2">Samples are dry without cracking, and break easily by hand.</td><td>Dried clumps pulverize easily by hand.</td><td>Is fissured cohesive.</td></tr>
<tr><td>Dried clumps pulverize into very small fragments.</td><td>Is granular.</td></tr>
<tr><td colspan="2">Soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder.</td><td>Is granular (any combination of gravel, sand, or silt).</td></tr>
<tr><td colspan="2">Soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty.</td><td>May be clay in any combination with gravel, sand or silt and is cohesive.</td></tr>
<tr><td colspan="2">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.</td><td>Is unfissured.</td></tr>
</table>

Thumb penetration test

Conduct the thumb test on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to limit the drying effects of exposure. See Table 2-4, below.

Table 2-4. Thumb test

TYPE	THUMB TEST RESULTS
A	Sample can be indented by the thumbnail readily, but penetrated only with very great effort, **and** the soil is very fine grained.
B	The thumb can penetrate with moderate effort.
C	Soil is easily penetrated several inches by the thumb, and can be molded by light finger pressure.
Low-strength C	Soil is easily penetrated several inches by the fist.

Other strength tests

Estimate the unconfined compressive strength using a pocket penetrometer or hand-operated shear vane.

2.3 Determine soil classification

When making the final soil classification, consider all of the following factors.

- What are the properties of the soil in the excavation?
- How does the soil perform now?
- What will happen to the soil over time once the excavation is opened (e.g., when the soil either dries out or gets wet)?
- Do environmental conditions reduce the stability of the sides of the excavation?

Remember:

- For layered soil, base the soil classification on the weakest layer.
- Consider only current conditions.
- When conditions change, re-evaluate the soil for possible reclassification.
- To determine soil type, use the soil classification chart in the tri-fold guide in the back pocket of this manual (TD-4621S, Attachment 1, “Excavation Safety Guide”).

3 Availability of materials

For each excavation, plan ahead so that shoring materials are available on time. Wooden shoring components, whether plywood or FinnForm composite material, may require a special order by the lumber supplier to meet special strength requirements (described in Table 4-2 on page 4-5). Metal shoring systems may also require extended delivery time. Identify construction needs as far in advance as possible and place orders early.

4 Work outside scope of manual

Consult with a registered P.E. or use stamped tabulated data for:

- A hydraulic shoring or shielding system deeper than 15'.
- A sloping or benching system deeper than 20'.
- Any method not described in this manual (e.g., tunneling, undermining, or other special case).

5 Special excavation conditions

Employees may encounter soil or site conditions that differ from the scope of this manual. These are special cases that are so variable they must be handled individually. All of the cases in this section require consultation with a registered P.E. or use of stamped tabulated data.

5.1 Very soft clay

Very soft clay, such as the soft mud found in the San Francisco Bay Area, may require the use of sheet piles. Engineering evaluations may be required to determine how deep to drive the piles, or for other special construction requirements.

5.2 Saturated sand

When the water table is higher than the proposed depth of the excavation, saturated clean or silty sand may be susceptible to a special type of failure known as “quicksand” or “piping.” These failures may occur if water flows upward when using sheet piles, or around existing utilities and underground structures if the groundwater level is high.

When saturated soil is excavated below groundwater level, the water can flow into the excavation around an embedded sheet pile or underground structures. Depending on the difference between the level of the groundwater surface and the depth of the excavation, unstable conditions (quicksand and piping) may develop quickly.

5.3 Peaty soil

Peaty or organic soil is made of organic matter in the form of partly decomposed vegetation. Peaty soil is dark gray or black, and usually has a characteristic odor of decay. This material is generally very lightweight, has very low shear strength, and deforms quickly. In Northern California, employees are likely to find peaty soil in river deltas.

5.4 Rubble rock or rock fill

Rubble rock and rock fill pose a threat to safe excavation because of large particles or obstructions. However, these field conditions do not automatically rule out the use of benching or shoring. Careful exploration is required to accurately define the nature and extent of the rubble.

5.5 Sloping ground

The designs in this manual assume that the excavation will take place on relatively flat ground. If the slope is less steep than 3:1 H:V, as shown in Figure 2-2 on page 2-12, use the procedures in this manual.

WARNING

When using a support system on a slope, make sure it can withstand the force at the bottom of the deepest side of the excavation.

If the high side of a trench is less than 5' high **and** the soil is stable, shoring is generally not required. Shoring is required if any of the following conditions exist:

- Obvious danger of landslide.
- Uphill slope of 3:1 H:V or steeper.
- Cracks in the soil.
- Other indications of unstable soil.

NOTE

Always measure the excavation's depth at the deepest point (high side if on a slope).

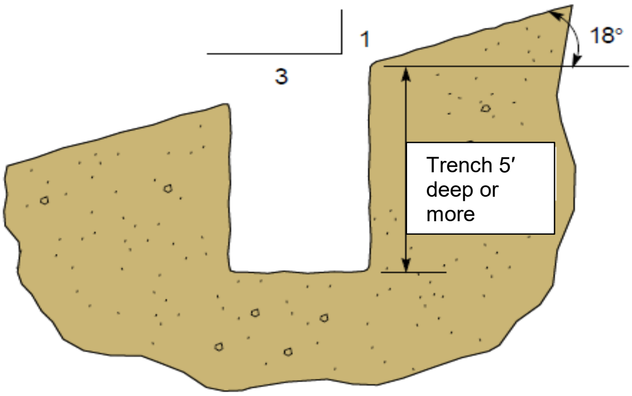

Figure 2-2. Maximum allowable slope for a standard excavation

5.6 Adjacent slopes

A slope or embankment close to an excavation can impose high loads on the sidewall of the excavation similar to those of a large adjacent structure.

Under either of the following conditions, **before** excavating, get help from a registered P.E. See Figure 2-3, below.

- The toe (base) of a slope of 3:1 H:V or steeper is closer to the excavation than the proposed depth of the excavation.
- The toe of a slope shallower than 3:1 H:V is located closer to the excavation than half the proposed excavation depth AND the proposed depth is greater than 10′.

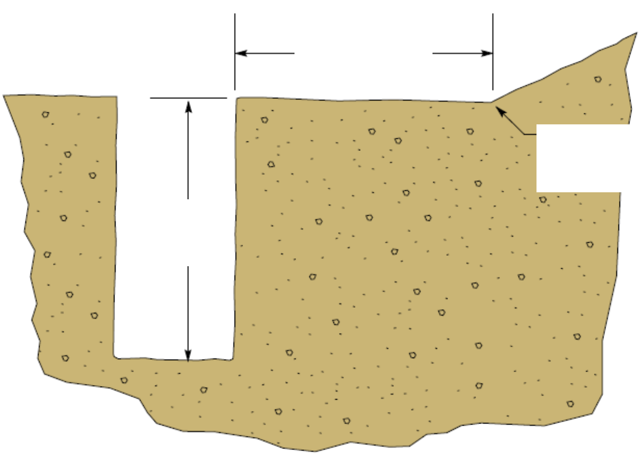

Figure 2-3. Excavation near an embankment

5.7 Sloping subsurface layers

In some excavations, the soil consists of layers of various types, marked by changes in color, texture, or composition. Where the layers meet, the soil is more likely to slide, creating a potential hazard. Test each soil type to determine its classification. If layers of the soil meet in a slope steeper than 4:1 H:V, increase the shoring requirements to the weaker soil classification.

To determine the slope of a layered system:

1. Measure the height at which the layers change on the right trench wall.
2. Measure the height at which the layers change on the left trench wall.
3. Find the difference in those heights between the right side and the left side.
4. Divide the difference by the trench width.

Example:

As shown in Figure 2-4 on page 2-13,

Measured trench width = 30″

Measured difference in height = 5″

1. Determine the maximum safe vertical of the layer.

   Divide the width by 4:

   30/4 = 7½

   Maximum safe vertical = 7½″

2. Compare the maximum safe vertical to the measured vertical of 5″.

   The measured vertical of 5″ is less than the maximum safe vertical of 7½″. Therefore, the slope of the layers does not require extra shoring (i.e., to the next weaker soil classification).

Although slope is not a critical factor in this example, other conditions at this excavation may call for additional shoring.

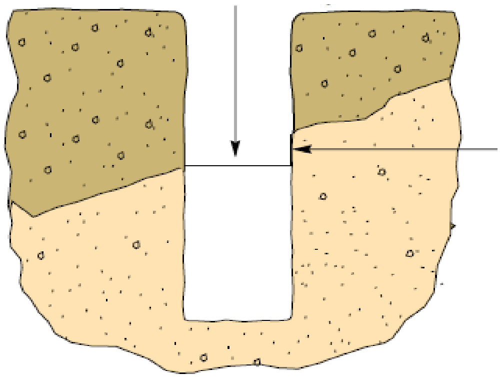

Figure 2-4. Determining the slope of a layered system

5.8 Working near structures or heavy machinery

Heavy loads such as foundations and large machinery exert a downward and outward force on the soil. This force is concentrated in a sector that extends 45° (a slope of 1:1) downward and outward from all sides of the load (base of the foundation or truck/machinery).

An inadequately-supported excavation intruding into the area that supports a structure may damage the structure and may be more likely to cave in. See Figures 2-5 and 2-6 on page 2-15. If the excavation will cut through the portion of the soil that is subject to the force of the foundation, **before** excavating, get help from a registered P.E.

If the building rests on piles, the force of the foundation starts at the bottom of the piles. In most cases the depth of the foundation or footing is unknown. If you do not feel comfortable assessing the foundation, **before** excavating, either draw the imaginary 45° line from grade level, or get help from a registered P.E.

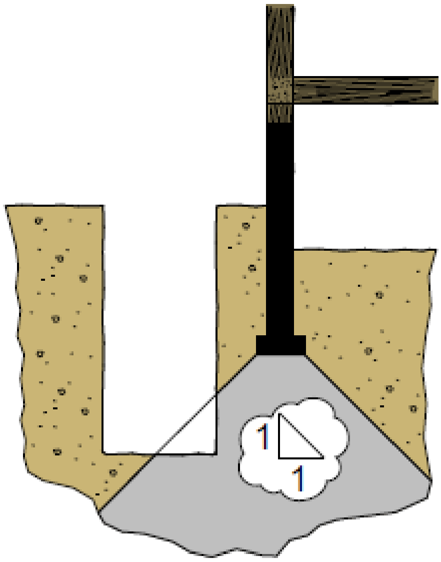

Figure 2-5. Excavation intrudes into area affected by weight of building

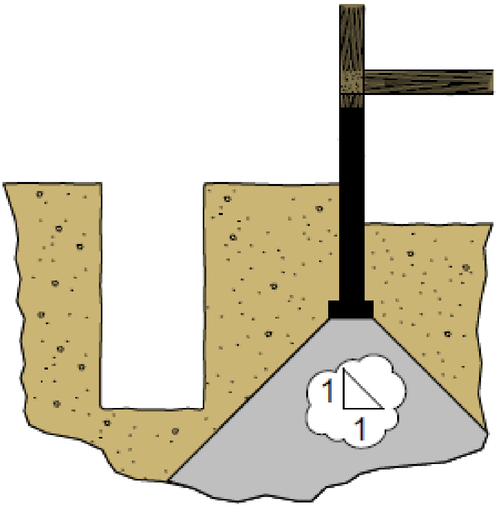

Figure 2-6. Excavation unaffected by weight of building

NOTE

Machinery weighing 20,000 lbs. or more is classified as a "heavy load" for this purpose under CAL/OSHA. However, the Competent Person should ALWAYS consider ANY piece of machinery when making this determination.

Like the foundation of a building, heavy loads such as trucks and backhoes also increase stresses on soil. If the surcharge load is 20,000 lbs. or greater, **before** excavating, get help from a registered P.E. See Figure 2-7, below, and Figure 2-8 on page 2-17 to determine whether you need additional shoring for a load such as a truck or heavy machinery.

It is best practice **never** to park or drive a truck or heavy machinery close to the excavation. Keeping a distance equal to the trench depth is required to ensure the load does not put additional stress on excavation walls.

For each excavation near a building or machinery, determine if special shoring or other procedures are required.

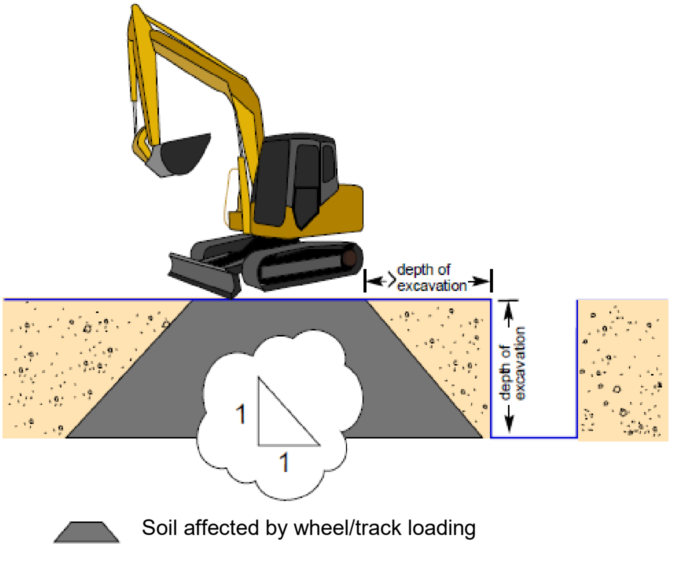

Figure 2-7. Heavy load nearby; excavation is stable

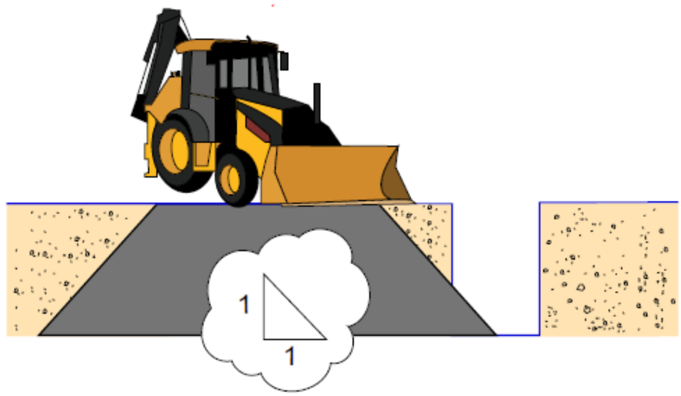

Figure 2-8. Heavy load nearby; machinery is too close

In Figure 2-9, below, Trench A is a service trench carrying utilities to the building. The amount of soil removed near the building is minimal and has little or no effect on the foundation of the building. If Trench A were wider or deeper than a normal service trench, there could be some effect on the foundation.

Trench B, however, parallels the foundation and is located close to the building. In this type of case, evaluate the depth of the excavation, the distance to the foundation, and the depth of the building's foundation to determine whether special shoring or other techniques are needed.

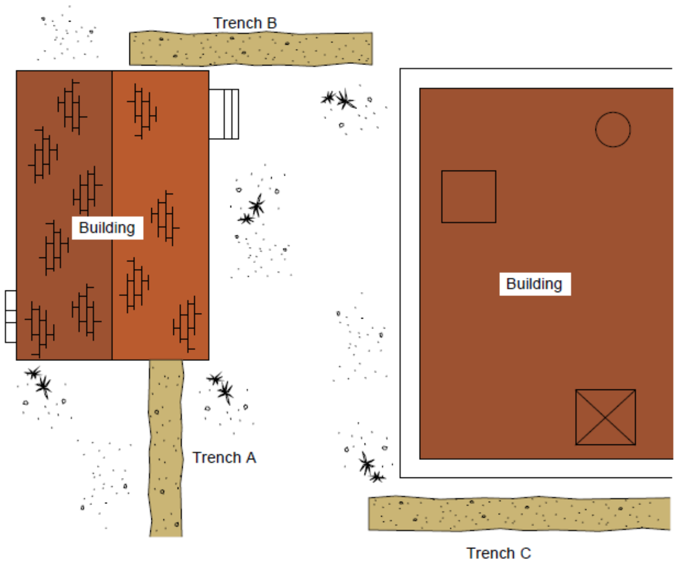

Figure 2-9. Examples of trenches near buildings

If the excavation is similar to Trench C in Figure 2-9 on page 2-17, determine whether the excavation will affect the foundation. Compare to Figures 2-5 and 2-6, on page 2-15, in which the area affected by the foundation's force is shown in the darker color.

Use extreme caution when shoring near basements. The outward pressure of the shoring system may cause a failure of nearby foundations and walls. See Figure 2-10, below, for an example.

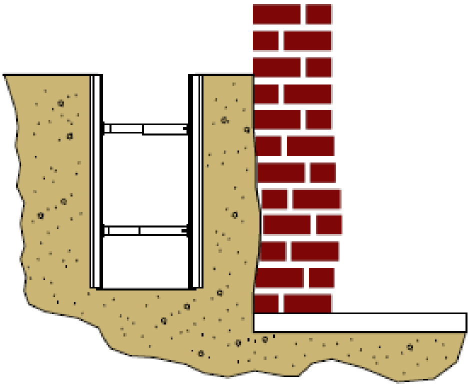

Figure 2-10. Pressure of shoring damaging basement walls

Part 3
Working Safely

1 Excavating

CAUTION
Damage to underground facilities may occur if excavations are performed without a current USA ticket. USA tickets are REQUIRED and valid for 28 days from the date issued.

1.1 Digging with power equipment

See Utility Procedure TD-4412P-05, “Excavation Procedures for Damage Prevention,” for necessary precautions.

1.2 Spoil placement

Temporary spoil

Place temporary spoil no closer than 2' from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. Do not measure this distance from the crown of the spoil deposit. At this distance, loose rock or soil from the temporary spoil is unlikely to fall on employees in the trench.

Place the spoil so that it:

- Channels run-off water away from the excavation.
- Cannot accidentally run, slide, or fall back into the excavation.

WARNING
The spoil bank must not be higher than 2′ if it is located within a distance equal to the depth of the excavation. See Figure 3-1 on page 3-2.

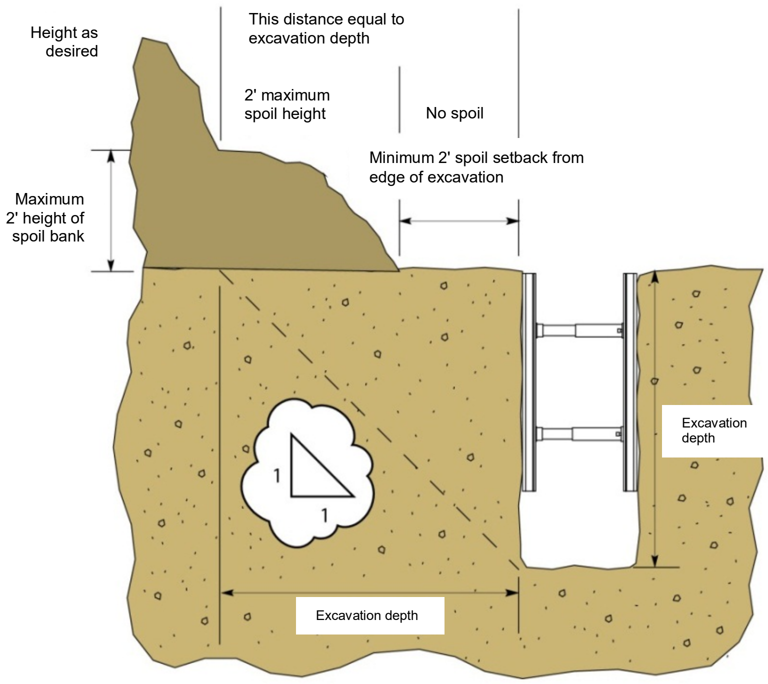

Figure 3-1. Placing spoil pile at least 2' from excavation

IF spoil cannot be placed 2' away from the side of the excavation,

THEN see subsection **Unusual conditions** on page 3-3 for mitigations.

IF the site (e.g., confined city street or site with limited right-of-way) requires either the accumulation of an unusually large or heavy earth spoil pile, or that unusually heavy excavators or trucks travel close to the excavation side walls,

THEN **before** excavating, get help from a registered Professional Engineer (P.E.).

Permanent spoil

Place permanent spoil away from the excavation. The improper placement of permanent spoil, i.e., at insufficient distance from the working excavation, can cause an excavation to be out of compliance with its H:V requirement. Compliance, or lack of it, can usually be determined through visual observation.

Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

Unusual conditions

IF unusual conditions require spoil to be placed within 2' of the edge of the excavation, THEN:

- Include the full height of the spoil when measuring the depth of the excavation.
- Use retaining devices, such as a trench shield, to prevent spoil or other material from falling into the trench.

EXAMPLE

Figure 3-2, below, illustrates an excavation where the spoil has been placed immediately next to the excavation. The excavation thus counts as 6' deep (2' of spoil, plus the 4' excavation). Do not enter such a trench without protection from a trench shield or other approved safety method.

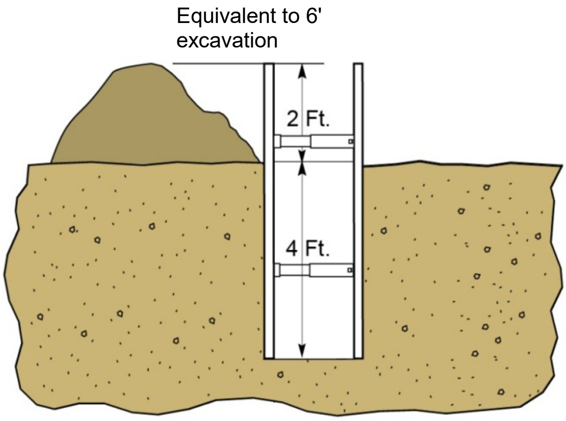

Figure 3-2. Height of spoil adds to depth of excavation

Contaminated soil

If soil contamination is suspected or known,

THEN follow Utility Work Procedure WP4710-02, “Contaminated Soil and Material Handling Procedures,” and contact the local environmental field specialist (EFS).

Ensure that the proper PPE is available to all employees handling contaminated soil. The proper PPE is described in Utility Standard S4710, “Gas Pipeline Production Fluid and Liquid; Leak Response and Contaminated Soil Handling Requirements.”

1.3 Remove hazardous conditions

Make safe or control trees, boulders, poles, or other surface objects that may create a hazard to employees making the excavation. Personnel are not permitted to work on the faces of sloped or benched excavations above other personnel unless personnel at the lower level are protected from the hazard of falling, rolling, or sliding material.

Loose rocks and other objects are hazards that could roll or fall from an excavation face. Protect employees by:

- Removing objects which may fall (such as curbs).
- Scraping excavation faces to remove loose debris (such as rocks).
- Installing protective barriers to stop or contain falling objects.
- Using other means to ensure safety.

