

Outline

OSHA 1926 Subpart P

Soil Mechanics

General Requirements

Engineering

Additional Resources

OUTLINE

OSHA 1926 SUBPART P

SOIL MECHANICS

GENERAL REQUIREMENTS

ENGINEERING

ADDITIONAL RESOURCES

Outline

CPT Course Outline

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OUTLINE

OSHA 1926 Subpart P

Subpart P -- Excavations

Authority: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act)(40 U.S.C. 33); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41-FR 25059), or 9-83 (46 FR 35736), as applicable, and 29 CFR Part 1911.

Source: 54 FR 45959, Oct. 31, 1989, unless otherwise noted.

OSHA Excavation Standard — Subpart P

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Code of Federal Regulations

How the Code of Federal Regulations (CFR) is structured

The CFR is a compilation of the rules published by the Federal Government departments and agencies. The CFR is divided into broad areas subject to federal regulation and are called Titles. Title 29 covers the Department of Labor.

The CFR is further broken down into chapters and each chapter is subdivided into Parts, Subparts, Sections, Paragraphs, and even further divisions when necessary.

For example, Part 1926 is Safety and Health Regulations for construction. Subpart P of Part 1926 covers Excavations.

A section is a number referencing a specific topic. For example, 1926.652 covers the requirements for Protective Systems. The paragraph following the sections break them down even further. For example, 1926.652 paragraph(g) is "Shield Systems".

The full OSHA Reference would look like 29 CFR 1926.652(g)

<u>29</u> CFR	<u>1926</u>	<u>652</u>	<u>(g)</u>	<u>(1)</u>
Title	Part	Section	Paragraph	Subparagraph

INTRODUCTION TO The OSHA Excavation Standard

The Creation of OSHA

An increasing number of fatalities and injuries caused the labor unions to pressure Congress to pass the Williams-Steiger Occupational Safety and Health Act of 1970. This Act along with its amendment legislation created the OSHA and brought private sector employees under its jurisdiction.

OSHA's Charge

OSHA's charge was to create standards by which private sector employers would have to abide. Further, they would provide education in the area of worker safety and compliance with the standards. These standards would be enforced by assessing fines for violators and referring some cases to the Department of Justice for criminal prosecution.

Today we see OSHA inspectors assessing maximum fines to pressure employers into complying with the standard. These compliance officers visit jobsites to ensure that rules and policies are enforced. They want to see that employees are trained to safely perform their duties and they are involved in safety activities. For example, compliance officers will want to know if a jobsite safety program has been prepared and effectively implemented. They check to see if someone is responsible for, and capable of implementing the safety program. An item of particular interest, involves the competent person. They want to see that a competent person has been assigned to meet the requirements of the excavation standard.

The Competent Person

Every excavation must have a competent person. The "competent person" is defined as *one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees and who has the authorization to take prompt corrective measures to eliminate them.*

Competent Person Responsibilities & General Requirements

Some of the responsibilities assigned to the competent person are:

- ✓ Conduct tests for soil classification
- ✓ Understand standards and any data provided
- ✓ Determine proper protective system
- ✓ Recognize and reclassify soil after changing conditions
- ✓ Determine if damage to trench safety equipment renders it inadequate for employee protection
- ✓ Conduct air test for hazardous atmosphere
- ✓ Design of structural ramps
- ✓ Locate underground installations/utilities
- ✓ Monitor water removal equipment and the operation
- ✓ Perform daily inspections

*Overview of
the structure*

Introduction to the Excavation Standard

Before we look at the standard, it may help to first see how it has been organized. The competent person should understand the overall structure and have a basic idea of where to look in the Standard to reference a particular item, table, or chart.

The first thing to note is that the excavation standard is composed of sections 1926.650, 1926.651, 1926.652 and Appendices A through F. These sections cover the following topics:

1926.650 Scope, application, and definitions applicable to this subpart.

1926.651 General requirements

1926.652 Requirements for protective systems.

Appendix A Soil Classification

Appendix B Sloping and Benching

Appendix C Timber Shoring for Trenches

Appendix D Aluminum Hydraulic Shoring for Trenches

Appendix E Alternatives to Timber Shoring

Appendix F Protective Systems Flow Chart

General to specific

Note that these sections cover the subject *from the general to the specific*. For example 1926.650 contains a brief statement about the subpart's application to excavations and trenches, then lists 29 definitions relevant to the standard. Successive sections provide more specific information and guidelines with increasing detail and specification.

*Regularly review
the Excavation
Standard*

We emphasize the importance of reviewing the Standard on a regular basis to familiarize yourself with its contents and OSHA's intentions. As you read through the Standard, we recommend that you use a highlighter or underline key portions for future reference. For example, by marking all references to the various duties of the competent person, you can easily review all related directives and responsibilities.

The text of the Excavation Standard follows.

OSHA Excavation Standards

29 CFR 1926

Subpart P – Excavations

§1926.650 Scope, Application, And Definitions Applicable To This Subpart.**(a) Scope and application.**

This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) Definitions applicable to this subpart

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

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

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

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

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

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

NOTES

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

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

Faces or sides means the vertical or inclined earth surfaces formed as a result of excavation work.

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

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

Kickout means the accidental release or failure of a cross brace.

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

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

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

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either pre-manufactured or job-built in accordance with 1926.652(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means 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."

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

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

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

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

Tabulated data means tables and charts approved by registered professional engineers and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

NOTES

Trench shield. See "Shield."

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

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

§1926.651 Specific Excavation Requirements.

(a) *Surface encumbrances.*

All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.*

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

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

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) Access and egress.

(1) Structural ramps.

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

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

(iii) Structural members used for ramps and runways shall be of uniform thickness.

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

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) Means of egress from trench excavations. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) Exposure to vehicular traffic.

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

(e) Exposure to falling loads.

No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with

1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

NOTES

(f) *Warning system for mobile equipment.*

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

(g) *Hazardous atmospheres.*

(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.650 - 1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

- (i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.
- (ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.
- (iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.
- (iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.*

- (i) Emergency rescue equipment, such as

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

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

(h) *Protection from hazards associated with water accumulation.*

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

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

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.*

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

NOTES

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

(i) A support system, such as underpinning, is provided to insure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

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

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

(j) *Protection of employees from loose rock or soil.*

(1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.*

(1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person

prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

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

(1) *Fall protection.*

(1) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with §1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

§1926.652 Requirements For Protective Systems.

(a) *Protection of employees in excavations.*

(1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:

(i) Excavations are made entirely in stable rock;
or

(ii) Excavations are less than 5 feet (1.52 m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.*

The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance

with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3); or, in the alternative, paragraph (b)(4), as follows:

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(1) Option (1) - Allowable configurations and slopes.

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

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

(2) Option (2) - Determination of slopes and configurations using Appendices A and B. Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) Option (3) - Designs using other tabulated data.

(i) Designs of sloping or benching systems shall be selected from and in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made

available to the Secretary upon request.

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

(i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project;

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.*

Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1) - Designs using appendices A, C, and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2) - Designs Using Manufacturer's Tabulated Data.*

(i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in

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accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

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

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3) - Designs using other tabulated data.*

(i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

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

(i) Support systems, shield systems, and other protective systems not utilizing Option 1,

Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment*

(1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

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

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

(e) *Installation and removal of support.*

(1) *General.*

(i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

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

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(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) Additional requirements for support systems for trench excavations.

(i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) Sloping and benching systems.

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

(g) Shield systems.

(1) General.

(i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of

the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A TO 1926 SUBPART P

SOIL CLASSIFICATION

(a) Scope and application.

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

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

(b) Definitions.

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

Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System; The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

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

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

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

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

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

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

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

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

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

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

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

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

Type A means cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam.

Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

- (i) The soil is fissured; or
- (ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
- (iii) The soil has been previously disturbed; or
- (iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater, or
- (v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

- (i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
- (ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
- (iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

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- (iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
- (v) Dry rock that is not stable; or
- (vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

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

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

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

(c) Requirements.

- (1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.
- (2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification.

cation and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

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

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

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

(d) *Acceptable visual and manual tests.*

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

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

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

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving

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ground and are indications of potentially hazardous situations.

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

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

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

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

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

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

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

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This

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

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated sheervane.

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

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

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

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

SLOPING AND BENCHING

(a) *Scope and application.*

This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in 1926.652(b)(2).

(b) *Definitions.*

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

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

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

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

(c) *Requirements.*

(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.*

(i) The actual slope shall not be steeper than the maximum allowable slope.

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

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with 1926.651(i).

(4) *Configurations*. Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1
MAXIMUM ALLOWABLE SLOPES

Soil Or Rock Type	Maximum Allowable Slopes (H:V) [1] For Excavations Less Than 20 Feet Deep [3]
Stable Rock	Vertical (90°)
Type A [2]	¾:1 (53°)
Type B	1:1 (45°)
Type C	1 ½:1 (34°)

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Footnote (1): Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

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

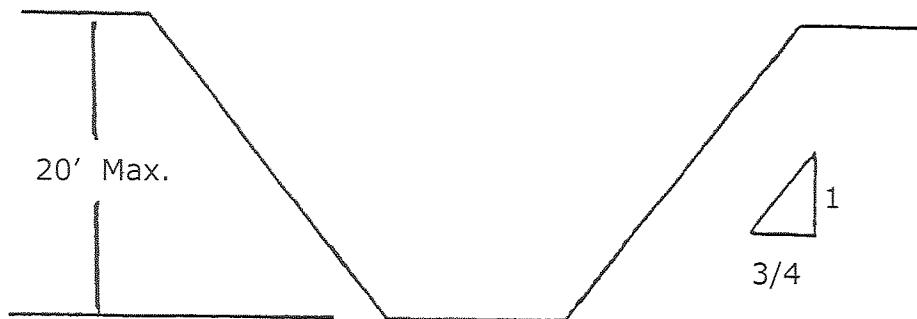
Footnote (3): Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

FIGURE B-1
SLOPE CONFIGURATIONS
(All slopes stated below are in the horizontal to vertical ratio)

B - 1.1 Excavations made in Type A soil.

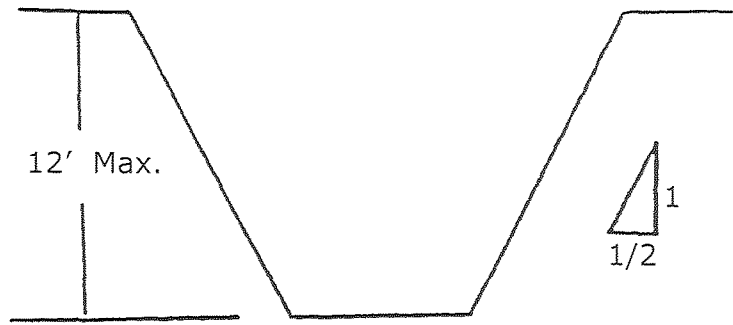
SIMPLE SLOPE - GENERAL

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of 3/4:1.



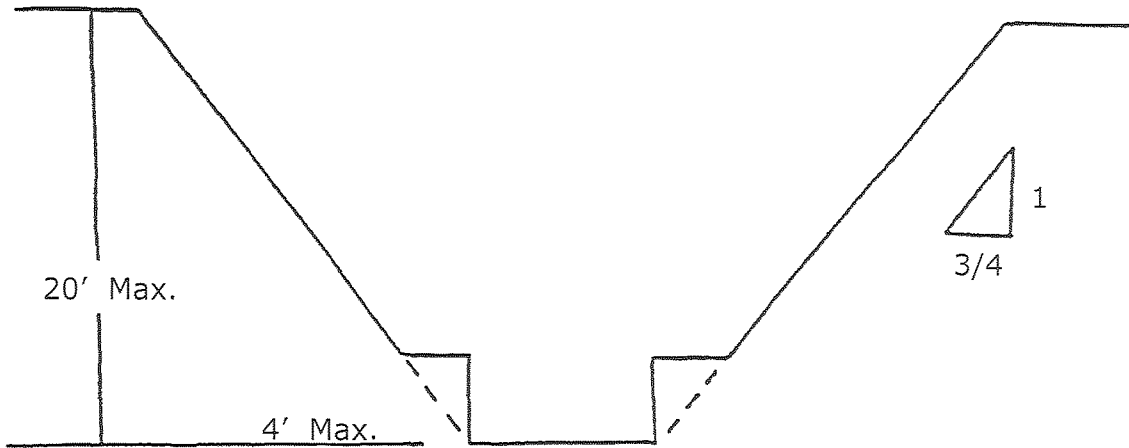
SIMPLE SLOPE - SHORT TERM

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of 1/2:1.

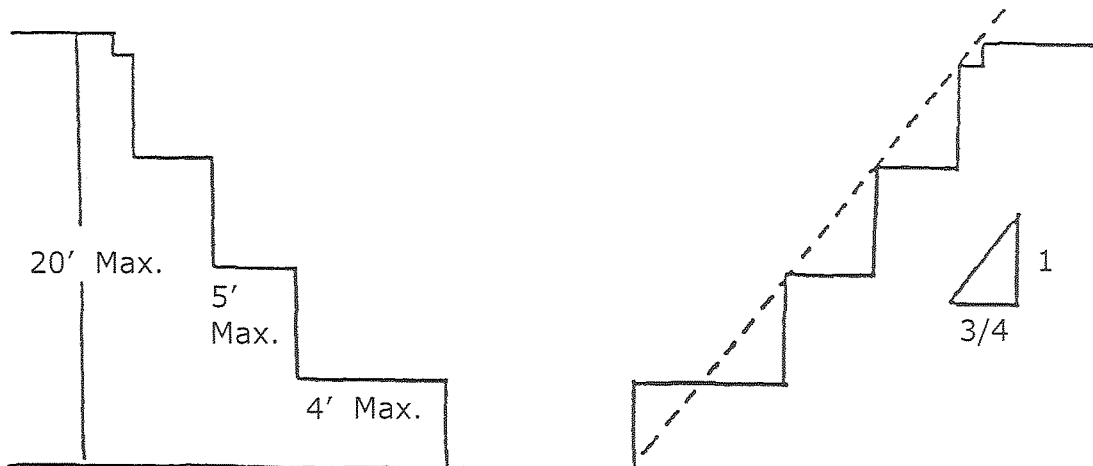


SIMPLE BENCH

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 3/4 to 1 and maximum bench dimensions as follows:

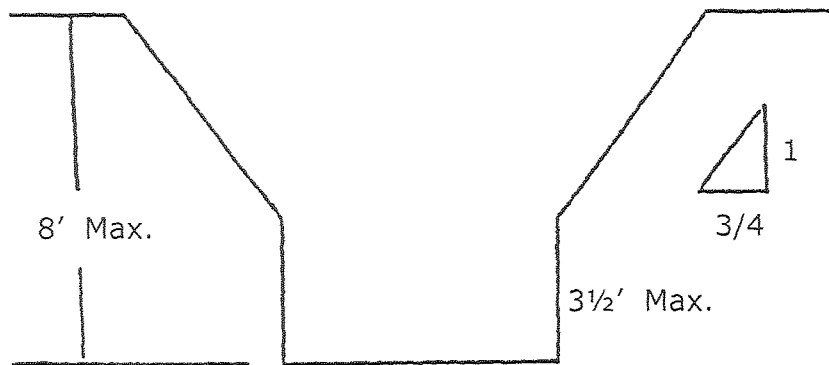


MULTIPLE BENCH



UNSUPPORTED VERTICALLY SIDED LOWER PORTION - MAXIMUM 8 FEET IN DEPTH

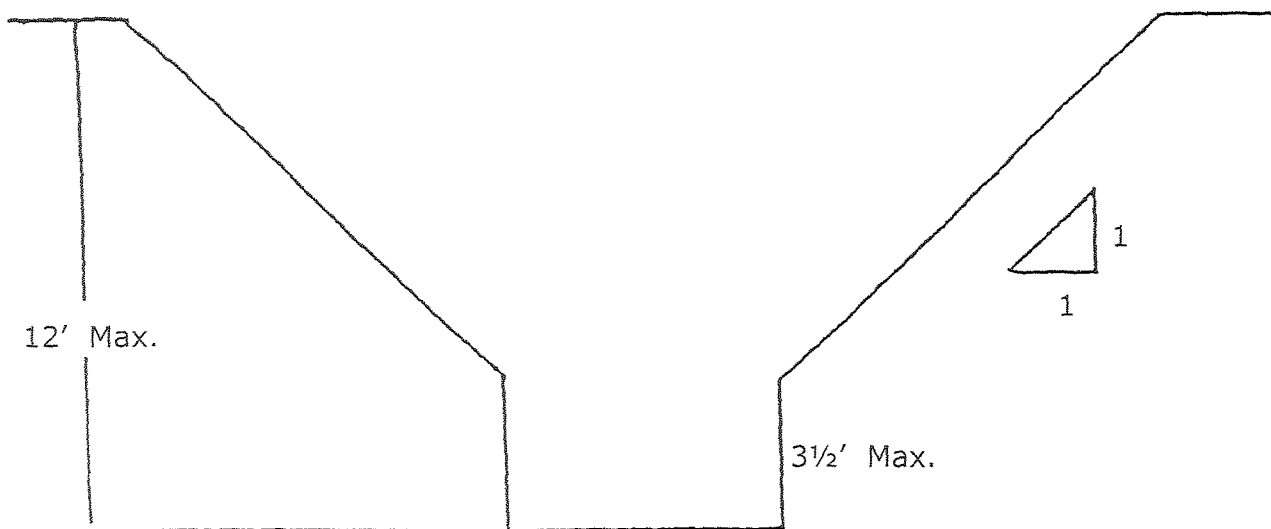
3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3 1/2 feet.