1.4 Excavating near electric utility structures

Excavations near electric utility structures, including power poles, may be subject to additional hazards. For each such excavation, a Qualified Worker must identify hazards that could cause electric utility structures to become unstable or fall.

Consider the following for hazardous potential:

- Leaning pole or structure
- Heavy equipment on the pole or structure
- Loose soil
- Excavation depth relative to the buried depth of the pole or structure
- Excavating around the entire pole or structure
- Existing excavations
- Guy cables
- Topped poles
- Risers
- Utility (or other) poles
- Ground rods connected to equipment such as cathodic protection rectifiers, transformers, capacitors, regulators, reclosers, etc.

After the Qualified Worker identifies and evaluates potential hazards, controls must be put in place to reduce or eliminate the hazards before beginning the work.

Contact the local Division or General Construction electric supervisor with any questions or concerns and for assistance to secure or support power poles or structures, if deemed necessary to ensure the safety of employees who will be performing the work and to protect Company assets.

2 Preparing to enter an excavation

This section explains the steps and considerations which must be taken to ensure safety before entering an excavation.

WARNING

If employees must cross a trench that is wider than 30" and deeper than 6", they must use a walkway (with standard guard rails) that is at least 24" wide and made of timber of at least 2" nominal thickness or plywood at least 1-⅛" thick. See Appendix C for illustrations of typical walkways.

2.1. Hazards associated with shoring and working in excavations

Safety Procedure SHC 232, “Other Confined Space/Confined Space Entry and Work," Attachment 5, "Entry into Excavations,” establishes a consistent process for entry into excavations. Follow this process.

Hazardous atmospheres

Under ANY of the following conditions, follow Safety Procedure SHC 232, Attachment 5.

- A hazardous atmosphere exists.
- A hazardous atmosphere can reasonably be expected to exist.

Testing must be performed prior to any employee breaking the plane of an excavation which may contain a hazardous atmosphere.

Confined space

The excavation is a confined space if both of these conditions are true:

- Insufficient ventilation: The existing ventilation is insufficient to remove dangerous air contamination or improve an oxygen deficiency that may exist or develop.
- Limited access: Access or egress for removing a suddenly disabled employee is impaired because of where or how big the openings are.

For more on confined space operations, see Safety Procedure SHC 232.

Safety around hydraulic shoring fluid

When using hydraulic shoring, consult the latest Safety Data Sheet (SDS) for current information on hydraulic fluids. Follow all the precautions listed on the SDS.

When requesting an SDS from the current vendor, supply the following information:

- Product name
- Manufacturer's name
- UPC code (if any)

Safety at heights

Excavation areas may present fall hazards. M62 1073, the Safety at Heights User Guide (Rev. 3/03) states:

> It is PG&E's policy that employees not be exposed to fall hazards. When practicable, work areas and processes will be designed or retrofitted to eliminate fall hazards. If the hazard cannot be practicably abated through design, and the potential fall distance is six ft or greater, approved fall protection systems shall be employed where feasible. Where the use of a fall protection system is not feasible, approved work procedures shall be implemented to protect employees from falls.
>
> Consistent work procedures shall be established and applied for similar fall hazards. All employees shall be trained to recognize and abate hazards and to implement control measures as appropriate.

Further information about fall protection is contained in Utility Standard D-S0421, "Fall Protection and Prevention."

Changes in environment or jobsite conditions

Changes in soil conditions at excavations may require an upgrade in shoring protection. Always watch out for any changes in work area soil conditions that could promote soil collapse. Examples of changes:

Moisture
As soil dries on exposure to air, the soil may crack and destabilize.

Vibration
Shoring requirements increase if there is vibration near the excavation from traffic, heavy machinery, pipeline flow, trains, etc. Pay especially careful attention when vibration is present.

Water
Water from rain, leaks, or water table changes may increase shoring requirements. Porous soils (gravels, sands, and silts) allow water to flow more easily than clay soil. Porous soils may also show the presence of water more quickly than clay soils do.

If you are unfamiliar with soil conditions in the work area, dig a test hole to the depth of the planned excavation. Cover the hole and leave it overnight. The depth of water in the hole the following day is a good indication of the location of the water table.

Do not discharge contaminated water into the environment.

Any personnel on the jobsite who recognize or suspect a hazard have both the authority and the responsibility to call “Stop Work” and evacuate personnel from the excavation. The Competent Person then evaluates the hazard and takes action to control it.

Hazards associated with water accumulation

WARNING
Do not work in excavations with accumulated water or in excavations where water is accumulating.

Worker protection may include special support or shielding systems to prevent cave-ins or water removal to control the level of accumulating water, and may also require use of a safety harness or lifeline.

The Competent Person does the following:

- Monitors the removal of accumulated water
- Ensures that any necessary environmental notifications are made.
- After the water has been removed, inspects the excavation and shoring.
- Before starting work, makes any necessary adjustments to the protective system.

To restore integrity to areas of the excavation washed away by water, fill voids. See Figure 3-3, below.

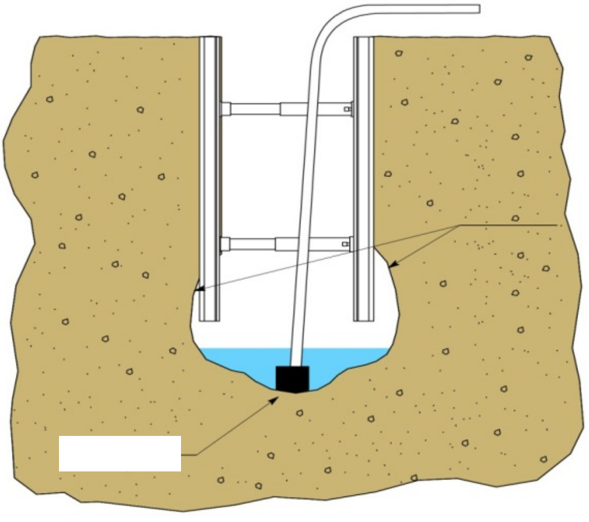

Figure 3-3. Wet excavation walls collapse, causing dangerous voids

Getting into and out of the excavation

Workers need a safe and convenient means of access to enter and leave excavations. Trenches 4' deep or deeper must have exits no more than 50' apart. No one should be farther than 25' from a ladder or other means of exit.

Ladders, stairways, or earthen ramps must meet the following requirements.

Earthen ramps

- Slope less than 3:1 H:V.
- Allow walking upright.
- Sides protected by shoring, shielding, sloping or benching.

Structural ramps

- Designed by a Competent Person or registered P.E.
- If 6' or higher, include a guardrail compliant with requirements specified in Appendix C.

Ladders

- Extend at least 36" above the surface.
- Secured mechanically or held by an employee when used.
- Approved in the *Ladder Safety Handbook*.
- See the Code of Safe Practices for more ladder requirements.

Cross the excavation only where it is safe to do so. Do not jump across the excavation.

If employees must cross a trench that is wider than 30" and deeper than 6′, they must use a walkway with standard guard rails that is:

- At least 24" wide and
- Made of either timber of at least 2" nominal thickness, or plywood at least 1⅛" thick.

See Appendix C for illustrations of typical walkways.

2.2 Installing protective systems

Refer to Parts 4, 7, 8, and 9 for instructions on protective system installation and requirements.

To ensure the safety of workers and the integrity of the job, install trench protection properly. When installing protective systems:

- Securely connect members of the protective systems selected.
- Safely install support systems.
- Never overload members of support systems.
- When you have to remove individual members temporarily, install other structural members to carry the load.

You may excavate 2' or less below the bottom of the members of a support or shield system of a trench if:

- The system is designed for and adequate for the full depth of the trench, and
- While the trench is open, there are no indications of a possible cave-in below the support system.

3 Zone of shoring

It is important to understand which areas of an excavation are NOT protected by shoring

3.1 Side walls

When shoring is used to protect the sides of the excavation from cave-in, the shoring supports, and therefore protects, **only part** of the opposing sides. The area between the protecting shores is called the **zone of shoring**. Employees may not enter any area outside the zone of shoring.

EXAMPLE

In Figure 3-4, the four shores create a zone of shoring. Employees who are between any two shores are ***inside*** the area protected by the zone of shoring. An employee who is not between two shores would be outside the zone of shoring. Always work inside the zone of shoring.

> **NOTE**
> In this example, the end wall was sloped according to the soil conditions. Employees must not enter the sloped area because there is no shoring to protect the side walls.

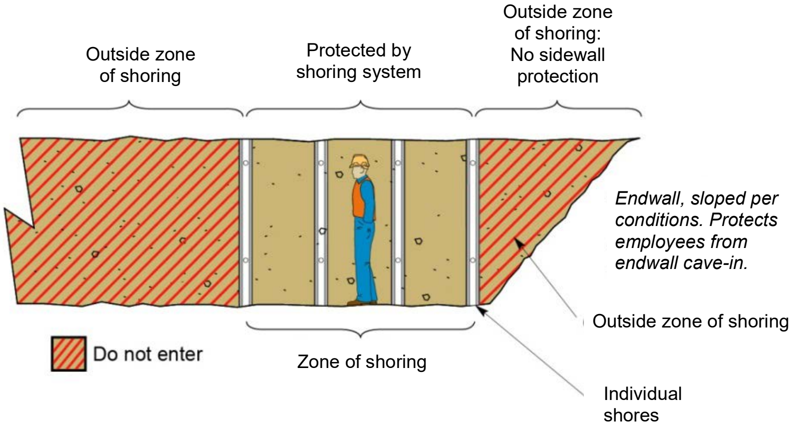

Figure 3-4. Zone of shoring

3.2 Trench ends

WARNING
Do not enter the unprotected trench ends for a distance equal to the depth of the trench.

Just as potential side wall failure creates no-work zones, the risk of end-wall failure also creates no-work zones. The end-wall defines the end of the trench as follows:

The end of the trench is a distance into the trench equal to the height of the end wall.

For example, if the end wall is 10' high, the end of the trench includes all of the trench that is 10' or less from the end wall.

The ends of trenches are not included in the zone of shoring established by the side wall shores. Trench ends must be stabilized by sloping, benching, or appropriate shoring (commonly called an end shore.)

It is a best practice to place your last shore at the end of the safe zone. That way, it serves as a reminder that as long as you remain within the shoring, you will not enter the endwall hazard zone. See Figure 3-5.

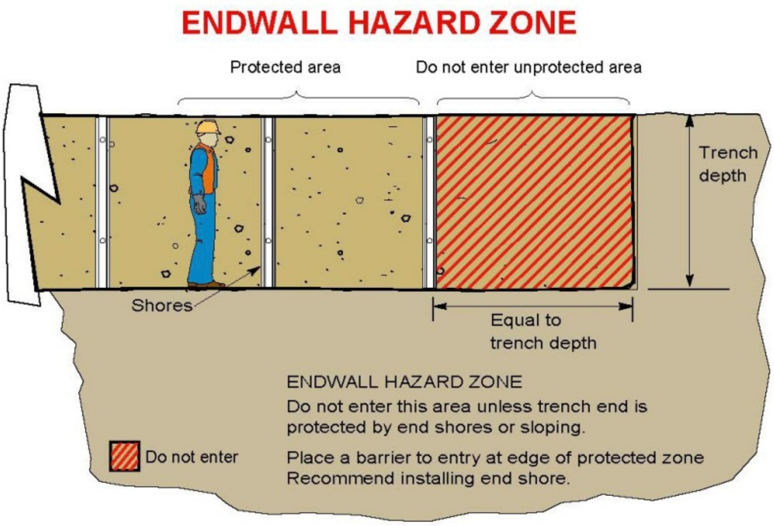

Figure 3-5. Avoiding unprotected trench ends

4 Maintaining safety in the excavation

4.1 Inspections

Inspections by CAL/OSHA or other regulators

An excavation may be inspected by a CAL/OSHA or other regulator. See Appendix B, "Foreman's Guide for Briefing Cal/OSHA Inspectors," for instructions on what to do and what information you should be prepared to discuss should that happen.

Competent Person inspections

For a detailed explanation of inspection points, see TD-4621S, Attachment 1, "Daily Excavation, Trenching & Shoring Safety Checklist/Report."

A competent person must inspect the excavation, the adjacent areas, and the shoring, shielding, benching, or sloping system(s) on the following schedule:

- Daily and at the beginning of each work shift.
- After every rainstorm or other hazard-increasing occurrence.
- As needed throughout the shift.

If any of the following conditions are present, evacuate all employees from the hazardous area until the necessary precautions have been taken to ensure safety.

1. Inspect the excavations, the adjacent areas, and the protective systems for evidence of the following:
    - Situations that could result in a cave-in.
    - Indications of protective system failures. Hydraulic cylinders must be maintained at 750–1500 pounds per square inch gauge (psig), or as specified in the vendor's tabulated data. See Part 4.
    - Hazardous atmospheres.
    - Other hazardous conditions.
2. Inspect the soil for the following factors that can change the classification:
    - Vibrations.
    - Moisture loss.
    - Water intrusion.

4.2 Public crossings

If the public must cross the trench, provide a convenient walkway or bridge. This crossing must have standard guardrails that include toprails, midrails, and toeboards. As needed, build in enough space for disabled persons. Additional barricading may be necessary to protect the public. See Appendix C.

Pedestrian crossings that use steel traffic plates require a nonslip coating on the metal plate. All openings in the plate (e.g., the lifting eye) must be covered.

For a description of acceptable guardrails, see Appendix C.

NOTE

Before using a crossing, verify that it is acceptable and follows codes and standards local to the area of the excavation.

Crossing ramps may be obtained from shoring vendors provided they meet or exceed the company requirements, or are accompanied by stamped tabulated data. Shoring must be used in excavations when the public may be crossing.

4.3 Jobsite access and traffic control

When the excavation must be open for multiple days, follow the *California Joint Utility Traffic Control Manual* and *Jobsite Access and Traffic Control*, as well as any permit requirements for closing the excavation each day and reopening it for work subsequent days. See the Traffic Control Plan (TCP).

Install and remove steel plates in accordance with Company standards and procedures.

WARNING

It is absolutely critical that no unauthorized persons enter the excavation. Secure the excavation before leaving for the day by covering it with steel plates, securely fastening plywood, or using other means that ensure no one can access the excavation.

Excavation barriers

Use boundary markers, traffic cones, barricades, stop logs, or observers to prevent mobile equipment from accidentally falling into excavations.

When the public is exposed to excavations, use barricading for protection. Backfill trenches or cover them with steel street traffic plates at the end of the work shift. If you are unable to maneuver a steel plate to the excavation, obtain permission from your supervisor to cover the excavation with securely fastened plywood or other means to ensure that no unauthorized people can access it.
This is critical. Secure all excavations before leaving for the day. After completing temporary excavations, consider installing shoring for steel-plate-covered excavations in trafficked areas, regardless of depth.

Work area protection must also include measures to safely direct traffic around the excavations. For more information on appropriate work-area protection procedures, consult the *Work Area Protection Guide*.

Traffic barriers

Where conditions permit, consider parking a large vehicle between the excavation and normal traffic flow. The vehicle can act as a two-way barrier, protecting the excavation and employees from traffic and protecting the public from the trench. Park the vehicle far enough away from the excavation to avoid additional stress on the trench wall.

Consider use of arrow boards to direct traffic around the excavation.

Non-traffic areas

If backfilling is not practical, secure the area to prevent public access to the excavation. At a minimum, install barricades secured to one another, barricades with fencing, steel plates, or other acceptable controls in a manner that deters public access. If using plywood, fasten it securely to ensure that no unauthorized people enter the excavation.

Part 4

Protective Systems: Shores and Shields

1 About protective systems

The protective systems described in this part are a mechanical means of stabilizing the walls of an excavation to ensure the safety of personnel working in the excavation.

This part discusses:

- Hydraulic Shoring
- Boxes
- Shields
- Walers

For preparation and processes, see Parts 2 and 3. To evaluate protective systems not detailed in this chapter or installed by a third party, see Appendix D.

1.1 Installing shoring

IF the jobsite requires an employee to deviate from the requirements in this manual,

THEN the deviations must be specified by a registered professional engineer (P.E.) or stamped tabulated data.

Install hydraulic shoring according to the manufacturer's recommendations and the specifications outlined in this manual.

Install shoring from the top of the excavation and work down to the bottom.

1.2 Removing shoring

Use extreme caution when removing the shoring. Work slowly and be alert to the formation of cracks in the edges of the excavation. Watch for soil movement after removing the supporting systems.

For added safety, backfill up to the bottom shoring braces before removing them.

Remove shoring from the bottom of the excavation and work up to the top.

2 Hydraulic shoring

2.1 Advantages

Hydraulic shoring is:

- **Safe:** Employees do not enter an excavation to install shoring.
- **Low-cost:** Generally more economical than other types of shoring.
- Readily **available**.
- **Consistent:** Construction of the rails and cylinders makes the strength of the shoring system much more consistent than other shoring systems.

WARNING
Pressure can bleed off overnight. The Competent Person must monitor the performance of hydraulic shoring during regular inspections.

2.2 Removing the pins from hydraulic shoring

WARNING
Follow all restrictions in the vendor's tabulated data when using hydraulic shoring with pins removed.

In some locations, existing facilities block the installation of vertical hydraulic shores as integral units (rails and cylinders pinned together). Some manufacturers allow their hydraulic shoring systems to be used with the pins removed (pins that usually connect the cylinder pads and vertical rails). When using the hydraulic shoring with the pins removed, personnel must keep at the jobsite a copy of the vendor's tabulated data authorizing the use of unpinned shores. Alternatively, consider using a waler system in these situations.

Figure 4-1 on page 4-3 shows an example of typical tabulated data.

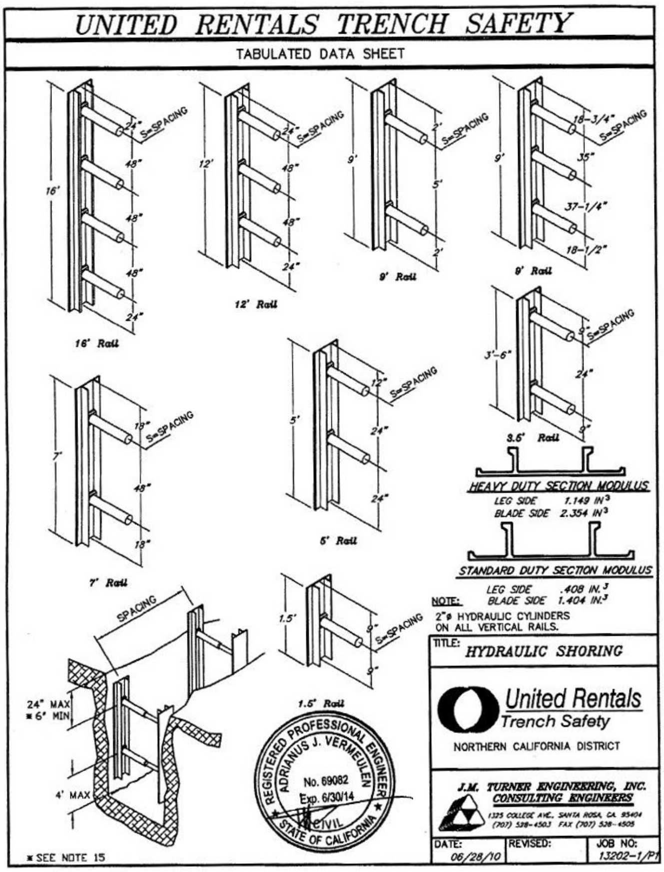

Figure 4-1. Tabulated data example. Used with permission from United Rentals.

Tabulated data shown here is only an example. Always have current, stamped tabulated data on site.

Additional safety issues

- Always work inside the zone of shoring. See Part 3, “Working Safely,” Section 3, Figure 3-4.
- Do not remove any part of the shoring system of any excavation until all necessary steps are taken to prevent hazards to employees.

2.3 Installation requirements

General

Install shores according to the manufacturer's directions.

Do not apply any vertical loads to the hydraulic cylinders (do not use them as ladders; do not use them to support scaffolding).

The vertical rails directly behind each hydraulic cylinder pad must bear on firm soil or on a solid and stable filler to distribute the cylinder load to the face of the excavation.

Inspect before each use and remove from service any damaged material a Competent Person cannot assure is safe for use. Return damaged material to the vendor for evaluation and approval by a registered P.E. before being returned to service.

Do not use shoring that has evidence of:

- Leaks
- Damaged hinge points
- Missing/removed parts
- Deformed components
- Broken connections
- Cracked nipples
- Bent bases
- Other damage

Table 4-1, below, shows the minimum number of shores required.

For spacing requirements based on soil type, always refer to the data in Parts 7, 8, and 9. **Regardless of the length or depth of the excavation, there must be a shore within 2'6" of each end of the excavation.**

Table 4-1. Minimum number of required shores

EXCAVATION		MINIMUM REQUIRED
DEPTH	LENGTH	
Up to and including 12' deep	12' long or less	3 sets of shores at required spacing (or closer)
	More than 12' long	3 sets of shores (4 preferred)
More than 12'	All	4 sets of shores

You may use a different number of shores if specified by a registered P.E. or stamped tabulated data.

Ensure that shoring material is inspected by a Competent Person before installation, daily during use, and when the Competent Person changes. Unfold the hydraulic shoring and inspect the components. Inspect as described on page 4-4.

Ensure that vertical rail overlaps sheeting material 4″ when shores are installed on a seam between two adjacent sheets of sheeting material. Ensure that sheeting material is held rigidly against each trench wall by hydraulic shoring. Table 4-2, below, lists Company-approved sheeting material. Stamped tabulated data may differ.

Table 4-2. Requirements for wooden shoring components

MATERIAL	SPECIFICATION	SPECIAL CONSIDERATIONS
Plywood	1⅛"-thick American Plywood Association (APA), C-C or C-C Plugged Grade, Exterior Glue Bond. Verify that each sheet of plywood is stamped with APA, the specified grade (e.g., C-C), and type of glue (e.g., exterior)	Never substitute other types of plywood (e.g., CD, CDX), unless specified by a registered P.E. or stamped tabulated data
FinnForm or Euroform composite	¾" thick, 14-ply, arctic white birch (FinnForm)	No substitution, unless specified by a registered P.E. or stamped tabulated data

Install hydraulic shores with the rails vertical and the hydraulic cylinders horizontal. Offset the rails vertically to ease their installation and removal (see Figure 4-2 on page 4-6).

Figure 4-3 on page 4-6 shows a side view of the shore placement. The horizontal distance between the shores is determined by soil type and excavation depth. See Parts 7, 8, and 9 for required spacing.

Use these rules when placing shores:

1. The centers of the hydraulic cylinders must be:
   - No more than 18" below the surface of the ground.
   - No more than 4’ between the centers of the hydraulic cylinders.
   - No more than 2’ of earth exposed between the rails vertically. See first two rails in Figure 4-2.
   - No more than 48" from the bottom of the trench.
   - No more than 2’6" from the trench end. Further than that will create a “no work zone.”
2. The rails may be unpinned from the struts if the vendor’s tabulated data allows the separation (see Part 4, Section 2.2 on page 4-2).

NOTE
If desired, butt the ends of the shores together to place them in a single vertical line.

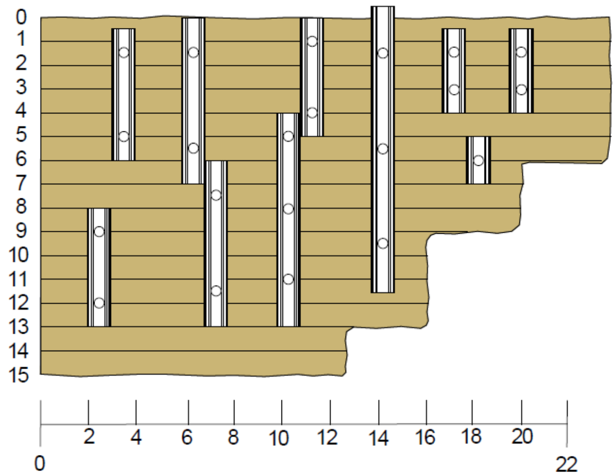

Figure 4-2. Sample placement of hydraulic rails

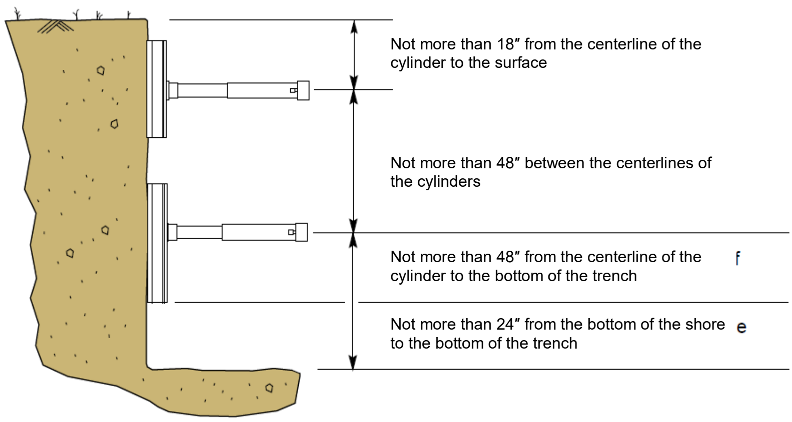

Figure 4-3. Sample placement of hydraulic shores

WARNING
Do not butt rails end to end across an excavation.

Tilting shores

Shores are designed to be installed vertically. They may be installed horizontally or diagonally if all the provisions of the tabulated data are satisfied.

Waler systems

Waler systems are available should a longer working section be needed. See Parts 7, 8, and 9 for tables on waler systems. In a waler system, the shores are oriented horizontally in the trench. This allows maneuvering around obstacles in the trench, such as pipelines.

3 Trench shields, boxes, or cages

Shields

Trench shields, also called boxes or cages, can provide a convenient way to solve difficult shoring problems. Trench shields are intended primarily to protect workers from cave-ins or similar incidents. Shields are available in many sizes, shapes, and strengths. Contact an approved vendor for tabulated data on the shields that are available for use in your area.

Shields must extend to the top of the excavation and not leave more than 2′ of exposed earth at the bottom.

Figure 4-4 shows one kind of shield.

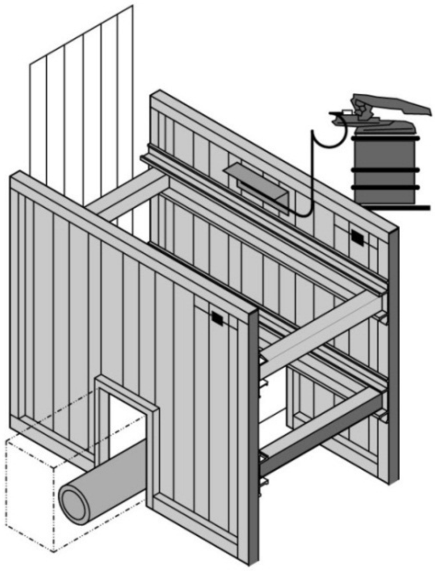

Figure 4-4. Example of hydraulic shield

Condition of materials

Ensure that all trench shields, boxes, or cages, and associated materials are free of defects and damage that might in any way impair their protective function. Immediately remove from service all questionable materials.

Inspect materials prior to installation and report all damage promptly. All damage must be evaluated and repairs made by the vendor's approved representative. Cal/OSHA code requires that a P.E. evaluate and approve the equipment repair prior to returning it to service. Missing or damaged parts must be replaced with parts approved by the vendor.

The excavation

The excavation must be large enough to easily accommodate the trench shield, but the distance between the outside of the box and the trench face should be as small as possible. When the shield is in place, backfill the space outside the shield to prevent it from moving. Fill the space to approximately ½ to ⅔ the excavation's depth if possible. Using washed rock makes shield removal easier.

The faces of the excavation must be cut near vertical and must be straight. The gap between the shield and the excavation face must be no more than the distance specified by the vendor's tabulated data.

Lifting and placing components

WARNING

The top of the excavation must not be above the top of the shield. Slope the sides of the excavation, if necessary, to provide proper clearance.

Inspect all lifting and pulling equipment (cables, slings, chains, shackles, safety hooks, etc.) that is used to handle shields. Evaluate all the components to ensure adequate lifting capacity.

Use tag lines or other approved safety devices to keep employees away from the loads handled by the lifting equipment. Do not stand in or under shields when they are being lifted or moved.

When placing the shield, move slowly, restrict lateral or other hazardous movement of the shield in the event of sudden lateral loads, such as wind loading.

In a compound excavation, the sides of the shield must extend 18" above vertical walls. Figure 4-5 on page 4-9 shows an example in Type B soil.

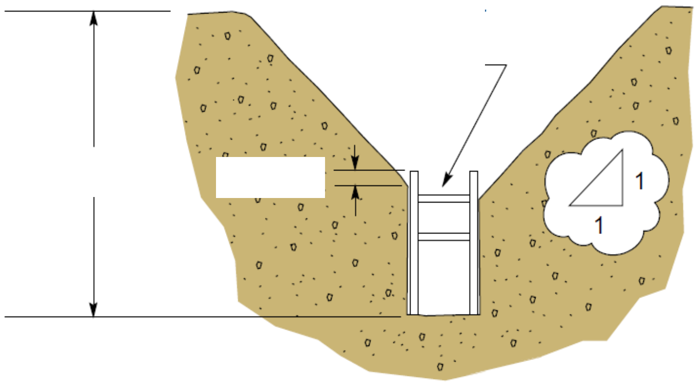

Figure 4-5. Example: Type B soil, supported or shielded

Stacking shields

Some shield units may be stacked for additional depth. Follow the vendor's tabulated data for stacking shields.

When stacking shields, consider using a separate sling for each shield section. This eliminates the need to enter any unprotected portion of the excavation to attach or remove tag lines from the shield sections when installing or removing the shield sections.

Entry/Exit

The climbing rungs built into shields **do not meet** the requirements for entry and exit. Install approved ladders in the shield. Ladders must be secured and must extend at least 36" above the top of the shield.

Do not enter an unprotected area

When installing, moving, and removing the shield:

- Employees must always be protected.
- Employees must not be in the shield.
- Employees must not enter an unprotected area.

Never enter or exit the shield through unprotected areas.

4 Protective systems: typical installations

4.1 Shoring bell hole with perpendicular corners

Figure 4-6, below, shows how shoring can protect a bell hole that has right-angle corners. Install the shores using the spacing recommended in tabulated data.

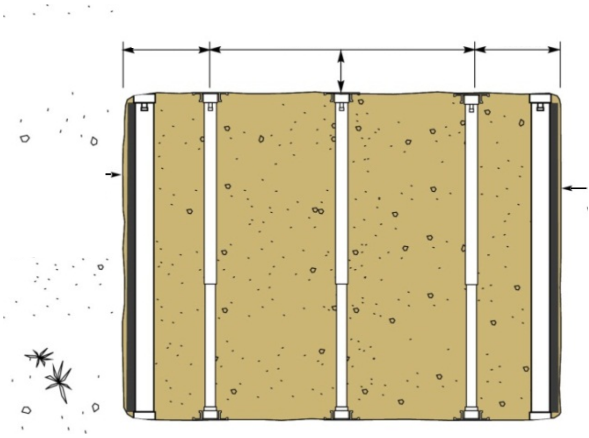

Figure 4-6. Typical bell hole with shoring (plan view)

4.2 Protecting a T intersection

The T intersection presents special problems. Figure 4-7, below, shows how to use a trench shield in addition to shoring to protect the work area.

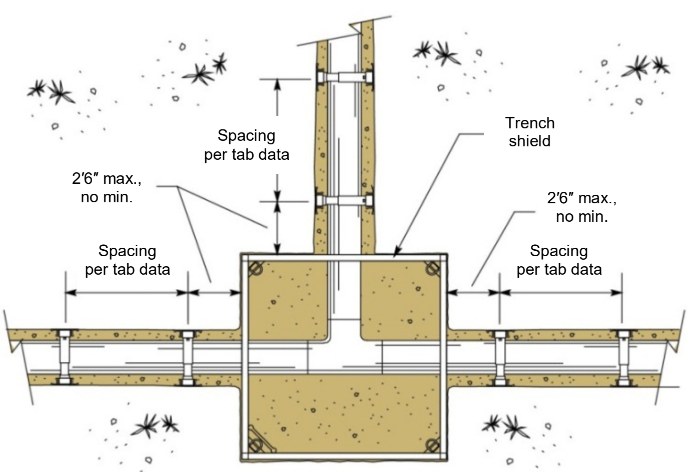

Figure 4-7. Protecting a T intersection (plan view)

4.3 Shoring around a box

In this installation, hydraulic shoring is used to span the area in the excavation that will contain the box. Choose shoring members from vendor's tabulated data. The trench is protected with conventional shoring.

Figures 4-8 and 4-9 show examples using #5 boxes. Conduit angles must be limited to the maximum allowed for the cable size.

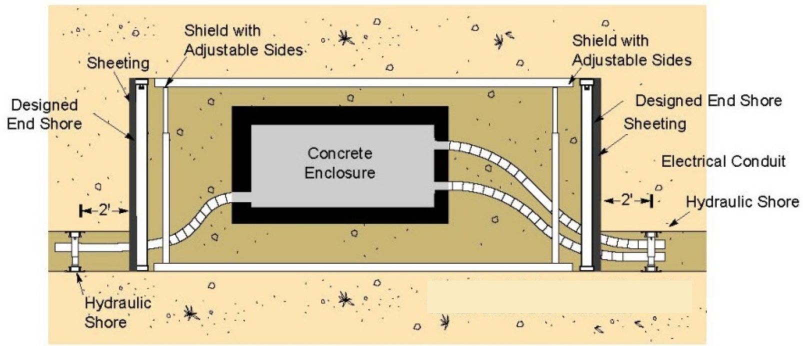

Figure 4-8. Shoring the #5 box, option 1

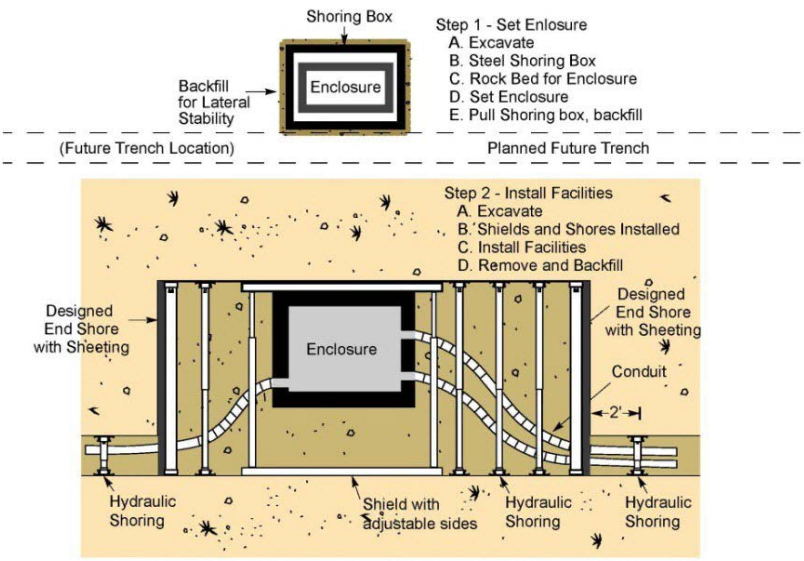

Figure 4-9. Shoring the #5 box, option 2

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Part 5
Sloping and Benching

1 Sloping excavation walls

1.1. Why slope?

Sloping is the simplest way to prevent a cave-in. In sloping, trench walls are cut back to create a V shape. When the correct slope is used, the sides of the excavation are stable and will not collapse.

Figure 5-1, below, is an example of a typical sloped excavation for Type A soil.

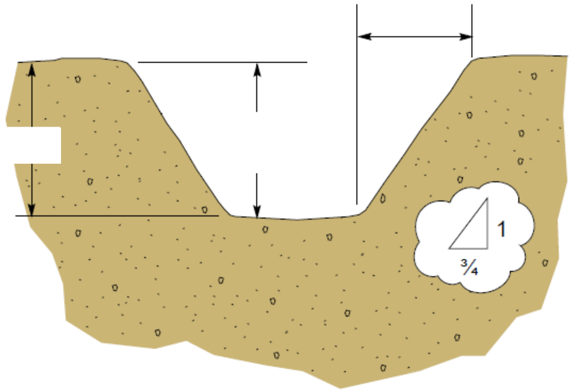

Figure 5-1. Typical sloped excavation for Type A soil

1.2. Profile of simple slope

The slope angle depends on the soil type. The maximum slope for each soil type is shown in Table 5-1 on page 5-2.

> **NOTE**
> Based on local conditions, you may choose to make the slope shallower (less steep) than the maximum slope permitted in Table 5-1.

Table 5-1. Maximum slope for different soil types

SOIL TYPE	MAXIMUM PERMITTED SLOPE	MAXIMUM ANGLE
A	¾:1 H:V 1 / ¾ or 12" / 9"	53°
B	1:1 H:V 1 / 1 or 12" / 12"	45°
C	1½ :1 H:V 1 / 1½ or 12" / 18"	34°

IF an excavation face is sloped at the maximum permitted slope and shows signs of distress (spalling, raveling, clumps separating), THEN the run (horizontal) must be increased by ½. For example, a 1½:1 H:V slope in Type C soil must be increased to 2:1 H:V.

Additionally, a Competent Person must determine whether the slope should be adjusted (reduced, or made less steep) due to the presence of heavy machinery.

For details on constructing various sloping systems for each soil type, see:

- Part 7 (Type A soil)
- Part 8 (Type B soil)
- Part 9 (Type C soil)

2 Sloping and vertical wall combinations

Digging with a vertical wall requires less soil to be removed and is faster than conventional sloping.

> **NOTE**
> Sloping with short vertical wall combinations without shoring is permitted in Type A soil only.

2.1 Sloping with short vertical walls

On occasion, you may need to use one of the methods shown in Figures 5-2 and 5-3, below. Note that the maximum depth of the excavation is limited by the slope.

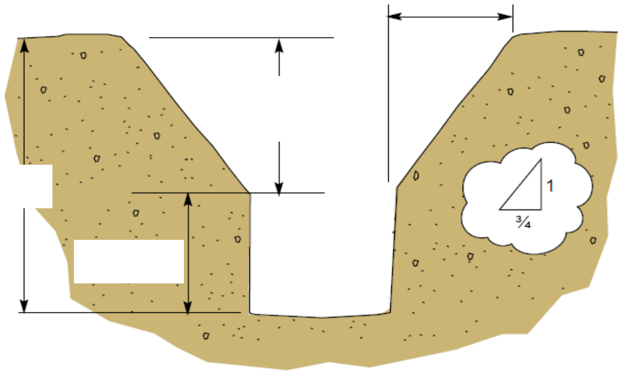

Figure 5-2. Type A soil, ¾:1 H:V sloping with initial vertical wall

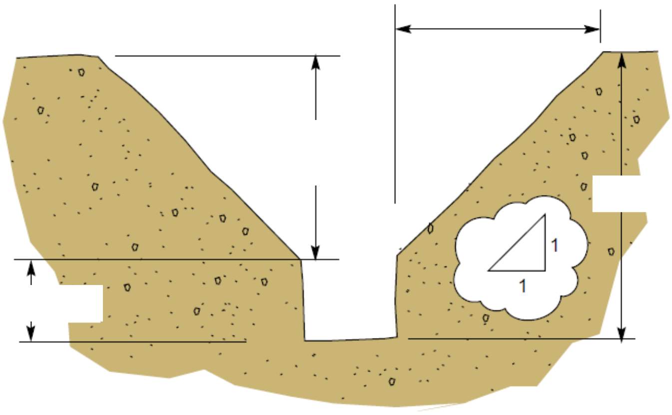

Figure 5-3. Type A soil, 1:1 H:V sloping with initial vertical wall

3 Benching an excavation

Benching is an alternative to shoring or sloping. A bench is composed of a short vertical rise and a horizontal step at the top of the rise.

Benching is authorized only for Type A and Type B-cohesive soils, which can hold the verticals in a benched excavation.

Choose the dimensions of the bench based on all of the following:

- The soil type
- The nature of the work to be done
- The depth of the excavation

The steps of the bench rise at the same slope as for a sloped excavation.

See Parts 7 and 8 for details on proper benching for each soil type.

Table 5-2. Required Benching Slopes

SOIL TYPE	REQUIRED SLOPE
A	¾:1 H:V, 9"H:12"V
B Cohesive	1:1 H:V, 12"H:12"V

You may change the sloped excavation to an excavation with multiple benches or steps. Figure 5-4, below, shows the profile of multiple benches.

Only part of the first horizontal step is allowed to extend beyond the excavation's maximum permissible slope.

For Type B soil, the minimum width of the first horizontal step is equal to the combined heights of the first rise and the second rise, as shown in Figure 5-4.

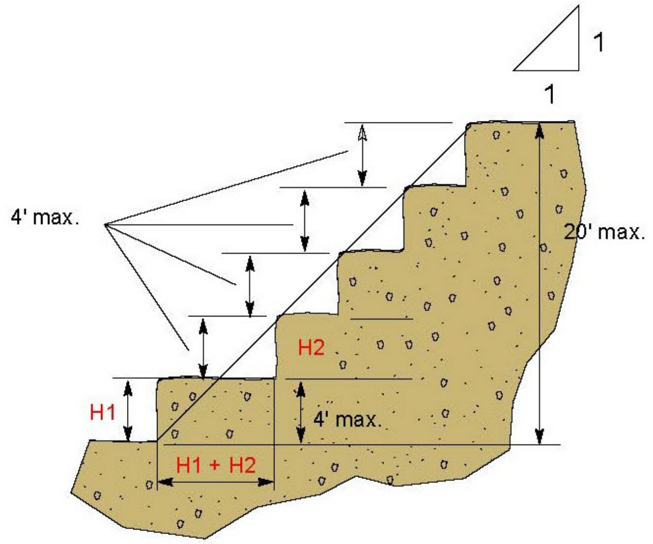

Figure 5-4. Type B soil, multiple-bench excavation (partial view)

Part 6
Cave-In Emergency Plan

1 Elements of the cave-in emergency plan

WARNING
Rescue by non-qualified personnel is dangerous.
Only qualified rescue workers shall attempt a rescue.

All crews must create and tailboard a basic cave-in emergency plan before installing shoring and before anyone enters the excavation.

A cave-in emergency plan must include requirements for:

- Emergency notifications.
- Locating and using emergency shoring materials, tools, etc.
- Initial “make-safe” actions to stabilize the situation and prevent further cave-in.
- Identifying hazards to both victim(s) and rescuers.

Document these actions on the Job Site Safety Analysis (JSSA). You may use TD-4621S-F01, “Daily Excavation, Trenching & Shoring Safety Checklist,” to address excavation safety, reducing the chance of a cave-in.

1.1 Emergency notification

1. IF someone is trapped by a cave-in,
   THEN call 911 immediately for emergency assistance.
   Tell the 911 operator:
   - The location and nature of the incident.
   - The number of victims involved.
   - That people trained in trench rescue are required.

   This call initiates an emergency response by medical and qualified rescue personnel.

NOTE
Calling 911 does not guarantee that all rescue services have proper training to stabilize a trench or excavate effectively in the event of a cave-in.

2. Evaluate what actions can be taken before emergency services arrive; decide what materials, equipment and personnel are needed.
3. Call Company supervision. The supervisor does the following:
   - Mobilizes Company resources and sends personnel and materials to assist with the rescue effort.
   - Coordinates with the ranking rescue officer throughout the operation to ensure the safety of the victim and the rescue workers.
   - Informs the Safety Department by calling the Helpline at (415) 973-8700, Option 1. Gives the location and emergency actions taken.

WARNING
Do not use machinery to dig around a victim. Hand digging is the only way to find the victim's body and limbs.

1.2 Supporting an emergency rescue

WARNING
A second cave-in can follow a first cave-in. Take precautions to protect those directly involved in the rescue, including the injured.

NOTE
Emergency response personnel establish incident command. The Company provides support and takes direction from incident command, or unified command may be established.

1.2, cont.

1. Assign a Safety Observer on either side of the excavation to:
   - Monitor the excavation.
   - Identify any present and potential hazards.
   - Inform the Site Supervisor of any changes.
2. Use hand labor (no machinery) to clear spoil and materials from the top edge of the trench.
3. Place plywood or wooden planks at the edge of the trench to distribute the weight of emergency personnel.

1.3 Stabilizing and entering the excavation

WARNING
Do not enter the excavation until it has been stabilized.

1. Determine how shoring can be safely lowered into the excavation without endangering the victim.
2. Install shoring to protect rescue workers.
3. Do not allow anyone to enter the trench or excavation until the trench has been stabilized and the foreman or site supervisor deems it safe.
4. The Safety Observer monitors the safety of emergency response workers throughout the rescue operation and notifies incident command of any issues observed.
5. Sample air quality before entering and at regular intervals during the entire rescue operation.
6. Attach lifelines to every person entering the excavation for any reason.
7. A rescue operation is time-consuming. Designate relief personnel to be ready to assist rescuers in first aid and cardiopulmonary resuscitation (CPR).

1.4 Caring for a victim

WARNING
Always assume that a victim has serious back and neck injuries.

If it is possible to safely reach a victim, give care as follows.

1. Clear the victim's face and chest to restore breathing.
2. Perform basic first aid.
   - Restore breathing.
   - Stop the bleeding.
   - Check for broken bones.
   - Perform CPR.