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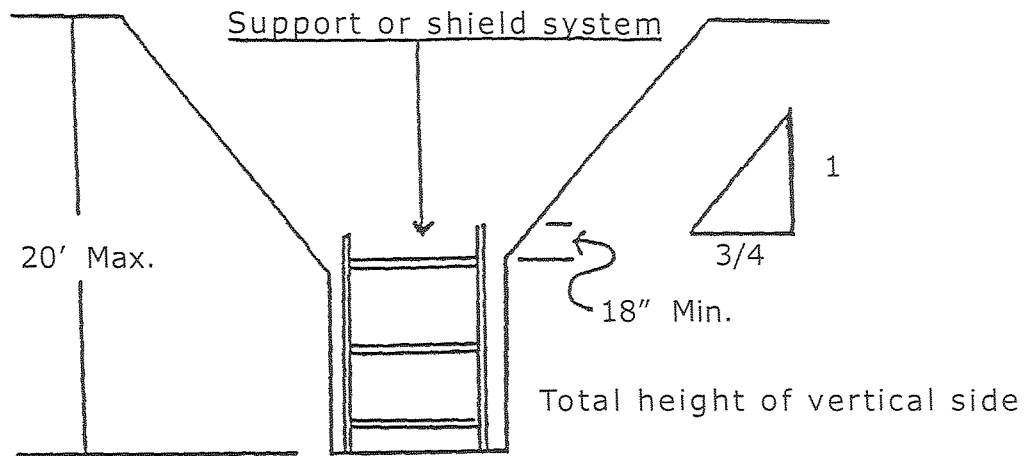
UNSUPPORTED VERTICALLY SIDED LOWER PORTION - MAXIMUM 12 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3 1/2 feet.



SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of 3/4:1. The support or shield system must extend at least 18 inches above the top of the vertical side.



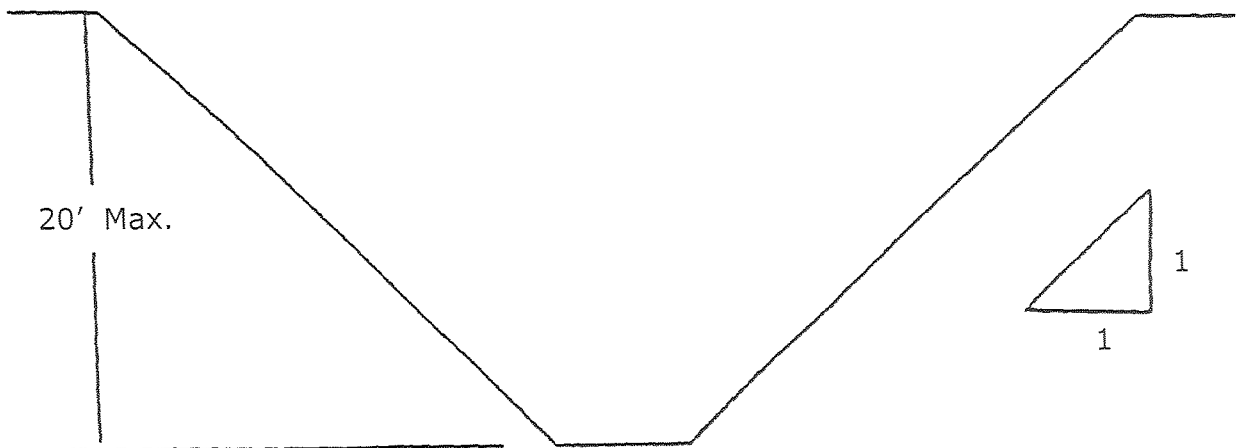
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4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under 1926.652(b).

B - 1.2 Excavations Made in Type B Soil

SIMPLE SLOPE

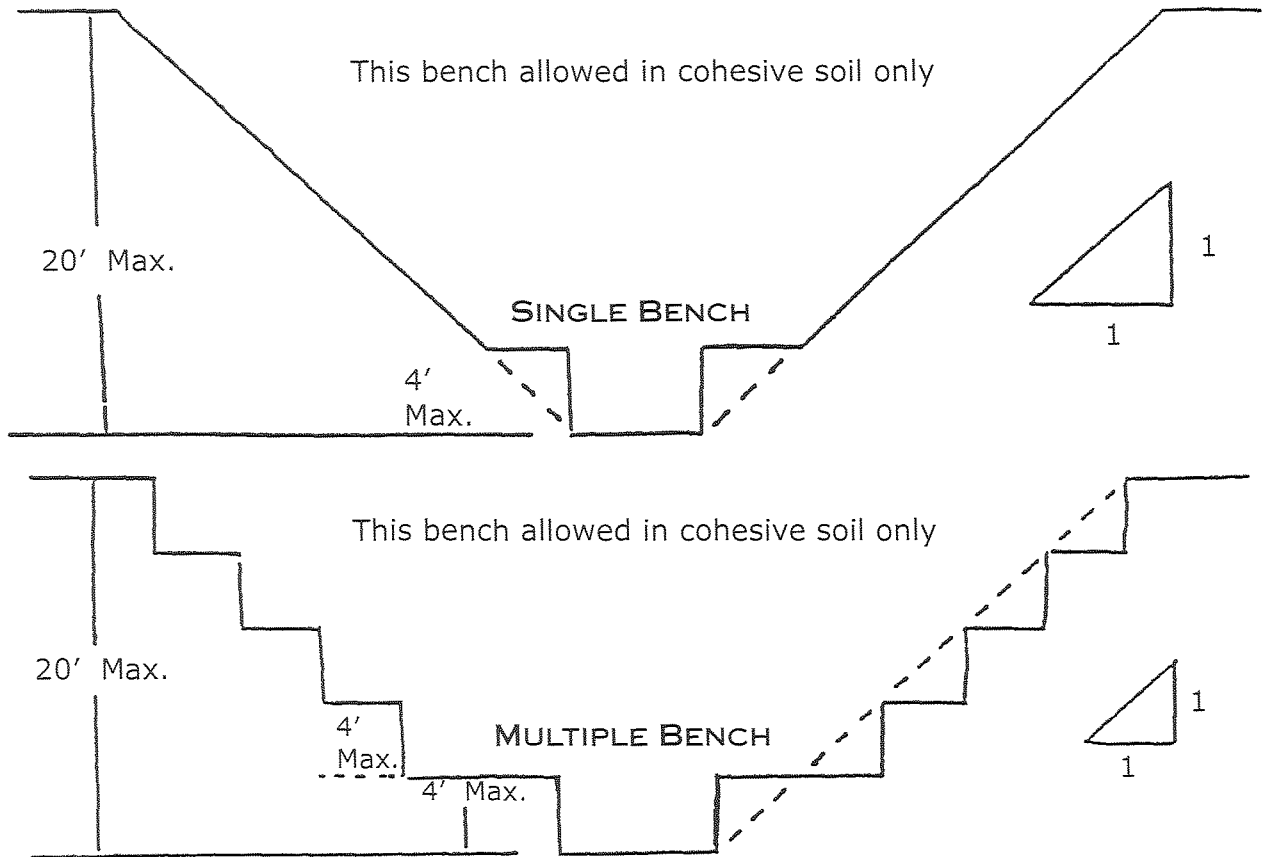
1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.



SINGLE BENCH AND MULTIPLE BENCH

(These benches allowed in cohesive soil only).

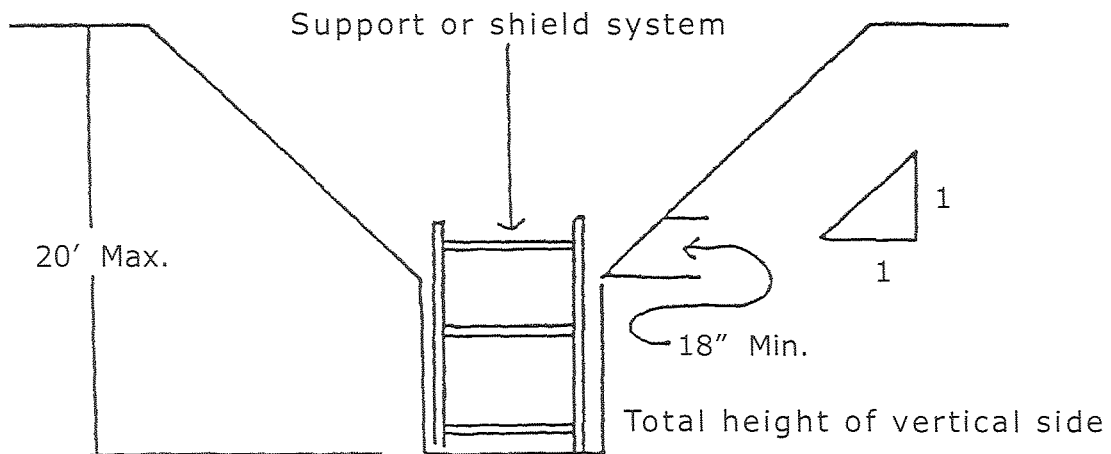
2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:



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VERTICALLY SIDED LOWER PORTION

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

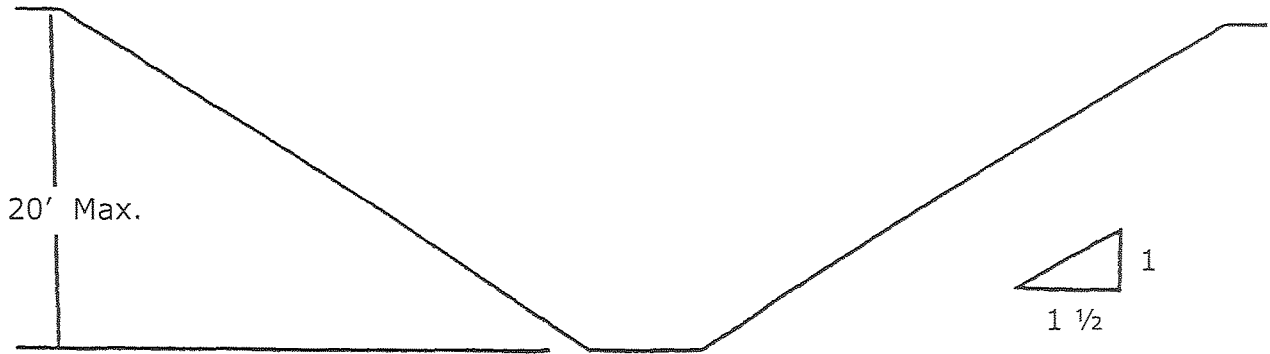


4. All other sloped excavations shall be in accordance with the other options permitted in 1926.652(b).

B - 1.3 Excavations Made in Type C Soil

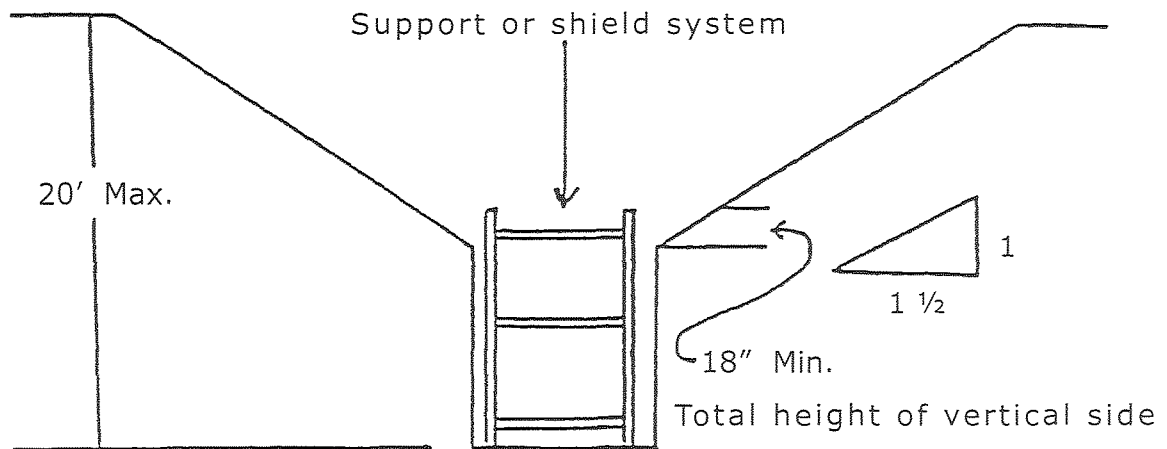
SIMPLE SLOPE

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1 1/2:1.



VERTICAL SIDED LOWER PORTION

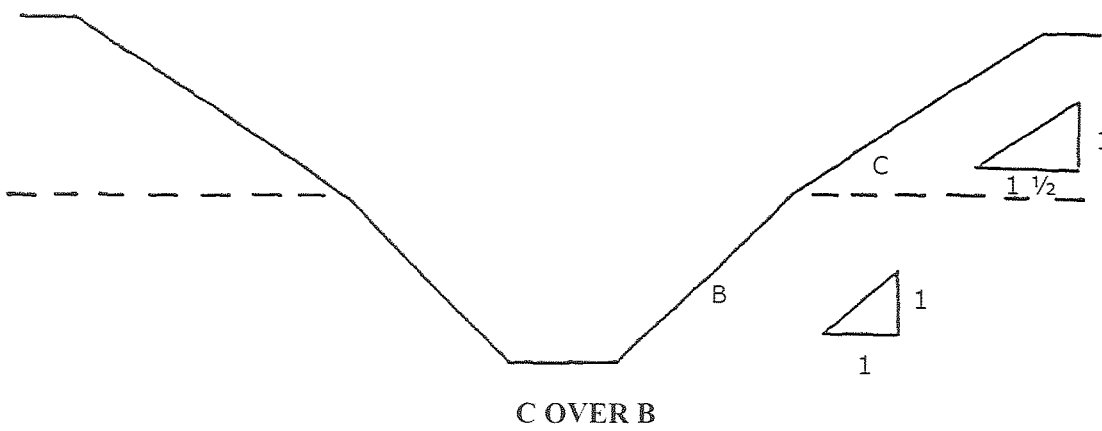
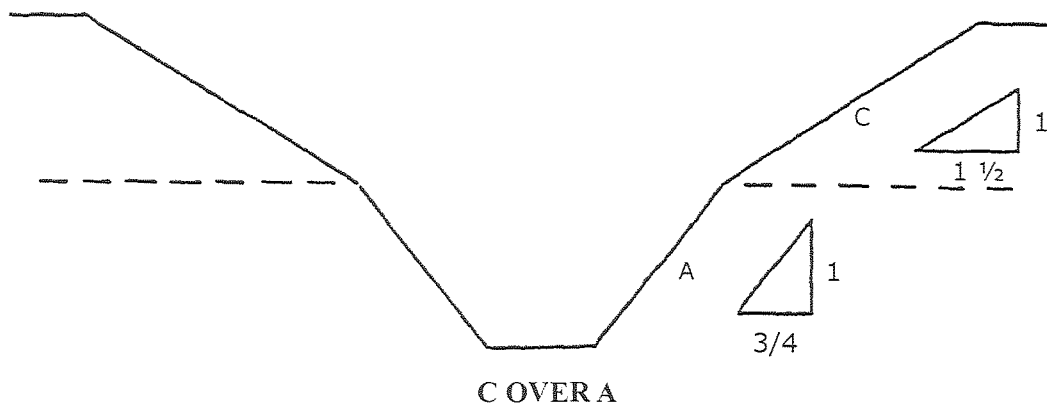
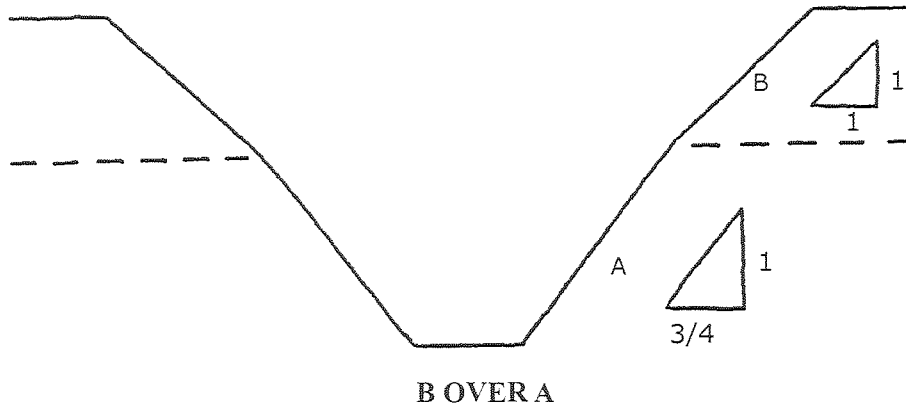
2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1 1/2:1.