1.5 Moving a victim

- **Only** move a victim in a life-threatening situation.
- Take adequate precautions to prevent further injuries.
- Only a properly trained rescue team, using the proper equipment, should move a victim.

2 Cave-in emergency checklist

2.1 Call for rescue service

☐ Call 911 and tell the operator:

- The exact location of the accident scene. This may include GPS coordinates.
- The number of victims.
- The approximate time of the cave-in.
- The depth of the trench or excavation.

☐ Help the rescue service understand clearly that they are responding to a cave-in. Some rescue teams have special equipment for a cave-in accident.

☐ Tell the rescue service about any utilities or other facilities that may create a hazard to the rescue operation.

☐ Be prepared to stay on the line with the 911 operator to relay information while another employee contacts Company supervision.

2.2 Notify Company supervision

- ☐ Call the Company dispatcher, gas dispatcher, electric system operator, or other Company office and tell them the:
  - Exact location of the accident scene.
  - Number of victims.
  - Approximate time of the cave-in.
  - Depth of the trench or excavation.
- ☐ Request any needed equipment or shoring materials.
- ☐ Confirm that local supervision is notified.
- ☐ Call the Safety Department Helpline, at (415) 973-8700, Option 1. Be prepared to describe location and actions taken in the emergency.
- ☐ Use the contact list in Part 1, section 2.1, to call for other assistance as needed.

2.3 Crew foreman or Competent Person's duties

WARNING
After any cave-in, there is danger of a second cave-in. Take precautions to protect those directly involved in the rescue, including the injured. 65% of cave-in victims are rescue personnel.

- ☐ Select crew members for the tasks they are best suited for and trained to perform.
- ☐ Stress the importance of immediately relaying progress reports and findings back to the supervisor.
- ☐ Keep a log of all significant events.

2.4 Prepare site for emergency response

- ☐ Document all actions taken and inform emergency response team of the situation upon arrival.
- ☐ Shut down equipment and eliminate other sources of vibration.
- ☐ Establish a clear work area for emergency equipment of 300′ in all directions (if possible).
- ☐ Direct traffic away from the scene until police arrive.

2.4, cont.

- ☐ Establish a staging area at least 50' away for shoring materials, plywood, and other equipment that rescue workers can use to shore the excavation.
- ☐ Use all available resources to obtain any needed additional shoring materials:
  - Lumber yards and shoring vendors
  - Construction sites
  - Local service centers, etc.

WARNING
Do not enter an unshored excavation cave-in.

- ☐ When it is safe, install emergency shoring to prevent a second cave-in and stabilize the excavation. Install the shoring using any system described in the Excavation Safety Manual or other approved, tabulated data.
- ☐ Use vacuum excavation, if available, to suck soil or water from the cave-in.

2.5 Identify hazards

- ☐ Be alert for and identify signs that indicate potential problems like signs of ground movement in the area, cracks, etc.
- ☐ Mark trouble areas with paint so they can be monitored.
- ☐ Be constantly aware of the possibility of a secondary cave-in.
- ☐ IF employees suspect a hazardous atmosphere,

  THEN ventilate the site until the appropriate test equipment takes a safe reading.
- ☐ Look for other construction in the area that could possibly compound a hazardous situation.
- ☐ Check for utilities in or near the trench that could create a hazard.
- ☐ Determine a method to remove water from the excavation, if needed.
- ☐ Keep all people away from the excavation, except those involved in the rescue activity.

2.6 Caring for a victim

☐ Move a victim only in a life-threatening situation.

☐ To care for a victim of an excavation cave-in:

1. Clear the victim's face and chest to restore breathing.
2. Perform basic first aid:
   - Restore breathing.
   - Stop the bleeding.
   - Check for broken bones.
   - Perform CPR.

☐ Always assume that a victim has serious back and neck injuries.

☐ Take precautions to prevent further injuries.

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Part 7
Type A Soil

This part discusses requirements, tabular data, and examples for shoring, sloping, and benching in Type A soil.

1 Characteristics

Type A soil is cohesive soil with unconfined compressive strength greater than or equal to 1.5 tons per square foot (TSF).

Examples of Type A soil:

- Clay
- Silty clay
- Sandy clay
- Clay loam
- Cemented soil (caliche and hardpan)

IF any of the following are true,

THEN the soil **cannot** be classified as Type A.

- Soil is fissured.
- Soil is subject to vibration from heavy traffic, pile driving, or similar effects.
- Soil has been previously disturbed.
- Soil is part of a sloped, layered system where the layers meet on a slope of 4:1 H:V or steeper. See Part 2, Section 5.7.

Other factors may also bar soil from classification as Type A.

2 Hydraulic shoring data

2.1 Spacing components

NOTE
Use the vendor's tabulated data or the numbers in Table 7-1, below, to determine the required horizontal spacing for shores.

If raveling or sloughing of the excavation face appears likely, use 4'-wide sheeting (approved plywood or FinnForm) at each vertical shore.

2"-diameter cylinders must have one of the following:

- A structural steel tube oversleeve 3.5" x 3.5" x 0.1875" extension (installed over the aluminum oversleeve extension)

  OR

- A steel tube oversleeve 3" x 3" x 0.1875" extension (installed without the aluminum oversleeve) that extends the full retracted length of the cylinder.

The bottom of the sheeting must extend within 2' of the bottom of the excavation.

IF there is an indication of possible loss of soil from behind the support system,
THEN sheeting must extend to the bottom of the excavation.

When vertical shores are used, there must be a minimum of three shores spaced equally throughout the excavation.

When working near the end of a trench or excavation, and shoring is required, use end shores or other approved methods to protect employees.

See Table 7-1, below, for sample spacing requirements.

Table 7-1. Type A soil: Cal/OSHA spacing requirements for hydraulic shoring in an excavation up to 15' deep

MAXIMUM HYDRAULIC CYLINDER SPACING		MINIMUM CYLINDER DIAMETER	
HORIZONTAL	VERTICAL	EXCAVATION 0 TO 8' WIDE	EXCAVATION 8' TO 12' WIDE
8'	4'	2"	2"

3 Shoring examples

Figure 7-1, below, shows shoring in Type A soil.

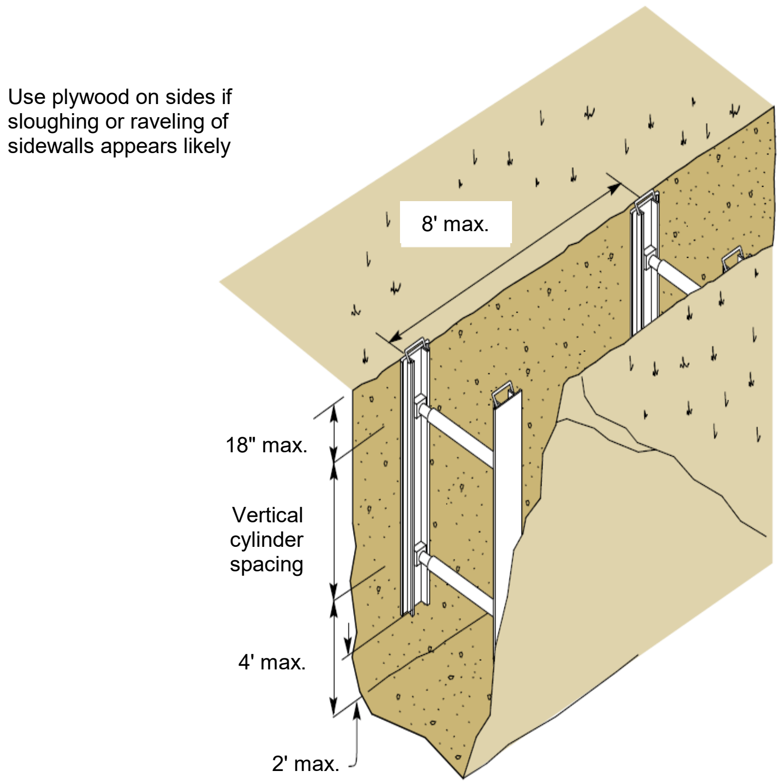

Figure 7-1. Hydraulic shoring in Type A soil

3.1 Other applications

For excavations that are deeper or wider than listed in Table 7-1 on page 7-2, see the vendor's tabulated data for the excavation system you install. You may also contact a registered P.E. for assistance. See Part 1, Section 2.1 for phone numbers.

4 Sloping

NOTE
Maximum depth of an excavation designed using this manual is limited to 20'.
See Part 10, "Sloping Layered Soil," for sloping layered soil types.

Sloping is permitted in Type A soil. The slope must be no steeper than ¾:1 H:V (i.e., 9" horizontal to 12" vertical). A profile of the excavation is shown in Figure 7-2, below.

IF an excavation face is sloped at ¾:1 H:V,

AND shows signs of distress (spalling, raveling, clumps separating),

THEN the wall must be sloped to 1¼:1 H:V.

For example, an excavation face that is sloped at 9" horizontal to 12" vertical and shows spalling must be re-sloped to 15" horizontal to 12" vertical.

See Table 7-2 on page 7-5 for pre-calculated values for sloping in Type A soil.

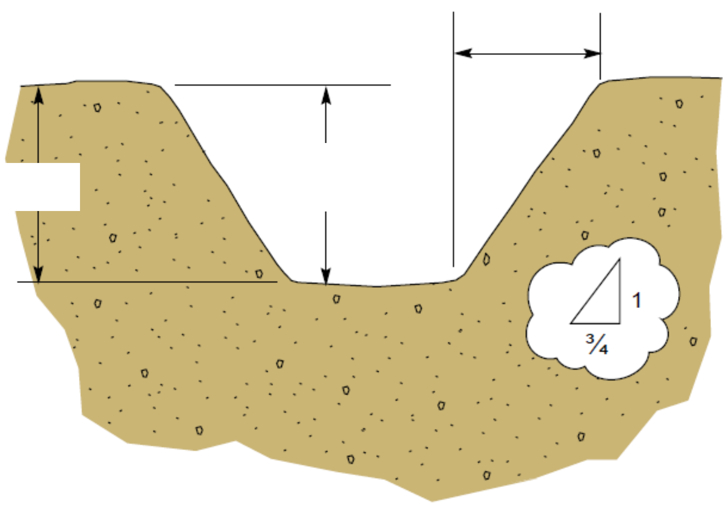

Figure 7-2. Sloping in Type A soil

Table 7-2. Sloping dimensions for Type A soil, ¾:1 H:V

EXCAVATION DEPTH	MIN. WIDTH AT TOP OF EACH SIDE CUT (SIDE CUT WIDTH MIN.)
4'	3'0"
5'	3'9"
6'	4'6"
7'	5'3"
8'	6'0"
9'	6'9"
10'	7'6"
11'	8'3"
12'	9'0"
13'	9'9"
14'	10'6"
15'	11'3"
16'	12'0"
17'	12'9"
18'	13'6"
19'	14'3"
20'	15'0"

Example:

Given: Work is being performed in a 13'-deep trench.

Determine: The side cut width.

Data from Table 7-2: A 13'-deep trench requires a side cut 9'9" wide.

4.1 Supported or shielded sloping

The maximum depth for this method is 20'.

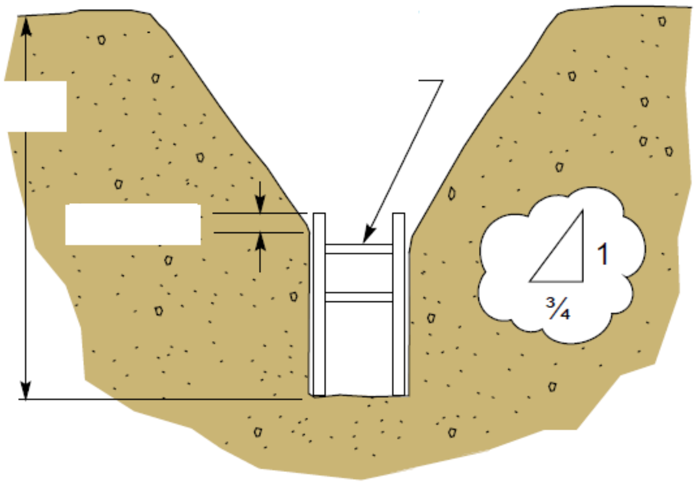

Figure 7-3. Type A soil: trench shield in sloped excavation

Design shield or shoring systems to protect the total depth of the excavation and extend at least 18" above the top of any vertical walls.

4.2 Unsupported vertical lower walls

Digging with a vertical wall requires less soil to be removed and is faster than conventional sloping. See examples in Figure 7-4 on page 7-7 and Figure 7-5 on page 7-8.

See Table 7-3 on page 7-7 and Table 7-4 on page 7-8 for horizontal dimensions. Note that the maximum allowable depth is determined by the slope used on the walls.

For excavations that are 8′ deep or less, use a slope of ¾:1 H:V or less steep.

The maximum height of the unsupported vertical wall is 3'6".

This trench configuration, shown in Figure 7-4, is permitted only in Type A soil.

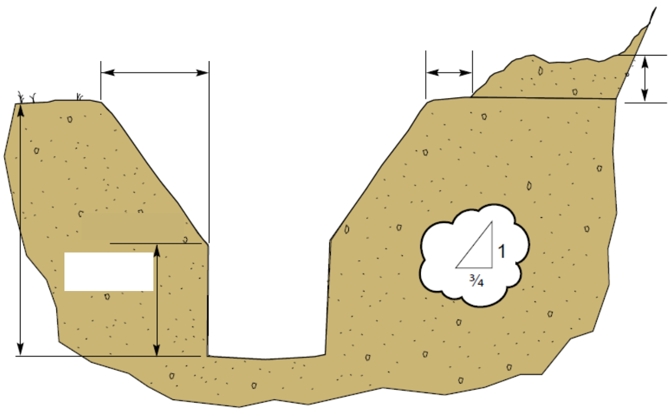

Figure 7-4. Sloped excavation with unsupported vertical lower walls, maximum depth 8'

Table 7-3. Sloped excavation with 3'6" initial unsupported vertical sides (8' max. depth, slope ¾:1 H:V)

TYPE A SOIL, ¾:1 H:V	
EXCAVATION DEPTH	WIDTH AT TOP OF EACH SIDE CUT (SIDE CUT WIDTH MIN.)
4'	5"
5'	1'2"
6'	1'11"
7'	2'8"
8'	3'5"

Excavations deeper than 8' (with vertical side) require a slope of 1:1 H:V.

- The maximum depth is 12'.
- The maximum height of the unsupported vertical wall is 3'6".

This trench configuration is permitted only in Type A soil.

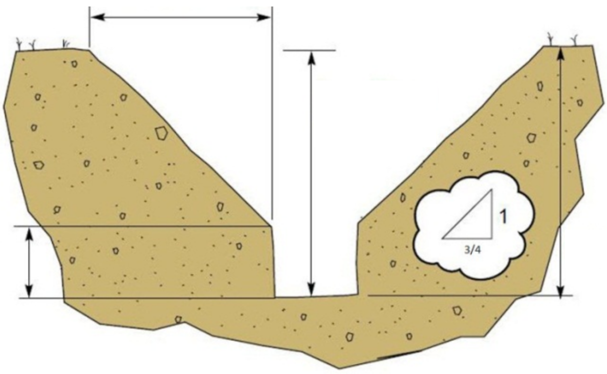

Figure 7-5. Sloped excavation with unsupported vertical lower walls

Table 7-4. Sloped Excavation with 3'6" initial unsupported vertical sides (12' max. depth, 1:1 H:V slope)

EXCAVATION DEPTH	WIDTH AT TOP OF EACH SIDE CUT
4'	0'6"
5'	1'6"
6'	2'6"
7'	3'6"
8'	4'6"
9'	5'6"
10'	6'6"
11'	7'6"
12'	8'6"

5 Benching

NOTE
Maximum depth of an excavation designed using this manual is limited to 20'.

Benching is permitted in Type A soil. The steps of the bench rise at the same slope as for a sloped excavation. The slope must be ¾:1 H:V or less steep. That is, 9" (¾') horizontal to 1' vertical, or less steep.

A profile of single bench excavation is shown in Figure 7-6, below, and a profile of a multiple bench excavation is shown in Figure 7-7 on page 7-10.

5.1 Single bench

The simplest form of benching is the single bench, or an excavation having one vertical rise and a horizontal step. Only the benched section may extend beyond the slope of the remaining excavation wall. Choose the dimensions of the bench based on:

- Soil type
- Nature of the work to be done
- Depth of the excavation

See Table 7-5 on page 7-10 for maximum dimensions.

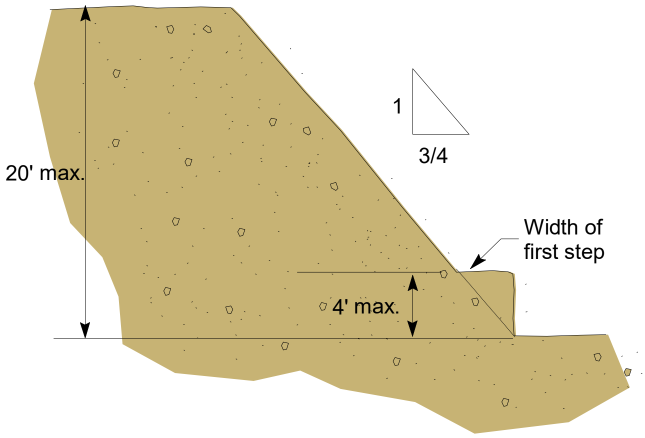

Figure 7-6. Type A soil, single-bench profile

Table 7-5. Maximum dimensions for a single bench in Type A soil

Maximum total depth	20'
Maximum bench height (vertical rise)	4'
Minimum slope (9" rise to 12" run)	¾:1 H:V
Minimum width of the step for a 4' vertical rise	3'

5.2 Multiple benches

Figure 7-7, below, shows a sample multiple-bench excavation.

Only a portion of the first horizontal step is allowed to extend beyond the excavation's maximum permissible slope.

Choose any convenient bench height within the maximum allowable dimensions.

Calculate the required width of the horizontal steps using the bench height and the rules shown in Table 7-6 on page 7-11. Common minimum bench widths based on bench heights are shown in Table 7-7 on page 7-11.

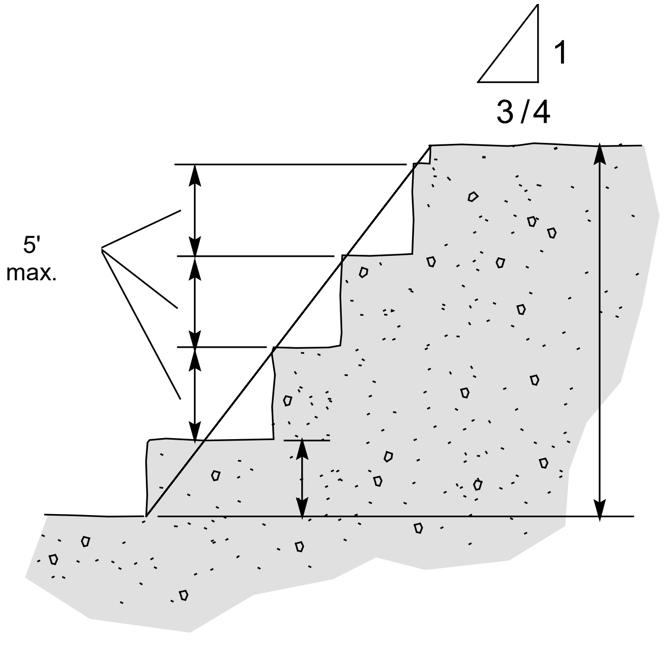

Figure 7-7. Type A soil, multiple bench excavation

The **minimum** width of the first bench **must be** based on the height of both the **first and second** rises **combined**.

Failure to combine the heights of both of the first two rises to determine the width of the first bench is one of the most common errors made in benching excavations.

Table 7-6. Dimensions of multiple benches in Type A soil

DIMENSION	SIZE
Height of first rise	Any convenient height less than 4'.
Height of remaining rises	Any convenient height less than 5'.
Minimum width of first horizontal step in inches	Add the height of the first rise to the height of the second rise, then multiply by ¾ (0.75) for the minimum width of the first horizontal bench. Adding the first two heights to determine the first width always gives a safe bench for Type A soil.
Minimum width of remaining horizontal steps in inches	Multiply the height of the rise by ¾ (0.75).

Table 7-7. Minimum benching widths based on bench heights (Type A soil)

HEIGHT	MINIMUM WIDTH (HEIGHT x 0.75)
1'	0'9"
2'	1'6"
3'	2'3"
4'	3'
5'	3'9"

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Part 8
Type B Soil

This part discusses requirements, tabular data, and examples for shoring, sloping, and benching in Type B soil.

1 Characteristics

Several types of soil are classified as Type B.

- Cohesive soil with an unconfined compressive strength greater than 0.5 tons per square foot (TSF), but less than 1.5 TSF.
- Granular cohesionless soil, including angular gravel (similar to crushed rock), silt, silt loam, sandy loam, and, in some cases, silty clay loam and sandy clay loam.
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration.
- Dry rock that is not stable.
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than 4:1 H:V, but only if the material would otherwise be classified as Type B.

Previously undisturbed soil is Type B **unless** it would otherwise be classified as Type C.

2 Hydraulic shoring

2.1 Spacing combinations

Use the vendor’s tabulated data or Table 8-1 on page 8-2 to determine the required horizontal spacing for shores.

If raveling or sloughing of the excavation face appears likely, use 4'-wide sheeting (approved plywood or FinnForm) at each vertical shore.

2"-diameter cylinders must have a structural, steel-tube oversleeve 3.5" x 3.5" x 0.1875" extension (installed over the aluminum oversleeve extension) or a steel-tube oversleeve 3" x 3" x 0.1875" extension (installed without the aluminum oversleeve) that extends the full retracted length of the cylinder.

The bottom of the sheeting must extend within 2' of the bottom of the excavation.

IF there is an indication of possible loss of soil from behind the support system,
THEN the sheeting must extend to the bottom of the excavation.

When working near the end of a trench or excavation, and shoring is required, use end shores or other approved methods to protect employees.

Figure 8-1, below, shows hydraulic shoring for Type B soil. Table 8-1, below, gives spacing requirements for shores.

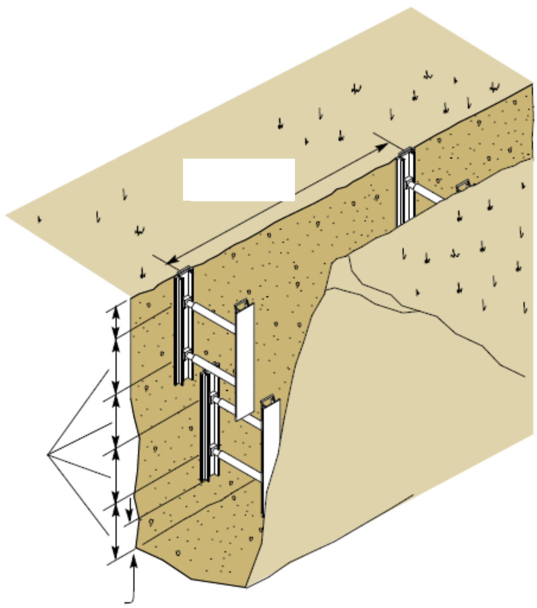

Figure 8-1. Stacked hydraulic shoring in Type B soil

Table 8-1. Type B soil: Cal/OSHA spacing requirements for hydraulic shoring

DEPTH OF EXCAVATION	MAX. CYLINDER SPACING		MIN. CYLINDER DIAMETER	
	HORIZONTAL	VERTICAL	EXCAVATION 0' 8' WIDE	EXCAVATION 8' 12' WIDE
0–10'	8'	4'	2"	2"
0–15'	6.5'	4'	2"	2"

3 Shoring examples

Figure 8-2, below, shows shoring in Type B soil.

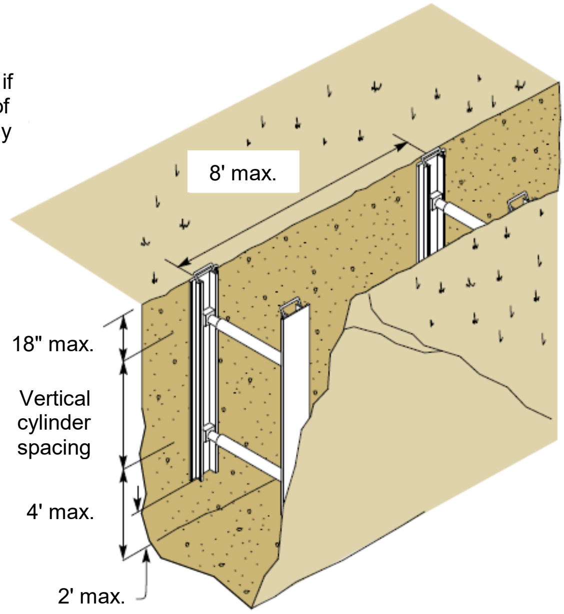

Figure 8-2. Hydraulic shoring in Type B soil

3.1 Other applications

For excavations that are deeper or wider than those listed above, consult a registered P.E. or use stamped tabulated data.

4 Waler systems

Figure 8-3, below, shows a sample waler system. Table 8-2 on page 8-5 gives spacing and cylinder diameter requirements for waler systems in Type B soil.

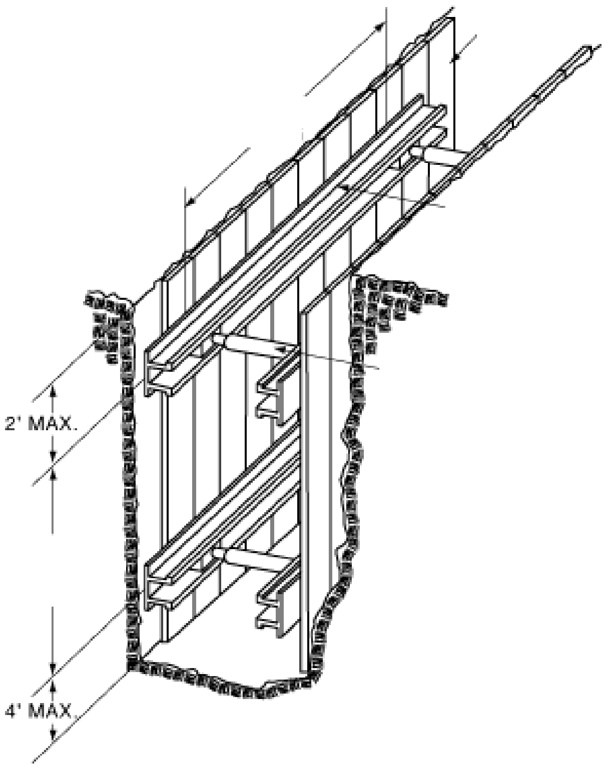

Figure 8-3. Hydraulic shoring in Type B soil: waler system

In a trench over 8' wide and up to 12' wide, 2"-diameter cylinders must have structural steel tube oversleeves (3.5" x 3.5" x 0.1875"), or structural oversleeves of manufacturer's specification, extending the full collapsed length.

Table 8-2. Aluminum hydraulic shoring waler systems, Type B soil

DEPTH OF TRENCH	WALES		HYDRAULIC CYLINDERS			
	VERTICAL SPACING	SECTION MODULUS (IN^3) [a]	TRENCH UP TO 8' WIDE		TRENCH OVER 8' UP TO 12' WIDE	
			HORIZ SPACING	CYLINDER DIAM.	HORIZ SPACING	CYLINDER DIAM.
Over 5' Up to 10'	4'	3.5	8.0	2"	8.0	2"
		7.0	9.0	2"	9.0	2"
		14.0	12.0	3"	12.0	3"
Over 10' Up to 15'	4'	3.5	6.0	2"	6.0	2"
		7.0	8.0	3"	8.0	3"
		14.0	10.0	3"	10.0	3"

Note for Table 8-2:

a. Consult product manufacturer and/or qualified engineer for section modulus of available wales.

For applications other than those listed in the tables, use manufacturer's tabulated data or call a registered P.E.For excavations that are deeper or wider than those listed above, refer to the vendor's tabulated data for the excavation system installed. You may also contact a registered P.E. for assistance. See Part 1, Section 2.1, for phone numbers.

5 Sloping

5.1 Slope profile

Sloping is permitted in Type B soil. The slope can be no steeper than 1:1. A profile of the excavation is shown in Figure 8-4, below.

IF an excavation face is sloped at 1:1 H:V

AND shows signs of distress (spalling, raveling, clumps separating),

THEN the wall must be sloped at 1½:1 H:V.

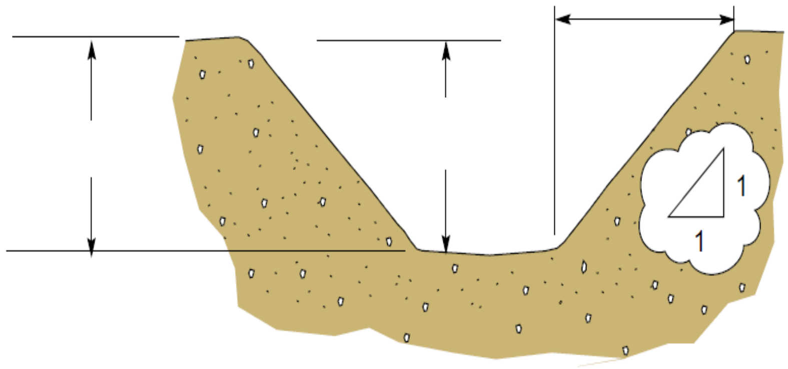

Figure 8-4. Sloping in Type B soil

Table 8-3 on page 8-7 contains pre-calculated values for sloping in Type B soil.

Table 8-3. Sloping dimensions for Type B soil, slope = 1:1

EXCAVATION DEPTH	SIDE CUT WIDTH (AT THE TOP OF EACH SIDE CUT, IN FEET)
4'	4'
5'	5'
6'	6'
7'	7'
8'	8'
9'	9'
10'	10'
11'	11'
12'	12'
13'	13'
14'	14'
15'	15'
16'	16'
17'	17'
18'	18'
19'	19'
20'	20'

Example for Table 8-3:

Given: Work is being performed in a 12'-deep trench.

Determine: Side cut width.

Data: From Table 8-3, a 12'-deep trench requires a 12' side cut width.

5.2 Supported or shielded sloping

Design the shield or shoring system to protect the total depth of the excavation and extend at least 18" above the top of the vertical walls, as shown in Figure 8-5, below.

NOTE

Installing trench shields often requires special lifting equipment due to the heavy weight of the components and the long "reach" needed to place the shield in a sloped trench.

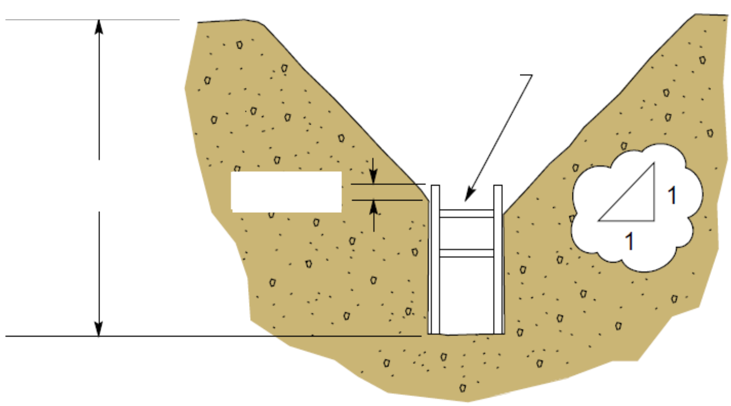

Figure 8-5. Type B soil: trench shield installed in sloped excavation

6 Benching

WARNING
Benching is permitted only in cohesive Type B soil. Do not bench in non-cohesive Type B soil.

6.1 Single bench

The simplest form of benching is the single bench, or an excavation having one vertical rise and a horizontal step. Only the benched section may extend beyond the slope of the remaining excavation wall. See Figure 8-6 and Table 8-4, below.

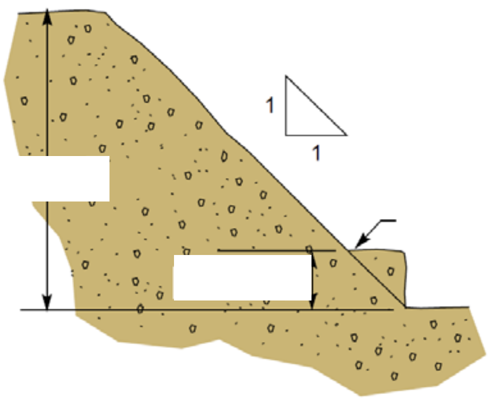

Figure 8-6. Type B cohesive soil, single-bench profile

Table 8-4. Maximum dimensions for a single bench in Type B cohesive soil

DIMENSION	MAXIMUM
Maximum total depth	20'
Maximum height, vertical rise	4'
Minimum slope	1:1
Minimum width of the step (for a 4' vertical rise)	4'

6.2 Multiple benches

The slope of a benched excavation must be 1:1 H:V or less (i.e., at least 1' horizontal to 1' vertical). A profile of the excavation is shown in Figure 8-7 on page 8-10. Only a portion of the first horizontal step may extend beyond the excavation's maximum permissible slope.

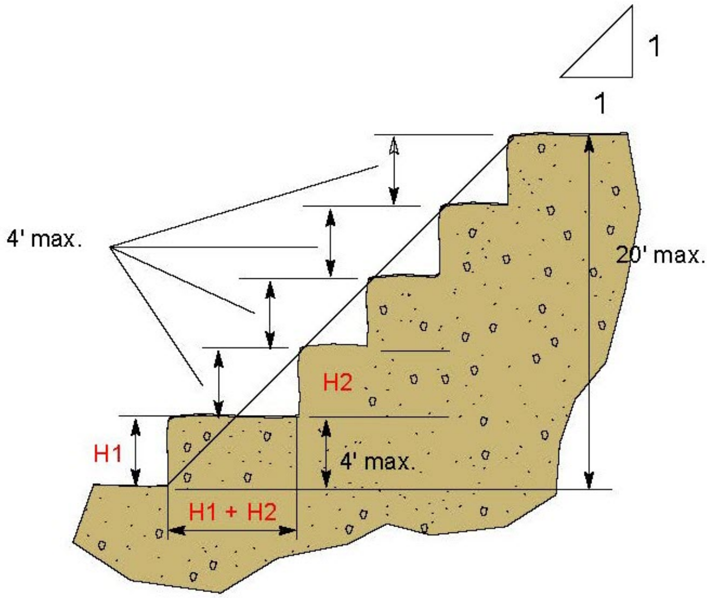

Figure 8-7. Type B cohesive soil, multiple bench excavation

Dimensions of multiple benches

Choose any convenient bench height, within the maximum allowable dimensions. Calculate the required width of the horizontal steps using the bench height and the rules shown in Table 8.5, below.

The width of the first bench **must be** equal to the **total** height of the **first and second** rises **combined**.

Failure to combine the heights of both of the first two rises to determine the width of the first bench is one of the most common errors made in benching excavations.

Table 8-5. Dimensions of multiple benches, Type B cohesive soil

DIMENSION	SIZES
Height of first rise	Any convenient height up to 4'.
Height of the remaining rises	Any convenient height up to 4'.
Minimum width of first horizontal step	Calculate the width by adding the height of the first rise to the height of the second rise.
Width of the remaining horizontal steps	The minimum width of each step is equal to the height of each vertical rise.

Part 9
Type C Soil

This part describes requirements, tabular data and examples for shoring and sloping in Type C soil.

Benching is NOT permitted in Type C soil.

1 Characteristics

WARNING
Type C is a broad classification, and only some Type C soils can be shored using the techniques in this manual.
Low-strength Type C soil is a special case and requires assistance from a registered P.E. See Part 1, Section 2.1.

Type C soil is:

- Cohesive soil with an unconfined compressive strength of 0.5 TSF or less
- NOT flowing or submerged

Examples of Type C soil:

- Granular soil
- Submerged rock that is not stable
- Moist cohesive or moist dense granular
- Soil that can be cut near-vertical and stand long enough to allow shoring and sheeting to be properly installed

Type C soil can be shored if:

- It is a moist, cohesive soil OR a moist dense granular soil that does not fit into Type A or B.
- It is not flowing or submerged.
- It can be cut with near-vertical sidewalls and will stand unsupported long enough to properly install a protective system.

2 Hydraulic shoring data

WARNING
Design the shoring system to protect the total depth of the excavation, even if partially backfilled. **Never enter an unprotected portion of any excavation for any reason.**

2.1 Requirements

1. There are no spacing requirements specified in Cal/OSHA code for vertical hydraulic shoring for Type C soil.
2. Vertical hydraulic shores in Type C soil must be specified by a registered P.E. (e.g., stamped tabulated data).
3. Retain tabulated data stamped by a registered P.E. on site.
4. Always use approved sheeting (plywood or FinnForm) with vertical hydraulic shoring in Type C soil.
5. When working with Type C soil, always use plywood or FinnForm sheeting at least 4′ wide on excavation sides with engineered vertical shoring, or use a waler system with approved sheeting. See Table 4-2 on page 4-5.
6. Use tabulated data to determine horizontal spacing for shores.
7. When horizontal spacing exceeds 4', monitor open spaces between sheeting to be sure that the excavation face does not slough or ravel.
8. For excavations less than 10' deep, extend the bottom of the sheeting to within 2' of the bottom of the excavation.
9. IF there is an indication of possible soil loss from behind the support system,
   THEN the sheeting must extend to the bottom of the excavation.
10. For excavations deeper than 10', extend the sheeting to the bottom of the excavation.

11. For 2"-diameter cylinders, install either:
    - A structural steel tube oversleeve 3.5" x 3.5" x 0.1875" extension, over the aluminum oversleeve extension

    OR

    - A steel tube oversleeve 3" x 3" x 0.1875" extension, without the aluminum oversleeve.

    The extension must extend the full retracted length of the cylinder.
12. When vertical shores are used, there must be a minimum of three shores spaced equally.
13. When working near the end of a trench or excavation, and shoring is required, use end shores or other approved methods to protect employees.

3 Waler systems

Figure 9-1, below, shows a sample waler system. Table 9-1 on page 9-4 gives spacing and cylinder diameter requirements for waler systems in Type C soil.

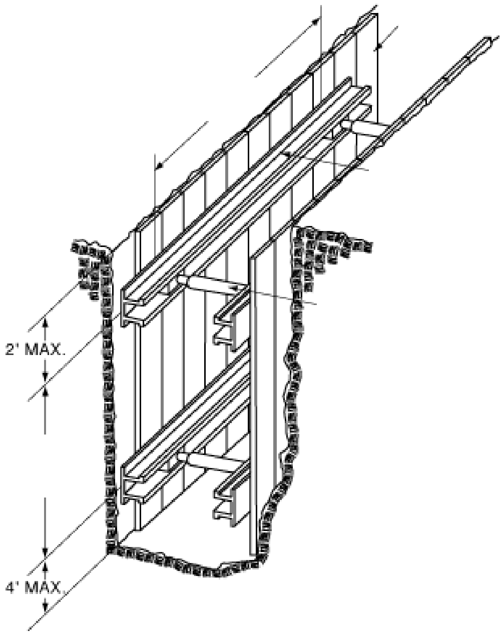

Figure 9-1. Typical aluminum hydraulic shoring: waler system

In a trench over 8' wide and up to 12' wide, 2"-diameter cylinders must have structural steel tube oversleeves (3.5" x 3.5" x 0.1875"), or structural oversleeves of manufacturer's specification, extending the full collapsed length.

Table 9-1. Aluminum hydraulic shoring - waler systems, Type C soil

DEPTH OF TRENCH	WALES		HYDRAULIC CYLINDERS			
	VERTICAL SPACING	SECTION MODULUS (IN^3) [a]	TRENCH UP TO 8 WIDE		TRENCH OVER 8 UP TO 12 WIDE	
			HORIZ SPACING	CYLINDER DIAM.	HORIZ SPACING	CYLINDER DIAM.
Over 5' Less than 10'	4'	3.5	6.0'	2"	6.0'	2"
		7.0	6.5'	2"	6.5'	2"
		14.0	10.0'	3"	10.0'	3"
10' to 15'	4'	3.5	4.0'	2"	4.0'	2"
		7.0	5.5'	3"	5.5'	3"
		14.0	8.0'	3"	8.0'	3"

Notes for Table 9-1:

a. *Consult product manufacturer and/or qualified engineer for section modulus of available wales.*

b. *For applications other than those listed in the tables, use manufacturer's tabulated data or call a registered P.E.*

3.1 Other applications

For excavations that are deeper or wider than those listed above, consult a registered P.E. or use stamped tabulated data.

4 Sloping

4.1 Profile of slope

Sloping is permitted in Type C soil. The slope must be no steeper than 1½:1 H:V.

IF an excavation face is sloped at 1½:1 H:V, AND shows signs of distress (spalling, raveling, clumps separating),

THEN the wall must be sloped to 2:1 H:V.

Figure 9-2, below, shows sloping in Type C soil. Table 9-2, below, gives side cut widths for specific excavation depths.

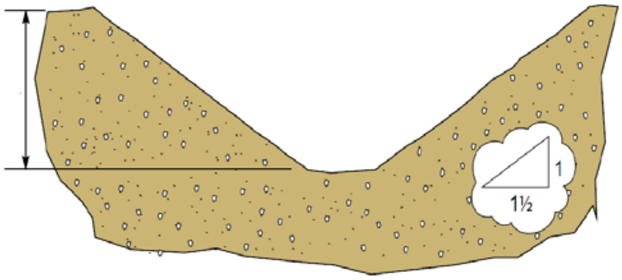

Figure 9-2. Sloping in Type C soil

Table 9-2. Sloping dimensions for Type C soil, 1½:1 H:V

EXCAVATION DEPTH	SIDE CUT WIDTH
4'	6'0"
5'	7'6"
6'	9'0"
7'	10'6"
8'	12'0"
9'	13'6"
10'	15'0"
11'	16'6"
12'	18'0"
13'	19'6"
14'	21'0"
15'	22'6"
16'	24'0"
17'	25'6"
18'	27'0"
19'	28'6"
20'	30'0"

Example for Table 9-2

Given: Work is being performed in a 12'-deep trench.

Determine: Side cut width.

From Table 9-2: A 12'-deep trench requires a minimum 18' side cut width.

4.2 Supported or shielded sloping

Figure 9-3, below, shows dimensions for supported or shielded sloping in Type C soil. In the figure, the total depth is 20'.

WARNING
Design shield or shoring systems to protect employees the total depth of the excavation plus at least 18" above the top of the vertical walls. Never enter an unprotected portion of any excavation for any reason.

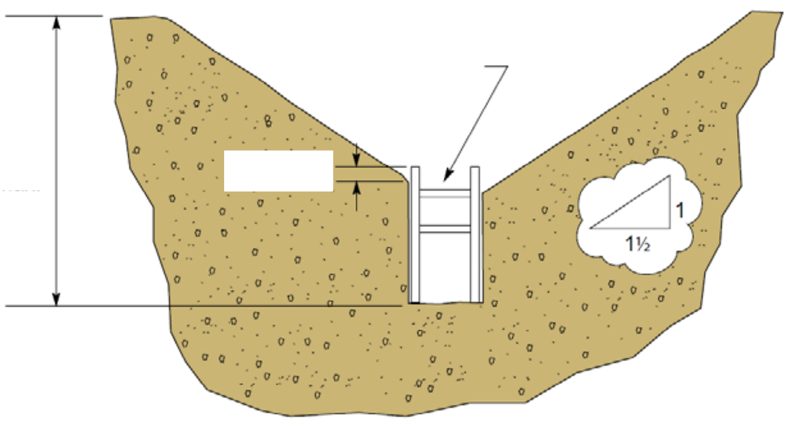

Figure 9-3. Type C soil: trench shield installed in sloped excavation

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Part 10

Sloping Layered Soil

Parts 7, 8 and 9 list requirements for and provide examples of sloping types A, B and C soils. This part outlines requirements for and provides examples of sloping excavations with layered soil types.

1 About sloping layered soil

Layered soils may be sloped. When planning such sloping, it is important to consider the following:

- A slope must NOT become steeper towards the top if the soil type changes. For example, if type A or B is above type C, you must use the weaker classification (type C) for the entire slope.

See Part 2, Section 5.7, for layered soil conditions.

1.1 Layered soil: Type A over Type B

Use the slope of the Type B component for the entire excavation. Figure 10-1 and Table 10-1 show sloping for Type A over Type B.

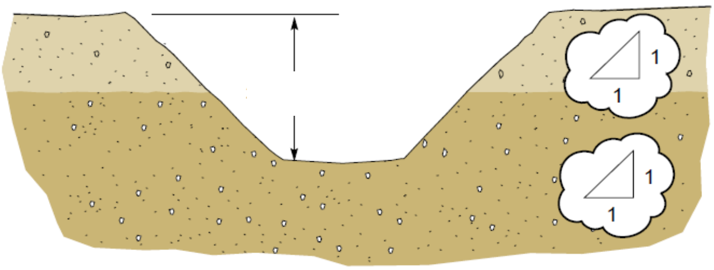

Figure 10-1. Sloping profile: Type A over Type B

Table 10-1. Sloping dimensions: Type A over Type B

DEPTH	COMBINED SETBACK: BOTH TYPES (1:1 H:V)
1'	1'0"
2'	2'0"
3'	3'0"
4'	4'0"
5'	5'0"
6'	6'0"
7'	7'0"
8'	8'0"
9'	9'0"
10'	10'0"
11'	11'0"
12'	12'0"
13'	13'0"
14'	14'0"
15'	15'0"
16'	16'0"
17'	17'0"
18'	18'0"
19'	19'0"
20'	20'0"

1.2 Layered soil: Type A over Type C

Use the slope of Type C soil for the entire excavation. When the least-stable soil is on the bottom, use the slope of the least-stable soil for the entire excavation. Figure 10-2 and Table 10-2 show sloping for Type A over Type C.