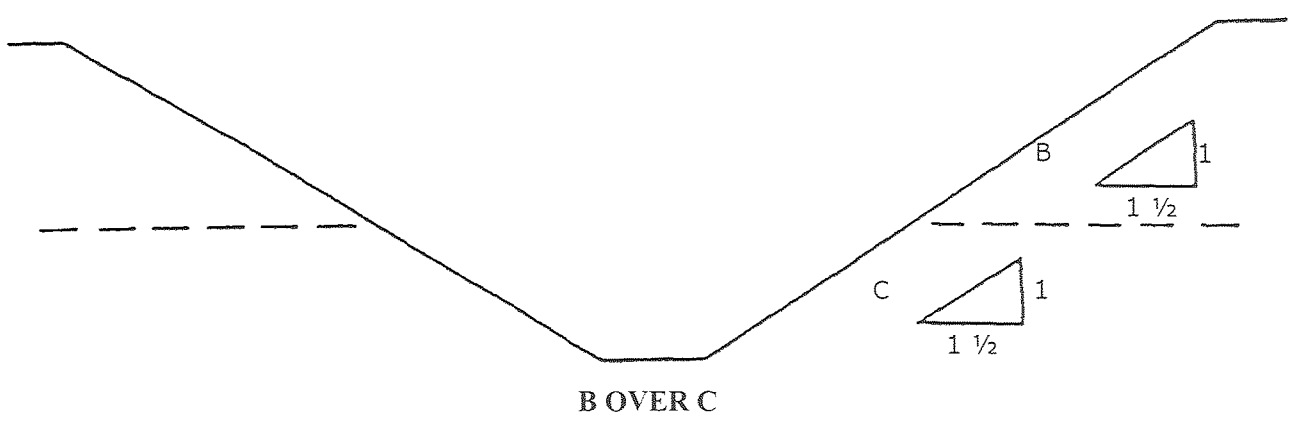
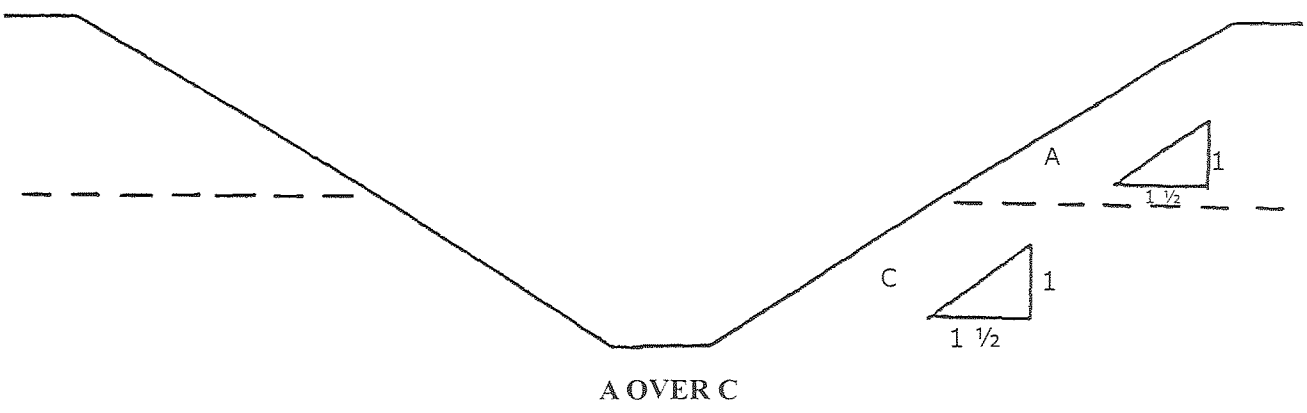
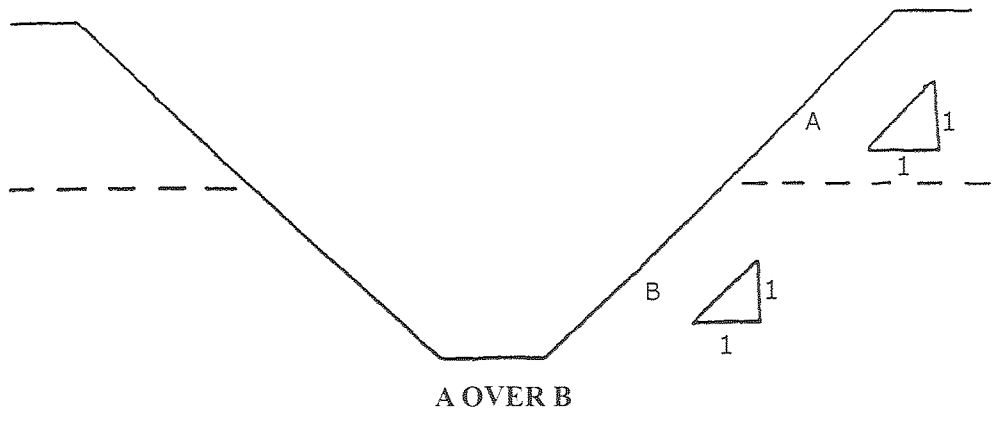
3. All other sloped excavations shall be in accordance with the other options permitted in 1926.652(b).

B - 1.4 Excavations Made in Layered Soils

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



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

TIMBER SHORING FOR TRENCHES

(a) Scope.

This appendix contains information that can be used when timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with 1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in 1926.652(b) and 1926.652(c).

(b) Soil Classification.

In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this report.

(c) Presentation of Information.

Information is presented in several forms as follows:

- (1) Information is presented in tabular form in Tables C-1.1, C-1.2 and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the cross braces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.
- (2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.
- (3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.
- (4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) Basis and limitations of the data.

(1) Dimensions of timber members.

(i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations". In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under 1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) Limitation of application.

(i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

NOTES

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) Use of Tables.

The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the cross braces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the cross braces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the cross braces are known, the size and vertical spacing of the cross braces are known, the size and vertical spacing of the cross braces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) Examples to Illustrate the Use of Tables C-1.1 through C-1.3.

(1) *Example 1.* A trench dug in Type A soil is 13 feet deep and five feet wide. From Table C-1.1, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4X4 cross braces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3X8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4X6 cross braces at eight feet horizontally and four feet vertically.

Space 8X8 wales at four feet vertically.

Space 2X6 uprights at four feet horizontally.

Arrangement #3

Space 6X6 cross braces at 10 feet horizontally and four feet vertically.

Space 8X10 wales at four feet vertically.

Space 2X6 uprights at five feet horizontally.

Arrangement #4

Space 6X6 cross braces at 12 feet horizontally and four feet vertically.

Space 10X10 wales at four feet vertically.

Space 3X8 uprights at six feet horizontally.

(2) Example 2. A trench dug in Type B soil is 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6X6 cross braces at six feet horizontally and five feet vertically.

Space 8X8 wales at five feet vertically.

Space 2X6 uprights at two feet horizontally.

Arrangement #2

NOTES

Space 6X8 cross braces at eight feet horizontally and five feet vertically.

Space 10X10 wales at five feet vertically.

Space 2X6 uprights at two feet horizontally.

Arrangement #3

Space 8X8 cross braces at 10 feet horizontally and five feet vertically.

Space 10X12 wales at five feet vertically.

Space 2X6 uprights at two feet vertically.

(3) *Example 3.* A trench dug in Type C soil is 13 feet deep and five feet wide. From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 8X8 cross braces at six feet horizontally and five feet vertically.

Space 10X12 wales at five feet vertically.

Position 2X6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8X10 cross braces at eight feet horizontally and five feet vertically.

Space 12X12 wales at five feet vertically.

Position 2X6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.* A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3.

Only one arrangement of members is provided.

Space 8X10 cross braces at six feet horizontally and five feet vertically.

Space 12X12 wales at five feet vertically.

Use 3X6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) Notes for all Tables.

1. Member sizes at spacings other than indicated are to be determined as specified in 1926.652(c), "Design of Protective Systems."
2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.
3. All spacing indicated is measured center to center.
4. Wales to be installed with greater dimension horizontal.
5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest cross brace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber cross braces.
7. Placement of cross braces. When the vertical spacing of cross braces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of cross braces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C - 1.1
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type A $P_a = 25 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (Actual) and Spacing of Members **													
	Cross Braces						Wales				Uprights			
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	4	5	6	8
5 to 10	Up to 6	4x4	4x4	4x6	6x6	6x6	4	Not Req'd	—				2x6	
	Up to 8	4x4	4x4	4x6	6x6	6x6	4	Not Req'd	—					2x8
	Up to 10	4x6	4x6	4x6	6x6	6x6	4	8x8	4			2x6		
	Up to 12	4x6	4x6	6x6	6x6	6x6	4	8x8	4				2x6	
10 to 15	Up to 6	4x4	4x4	4x6	6x6	6x6	4	Not Req'd	—				3x8	
	Up to 8	4x6	4x6	6x6	6x6	6x6	4	8x8	4		2x6			
	Up to 10	6x6	6x5	6x6	6x8	6x8	4	8x10	4			2x6		
	Up to 12	6x6	6x6	6x6	6x8	6x8	4	10x10	4				3x8	
15 to 20	Up to 6	6x6	6x6	6x6	6x8	6x8	4	6x8	4	3x6				
	Up to 8	6x6	6x6	6x6	6x8	6x8	4	8x8	4	3x6				
	Up to 10	8x8	8x8	8x8	8x8	8x10	4	8x10	4	3x6				
	Up to 12	8x8	8x8	8x8	8x8	8x10	4	10x10	4	3x6				
Over 20	See NOTE 1.													

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C - 1.2
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type B $P_a = 45 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (Actual) and Spacing of Members **													
	Cross Braces						Wales		Uprights					
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	2	3		
5 to 10	Up to 6	4x6	4x6	6x6	6x6	6x6	5	6x8	5			2x6		
	Up to 8	6x6	6x6	6x6	6x8	6x8	5	8x10	5			2x6		
	Up to 10	6x6	6x6	6x6	6x8	6x8	5	10x10	5			2x6		
	See Note 1													
10 to 15	Up to 6	6x6	6x6	6x6	6x8	6x8	5	8x8	5			2x6		
	Up to 8	6x8	6x8	6x8	8x8	8x8	5	10x10	5			2x6		
	Up to 10	8x8	8x8	8x8	8x8	8x10	5	10x12	5			2x6		
	See Note 1													
15 to 20	Up to 6	6x8	6x8	6x8	8x8	8x8	5	8x10	5	3x6				
	Up to 8	8x8	8x8	8x8	8x8	8x10	5	10x12	5	3x6				
	Up to 10	8x10	8x10	8x10	8x10	10x10	5	12x12	5	3x6				
	See Note 1													
Over 20	See NOTE 1.													

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C - 1.3
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type C $P_a = 80 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (Actual) and Spacing of Members **													
	Cross Braces						Wales				Uprights			
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close				
5 to 10	Up to 6	6x8	6x8	6x8	8x8	8x8	5	8x10	5	2x6				
	Up to 8	8x8	8x8	8x8	8x8	8x10	5	10x12	5	2x6				
	Up to 10	8x10	8x10	8x10	8x10	8x10	5	12x12	5	2x6				
	See Note 1													
10 to 15	Up to 6	8x8	8x8	8x8	8x8	8x10	5	10x12	5	2x6				
	Up to 8	8x10	8x10	8x10	8x10	8x10	5	12x12	5	2x6				
	See Note 1													
	See Note 1													
15 to 20	Up to 6	8x10	8x10	8x10	8x10	8x10	5	12x12	5	3x6				
	See Note 1													
	See Note 1													
	See Note 1													
Over 20	See NOTE 1.													

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C - 2.1
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type A $P_a = 25 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (S4S) and Spacing of Members **														
	Cross Braces						Wales				Uprights				
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)					
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	4	5	6	8	
5 to 10	Up to 6	4x4	4x4	4x4	4x4	4x6	4	Not Req'd	Not Req'd				4x6		
	Up to 8	4x4	4x4	4x4	4x6	4x6	4	Not Req'd	Not Req'd					4x8	
	Up to 10	4x6	4x6	4x6	6x6	6x6	4	8x8	4			4x6			
	Up to 12	4x6	4x6	4x6	6x6	6x6	4	8x8	4				4x6		
10 to 15	Up to 6	4x4	4x4	4x4	6x6	6x6	4	Not Req'd	Not Req'd				4x10		
	Up to 8	4x6	4x6	4x6	6x6	6x6	4	6x8	4		4x6				
	Up to 10	6x6	6x6	6x6	6x6	6x6	4	8x8	4			4x8			
	Up to 12	6x6	6x6	6x6	6x6	6x6	4	8x10	4		4x6		4x10		
15 to 20	Up to 6	6x6	6x6	6x6	6x6	6x6	4	6x8	4	3x6					
	Up to 8	6x6	6x6	6x6	6x6	6x6	4	8x8	4	3x6	4x12				
	Up to 10	6x6	6x6	6x6	6x6	6x8	4	8x10	4	3x6					
	Up to 12	6x6	6x6	6x6	6x8	6x8	4	8x12	4	3x6	4x12				
Over 20	See NOTE 1.														

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C - 2.2
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type B $P_a = 45 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (S4S) and Spacing of Members **													
	Cross Braces						Wales		Uprights					
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close	2	3	4	6
5 to 10	Up to 6	4x6	4x6	4x6	6x6	6x6	5	6x8	5			4x8		4x12
	Up to 8	4x6	4x6	6x6	6x6	6x6	5	8x8	5		3x8		4x8	
	Up to 10	4x6	4x6	6x6	6x6	6x8	5	8x10	5			4x8		
	See Note 1													
10 to 15	Up to 6	6x6	6x6	6x6	6x8	6x8	5	8x8	5	3x6	4x10			
	Up to 8	6x8	6x8	6x8	8x8	8x8	5	10x10	5	3x6	4x10			
	Up to 10	6x8	6x8	8x8	8x8	8x8	5	10x12	5	3x6	4x10			
	See Note 1													
15 to 20	Up to 6	6x8	6x8	6x8	6x8	8x8	5	8x10	5	4x6				
	Up to 8	6x8	6x8	6x8	8x8	8x8	5	10x12	5	4x6				
	Up to 10	8x8	8x8	8x8	8x8	8x8	5	12x12	5	4x6				
	See Note 1													
Over 20	See NOTE 1.													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C - 2.3
TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS*

Soil Type C $P_a = 80 \times H + 72$ psf (2 ft. surcharge)

Depth Of Trench (Feet)	Size (S4S) and Spacing of Members **													
	Cross Braces							Wales			Uprights			
	Horizontal Spacing (Ft.)	Width of Trench (Ft.)					Vertical Spacing (Ft.)	Size (Inches)	Vertical Spacing (Ft.)	Maximum Allowable Horiz. Spacing (Ft.)				
		Up to 4	Up to 6	Up to 9	Up to 12	Up to 15				Close				
5 to 10	Up to 6	6x6	6x6	6x6	6x6	8x8	5	8x8	5	3x6				
	Up to 8	6x6	6x6	6x6	8x8	8x8	5	10x10	5	3x6				
	Up to 10	6x6	6x6	8x8	8x8	8x8	5	10x12	5	3x6				
	See Note 1													
10 to 15	Up to 6	6x8	6x8	6x8	8x8	8x8	5	10x10	5	4x6				
	Up to 8	8x8	8x8	8x8	8x8	8x8	5	12x12	5	4x6				
	See Note 1													
	See Note 1													
15 to 20	Up to 6	8x8	8x8	8x8	8x10	8x10	5	10x12	5	4x6				
	See Note 1													
	See Note 1													
	See Note 1													
Over 20	See NOTE 1.													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO 1926 SUBPART P NOTES

ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.*

This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with 1926.652(c)(2).

(b) *Soil Classification*

In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.*

Information is presented in several forms as follows:

- (1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and D-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D-1.4 are for horizontal waler systems in Types B and C soil.
- (2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.
- (3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.
- (4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.
- (5) Miscellaneous notations (Footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.
- (6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the

Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring: Typical Installations."

(d) Basis and limitations of the data.

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications.

(i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with 1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

NOTES

(C) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.

The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting, are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members are made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(e) Example to Illustrate the Use of the Tables.

(1) *Example 1:* A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) *Example 2:* A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) *Example 3:* A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. the trench is 16 feet deep and 9 feet wide. From Table D-1.2:

Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by Footnote #2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically. Plywood (per Footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) *Example 4:* A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep, and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally, 3 x 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) *Example 5:* A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically, 3 x 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.

(1) For applications other than those listed in the tables, refer to 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to 1926.652(c)(2) and 1926.652(c)(3).

(2) 2-inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities.