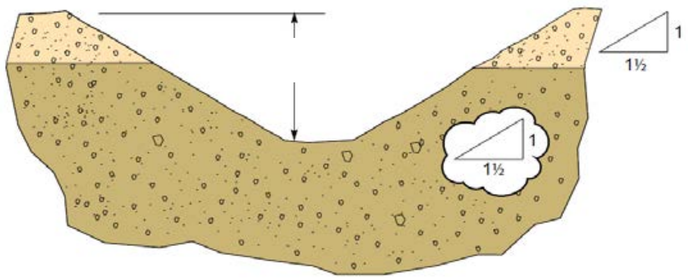

Figure 10-2. Sloping profile: Type A over Type C

Table 10-2. Sloping dimensions: Type A over Type C

DEPTH	COMBINED SETBACK: BOTH TYPES (1½:1 H:V)
1'	1'6"
2'	3'0"
3'	4'6"
4'	6'0"
5'	7'6"
6'	9'0"
7'	10'6"
8'	12'0"
9'	13'6"
10'	15'0"
11'	16'6"
12'	18'0"
13'	19'6"
14'	21'0"
15'	22'6"
16'	24'0"
17'	25'6"
18'	27'0"
19'	28'6"
20'	30'0"

1.3 Layered soil: Type B over Type A

Use the slope of the Type B component for the entire excavation. Figure 10-3 and Table 10-3 show sloping for Type B over Type A.

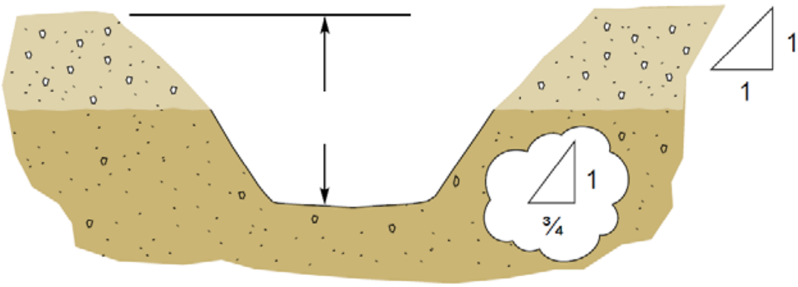

Figure 10-3. Sloping profile: Type B over Type A

Table 10-3. Sloping dimensions: Type B over Type A

DEPTH	SETBACK	
	TYPE B (1:1 H:V)	TYPE A (¾:1 H:V)
1'	1'0"	0'9"
2'	2'0"	1'6"
3'	3'0"	2'3"
4'	4'0"	3'0"
5'	5'0"	3'9"
6'	6'0"	4'6"
7'	7'0"	5'3"
8'	8'0"	6'0"
9'	9'0"	6'9"
10'	10'0"	7'6"
11'	11'0"	8'3"
12'	12'0"	9'0"
13'	13'0"	9'9"
14'	14'0"	10'6"
15'	15'0"	11'3"
16'	16'0"	12'0"
17'	17'0"	12'9"
18'	18'0"	13'6"
19'	19'0"	14'3"
20'	20'0"	15'0"

1.4 Layered soil: Type B over Type C

Use the slope of Type C soil for the entire excavation. When the least-stable soil is on the bottom, use the slope of the least-stable soil for the entire excavation. Figure 10-4 and Table 10-4 show sloping for Type A over Type B.

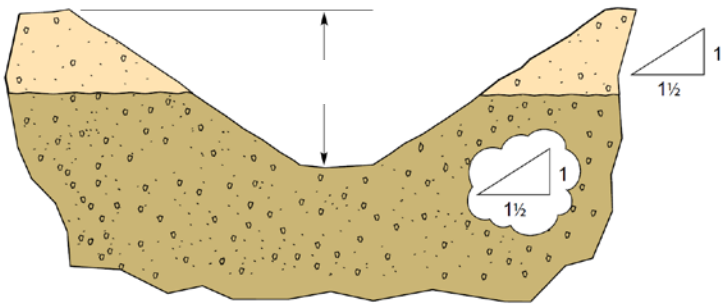

Figure 10-4. Sloping profile: Type B over Type C

Table 10-4. Sloping dimensions: Type B over Type C

DEPTH	COMBINED SETBACK: BOTH TYPES (1½:1 H:V)
1'	1'6"
2'	3'0"
3'	4'6"
4'	6'0"
5'	7'6"
6'	9'0"
7'	10'6"
8'	12'0"
9'	13'6"
10'	15'0"
11'	16'6"
12'	18'0"
13'	19'6"
14'	21'0"
15'	22'6"
16'	24'0"
17'	25'6"
18'	27'0"
19'	28'6"
20'	30'0"

1.5 Layered soil: Type C over Type A

Figure 10-5 and Table 10-5 show sloping for Type C over Type A.

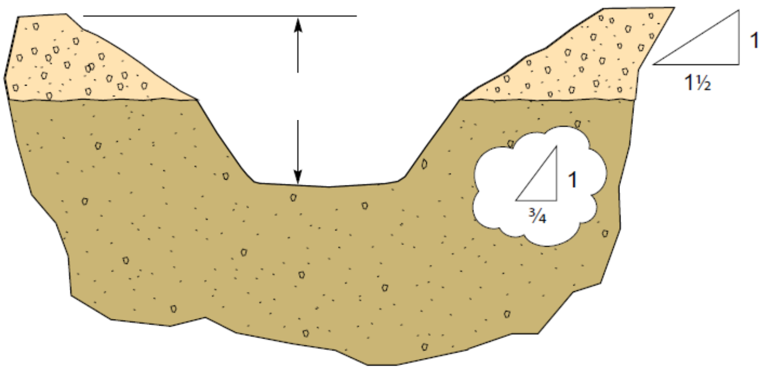

Figure 10-5. Sloping profile: Type C over Type A

Table 10-5. Sloping dimensions: Type C over Type A

DEPTH	SETBACK	
	TYPE C (1½:1 H:V)	TYPE A (¾:1 H:V)
1'	1'6"	0'9"
2'	3'0"	1'6"
3'	4'6"	2'3"
4'	6'0"	3'0"
5'	7'6"	3'9"
6'	9'0"	4'6"
7'	10'6"	5'3"
8'	12'0"	6'0"
9'	13'6"	6'9"
10'	15'0"	7'6"
11'	16'6"	8'3"
12'	18'0"	9'0"
13'	19'6"	9'9"
14'	21'0"	10'6"
15'	22'6"	11'3"
16'	24'0"	12'0"
17'	25'6"	12'9"
18'	27'0"	13'6"
19'	28'6"	14'3"
20'	30'0"	15'0"

1.6 Layered soil: Type C over Type B

Figure 10-6 and Table 10-6 show sloping for Type C over Type B.

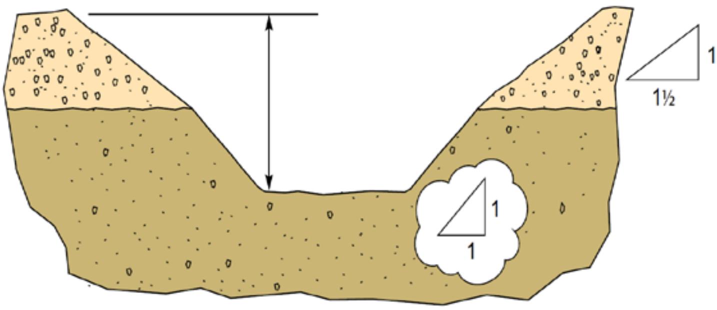

Figure 10-6. Sloping Profile: Type C over Type B

Table 10-6. Sloping Dimensions: Type C over Type B

DEPTH	SETBACK	
	TYPE C (1½:1 H:V)	TYPE B (1:1)
1'	1'6"	1'0"
2'	3'0"	2'0"
3'	4'6"	3'0"
4'	6'0"	4'0"
5'	7'6"	5'0"
6'	9'0"	6'0"
7'	10'6"	7'0"
8'	12'0"	8'0"
9'	13'6"	9'0"
10'	15'0"	10'0"
11'	16'6"	11'0"
12'	18'0"	12'0"
13'	19'6"	13'0"
14'	21'0"	14'0"
15'	22'6"	15'0"
16'	24'0"	16'0"
17'	25'6"	17'0"
18'	27'0"	18'0"
19'	28'6"	19'0"
20'	30'0"	20'0"

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Part 11
Frequently Asked Questions

1 Resource information

QUESTION	ANSWER
1. Does this manual need to be at the job site?	Yes. This manual must be in the vicinity of the job site. See the Preface.
2. If you have a laptop in your truck, does this count as a manual?	No. Because OSHA requires the information to be on site, and due to battery and accessibility issues with having the manual on a laptop, personnel must have the physical book on site with them.
3. Whom can I call for assistance with excavation problems?	See the key contacts in Part 1, Section 2.1.
4. When do I call a registered P.E. for advice or use stamped tabulated data?	For any of the following reasons: ▪ If soils are special, loose or flowing (Part 2, Section 5), e.g., very soft clay, saturated sand, peaty soil, rubble rock. ▪ Excavating across a slope steeper than 3:1 H:V. (Part 2, Section 5.5) ▪ Adjacent slope nearby (Part 2, Section 5.6) AND either: • The toe (base) of a slope that has an angle steeper than 3:1 H:V is located closer to the excavation than the proposed depth of the excavation **or** • The toe of a slope with an angle less than 3:1 H:V is closer to the excavation than ½ the proposed excavation depth AND the proposed depth is greater than 10'. ▪ If large vehicles will travel close to the excavation walls or if large or heavy spoil piles will be placed close to the excavation. (Part 2, Section 5.8)

QUESTION	ANSWER
(4., continued)	▪ Excavating near structures or foundations, if you are concerned about building loading on the trench sidewall. (Part 2, Section 5.8) ▪ Design of structural ramps. (Part 3, Section 2.1) ▪ Assistance with water removal or evaluation of an excavation damaged by water. (Part 3, Section 2.1, and Appendix E) ▪ Approval of alternative sheeting. (Part 4, Section 2.3) ▪ Design of hydraulic shoring systems greater than 15' deep or 12' wide. (Parts 7, 8, and 9) ▪ Design of protective systems in low-strength Class C soil that cannot hold a vertical side long enough to install shoring. (Part 9) ▪ Design of shield or shoring box protective system used in excavations over 20' deep. ▪ Evaluating feasibility of bracing the shoring against the foundation of a building. ▪ Tunneling under a curb, sidewalk, or pavement. ▪ Design of a timber-shoring installation.
5. The *Excavation Safety Manual* does not show excavations wider than 12'. What do we do for wider excavations?	Call a registered Professional Engineer (P.E.) for advice or use stamped tabulated data.
6. What is covered by the *Excavation Safety Manual*?	Excavations that are protected as follows are covered by the methods contained in the *Excavation Safety Manual*: ▪ Hydraulic shoring, waler or shielding systems up to and including 15' deep. ▪ Sloping or benching systems up to and including 20' deep. Methods of tunneling or undermining are not covered.

2 Creating the excavation

QUESTION	ANSWER
7. As the backhoe is digging, is it OK to help clear the trench?	Never enter an excavation while a backhoe is digging. If **all** the following conditions are met, it is acceptable to enter the trench: ▪ Trench is less than 5' deep. ▪ The Competent Person has designated the excavation safe for entry. ▪ The backhoe is not digging when the worker is in the excavation. ▪ There is no hazardous atmosphere. Deeper trenches require employees to install shoring or protection before assisting with excavation clean-out.
8. How do I dispose of the water that enters the excavation?	Disposing of water that accumulates in excavations is becoming more difficult. Federal, state, and local laws govern the discharge of water from the worksite. Consult with local environmental representatives in your area about the specific situation prior to discharge of any accumulated water from a worksite or excavation. Contact your local environmental field specialist (EFS) or Safety Department; see Part 1, Section 2.1. See also Appendix E, Section 2.
9. Does the *Excavation Safety Manual* allow tunneling under a curb?	No. Neither tunneling nor undermining is covered in the *Excavation Safety Manual*. This work is a special case and requires consultation with a registered P.E. Contact the Company Geosciences department for assistance. See Part 1, Section 2.1.

3 Competent Person

QUESTION	ANSWER
10. After attending an excavation safety class, am I considered a "Competent Person?"	No, formal training is only one component of being considered as a Competent Person. You must also pass an accepted competency test, be proficient in soil classification and selecting protective systems, and be designated as a Competent Person. See Part 2, Section 1.1.
11. I attended vendor-provided excavation safety training and have a certificate stating I am a Competent Person. Does that training meet all the Company criteria for becoming a Competent Person?	No, vendor training alone is not sufficient to meet Company requirements. See Question 10 answer, above.
12. I've been through the Competent Person training; however, I don't feel comfortable being the person on site making these decisions. Do I have to act as a Competent Person?	No. Discuss with your supervisor your concerns and desire for additional training to ensure you can become competent. It is important for all crew personnel to understand excavation safety and be aware of changing conditions that may introduce hazards.
13. Many employees have been trained as Competent Persons – who is the Competent Person?	There is only one Competent Person in charge per excavation. The Competent Person for the excavation is designated by the supervisor or person in charge. Many employees have been trained so that each is knowledgeable about the hazards and aware of changing conditions. If you notice a hazard or changed condition, bring it to the attention of the designated Competent Person.

4 Soils and soil classification

QUESTION	ANSWER
14. What happened to C-60 and C-80 soil classifications?	The Company adopted the Cal/OSHA soil classification system, which has only one type of C soil. References to a lower-strength C soil are similar to the old C-80 classification.
15. How many tests must I perform to classify a soil sample?	You must perform at least two tests for each sample. You must perform one visual test and one manual test. If there are several soil types in the excavation, you must test each type and then select your excavation safety system based on the weakest soil.
16. Why is Type A soil in the manual?	Type A is in the manual for those rare conditions when you may be excavating in or near stable rock. Realistically, any soil that classifies initially as A soil, unless it is stable rock, will likely downgrade to B soil with exposure to atmospheric conditions. Always think twice before classifying soil as type A.
17. Can we use a pocket penetrometer to classify soil type?	Yes. This is the most accurate way to classify unconfined compressive strength of cohesive soils. It is a good idea to take tests on a few soil samples from the same part of the excavation. Type A soil reads at least 1.5 tons per square foot (TSF), but a soil cannot be classified as Type A if it has been disturbed. Type B reads between 1.5 TSF and 0.5 TSF. All soils less than 0.5 TSF are Type C.

5 Benching and sloping

QUESTION	ANSWER
18. When is benching permitted?	The Company and Cal/OSHA permit benching only in Type A soil and in Type B cohesive soil. Double-check your soil classification before choosing to bench. See Parts 7 and 8 for specifics on benching.
19. I have a benched excavation. The bottom bench width is not equal to the height of the first two steps added together. Why do I have to make it wider?	The first bench must be wide enough to achieve the required slope for the soil type.
20. Can I make the bottom bench wider than the first two steps added together?	Yes, you can. Keep in mind that this will make the excavation larger.
21. I'm in a 4'-deep part of an excavation that extends to 5' deep at the deepest part. I'm OK to work without a protective system, right?	No. The excavation is measured at the deepest part of the excavation to determine depth. If any part of the excavation is 5' deep or greater, a protective system must be installed if workers are to enter any part of the excavation.

6 Shoring and protective systems

6.1 What to use and when

QUESTION	ANSWER
22. When do we need shoring?	If you plan to enter the excavation, and any part is 5' deep or deeper, or there is a chance of a cave-in, the excavation must be shored or protected on all sides.
23. The excavation is more than 5' deep, but I will only be in it for a minute or two. Do I need to install shoring?	Yes. You must use shoring or some other protective method if anyone will be in the excavation at any time. The conditions or circumstances that establish the need for shoring do not include time.

Shoring and protective systems: What to use and when, cont.

QUESTION	ANSWER
24. When do I need to shore or use other protective methods?	Shoring, benching, shielding, or sloping is always required under any of the following conditions: ▪ The sides of the excavation are unstable and the work cannot be performed safely. This includes excavations that are less than 5' deep everywhere. ▪ The excavation is at least 5' deep, and someone will enter the excavation. Shoring, benching, or sloping may be required if: ▪ There is vibration in the excavation area. ▪ There are heavy loads or vehicles near the excavation. ▪ Other environmental factors decrease the soil stability.
25. If I dig an excavation 5½' deep, and I backfill to 4' deep, am I OK without shoring?	No. For the purposes of protection, the excavation must be considered 5½' deep, because the backfill is not compacted and there is no way to compact it without shoring the excavation.
26. The ground around the excavation is uneven. It looks like the excavation, for the most part, is less than 5' deep. Employees will work in the excavation. Must I measure the depth? Where?	Because employees will be in the excavation, you must be sure it is less than 5' deep before you choose not to use shoring. Measure the excavation at the deepest point and determine shoring requirements based on that measurement. Remember that if risk factors indicate a cave-in is possible, you must shore even if the excavation is less than 5' deep. See Part 2, Section 1.2.

Shoring and protective systems: What to use and when, cont.

QUESTION	ANSWER
27. Can we use air jacks (shores) on the job?	Air jacks and other shoring systems designed by a registered P.E. may be used if the following statements are true: ▪ A Company management person approves the use of the air jacks. ▪ The employee using the air jacks is trained and knowledgeable on their installation and use. ▪ The shores are inspected and maintained according to the manufacturer's requirements. ▪ The shores are installed as specified in the manufacturer's tabulated data.
28. Do I need to protect an entire excavation?	Perhaps. If the soil appears unstable and a cave-in is possible, you must shore all areas that appear to be at risk. If the soil appears to be stable, then protection is required only in the areas where employees will be working or entering and exiting the excavation. When protecting only a section of an excavation, consider all phases of the work that will be performed inside the excavation. Anticipate where employees must go to enter and exit, position materials, and work. If you do not choose to shore or protect the entire excavation, barricade the "no entry" zone and tailboard the barricade often during the day. Do not enter this zone for any reason. Remember the basic rule of shoring: "If there is an unsafe spot in the excavation, someone will find a reason to stand there."
29. Do we have to shore all four sides?	If you plan to enter the excavation, and it is 5' deep or deeper, or there is a chance of a cave-in, the excavation must be shored or protected on all sides. An unprotected area of the excavation can be identified and barricaded to prevent entry.
30. Can we use shoring and benching, or do I have to bench everything?	Any combination of approved methods for the soil type can be used to protect the worker entering the excavation.

6.2 Sheeting

QUESTION	ANSWER
31. Is plywood required for shoring?	For loose Type B and Type C soil, yes. For other soils, it is required if spalling or raveling is occurring. FinnForm and Euroform are alternatives to plywood for use as sheeting. See Part 4, Section 2.3.
32. Can holes be cut in the plywood?	To maintain the structural integrity of the plywood, keep the number of holes to a minimum. Plywood may be cut to clear the substructures. In this case, do not re-use it; recycle it instead. Small holes can be drilled in the plywood to attach lifting or guidance lines. These attachments must be inspected periodically to ensure the sheet is structurally sound.
33. How do we inspect the plywood to ensure it's OK for use as sheeting? When do we need to replace the plywood?	Plywood is OK to reuse if it does not appear to be damaged. Recycle plywood with obvious cracks or large holes in the sheet. Recycle plywood if it is bowed or does not lay flat against the excavation side wall.
34. How do I lift the plywood that was used for sheeting out of the excavation?	A small hole can be drilled in the plywood and ropes attached to facilitate lifting of the plywood. Plywood can be lifted using the backhoe bucket.

6.3 Installation

QUESTION	ANSWER
35. Can I pump a hydraulic cylinder under the green zone to avoid damaging the surrounding material?	No. The shoring is not properly installed if the cylinders are not pressurized to the green zone. If the excavation walls cannot withstand the necessary pressure, choose an alternate protective method, such as a shield or shoring box.
36. Where do I find the standards for public crossings?	Contact your local city offices for their standards. See Appendix C. ***NOTE:*** **Verify that this crossing is acceptable locally before building or using a crossing with these dimensions.**
37. Can I brace my shoring up against the foundation of a building?	Only if a registered P.E. determines that the foundation of the building can hold the pressure of the shores pressing against it. See Part 2, Section 5.8 for more information.

Shoring and protective systems: Installation, cont.

QUESTION	ANSWER
38. I have to shore up against or very near other utilities—what is the procedure? What precautions do I need to take? Do we need to talk to other utilities in case they have to take precautions?	Notify the existing utility either directly or through the 811 system that you are excavating near their facilities and will be installing shoring very close to those facilities. Take care to protect third-party facilities during the shoring installation.
39. If there is plenty of room around a shield (cage) when it is installed in the excavation, can we use shoring to prevent the shield from shifting or must we backfill around the shield?	Backfilling to ½ to ⅔ of the height of the shield is an industry best practice. See Part 4, Section 3.
40. How do we test the hydraulic shoring each day?	Connect the hydraulic pump and verify pressure in each cylinder daily to verify that the pressure is in the green zone.
41. Can we use a backhoe to assist in removal of shoring?	After the pressure has been released and the shoring has been folded, it is permissible to use any available mechanical lifting equipment to remove the shoring.
42. Can hydraulic shoring be installed as an end shore, using a steel plate across the trench end?	No, unless tabulated data supports the lateral loading on the cylinder.
43. Can we combine any of these protective methods? How?	Yes, any methods can be used in combination. Each system must follow the tabulated data requirements for the system. Common uses are: ▪ End shores with hydraulic shoring or walers ▪ Shields or shoring boxes with sloping or benching
44. Can I install shoring jacks in the steel boxes – against a strut or foundation?	Do not brace shoring against a shield or box strut unless there is tabulated data to support the use of the shoring in this manner and a registered P.E. has reviewed the work.

Shoring and protective systems: Installation, cont.

QUESTION	ANSWER
45. Can I use a double-ram shore as an end shore (i.e., applying force laterally to a hydraulic ram, either with or without a steel plate or plywood)?	No, unless the tabulated data supports this use.
46. I have to move some shoring supports around to get the pipe in the excavation—what are the precautions and rules about this?	▪ All personnel shall be out of the excavation when supports are removed. ▪ Lower the pipe into the excavation using tag lines, then reinstall shoring. ▪ Personnel are allowed to re-enter the excavation once the Competent Person has inspected and given approval.

6.4 Shoring maintenance

QUESTION	ANSWER
47. How do I determine if the shoring is damaged or cannot be used?	Inspect visually. Identify any cracks, misalignment, damaged cylinders, or suspected damage. Do not use any section or component that does not appear in good condition.
48. I'm rebuilding shoring. What are the testing requirements?	Contract the work to a qualified shoring vendor who can classify the shoring, provide tabulated data for it, and make any needed repairs.
49. What do I do with damaged shoring?	Contact the vendor that provided the shoring. Damaged shoring must be repaired by the vendor or manufacturer's designated representative and verified by a registered P.E. **before** being returned to service.

7 Excavation security

QUESTION	ANSWER
50. If an excavation is outside of a traffic area, such as in a field or a sidewalk, how should the area be secured from the public?	**It is critical that excavations are secure.** When the public is exposed to excavations in non-traffic areas, the excavations must be either backfilled or covered with steel plates. Installation of cyclone fencing is also recommended to secure the area. If it is impossible to use a steel plate, obtain permission from your supervisor to use plywood. It must be secure so that no unauthorized people can access the excavation.
51. Is plywood acceptable to cover excavations or sidewalks when the crew is not there?	Secure excavations outside of trafficked areas with steel plates and cyclone fencing to prevent access. See question 50.

8 Cal/OSHA

QUESTION	ANSWER
52. Can Cal/OSHA cite the Company if I am in an unshored trench that is less than 5′ deep?	Yes. If the inspector believes the sides of the excavation are unstable, the Company may be cited. If there is a cave-in and someone is injured, a citation is even more likely.
53. I have heard that Cal/OSHA regulations do not apply to owners of companies. Does that mean that a Company supervisor is exempt from the rules in the *Excavation Safety Manual*?	No. Compliance with Cal/OSHA and the *Excavation Safety Manual* is mandatory for all employees.
54. What should I do if an OSHA inspector shows up on the jobsite?	See Appendix B.

9 Controlling hazards

QUESTION	ANSWER
55. Is the fluid used in hydraulic shoring dangerous?	There may be hazards associated with some of the hydraulic shoring fluids now in use. Read the Safety Data Sheet (SDS) for information about the particular hydraulic shoring fluid you are using. When required, wear appropriate personal protective equipment (PPE) when exposed to hydraulic shoring fluid. Always follow the manufacturer's recommended procedures for containing and cleaning up leaks and spills.
56. When do I specifically need to test the air in an excavation?	Where a hazardous atmosphere exists or could reasonably be expected to exist. See Part 3, Section 2.1, and Safety Procedure SHC 232, Attachment 5, "Entry into Excavations." ***NOTE:*** **Not all excavations qualify as a "confined space."**
57. I occasionally have multiple bell holes on the same jobsite. Do I have to test each bell hole?	See the answer to Question 56, above. Different situations require different levels of testing.

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Appendix A
Soil Mechanics

1 Earth Pressures

An understanding of earth pressures supports an understanding of the need for shoring to ensure safety. The amount of earth pressure exerted upon the side wall of any excavation depends on the weight and depth of the soil that it supports.

Earth pressure is based on:

- Type of soil
- Depth of excavation
- Moisture conditions

An example of earth pressure distribution is shown in Figure A-1, below.

The center of the earth pressures (as estimated in Figure A-2 on page A-2) is normally found between ½ and ⅔ of the depth of a simple excavation. However, additional earth pressures result from surface encumbrances or loading and differences in soil layer cohesiveness. These additional pressures influence the actual center of pressure at an excavation site.

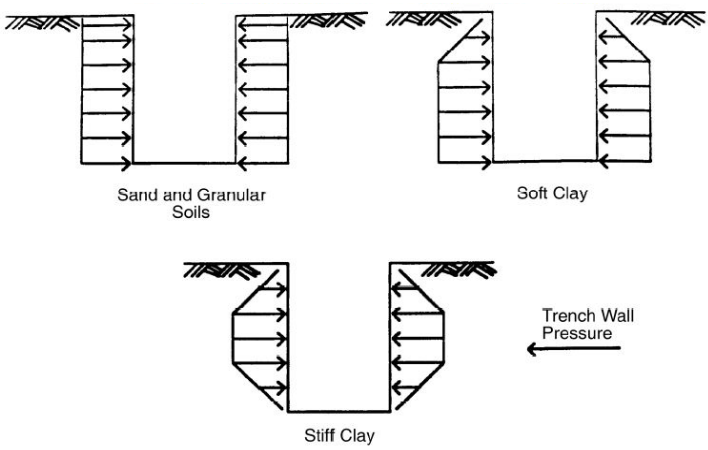

Figure A-1. Pressure distributions on the side walls of an excavation

Lateral forces from soil are transferred onto the side walls of an excavation. As a general rule, the center of pressure is at a lower depth when cohesion is poor (as in fresh fill dirt, water-bearing sand, or loose ground). Where cohesion is high, the center of pressure is higher (as in good compact soil).

The location of the center of pressure can change after a cut is made, unless support is provided to prevent earth movement.

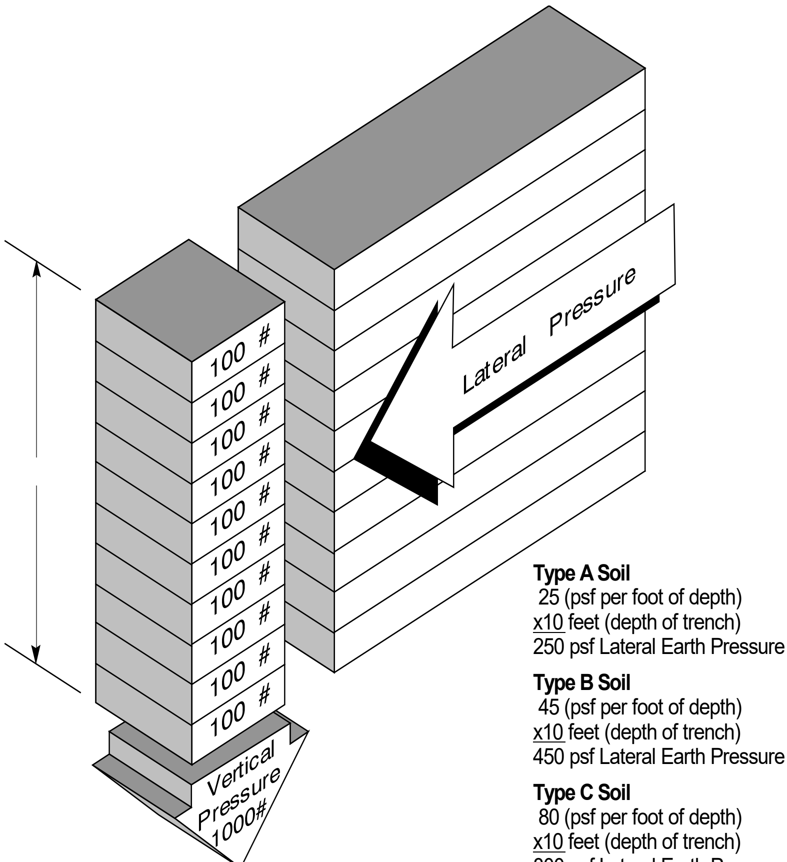

Figure A-2. Lateral pressure

Regardless of the soil type, as the depth of the trench increases, the magnitude of pressures on the full height of the excavation also increases. The presence of ground water adds hydrostatic (water) pressure against the walls of the trench, as shown in Figure A-3 on page A-3.

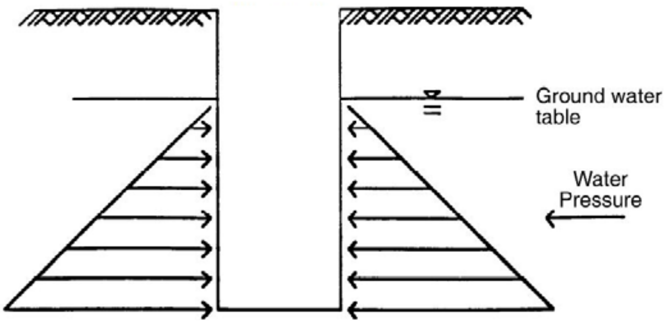

Figure A-3. Added effect of water pressure

Water reduces cementation and friction bonding of individual soil particles, which then tend to float apart. This increases the weight of the soil and can overpower the soil's strength, so that it acts more like water than soil.

Consider the effect of moisture on clay. When dry, clay weighs approximately 65 pounds per cubic foot. Because of clay's absorptive properties, it nearly doubles its weight when saturated. Clay also becomes slick and fluid.

Water negatively affects the stability of other soil types as well, because of the increase in weight and fluidity.

2 Trench stress and failure

Stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can reduce the stability of a trench or excavation. The following diagrams show some of the more frequently identified causes of trench failure.

Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See Figure A-4, below, for additional details.

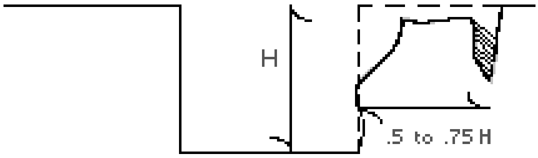

Figure A-4. Tension cracks

2.1 Sliding or sloughing

Sliding or sloughing may result from tension cracks, as shown in Figure A-5.

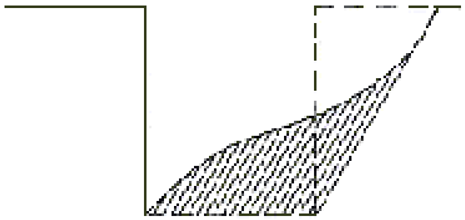

Figure A-5. Sliding

2.2 Toppling

In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation, as shown in Figure A-6.

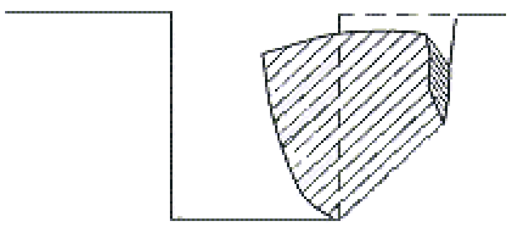

Figure A-6. Toppling

2.3 Subsidence and bulging

An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench, as shown in Figure A-7, below. If uncorrected, this condition can cause face failure and trap workers in the trench.

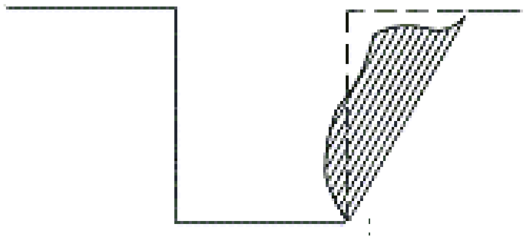

Figure A-7. Subsidence and bulging

2.4 Heaving or squeezing

Bottom heaving or squeezing is caused by downward pressure created by the weight of soil adjacent to the trench. This pressure causes a bulge in the bottom of the cut, as illustrated in Figure A-8, below.

Heaving and squeezing can occur even when shoring or shielding has been properly installed.

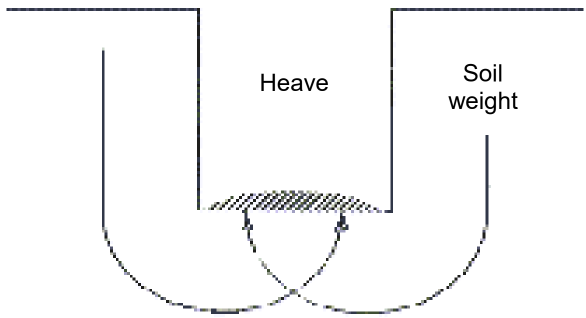

Figure A-8. Heaving or squeezing

2.5 Boiling

Upward water flow into the bottom of the cut is evidence of boiling. A high water table is one of the causes of boiling, as shown in Figure A-9, below. This requires a registered Professional Engineer (P.E.) to design the system. Boiling produces a "quick" condition (similar to quicksand) in the bottom of the cut, and can occur even when shoring or trench boxes are used.

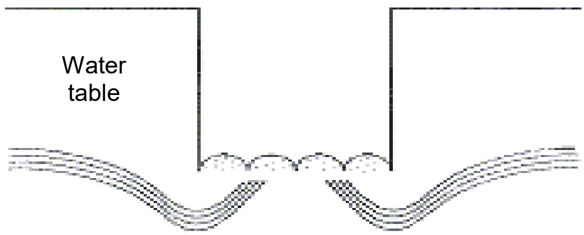

Figure A-9. Boiling

2.6 Unit weight of soils

Unit weight of soils is the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh more than 3,000 pounds.

3 The cave-in process

3.1 Surface weight causes sideways (lateral) pressure

The weight of the soil adjacent to the excavation, including any spoil pile, vehicles, equipment, foundations, and so on, exerts downward force due to gravity. The downward pressure, through soil mechanics, transfers force to the side wall of the trench, as shown in Figure A-10, below.

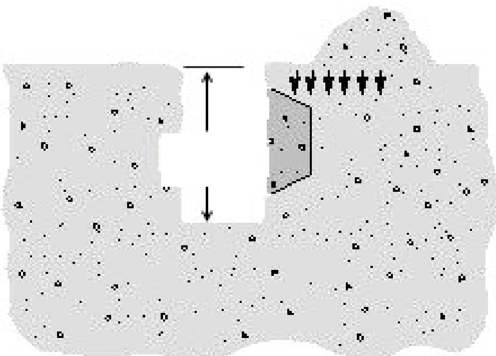

Figure A-10. Soil loads exert side-wall force on excavation sides

3.2 Trench wall bulges

The side of the trench bulges and creates a bulge or side-wall failure that is forced into the opening of the excavation, as shown in Figure A-11. This collapse is rapid and may appear to be instantaneous. There may be no warning before the trench wall collapses.

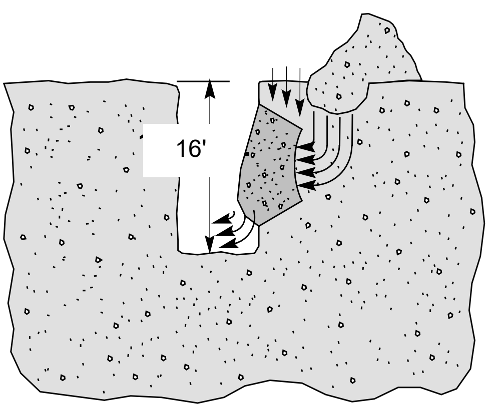

Figure A-11. Trench wall bulges before failure

3.3 Initial trench failure

The soil in the bulge collapses and fills the bottom of the excavation, as shown in Figure A-12. In this example, the initial flow of soil weighs 3,550 pounds. This weight presses down and traps personnel in the bottom of the trench. Crushing injuries may occur due to the weight of the soil.

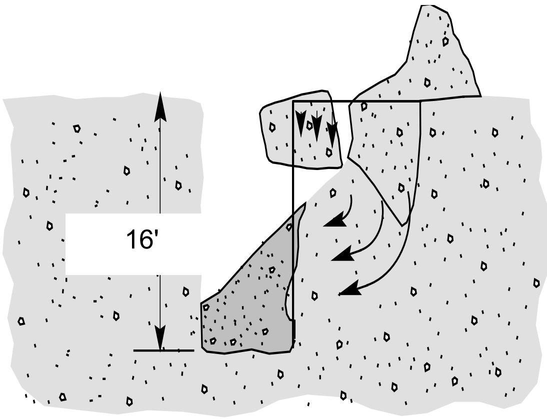

Figure A-12. Initial trench failure

3.4 Remainder of the earth face collapses

In one smooth, flowing motion, the remainder of the side excavation collapses and flows into the bottom of the excavation, adding additional weight to the soil that traps the employees. See Figure A-13 on page A-8.

WARNING
It is possible for an employee to suffocate in a standing position with his or her head above the ground due to the pressure of the soil on the chest and abdomen.

The remaining sides of the excavation may be unstable and may collapse and bury would-be rescuers. The soil can hide trapped workers and prevent the use of power equipment in their rescue.

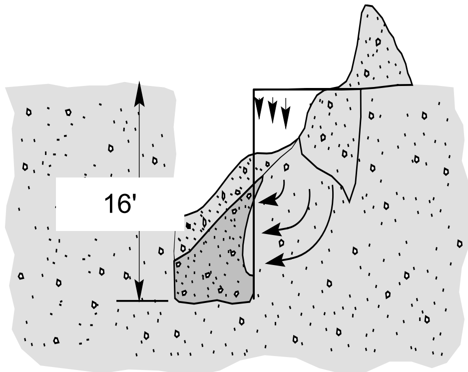

Figure A-13. Excavation after side-wall collapse

A soil excavation or hillside with cracking and soil tension continues to have sloughing, land subsidence, cave-ins, or spalling until the soil is once again in equilibrium and supported. This is why the Competent Person reviews the excavation at the beginning of each shift, as conditions change, and throughout the shift — to understand how stable the excavation is, and determine if any additional protection is needed.

This manual provides direction for installing worker protection when excavations are at or over 5′ deep or any time there is a danger of a cave-in. Understanding how soil pressures and mechanics generally work, together with the protection systems and procedures shown in the manual, ensures that you have the knowledge to prevent such incidents.

Appendix B
Foreman's Guide for Briefing Cal/OSHA Inspectors

A Compliance Engineer (CE) representing Cal/OSHA or another regulator may come to the excavation to perform an inspection. This appendix outlines the basic steps of working with the inspector, and what you should be prepared to discuss with any inspector.

1 What to do

The following steps are excerpted from SHC 207, "Regulatory Agency Inspections or Investigation." Order employee wallet cards through SAP, Code 623284.

1. Examine and verify the CE's ID.
2. Obtain the CE's business card.
3. Notify your exempt supervisor.
4. Notify safety and health personnel at (415) 973-8700/ internal 8-223-8700. Press option 1 for additional guidance.
5. Notify the CE that an exempt representative will be on the site, and in how many minutes.
6. If the CE will not wait for the exempt representative, and the inspection is to begin immediately, the employee in charge accompanies the CE and acts as the management representative.
7. The acting management representative:
   a. Details the work site (including tools, equipment, work location and activities) using written notes or drawings.
   b. Collects duplicates of physical samples taken by the CE.
   c. Requests copies of photos taken.
   d. Writes a description of photos taken.
   e. Answer questions truthfully and directly. Do not speculate, offer an opinion, or volunteer information.
8. A CE is legally entitled to speak privately with employees. Ask the CE if you may attend.

2 Inspector checklist

The Competent Person can use this checklist to brief a Cal/OSHA or other inspector who may visit the jobsite. Be prepared to discuss each of these items.

2.1 Personal information

My name is ______________________________.

My job classification is _____________________.

I have worked for the Company _____ years.

I have worked in my job classification for _____ years.

2.2 The Competent Person

I am the Competent Person on this job. I have been trained in:

- Soils analysis.
- The use of protective systems.
- The requirements documented in the Company Excavation Safety Manual.

I have the authority to:

- Take prompt corrective action to eliminate existing and predictable hazards.
- Stop the work.

I have conducted daily inspections of the:

- Excavation(s)
- Adjacent area(s)
- Protective system(s)

My inspections were conducted (indicate which of the following apply):

- At the beginning of each shift.
- As needed throughout the work shift.
- After a rainstorm or other hazard-increasing event.

2.3 Soil classification

I used procedures found in the Company Excavation Safety Manual to classify the soil.

I used the ____________ (visual test) and the __________ (manual test).

I found the soil to be primarily (choose only one):

______ Sand

______ Silt

______ Clay

The initial soil classification was:

______ A

______ B

______ C

______ Solid rock

______ Special case

I found these soil-destabilizing factors present on the job site:

______ Submerged or flowing water

______ Vibration

______ Surcharge

______ Previously disturbed soil

______ Soil cracks or fissures

______ Weak layers

______ Structures or foundations

______ Sloping ground

______ Adverse weather

______ How long the excavation will be open

Based upon the initial classification and the presence of destabilizing factors, my final soil classification was:

______ A

______ B

______ C

______ Solid rock

______ Special case

2.4 Protective systems

I examined the ground for indications of cave-in potential.

I have examined the material used in the protective system and found that it is suitable for its intended use. Damaged equipment or material (if any) was ____.

2.5 Water conditions

- Dewatering equipment is/is not being used on this job.
- I am/am not monitoring the dewatering equipment and its operation.
- The excavation has/has not had water accumulation.
- The soil in the excavation has/has not been adversely affected.

2.6 Ramps

Ramps are/are not being used to provide access or egress to the excavation.

The ramps were designed by ______________ for safe access and egress.

The ramps are/are not used for access and egress of equipment.

Ramps being used for equipment were designed by __________________, who is qualified in structural design.

2.7 Confined space

I have completed the Company's confined space training.

The excavation **does/does not** meet the definition of a confined space. A confined space has the following:

- **Insufficient existing ventilation:** Existing ventilation is insufficient to remove dangerous air contamination or to address oxygen deficiency that may exist or develop.
- **Limited access:** Ready access or egress for removing a suddenly-disabled employee is difficult because of the location or the size of the openings.

Appendix C
Acceptable Bridges and Guardrails for Public Crossing of Excavations

Figures C-1, C-2 and C-3 on pages C-2 through C-3 show some acceptable guardrail designs for public crossings. Other designs that provide equivalent protection may be used.

NOTE
Check local building regulations.
More restrictive requirements may apply.

1 Walkway

Construct the walkway of 1⅛" plywood or 2" planks. It must be wide enough for the anticipated foot traffic, including the physically challenged (e.g., wheelchairs).

2 Toeboards

Toeboards on crossings are required only if someone will be working below or passing under the crossing. Check with your local regulations for specifics.

3 Guardrails

Provide a smooth-surfaced top rail, a midrail, and a toeboard.

The ends of the rails must not overhang the terminal posts if the overhang is a projection hazard.

Design guardrails (including their connections and anchors) for a test load of 200 lbs. If heavy stress from crowds, trucking, handling materials, etc., is likely, use heavier stock; space the posts, bracing, and related material more closely together; etc.

Construct toeboards of wood, concrete, metal, or other suitable material. The top of the toeboard must be at least 4" above the walkway and the bottom clearance must not exceed ¼".