(i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

NOTES

- (ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.
- (4) All spacing indicated is measured center to center.
- (5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.
- (6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.
- (7) Plywood shall be 1.125 inch thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.
- (8) See appendix C for timber specifications.
- (9) Wales are calculated for simple span conditions.
- (10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING TYPICAL INSTALLATIONS

OSHA 1926 SUBPART P

Figure No. 1
Vertical aluminum hydraulic shoring (spot bracing)

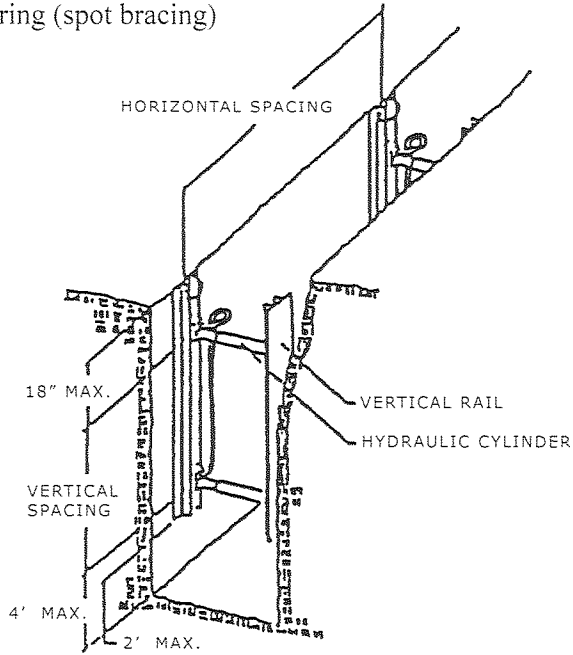


Figure No. 2
Vertical aluminum hydraulic shoring (with plywood)

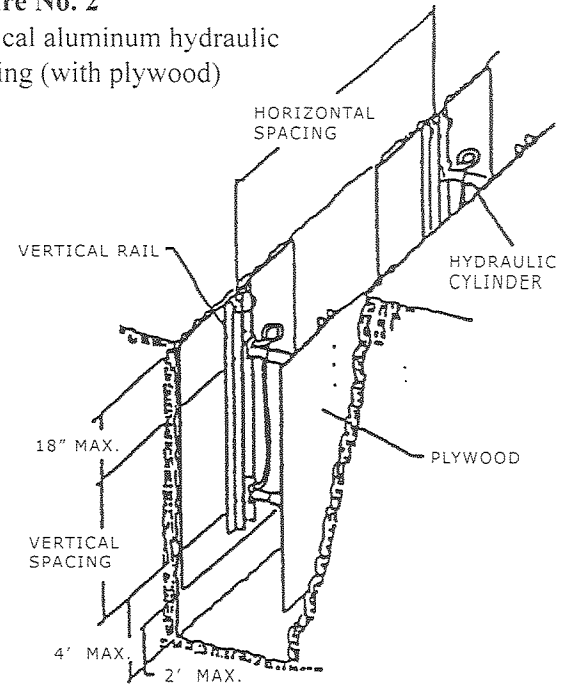


Figure No. 3
Vertical aluminum hydraulic shoring (stacked)

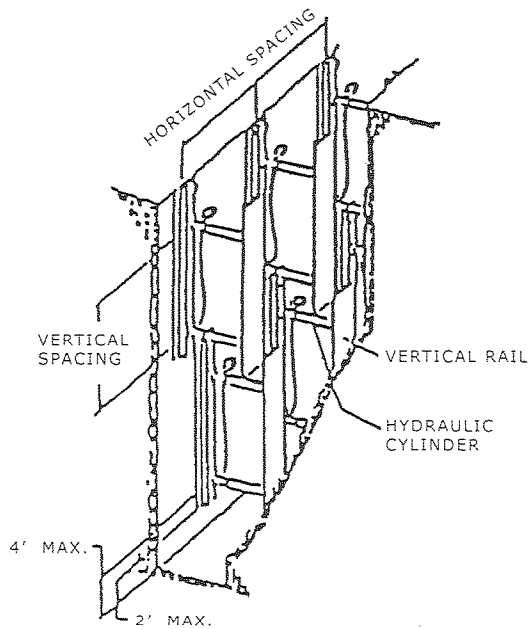


Figure No. 4
Aluminum hydraulic shoring -
Waler System (typical)

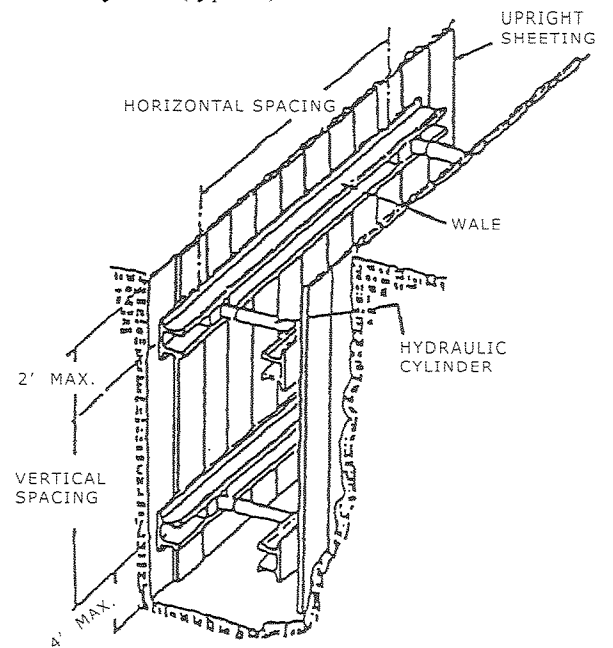


TABLE D - 1.1
ALUMINUM HYDRAULICS SHORING (Vertical Shores for Soil Type A)

Depth Of Trench (Feet)	Hydraulic Cylinders				
	Maximum Horizontal Spacing (Feet)	Maximum Vertical Spacing (Feet)	Width Of Trench (Feet)		
			Up to 8	Over 8, Up to 12	Over 12, Up to 15
Over 5 Up To 10	8	4	2 Inch Diameter	2 Inch Diameter NOTE (2)	3 Inch Diameter
Over 10 Up To 15	8				
Over 15 Up To 20	7				
Over 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g).

NOTE (1): See Appendix D, Item (g)(1)

NOTE (2): See Appendix D, Item (g)(2)

TABLE D - 1.2
ALUMINUM HYDRAULICS SHORING (Vertical Shores for Soil Type B)

Depth Of Trench (Feet)	Hydraulic Cylinders				
	Maximum Horizontal Spacing (Feet)	Maximum Vertical Spacing (Feet)	Width Of Trench (Feet)		
			Up to 8	Over 8, Up to 12	Over 12, Up to 15
Over 5 Up To 10	8	4	2 Inch Diameter	2 Inch Diameter NOTE (2)	3 Inch Diameter
Over 10 Up To 15	6.5				
Over 15 Up To 20	5.5				
Over 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g).

NOTE (1): See Appendix D, Item (g)(1)

NOTE (2): See Appendix D, Item (g)(2)

TABLE D - 1.3
ALUMINUM HYDRAULICS SHORING (Waler Systems for Soil Type B)

Depth Of Trench (Feet)	Wales		Hydraulic Cylinder						Timber Uprights		
	Vertical Spacing (Feet)	Section Modulus (inches ³)	Width Of Trench (Feet)						Maximum Horiz. Spacing (On Center)		
			Up To 8		Over 8, Up To 12		Over 12, Up To 15		Solid Sheet	2 Feet	3 Feet
			Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter			
Over 5 Up To 10	4	3.5	8.0	2 inches	8.0	2 inches NOTE (2)	8.0	3 inches	—	—	3x12
		7.0	9.0	2 inches	9.0	2 inches NOTE (2)	9.0	3 inches			
		14.0	12.0	3 inches	12.0	3 inches	12.0	3 inches			
Over 10 Up To 15	4	3.5	6.0	2 inches	6.0	2 inches NOTE (2)	6.0	3 inches	—	3x12	—
		7.0	8.0	3 inches	8.0	3 inches	8.0	3 inches			
		14.0	10.0	3 inches	10.0	3 inches	10.0	3 inches			
Over 15 Up To 20	4	3.5	5.5	2 inches	5.5	2 inches NOTE (2)	5.5	3 inches	3x12	—	—
		7.0	6.0	3 inches	6.0	3 inches	6.0	3 inches			
		14.0	9.0	3 inches	9.0	3 inches	9.0	3 inches			
Over 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

NOTES (1): See Appendix D, Item (g)(1)

NOTES (2): See Appendix D, Item (g)(2)

*Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULICS SHORING (Waler Systems for Soil Type C)

Depth Of Trench (Feet)	Wales		Hydraulic Cylinder						Timber Uprights		
	Vertical Spacing (Feet)	Section Modulus (inches ³)	Width Of Trench (Feet)						Maximum Horiz. Spacing (On Center)		
			Up To 8		Over 8, Up To 12		Over 12, Up To 15		Solid Sheet	2 Feet	3 Feet
			Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter			
Over 5 Up To 10	4	3.5	6.0	2 inches	6.0	2 inches NOTE (2)	6.0	3 inches	3x12	---	---
		7.0	6.5	2 inches	6.5	2 inches NOTE (2)	6.5	3 inches			
		14.0	10.0	3 inches	10.0	3 inches	10.0	3 inches			
Over 10 Up To 15	4	3.5	4.0	2 inches	4.0	2 inches NOTE (2)	4.0	3 inches	3x12	---	---
		7.0	5.5	3 inches	5.5	3 inches	5.5	3 inches			
		14.0	8.0	3 inches	8.0	3 inches	8.0	3 inches			
Over 15 Up To 20	4	3.5	3.5	2 inches	3.5	2 inches NOTE (2)	3.5	3 inches	3x12	---	---
		7.0	5.0	3 inches	5.0	3 inches	5.0	3 inches			
		14.0	6.0	3 inches	6.0	3 inches	6.0	3 inches			
Over 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

NOTES (1): See Appendix D, Item (g)(1)

NOTES (2): See Appendix D, Item (g)(2)

*Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO 1926 SUBPART P
ALTERNATIVES TO TIMBER SHORING

OSHA 1926 SUBPART P

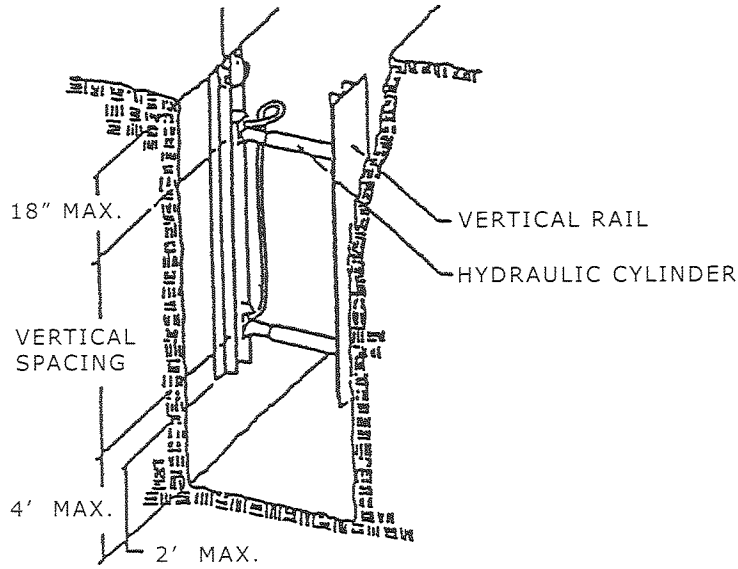


Figure 1. Aluminum Hydraulic Shoring

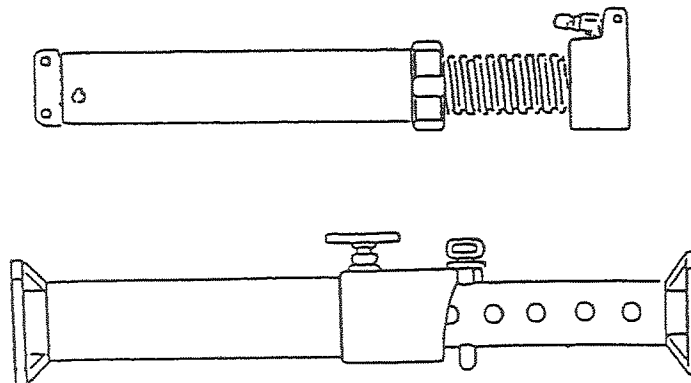


Figure 2. Pneumatic/Hydraulic Shoring

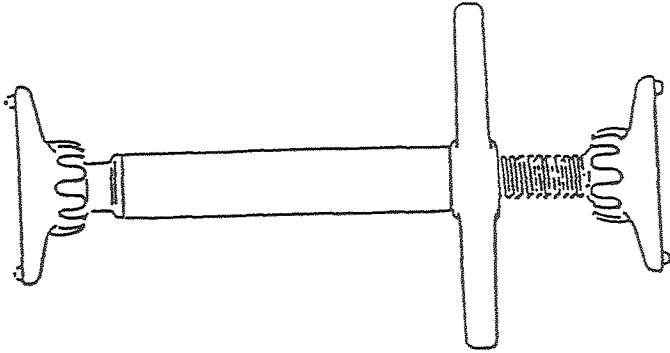


Figure 3. Trench Jacks (screw jacks)

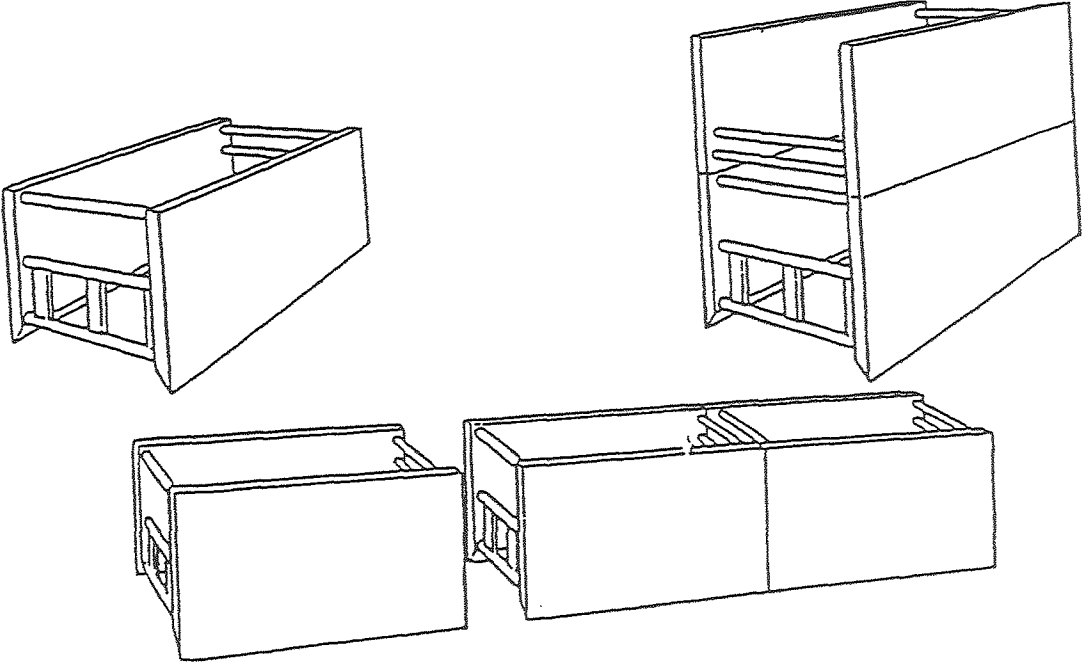


Figure 4. Trench Shields

APPENDIX F TO 1926 SUBPART P

SELECTION OF PROTECTIVE SYSTEMS

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with §1926.652 (b) and (c).