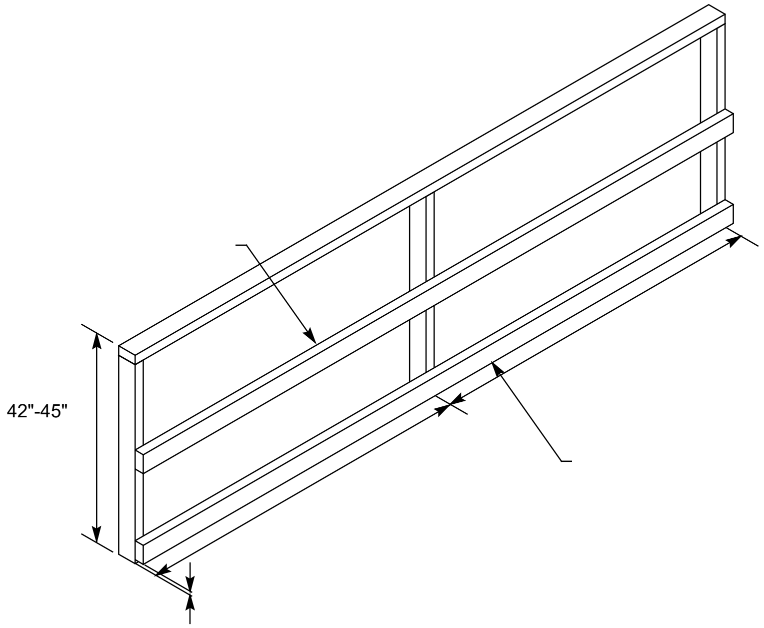

Figure C-1. Wooden Rails for Crossing

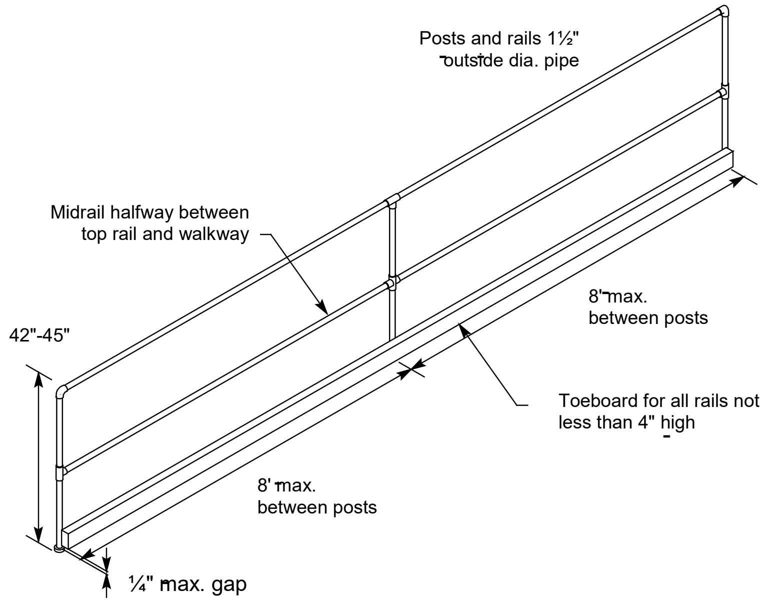

Figure C-2. Pipe Rails for Crossing

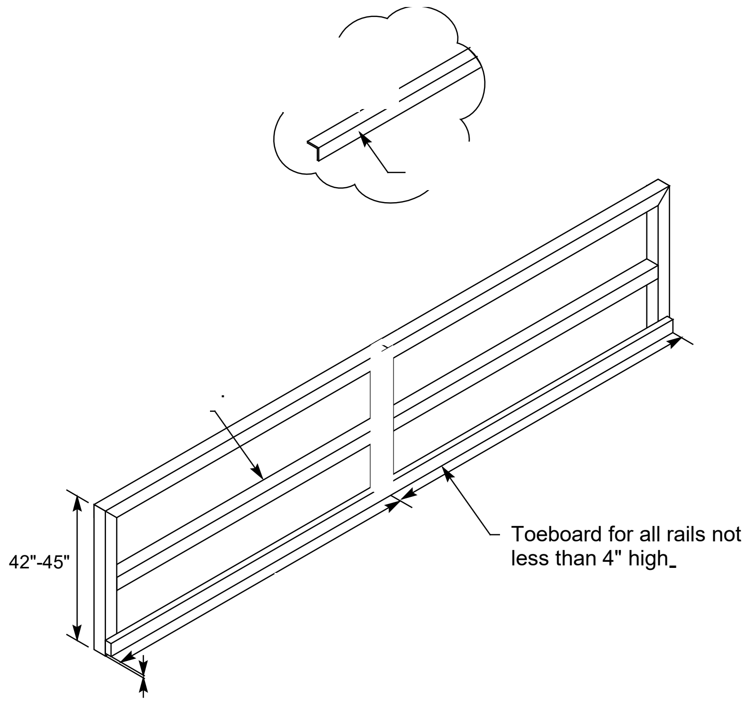

Figure C-3. Structural Steel Rails for Crossing

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Appendix D
Third-Party Protected Excavations

1 Ensuring worker safety

Pacific Gas and Electric Company (the Company) uses contractors to perform utility work that often involves creating excavations and installing protective systems in excavations. Company workers and Competent Persons must know and understand what actions to take to ensure workers are safe in excavations dug by a third party.

As a Company Competent Person, you may use your "Stop Work" authority to ensure that no Company representative will enter an unsafe excavation.

This section provides instructions on:

- How to use tabulated data to verify the proper installation and safety.
- Actions to take if the excavation is not properly protected at the time the Company plans to enter the excavation.

Responsibility for the safety of the workers in the excavation rests with the employer of the workers, regardless of what entity dug the excavation. If you enter an excavation, it is your excavation.

1.1 Why third parties excavate for the Company

Cal/OSHA enforces safety and health regulations for every employer and place of employment in California. Therefore, any construction company that employs a worker is subject to Cal/OSHA regulations. Cal/OSHA regulations do not apply to owner-operator excavators. The regulations do apply to the Company and any worker entering the excavation prepared by the owner-operator. It is the Company's responsibility to inspect the third-party-dug excavation and protective systems BEFORE workers enter the excavation to perform work for the Company.

1.2 Contractors

Contractors working for and with the Company are required to understand the concepts in this manual. They must be familiar with protecting their workers and creating shoring safety plans.

1.3 Pre-excavation notification

Make sure that excavation safety is a topic in any pre-construction meeting if the Company representative anticipates that workers will enter an excavation near 5' deep. Notify the applicant or contractor that shoring is likely to be necessary, and make sure that they have adequate knowledge and resources to address worker safety.

1.4 Site inspection before excavation

The job pre-check inspector has the responsibility of seeing that the excavations is properly protected. This should include reviewing:

- The shoring plan for the site.
- The site-specific safety plan.

Review the plan to determine if it is adequate for the work planned. If shoring, walers, shields, or any combination are in place, verify that the tabulated data is on-site and correct for the excavation you are pre-checking. Verify that the installation is aligned with the tabulated data for the size of excavation and type of protection.

Notify the responsible party on site of your findings, and that the excavation will be inspected on the day the excavation will be entered. Emphasize that conditions may change as the excavation remains exposed to the environment, and that the excavation protection system must be adjusted or modified for soil conditions that change.

2 Verifying tabulated data

2.1 Hydraulic shoring

1. Review the tabulated data provided. Check that the type of shoring listed in the title is the type you see in the excavation. Verify that the data has been stamped and signed by a registered Professional Engineer (P.E.).
2. Review soil classification notes in the shoring plan or site safety plan. Observe freshly excavated soil, if available, as well as trench sides to validate the soil classification. Visual and manual tests may be performed.
3. Note the depth of the excavation, spacing of the horizontal and vertical members, if oversleeves are present if required, and the oversleeve size. Note the number of cylinders in each vertical rail.
4. Review size of vertical members listed and compare to size of vertical members in the excavation. Tabulated data may include both a standard and a heavy-duty member. Dimensions are shown on the tabulated data.

5. Verify the depth of the excavation. Using the tabulated data provided, for the classification of soil cited in Item 2 on page D-2, verify maximum vertical and horizontal spacing. Check installation for correct spacing.
6. Verify trench width compared to the tabulated data for oversleeve requirement.
7. Verify that sheeting, if installed, corresponds to the tabulated data requirements or the Company's requirements if not mentioned in tabulated data.
8. Verify that shoring is tight against trench wall with no voids.
9. Check that the pressure in the hydraulic cylinders matches the tabulated data requirement. There may be a gauge that will indicate a green zone.
10. If any of these steps finds a conflict or inappropriate use of the shoring, the excavation is not acceptable and must be discussed with the site representative in charge. Corrective action must be taken before entry by Company personnel.

2.2 Shields and boxes

1. View the box or shield provided. Validate and record model number, if available.
2. Review the soil classification notes in the shoring plan or site safety plan. Observe freshly excavated soil, if available, as well as the trench sides to validate the soil classification. Visual and manual tests may be performed.
3. Review the tabulated data provided on site. Look up the model number and verify maximum depth for type of soil onsite. Verify that the data has been stamped and signed by a registered P.E.
4. Visually check that pins and keepers are installed and appear secure. If hydraulic, verify that the pressure in the hydraulic cylinders matches the tabulated data requirement or is in the green zone on the gauge.
5. Check that the shield or box is no more than 2' above the bottom of the excavation for Type A and B soil, and extends to the bottom of the excavation for Type C soil. Backfill must extend ½ to ⅔ of the way up the side of the box to secure it snugly to the excavation wall.
6. For multiple sections, verify that all components of box are seated properly.
7. If any of these checks do not agree with the tabulated data provided, or shields are assembled improperly, the excavation is not acceptably protected. Specifics must be discussed with the site representative in charge. Corrective action must be taken before entry by Company personnel.

2.3 Walers

1. View the waler system installed. Validate and record model number, if available.
2. Review the tabulated data provided. Check that the waler model number recorded is in the tabulated data. Verify that the data has been stamped and signed by a registered P.E.
3. Review the soil classification notes in the shoring plan or site safety plan. Observe freshly excavated soil, if available, as well as the trench sides to validate the soil classification. Visual and manual tests may be performed.
4. Note the depth of the excavation, the spacing of the rails and cylinders, and whether extensions are present. If hydraulic, note the size of rails and number of struts.
5. Verify the depth of the excavation. Using the tabulated data provided, for the classification of soil cited in Item 3, above, verify maximum vertical and horizontal spacing. Check that this spacing requirement has not been exceeded in the excavation.
6. Verify that sheeting corresponds to the tabulated data requirements and is installed properly.
7. Verify that the waler system is tight against the trench wall with no voids.
8. Check that the pressure in the hydraulic cylinders matches the tabulated data requirement. There may be a gauge that indicates a green zone.
9. If any of these actions results in a conflict or inappropriate use of the shoring, the excavation is not acceptable. Discuss with the site representative in charge. Corrective action must be taken before entry by Company personnel.

2.4 Excavation safety discussions

When evaluation of the tabulated data and the protective system is complete, discuss the inspection results with the responsible site supervisor. State any issues discovered in the inspection and allow the responsible site supervisor to respond and take action to correct any issues. Set a time for a repeat inspection.

If issues arise that cannot be resolved, inform the site supervisor that the Company will not return, and the utility work must stop, until the excavation can be corrected. Escalation of the discussion may be referred to your supervisor.

2.5 Prepare to enter excavation

Upon successful inspection of the excavation safety systems, the excavation is ready for worker entry. Follow instructions in Part 3, Section 2, before entering the excavation.

3 Checklist

Before entering an excavation, verify excavation protective system(s) installed by third party.

> **NOTE**
> If excavation is benched or sloped, see Parts 7, 8, and 9 for details to support inspection.

3.1 All types of protection

- ☐ Ask to review the site safety plan or shoring plan, and tabulated data for the protective system installed.
- ☐ Verify that the tabulated data is stamped by a registered P.E.
- ☐ Perform soil classification, using at least one visual and one manual test.
- ☐ Document excavation size, including depth.
- ☐ Observe type of protective system installed, note size and spacing of members installed.
- ☐ Verify that sheeting, if present, is of size and type called out in tabulated data.
- ☐ Protective system is installed tight against walls (shoring, walers) or backfilled to prevent movement (shields, boxes).

Perform specific checks per the type of protection installed (see Appendix D, sections 3.2, 3.3, and 3.4, following).

3.2 Hydraulic shoring

Compare these items to the tabulated data for the soil type identified. Note any deficiencies.

- ☐ Verify correct size/spacing of vertical shores.
- ☐ Verify that oversleeves are installed correctly, if required.
- ☐ Verify that the correct number of cylinders for the depth of trench has been installed.
- ☐ Check pressure in each cylinder by reconnecting pump and ensuring gauge is indicating in the green zone or at the pressure specified.

3.3 Shields or shoring boxes

Compare these items to the tabulated data for the soil type identified. Note any deficiencies.

- ☐ Verify that the model type installed matches the tabulated data provided.
- ☐ Visually check that pins and keepers are installed and appear secure.
- ☐ If hydraulic, verify that the pressure in the hydraulic cylinders is adequate.
- ☐ Verify that the shield or box is no more than 2' above the bottom of the excavation for Type A and B soil, and extends to the bottom of the excavation for Type C soil.
- ☐ Verify that adequate backfill has been installed to restrict lateral movement. An industry best practice is to backfill ½ to ⅔ up the side of box.
- ☐ If multiple sections, verify that all components of the box are seated properly.

3.4 Walers

Compare these items to the tabulated data for the soil type identified. Note any deficiencies

- ☐ Verify that the rails and struts are the same material as identified in the tabulated data.
- ☐ Verify that the vertical and horizontal spacing of members is correct.
- ☐ If hydraulic, check pressure in each cylinder by reconnecting pump and ensuring gauge is indicating in the green zone or at the pressure specified.

3.5 End shoring

Any of the above protective systems can be used with each other and with end shores. End shores have their own tabulated data and are verified similarly to hydraulic shoring.

Document issues discovered and bring to the attention of the site supervisor for correction before entering excavation.

Appendix E

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Effects of Water and Remedies

1 Effects of water

The natural water table can cause many types of problems. For example, trenches excavated below the natural water table in sandy soils and soft clay are highly susceptible to heaving, the seepage of water at the bottom of the trench causing the soil to be pushed upward, as illustrated in Figure E-1, below. This heaving is a signal that a failure may occur.

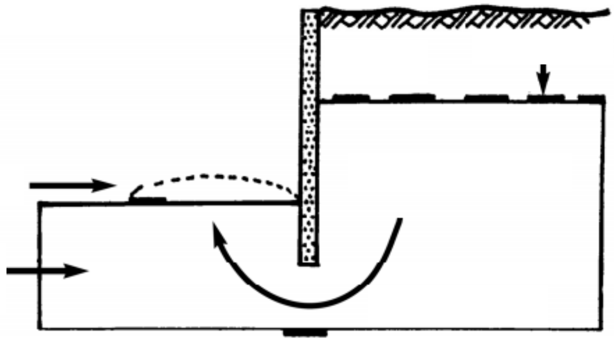

Figure E-1. Heaving

Wet conditions at the bottom of a trench may present another problem. If the bottom of the trench begins to puff and bubble and the earth rises, a quicksand condition is occurring. This is also a signal that a failure may occur.

2 Dewatering

If heaving or quicksand conditions are expected, consider dewatering before beginning an excavation. Dewatering drastically reduces the presence of water and the additional pressure it causes. Without dewatering, a more robust protective system would be needed to support the extra pressures caused by the water. The two most frequently used dewatering systems are well-points and sump pumps.

2.1 Well-point system

The well-point system (illustrated in Figure E-2, below) is a very popular method of dewatering. Located on a line at least 2' behind the sheeting, well-points are inserted to the depth of the excavation. Spacing between the well-points varies from 3' to 8'.

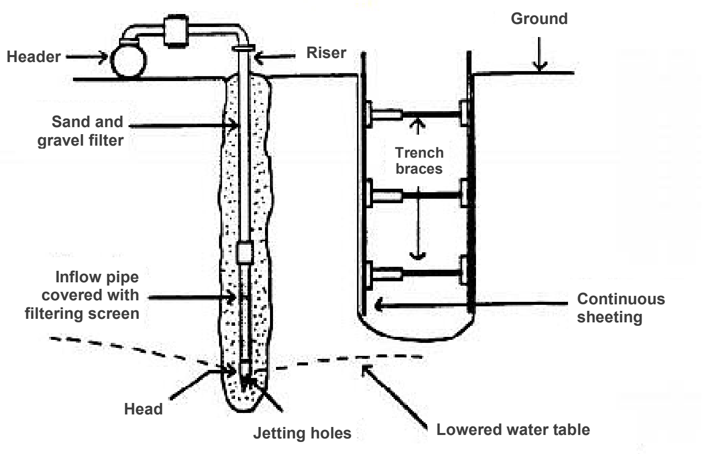

Figure E-2. Well-points

Well-points are pipes with a point at the lower end and a screen or filter over perforations along 3'-4' of the lower ends of the pipes. There are two types of well-points:

- Those driven with a maul.
- Those that are jetted in.

The selection of the size of the well-points and the required spacing are based on site conditions and the type of excavation to be accomplished. **Before** excavating, get help from a registered Professional Engineer (P.E.).

Above the ground, well-point pipes are connected by piping to a high-capacity pump. Pumping keeps the water level below the bottom of the excavation so that only a moist soil condition will be encountered within the excavation.

The well-point system should have a capacity sufficient to remove any inflow of water as quickly as it occurs. The depth limit of this method’s practical effectiveness is approximately 15'-20', sufficient for protection in excavations.

Dewatering does not permit any substantial excavation without providing ground support. Although the dewatered soil is usually firmer than it was before dewatering, working conditions may still be unsafe. Shoring, or banked walls at a safe slope, should be used in dewatered ground in the same manner as in any other excavation.

2.2 Sump pump

The second common type of dewatering system is the sump pump, as shown in Figure E-3.

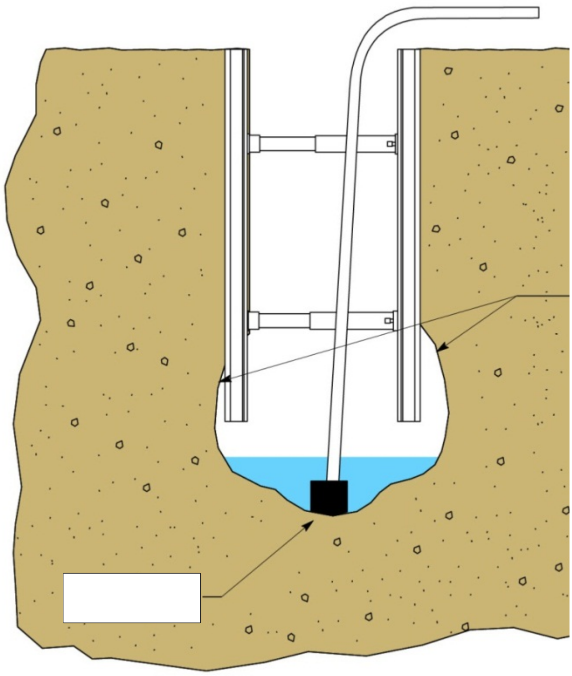

Figure E-3. Dewatering with a sump pump

Sump pumping, as contrasted with well-pointing, has several advantages. Sump pumps:

- Can be installed quickly by inexperienced labor.
- Require less space and cause less interference on the site.
- Can be added or removed easily to meet required pumping capacity.
- Can be started by simply switching on the power supply because no balancing or turning is required.
- Do not freeze in cold weather because of the fast, high volume flow of water.
- May be removed from one sump and used elsewhere if needed.
- Usually cost less than well-points.

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Appendix F
References and Related Resources

Part 1

Code of Federal Regulations (CFR) Title 29, Labor, Part 1926—Safety and Health Regulations for Construction, Subpart P – Excavations, Section 1926.650, “Scope, application, and definitions applicable to this subject.”

California Code of Regulations (CCR), Title 8, “Construction Safety Orders,” Subchapter 4, Article 6, “Excavations”, Section 1540 (b) Definitions.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix A (b).

8 CCR Subchapter 4, Article 6, § 1504 (a).

OSHA Technical Manual (OTM), Section v, Chapter 2, “Excavations: Hazard Recognition in Trenching and Shoring,” II Definitions.

Part 2

Figure 2-1

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix F.

Part 3

29 CFR § 1926, Subpart P, Appendix A (b).

8 CCR Subchapter 4, Article 6, § 1541(g).

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix A (b).

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix A (d).

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix F.

Part 5

Figure 5-4

29 CFR § 1926.451 (e)(5).

29 CFR § 1926.651 (c)(1)(i –v).

8 CCR Subchapter 4, Article 6, § 1541 (c) (2), and (l).

Part 7

Figures 7-1 and 7-3

29 CFR § 1926, Subpart P, Appendix D (g), Table D-1.1.

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.3.

Figure 7-5

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.3.

Table 7-2

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.1.

Table 7-4

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.3.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.1.3.

Table 7-5

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 7-6

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 7-7

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 7-8

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 7-10

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.2.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.1.2.

Table 7-11

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.1.2.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.1.2.

Part 8

Figure 8-4

29 CFR § 1926, Subpart P, Appendix D.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix D.

Figure 8-7

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.2.3.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.2.3.

Table 8-2

29 CFR § 1926, Subpart P, Appendix D.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix D, Figure 4, Table D-1.3.

Table 8-3

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.2.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.2.1.

Table 8-4

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 8-5

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 8-6

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 8-7

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Table 8-9

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.2.2.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.2.2.

Part 9

Section 9-2

29 CFR § 1926, Subpart P, Appendix D.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix D.

Figure 9-3

29 CFR § 1926, Subpart P, Appendix B, Figure B-1.3.1

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.3.1

Table 9-1

29 CFR § 1926, Subpart P, Appendix D.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix D, Figure 4, Table D-1.3.

Table 9-2

29 CFR § 1926, Subpart P, Appendix B, Figure B-1.3.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.3.1.

Table 9-3

29 CFR § 1926, Subpart P, Appendix B, Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B 1.4.1.

Table 9-4

29 CFR § 1926, Subpart P, Appendix B, Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, Section 1541.1, Appendix B, Figure B-1.4.1.

Table 9-5

29 CFR § 1926, Subpart P, Appendix B, Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, §1541.1, Appendix B (c), Figure B-1.4.1.

Table 9-6

29 CFR § 1926, Subpart P, Appendix B (c), Figure B-1.4.1.

8 CCR Subchapter 4, Article 6, § 1541.1, Appendix B (c), Figure B-1.4.1.

Appendix A

OTM Section V: Chapter 2, "Excavations: Hazard Recognition in Trenching and Shoring."

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http://www.nclabor.com/osha/etta/indguide/ig14.pdf

Appendix E

8 CCR Title 8, Subchapter 4, Article 6, 1541, (h)(1) to (2).

North Carolina Department of Labor, Occupational Safety and Health Division, "A Guide to the OSHA Excavations Standard", updated 2011:

http://www.nclabor.com/osha/etta/indguide/ig14.pdf

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Utility Standard S4412, "Damage Prevention Manual."

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Interstate Natural Gas Association of America (INGAA) Construction Safety Consensus Guidelines – "Trenching and Excavations Safety" Draft, December 2011.

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8 CCR Subchapter 4, Article 6, § 1540

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8 CCR Subchapter 4, Article 6, § 1541

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