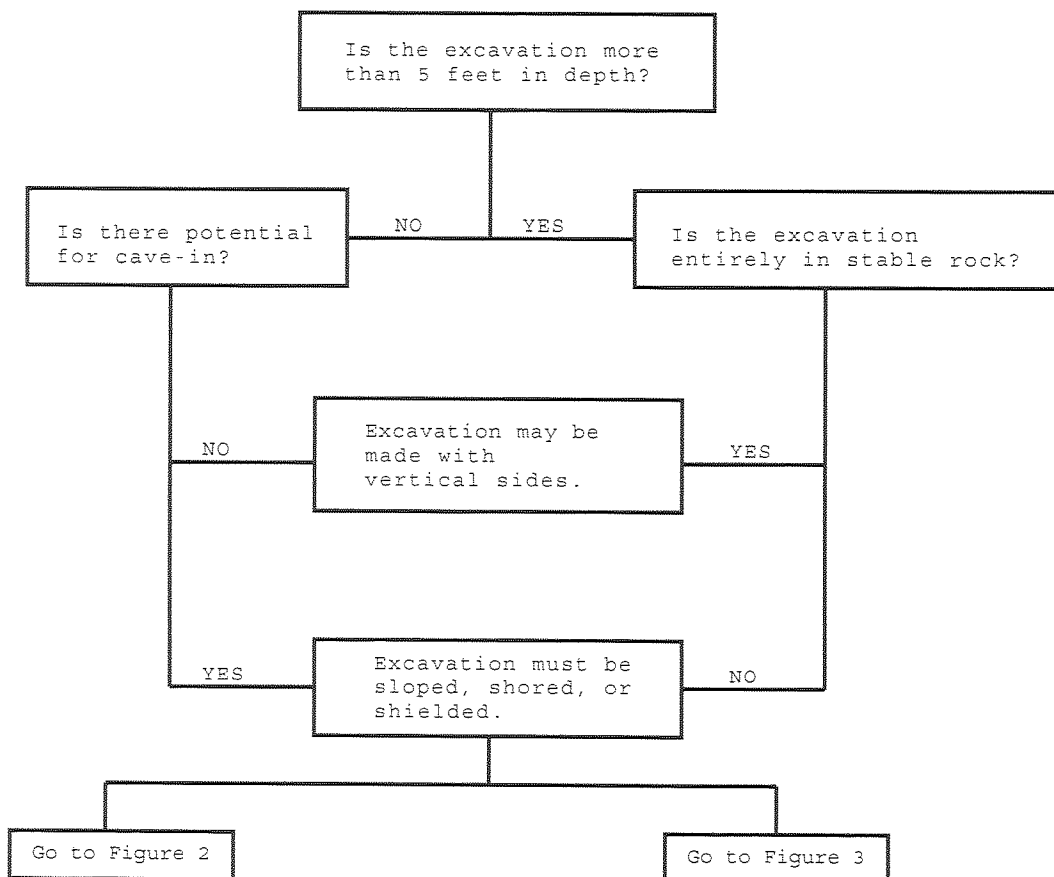


Figure 1. Preliminary Decisions

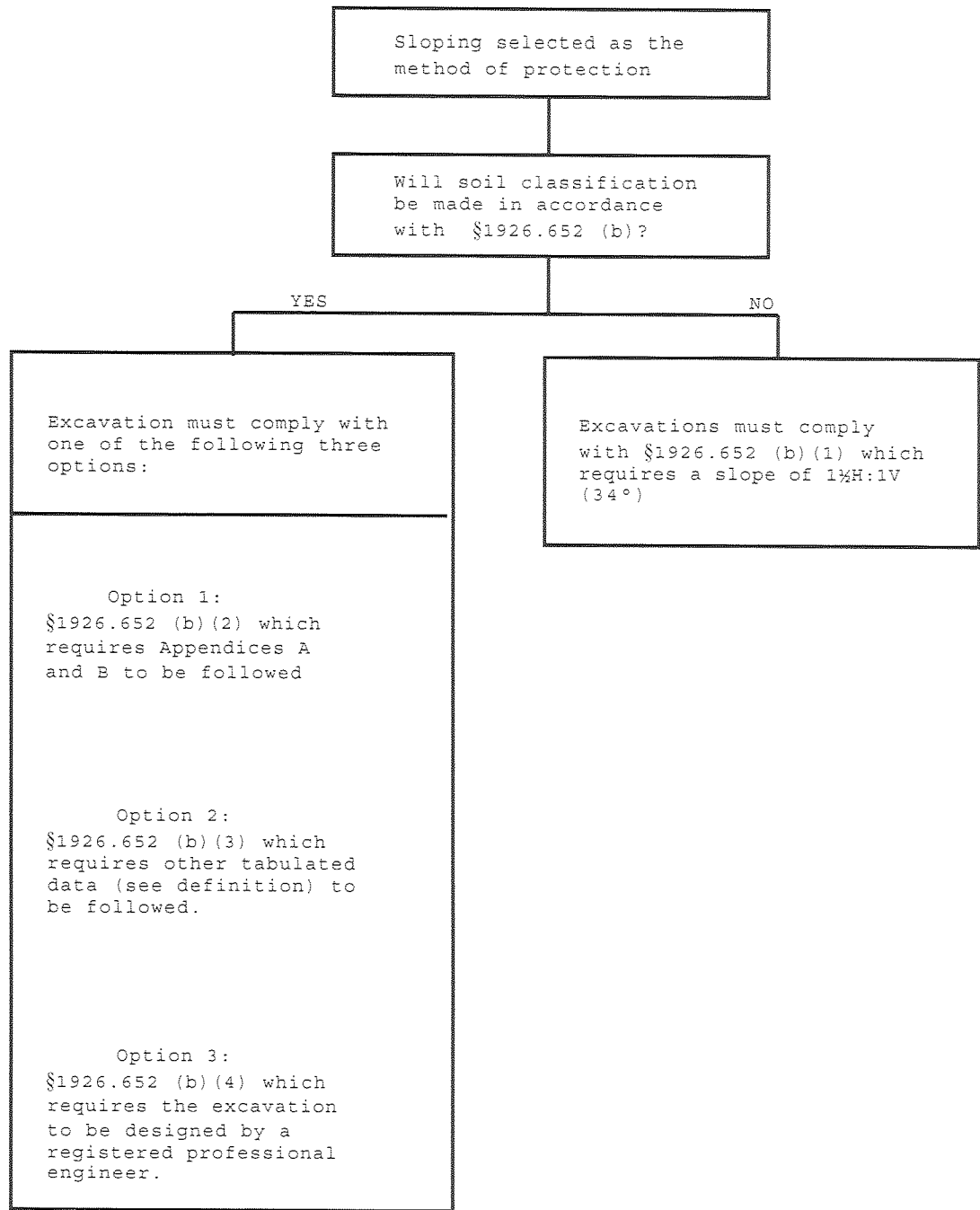


Figure 2. Sloping Options

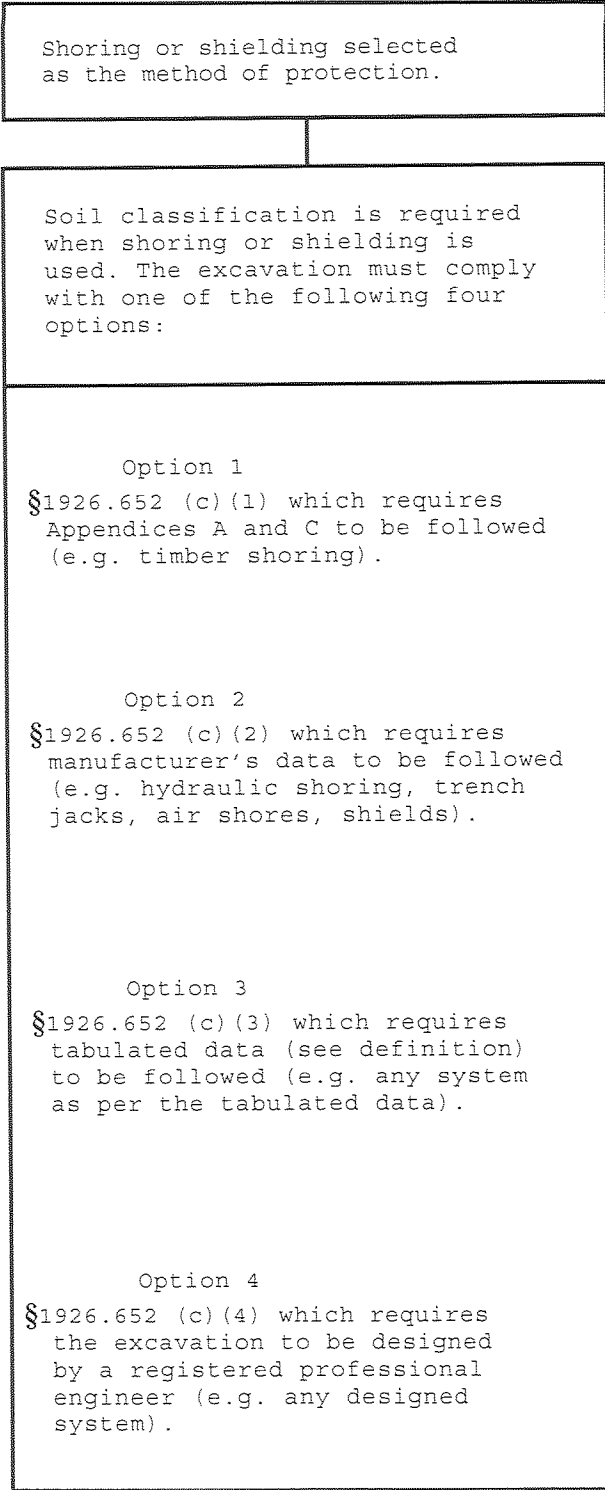


Figure 3. Shoring And Shielding Options

NOTES

OSHA 1926 SUBPART P

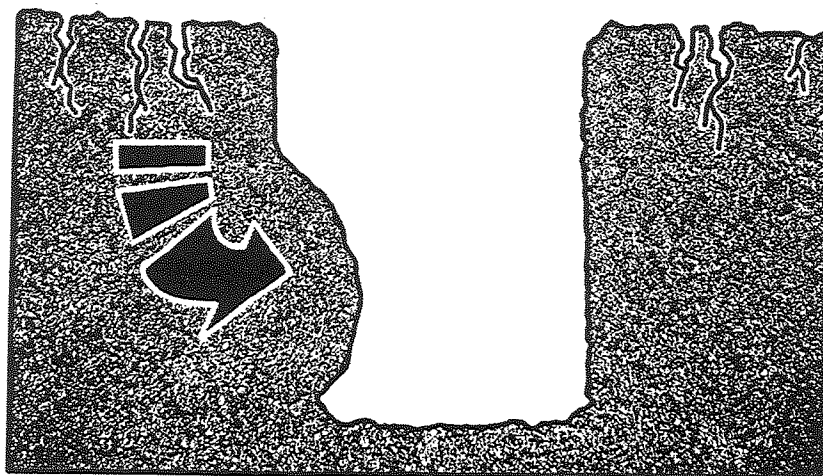
Soil Mechanics

Soil Mechanics

Soil is disintegrated rock, which is usually deposited in layers by wind and water. The disintegration process includes both physical and chemical components. Physical processes such as freezing and thawing, expansion and contraction, grinding, fracturing, faulting and transportation via water and wind progressively reduce (or erode) rock from large formations to smaller particles. Rock formations become boulders, which in turn become cobbles, then gravel, then sand and finally, silt sized particles. Chemical processes, collectively known as weathering, result from exposure to the elements. They include dissolution, re-precipitation and chemical alteration. These processes result in the generation of the extremely fine-grained clay soils. Organic material, introduced when plant material decays, contributes to the generation of “top” soil and peat. Climatic and geological forces result in a continuous mixing and regeneration process that leads to the creation of a wide variety of soil types.

Soils have been studied and classified extensively from a variety of perspectives, based upon the particular interest in the soil. What an engineer wishes to know about a soil might differ significantly from what an agronomist or geologist would want to know. The concerns of one involved in excavation safety issues most closely reflect those of the engineer. They would want to know how the soil performs during construction activities; what kinds of loads a particular soil could bear in shear or compression, or would impose on a support system, and what factors would increase or decrease its stability. Fortunately, a great deal is known about soil and its performance characteristics. In that sense, the problem with soil, from a safety perspective, is not soil. The problem is with an incorrect perception of the soil; in other words, seeing what one wants to see instead of what is really there.

The incorrect and dangerous view is that soil is a homogenous cohesive solid that will stand at attention when excavated until the construction activity is completed. The point, in fact, is that an excavation represents an unnatural phenomenon; a wound in the earth’s surface that natural plus man-made influences immediately seek to heal by forcing the sides of the excavation back together. All excavations fail, given enough time. When the natural and man-made forces brought to bear on a soil exceed its internal strength, the walls collapse in what is known as a cave in. (Figure 1). The records clearly show that for those trapped by a cave-in, the likelihood of a serious injury or fatality resulting is great.



When vertical and lateral pressures generated by natural and man-made influences exceed the internal strength of the soil, the excavation collapses.

Figure 1

The OSHA standard requires that the competent person be able to recognize both existing and predictable hazards in the surroundings that would pose a danger to the employees so that prompt, corrective measures can be taken to avoid an accident. Where soils are concerned, this means understanding the factors that affect soil strength and being able to recognize and evaluate those factors on job sites.

Factors Affecting Soil Strength

There are a number of factors affecting the strength of a soil:

- Type
- Moisture Content
- Freezing
- Previous Disturbance

Soil Type

The type is important because some soils are inherently more stable than others. A wide variety of soil types exist, as do many soil classification systems. When OSHA created its new classification system, found in Appendix A of the Excavation Standard, they addressed five kinds of soil: rock, cemented soils, non-cohesive (granular) soils, cohesive soils and loams.

Rock

Rock is naturally occurring, solid mineral matter. Geologists classify rock on the basis of its origin (i.e. igneous, sedimentary or metamorphic) and constituent mineral components (i.e. sandstone, granite, limestone). OSHA makes no such distinctions. Their concern is performance based, that is, they would want to know “how does the rock perform?” Does the rock remain intact when excavated, or does it break-off and cave-in?

The common misperception that OSHA wishes to eliminate in the minds of excavators is that “solid” rock is “stable” rock. People tend to conclude that because rock is difficult to excavate, is it somehow automatically stable. That is simply not true. Most rock is faulted and fissured by natural movements of the earth’s surface. Layered sedimentary soils may be inclined at steep angles and include “grease” layers such as coal, gypsum, or shale. Water may be seeping through the layers, as well. Excavating through rock, which generally requires blasting or rock sawing, further fractures the rock as well as providing a place for the disturbed rock to go. Anyone who believes rock to be inherently stable should reflect back to their last drive on highways through rock cuts, where they will have seen “Danger, Watch Out For Falling Rock” signs on the shoulders, or spend a few minutes talking to a coal miner. They will find that miners rock bolt or shore all their work to avoid being buried by “solid” but not “stable” rock. The competent person should carefully observe any rock they excavate for evidence of fissures, fractures, inclined bedding planes, or any other deficiencies that might cause the rock to fall into the excavation.

Cemented Soils

Cemented soils, those that seem to be “as hard as a rock”, are formed by soil particles that are cemented together like bricks in a wall by naturally occurring cements like calcium carbonate or silica. The cement is generated by ground water or run-off which dissolves other mineral matter that later precipitates out and cements soil particles together. This is extremely common in limestone derived soils, which can become cemented to form what is often incorrectly referred to as caliche. Excavators tend to make the same perceptual error with cemented soils that they do with rock; if it is so hard that it requires a rock saw to cut it, it must be stable. Not only can cemented soils be unstable because of the same faulting, fracturing and fissuring processes rock is subject to, the cement can also be subject to dissolution from ground water, creating localized weak zones. The competent person should closely observe the walls of excavations in cemented soils for any evidence of such fracturing or dissolution, and be mindful that sometimes rock sawing can “rough sand” the surface of the walls, filling in and obscuring the fracture lines.

Non-cohesive or Cohesion-less Granular Soils

Non-cohesive or Cohesion-less Granular Soils are the “grainy” soils that do not stick together. As mentioned above, a variety of physical forces will mechanically break rock down into progressively smaller sized particles or grains. As defined by most classification systems, the grains come in three sizes; small, medium and large. Large sized grains are gravel, the medium sized grains are sand and the small sized grains are silt. Insofar as the difference in the primary particles is their size, the performance characteristics of those soils are likewise, very similar. The size measurements are listed below in Figure 2.

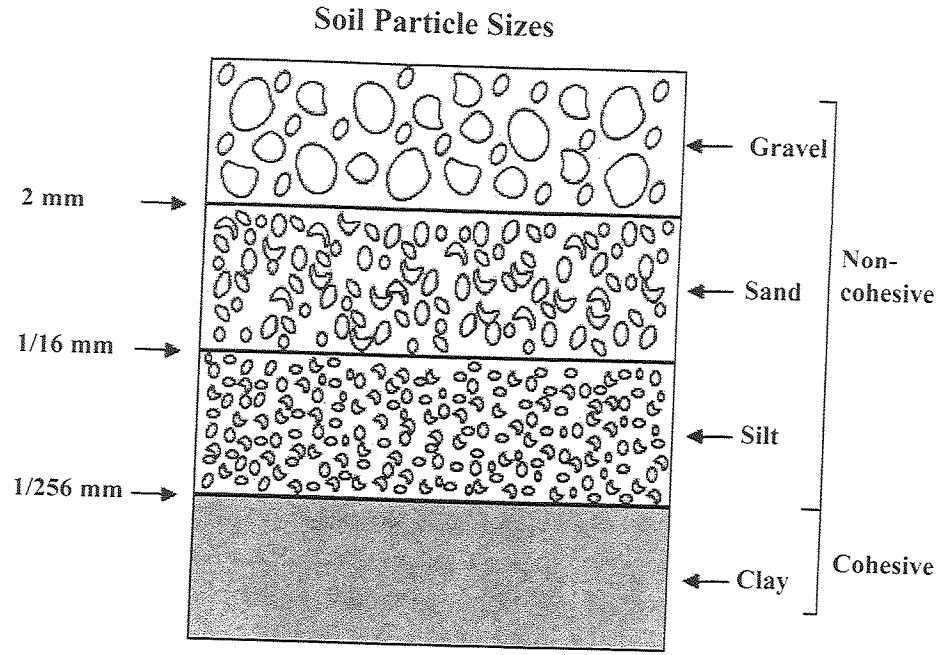


Figure 2

Granular soils are very permeable and tend to make good base or bedding material, but they are very unstable. Unsupported granular soils tend to collapse very quickly as the particles tend to roll and slide past one another. Excavators know that when they encounter a granular soil such as sand, it will typically begin caving in as soon as the excavating commences and continue until the walls are sloped back to an angle where its internal strength will permit it to stand. That angle is determined by such factors as the angularity, or “texture” of the grains, and the water content. Sharp edged, or highly angular grains tend to lock together like puzzle pieces, increasing the internal friction of the soil and allowing it to stand at a steeper angle than well rounded grains, which tend to slide or roll past each other more easily. If water is present, it can lubricate the grains, further decreasing the internal friction of the soil. As will be discussed later, the inherent instability of granular soils caused OSHA to classify them as the worst “type”.

Cohesive Soils

Cohesive Soils are the clay or clay rich soils that stick together. As noted earlier, clay minerals arise from the chemical degradation of rock by environmental influences. Clay particles are typically flat, with distinctive plate-like features. When the particles are exposed to water, they bond with one another to form a cohesive mass. After the initial bonding occurs, the performance characteristics of the clay vary significantly with the water content, as anyone who has driven a clay road in a variety of weather conditions can attest. The problems clay soils create for motorists and foundation engineers reflect those they likewise create for excavators.

Consider a clay soil that has been baked by a hot summer sun for several days in succession. It may be as "hard as a rock" or, more accurately, a brick, and be extremely difficult to excavate with a shovel or a smooth mouthed bucket. If the excavator digs deeper, however, they will invariably reach a depth where the moisture content is greater and the clay softens to a stiff, cheese-like texture that can be easily excavated and shaped by the bucket or shovel. At this point the soil is exhibiting what is known as plasticity, which is the ability to be molded. If the clay soil is somewhere between "rock hard" and "cheddar cheese stiff", excavators often incorrectly assume that it will stand indefinitely, allowing them to complete their work without the use of a protective system. Nothing could be further from the truth. Once exposed to the atmosphere, the clay immediately begins to change. If the air is hot and dry, the moisture in the clay begins to evaporate and the clay begins to dry and shrink. When it shrinks sufficiently, it will begin to crack (or fissure). These cracks, known as tension cracks, generally form parallel to the trench, about $\frac{1}{4}$ to $\frac{1}{2}$ the distance of the depth of the excavation back from the edges. When the blocks crack loose, they can easily topple into the excavation, pinning an employee. Conversely, if water is introduced into the walls of a clay soil excavation, either by humidity, fog, rain, run-off or ground water, the clay will begin to absorb the water, swelling and softening in the process. The wet clay can quickly lose the ability to support its own weight, and will fail in what is known as a shear collapse, where the lower third or belly of the trench begins to bulge inward, the upper section tears loose in tension and the loose section of wall slides or shears away from the section behind it. Excavations in clay soil are always either gaining or losing moisture, and either situation can result in a cave-in. Clay soil should never be trusted, but it is; far too often with disastrous results.

Loams

Loams are mixtures of sand, silt and clay, which bring both the benefits and detriments of each soil type to the mixture. Agronomists are fond of loams in the correct relative proportions because they offer the permeability and porosity (i.e. water handling) characteristics of the granular soils, along with the nutrient and "binding" properties of the clay. Engineers likewise prefer loams in the corrective relative proportions for foundations, road-beds, and embankments. The proportions of the three types are typically plotted on a triangle, as shown in Figure 3.

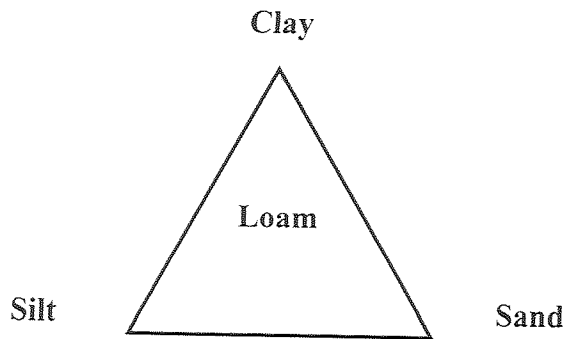


Figure 3

If a loam is predominantly clay, it is called a clay loam. If it has a significant amount of sand, but the performance characteristics of clay due to a more significant amount of clay, it is called a sandy, clay loam, and so forth. Excavators should be especially wary of any loam in which clay is present in sufficient quantity to affect the performance characteristics. While the clay may well hold the otherwise loose, granular material together initially in a state of what is known as “apparent cohesion,” a change in the moisture content, or the sudden loading of the wall by heavy equipment or vibration may cause the clay to fail, allowing the granular material to flow back together as it would absent the clay. The fact is that clay, or clay rich soils account for more excavation injuries and fatalities than all the other soil types combined.

Moisture Content

Water has a tremendous effect on soil stability. In some cases, it may increase stability. Consider dry dune sand or clay dust. Little or nothing can be done with either in terms of molding or shaping. If a small amount of water is added to sand, however, the “liquid links”, or menisci, formed between the grains are sufficiently strong to allow for the construction of a sand castle. If a small amount of water is added to clay, it begins to stick as the particles bond to one another, allowing for molding into desired shapes. As more water is added, however, a soil tends to become unstable as the water begins to first lubricate, then suspend the particles while adding its own weight to the soil.

Consider the effect of water on clay. Clay weighs approximately 65 pounds per cubic foot dry. Because of its great ability to absorb water, clay swells to 110 pounds when saturated, becoming slick and fluid like in the process. Many a clay rich embankment or excavation has failed because of the introduction of water in the form of rain, run-off or ground water migration. If the clay is present in the form of an inter-bed

between other layers or soil or rock (in which case it may be a shale or mudstone) it may serve as a “grease layer” or “slickenside” when wet, and function as the surface along which inclined layers of soils or rock fail. Water has a similar, though less pronounced, effect on the weight of other soils, as indicated by the chart in Figure 4.

Water and Soil Density (lbs/ft ³)		
	Dry	Saturated
Clay	65	110
Loose earth	75	105
Packed earth	95	115
Sand gravel	115-120	125

Source: American Water Works Association

Figure 4

The rule of thumb is, “the more water you add, the more the soil acts like water”, as the water increases the weight of the soil and lubricates the particles to facilitate flow and failure. OSHA requires that the excavation be protected from water running off slopes by dams or diversion. The competent person should also watch for evidence of infiltration by ground water or capillary action that would create a weak zone in the bottom of the excavation. (See figure 5)

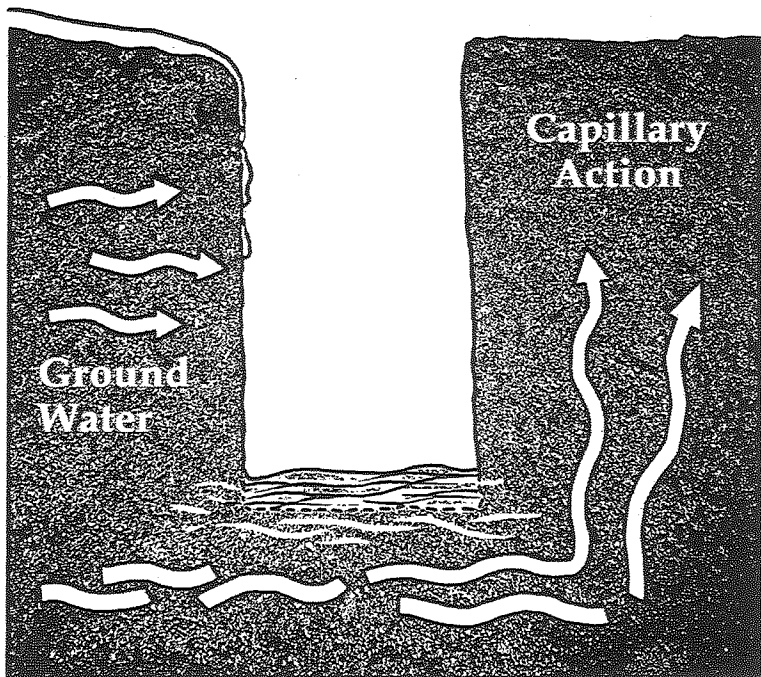
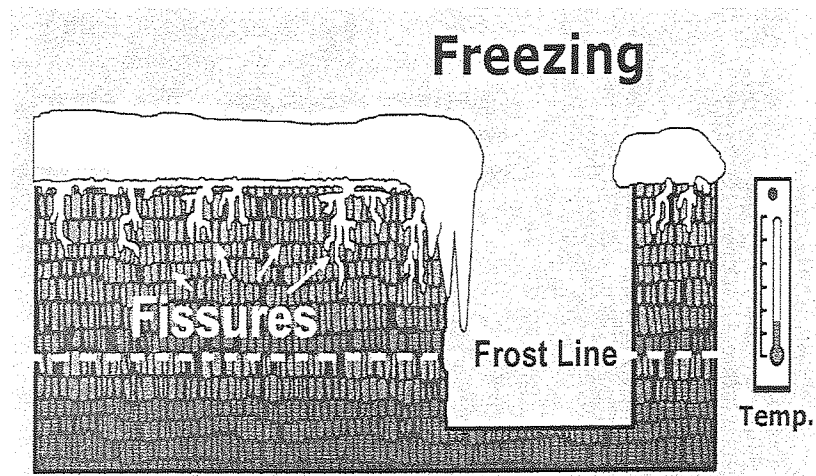


Figure 5

While water will typically decrease the stability of a soil when added, it can also decrease it when removed. As noted earlier, clay will shrink when water evaporates from it, causing cracking and toppling. An excavation in damp sand may hold temporarily, but as the water evaporates and turns the grains loose, the excavation collapses.

Freezing

Freezing causes soil to become quite hard, which can lead an excavator to reach the same conclusion concerning frozen ground that they do with rock or hard clay, namely, that it must be safe to dig simply because it is hard to dig. While it is true that the surface may be so hard that it is very difficult to excavate by conventional means, it may be considerably softer and less stable below the frost line. Combinations of soils with different porosities may have zones of greater and lesser pressure generated by the expansion of the water in the pore spaces between the grains: This may generate areas that are less stable, which is particularly the case around existing utilities and old trench lines using select fill materials for backfill. Finally, during the spring and fall as temperatures rise and fall during the day, the thawing of frozen ground will introduce water into the excavation which can soften and erode areas in its path, causing the failure of frozen blocks of soil.



Previous disturbance

Previous disturbance or prior excavation of the soil creates a weak zone that should be of special concern to excavators. The forces that Mother Nature brings to bear to consolidate and compact a soil are effective, but slow. A soil may show signs of disturbance and be less stable than the undisturbed area around it for a great many years, particularly if a fill material differing from the native soil is used.

Contractors often use probe rods to find old trench lines or excavation sites by looking for the "soft" spots. Archeologists use the same methods to find fire pits and chambers that may have been covered and abandoned thousands of years earlier. While it is true that modern

compaction techniques do a great deal to restore a soil to its original state, no one should automatically assume that such an effort was made on every excavation. An excavator paralleling or crossing existing trench lines should consider those areas to be of special concern where they are likely to be “ambushed” by disturbed material pushing out through the face of the wall they are excavating. (See Figure 7)

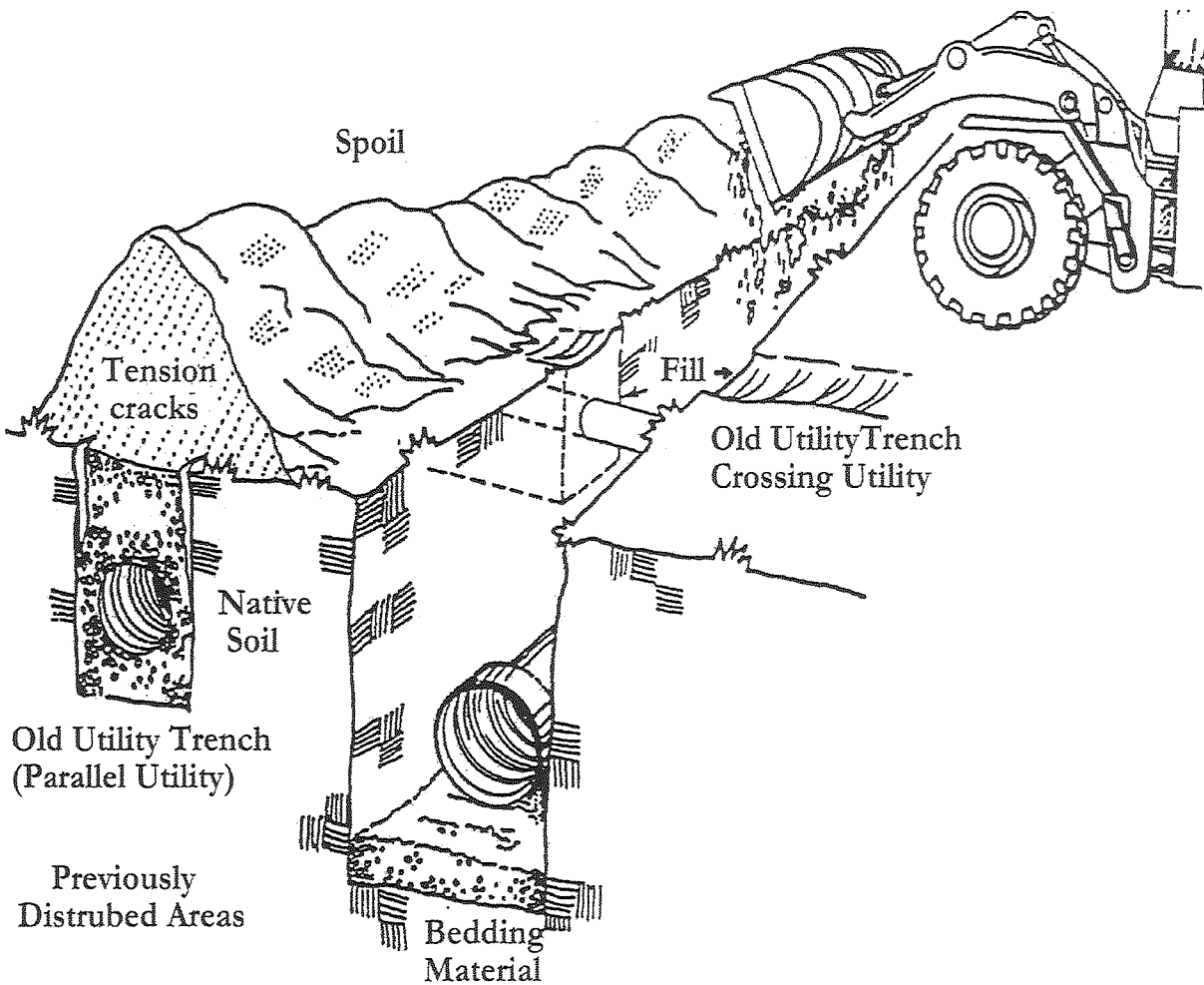


Figure 7

Factors Affecting Downward Force

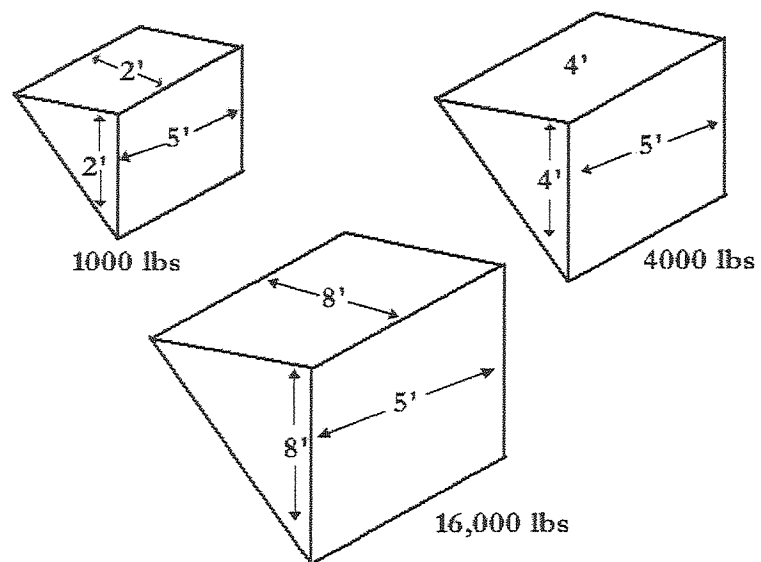
Downward forces are both natural and man-made. Gravity is the primary force nature brings to bear on an unsupported excavation wall. Gravity translates to weight, which generates downward pressure that can cause the soil in the wall of excavation to fail in compression, shear or tension.

The downward pressure is provided by two sources; the depth of the excavation and surcharge loads. Surcharge loads are loads imposed by the weight of anything atop the excavation in proximity to the walls. When the pressures generated by the weight of the soil and the surcharge loads exceed the strength of the soil, it relieves the pressure by collapsing into the excavation.

In the classical model, the lower third of the excavation wall will start to bulge and move laterally into the excavation. The top of the excavation will begin to tear open in a series of tension cracks at a distance back from the edge about $\frac{1}{4}$ to $\frac{1}{2}$ the depth of the excavation. The wall then collapses, leaving a new face that will begin failing in the same manner. It is possible to think of the wall of an excavation being a series of columns, one behind the other that likewise fail, one after the other.

Depth

The depth of the excavation and the surcharge loads, acting in concert, create an unstable wedge in the wall of the excavation that OSHA wants the competent person to visualize and address. Any thing within or atop the wedge needs to be considered. The size of the wedge varies with the stability of the soil comprising it, but the wedges become sufficiently large and heavy, even at shallow depths, to represent a serious threat to employees if they were to collapse on them. (See Figure 8)



Using 100 lbs/ft³ for average soil weight

Figure 8

The deeper an excavation is, the more dangerous it is because the weight of the soil in the unsupported wall increases with the depth. As illustrated by the diagram below, a wall can be viewed as a stack of soil blocks or cubes. If we use the figure of 100 pounds per cubic foot as an average weight of soil, the wall of a ten-foot deep excavation could be viewed as a series of 100-pound stacks of soil cubes. The pressure at the bottom of each stack would be equivalent to the weight of the stack, or 1000 pounds. The downward pressure also generates lateral pressure. If you press down on an air or liquid filled cushion, the sides bulge outward as the downward pressure translates into lateral pressure. The same thing happens in the wall of an excavation as the load increases. The amount of lateral pressure (sometimes called ground weight effect or equivalent fluid pressure) varies, depending upon the soil type and the moisture content. (See figure 9).

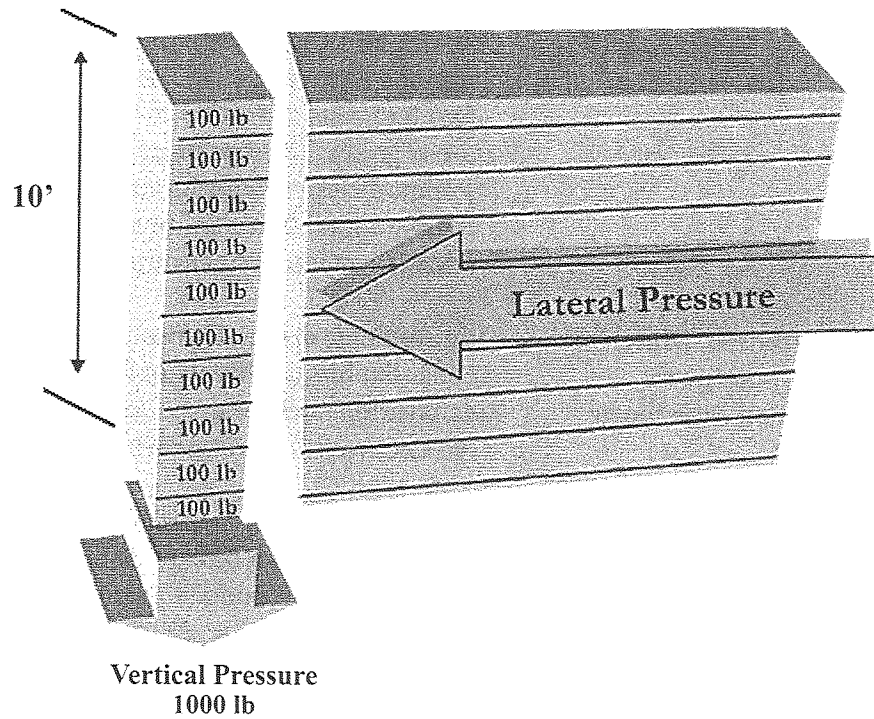


Figure 9

As will be discussed later, the amount of lateral pressure generated by a particular soil is a factor considered by OSHA in its soil classification system, and by the designers of excavation safety equipment, who multiply that pressure by the depth of the excavation to determine the load that must be borne by the shoring or shielding equipment. Soils generating equivalent fluid pressures below 60 pounds per square foot will typically stand when excavated, at least temporarily.

Soils in the 80 psf range or greater, tend to fail immediately. Soils in the 80 psf range would be sugar sands, bay mud and muck.

Surcharge Loads

Surcharge loads are generated by the weight of anything in close proximity to the edge of an excavation. The increased load they bring to bear functions in the manner of a “push-start” for the cave-in. Surcharge loads include: spoil piles, equipment, materials, structures, trees, and personnel.

Spoil Piles

Spoil piles, which are formed by piling soil from the excavation alongside it, can generate enormous loads. In tight right-of-way situations, the contractor may place them right on the edge of the excavation. The OSHA standard requires the spoil be placed at least two feet back from the edge of an excavation to reduce the loading and give personnel room to walk alongside the edge. They further require that the spoil pile be properly sloped so as to prevent any soil from falling back into the excavation. While the minimum set back requirement is at least two feet, it is advisable to place the spoil 3-4 feet back to better achieve those goals. The employer should always be mindful that the OSHA standards represent minimum requirements. It is easy for any job to require more than minimum considerations. The employer should do what is necessary to ensure safety in all situations.

Equipment, Material and Structures Effect on Surcharge Loads

Equipment, materials, structures, trees and personnel can also generate considerable surcharge loads. Heavy equipment is always present at excavation sites, along with trucks. Traffic may be in close proximity to the excavation, particularly if the work is performed alongside roadways.

Rubber tired equipment such as dump trucks, concrete mixer trucks and wheel loaders can be especially troublesome because their weight comes to bear on small contact patches (as compared to track type equipment which has a much larger “footprint”), resulting in high ground contact pressure that can easily cause the walls of an excavation to fail when they come too close to the edge. As an analogy, think of walking on snow in boots as compared to snowshoes. Fuel or other storage tanks, construction materials and buildings also bring their weight to bear on the walls of an excavation.

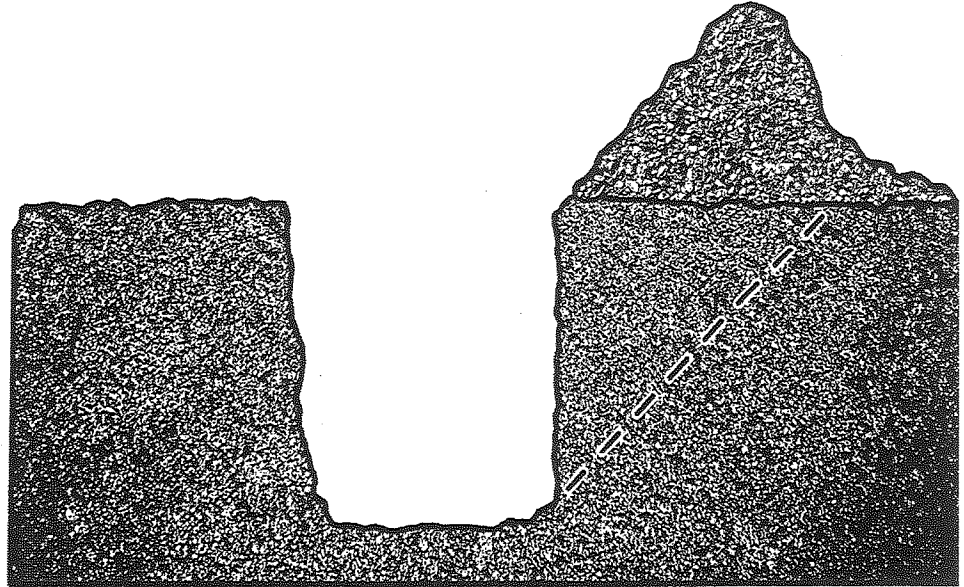


Figure 10

Finally, trees or utility poles or signs in close proximity to the edge of excavations and the personnel doing the work along the edges bring loads to bear on the walls. The competent person should take into consideration the effect of the surcharge loads on the excavation and take appropriate measures to accommodate them. The rule of thumb is, if the surcharge load rests within the unstable “wedge”, it needs to be considered. (Figure 10)

Other Factors Affecting Soil Stability:

Vibration

Vibration is a force that is drastically underestimated, but one that OSHA recognizes as significant and one that the competent person must address. Most folks have had the opportunity to watch railroad tracks move up and down as trains roll over them. If the observer looks down the tracks, they will see that the train is actually generating a series of waves that move along the track bed. On that scale, it is easy to envision the effect of such a ground wave encountering an excavation; it will push or “wash” it back together. The waves generated by vibration not only cause the soil to move, but also ground water or moisture it contains. The excavation represents a low pressure zone or void the water naturally migrates toward when vibration allows it to begin to migrate.

As discussed earlier, water tends to lubricate soil particles, making it easier for them to slide past one another and initiate a cave-in.

Construction sites are generally replete with sources of vibration. Construction equipment and traffic are invariably present, but the list of other potential sources such as trains, compressor stations, drilling operations, and jet planes is lengthy.

Liquefaction

If the right combination of soil, water and vibration are present, the soil can undergo a strange process called “liquefaction”, where it begins to flow like a liquid. Construction workers who place concrete are familiar with the process, as the vibrations from the machines they use to eliminate air pockets from the mix cause it to “flow” in liquid-like fashion. Tapping your foot at the shoreline where water meets the beach can create the same effect. Earthquakes occurring in coastal areas cause liquefaction on a grand scale. The Marina District in San Francisco and the downtown area of Mexico City are known for the devastation it causes, as the buildings sink or topple in the liquefied soil.

The competent person should take the presence of vibration very seriously and monitor the excavation to determine the effect it may be having. Pumps may have to be installed if the vibration causes ground water to infiltrate and accumulate in the excavation. Sheet piling may be required if the walls begin to slough, or sloping may have to be increased. Workers should be instructed to be especially attentive if an increase in vibration from a source such as a passing train occurs and evacuate the excavation if there is any indication of a failure of the walls. The vibration may well be the precursor to a cave-in.

Duration of Exposure

The longer an excavation is open, the more dangerous it becomes because the forces driving the collapse have more time to work on them. Ground water has time to migrate into the lower pressure area of the excavation, rain may occur, vibration will take its toll, and the walls will eventually fail if they are not supported.

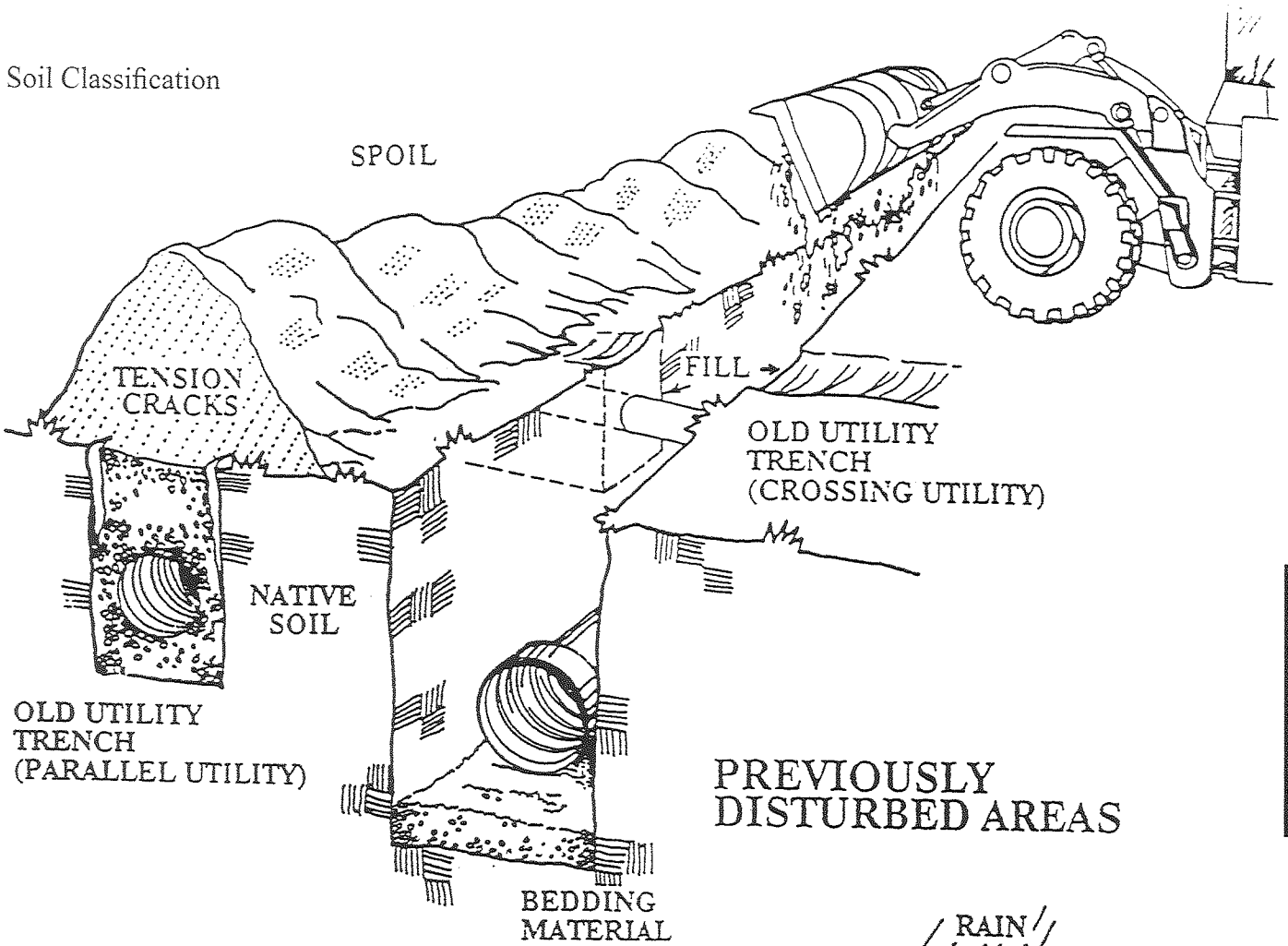
Additionally, the chance of a vehicle driving off into an excavation, or a child or other civilian falling into it or being injured in it increases with duration. Excavators should take special measures to ensure proper barricading and covering, as necessary, to prevent those occurrences. Ideally, the excavator will plan the work to minimize the time the excavation is open.

Undermining

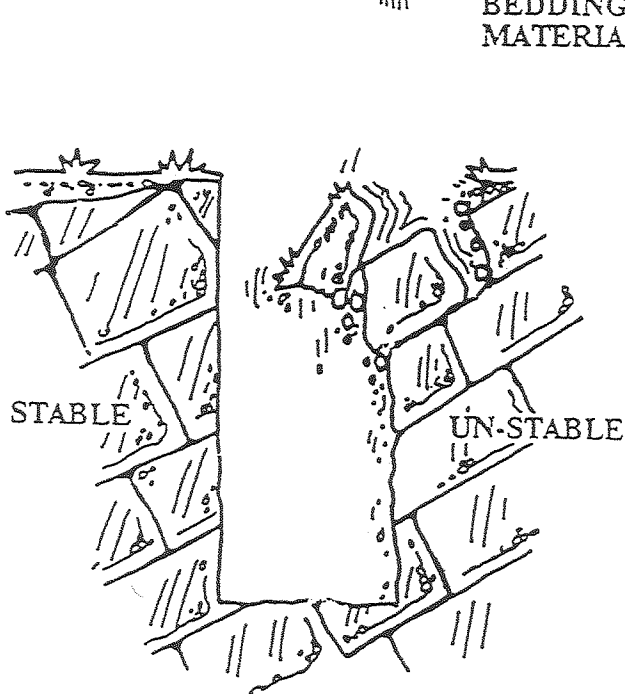
Undermining, or “bell bottoming” occurs when the lower section of the excavation fails, leaving a cantilevered, unsupported upper section above it. Sand underlying clay will often fail, leaving that configuration, as will leaching or eroding by leaks or groundwater. Backhoe operators who tend to over dig excavations, that is, digging back under themselves, can create the same problem. Undermining is very dangerous because of the unsupported overhangs they create, particularly if a building or other structure is compromised in the process. In such cases, registered professional engineers should be consulted for solutions, and employees should be trained to stay well back from the edges.

Time

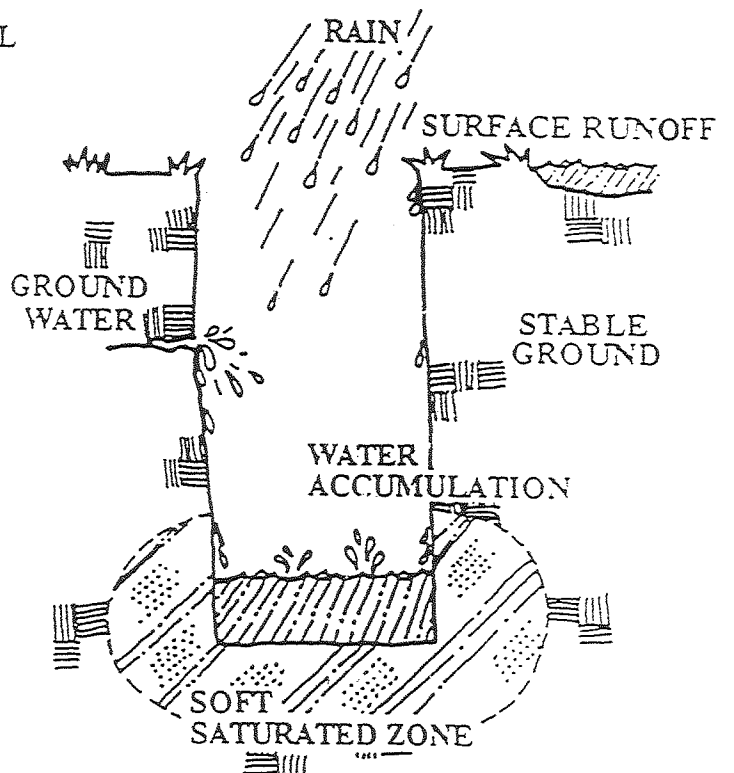
The longer an excavation is open, the more dangerous it becomes because Mother Nature, plus man-made forces, have more time to act upon it. The excavator should plan the job so that it can be completed and backfilled as quickly as possible. OSHA requires that remote pits and excavations be barricaded or covered.



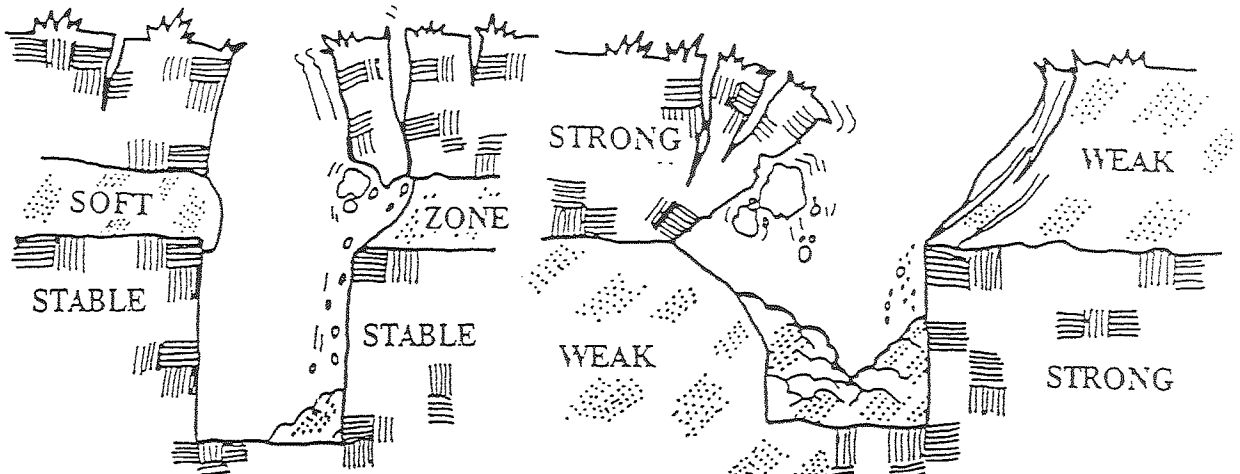
SOIL MECHANICS



FRACTURED ROCK

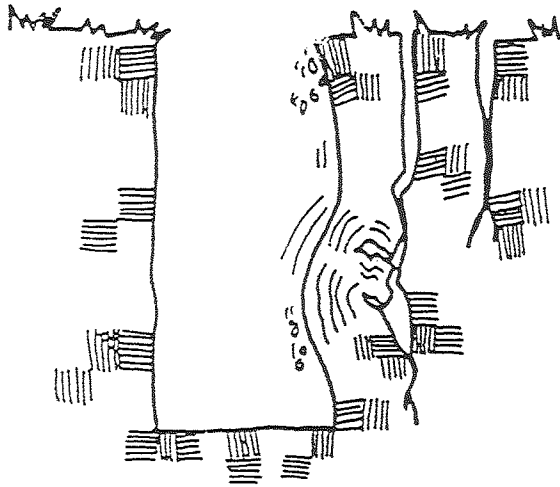


EFFECTS OF WATER

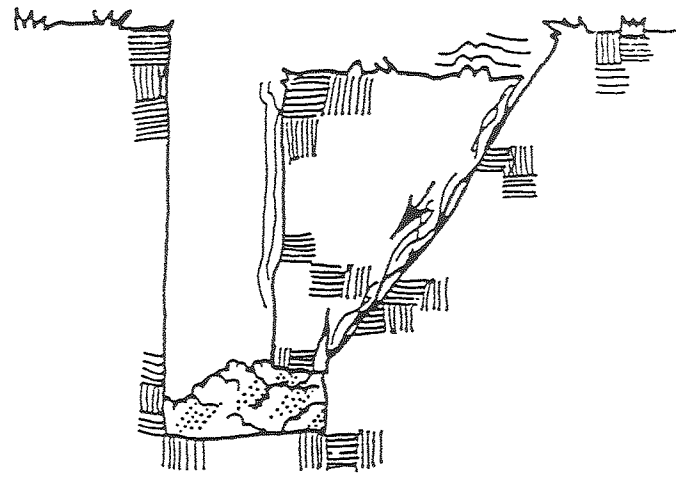


SOFT ZONE FAILURE

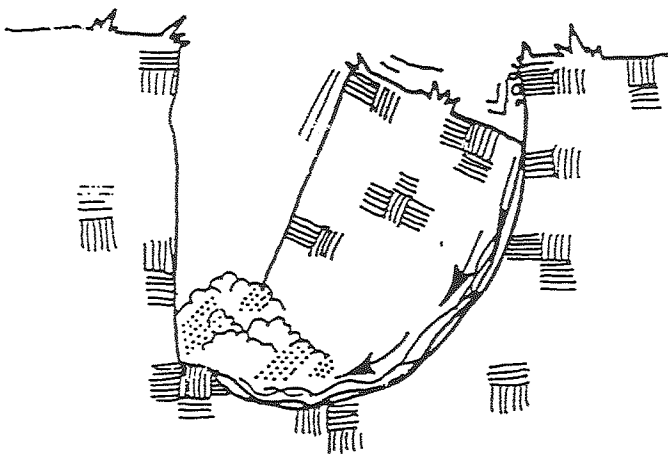
LAYERED SOILS



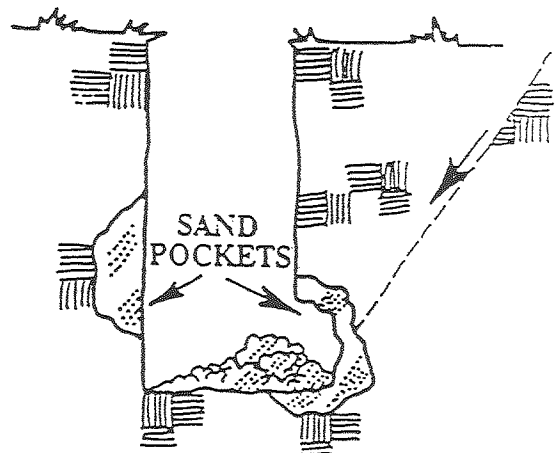
SLOUGHING (AIR DRYING)



WEDGE FAILURE



ROTATIONAL FAILURE



SOFT POCKETS

SOIL MECHANICS

Hazard Recognition Training

The OSHA standard requires employers to train employees in “...the recognition and avoidance of hazards” in Subpart C so that they will know enough to keep themselves out of harms way. Where excavations are concerned, that would mean knowing enough to recognize and avoid entering unsafe excavations, as well as exiting ones that evidenced a potential problem. For example, an employee looking at a 6-foot deep excavation with vertical, unsupported walls would know that they could not enter the excavation until it was shored, sloped or shielded. Likewise, if they were in an excavation and noticed that water was beginning to infiltrate from groundwater or runoff, or that there appeared to be a problem with the shoring, they would know to exit the excavation and get the competent person to inspect the problem and determine a solution for it.

Danger Signs

The following are kinds of things that all employees should be able to recognize as danger signs when working in or around excavations. The competent person should not only be able to recognize them, but be able to take prompt, corrective measures to eliminate them.

- Bulges in the walls of an excavation
- Cracks running parallel to the edge
- Loose material or debris that might fall from the walls
- Vibration
- Undermined structures, poles, or trees
- Spoil pile or other heavy surcharge load too close
- Water entering and accumulating in the excavation
- Parallel or crossing utilities exposed by the excavation

Sedimentation Test

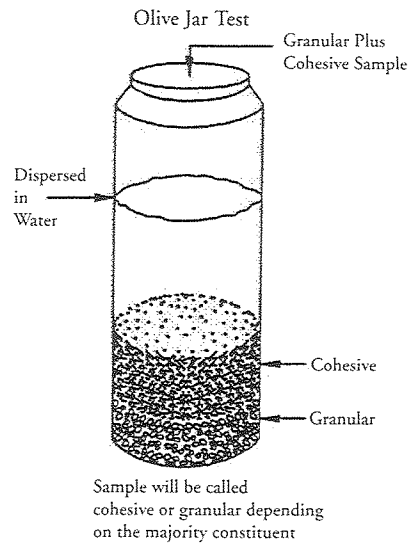
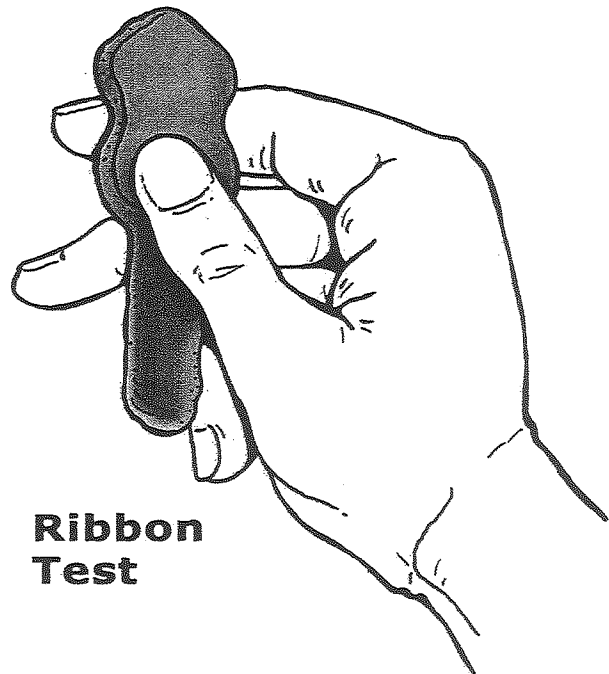


Figure 2



Ribbon Test

Figure 3

Thread Test

2" long
1/8" diameter

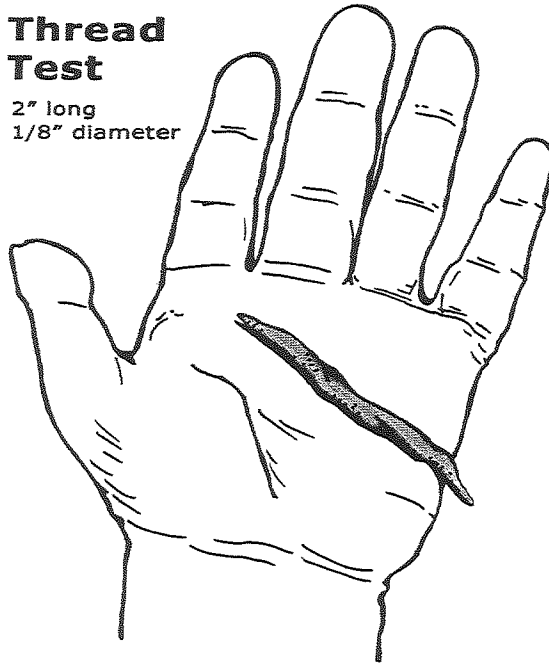


Figure 4

To reiterate, if the competent person determines the soil is a granular, non-cohesive soil, they should classify it as Type C. If they determine it is a cohesive soil, they should then move on to questions 2 and 3 to determine its Type.

Question #2: Using the definitions in the Standard, can the possibility of Type A be automatically eliminated or must it automatically be classified as Type C? Fissures, vibrations, previous disturbance, layers or fissures dipping into the excavation, or other “unspecified factors”, automatically eliminate the possibility of Type A soil on a typical construction site. The competent person should then determine if the cohesive soil is submerged, if water is seeping from it, or if there are layers or fissures that dip into the excavation on a slope of 4 horizontal to 1 vertical or greater. If so, it is automatically Type C. If not, they should move on to question 3.

Question #3: How stiff is it? In other words, what is its unconfined compressive strength, measured in tons per square foot. OSHA says that Type C soil has an unconfined compressive strength less than .5 tsf. Type B is between .5 and 1.5 tsf, and Type A, which will have been eliminated by this point, is 1.5 tsf or greater. To determine the unconfined compressive strength, the competent person can use one of three instruments: a pocket penetrometer, a shear vane, or their thumb.

The pocket penetrometer, illustrated below, is a simple, spring loaded instrument that gives a direct reading of the unconfined compressive strength. The competent person simply inserts the probe to the depth of a groove on the instrument, and then reads the measurement from the displacement of a ring or band on the scale. It is important that the competent person follow the instructions provided by the manufacturer and select good, representative samples, as the soil is likely to change both vertically and horizontally in the excavation, and double check their results.

Penetrometer

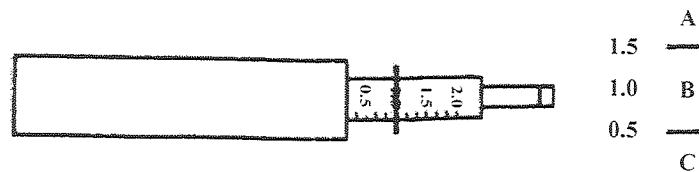


Figure 5

The shear vane is a more complicated, expensive instrument that requires the competent person to select a wheel with fins or vanes on its surface, imbed it in the sample, and then twist it with a spring loaded handle until it shears through the soil. The amount the instrument is twisted is registered on the displacement of a dial on the handle. The competent person must then multiply the reading by 2 to convert the shear strength reading they just measured to convert it to the unconfined compressive strength. The expense, extra steps and complexity of the shear vane make it an unlikely candidate to be the preferred tool for determining the unconfined compressive strength of the soil. The preferred tool for most is the thumb. OSHA allows the competent person to perform the thumb penetration test because its creation by the American Society for Testing and Materials (ASTM) establishes its credibility. The competent person simply holds the cohesive sample and tries to penetrate it with the thumb to the bottom of the thumbnail. Type A soil can be dented, but only penetrated with great effort (think of pushing your thumb into drywall). Even though it may be hard enough to be Type A, the exclusions for Type A typically eliminate Type A as a possibility on most construction sites. Even though the material felt stiff enough to be Type A, it should be downgraded to Type B. Type C is easy; the competent person will probably sink into the soil trying to collect the sample, and will be able to push their entire thumb (as well as their hand and arm) into the sample. Type C is simply, soft, wet clay. Type B can be penetrated to the

bottom of the nail, but it will take some effort, but only with some effort. The competent person will feel the muscles in their forearm tighten as they push to that depth. In order to gauge the “feel” of Type B, a competent person can double check the sample with a penetrometer until they have a good sense of it.

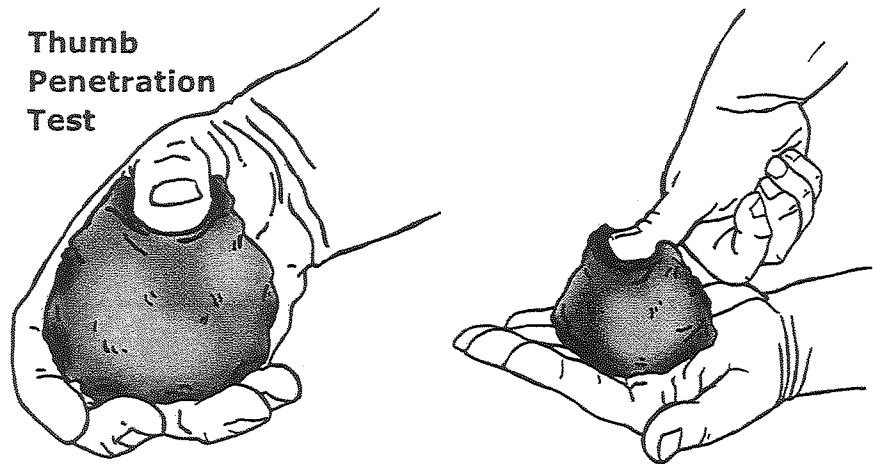


Figure 6

The thumb test may seem too simple for some, but it has proven to be an effective test, particularly for field construction personnel who have an affinity for that kind of test to begin with, and who will look at and think carefully about the soil they are excavating and the environment they are excavating in.

As a reminder, even if the soil can be classified as Type B, it only takes the introduction of water in the form of runoff, ground water infiltration, or rain to automatically change the classification to Type C. The competent person should keep an eye on the weather and the excavation and make changes in the protective systems to accommodate a change in the soil Type from B to C. It might occur quite rapidly in the wake of a sudden rain shower.

Once the competent person has determined their soil “Type”, they can then turn to the sloping and shoring appendices of the standard, or the shielding paragraphs, to design the protective system if they choose to use the resources of the OSHA Standard. They may also look to manufacturers of trench safety equipment, or trench safety engineers for solutions for their excavation problems if the OSHA standard proves inadequate or less preferable.

General Requirements

General Requirements

The research OSHA conducted in the course of revising the excavation standard revealed that a wide variety of hazards were present on a typical construction site. Most recently, the review of the 2003 excavation fatalities revealed that nearly 30% of the fatalities were attributable to causes other than a collapse of the soil; causes such as electrocution or being struck by an object or piece of equipment. For that reason, OSHA broadened the scope of the regulation to cover hazards likely to be encountered on excavation sites such as vehicular traffic and hazardous atmospheres. The new requirements are found in what is called the General Requirements section, 1926.651, paragraphs a-1.

General Requirements for Excavations

Employers should take special care to review these requirements, and determine if other hazards not included by them are present and in need of being addressed. The simple fact is no one subpart covers all the hazards that can be found on a construction site. Employers have the obligation to abide by all applicable standards to ensure the health and safety of their workers. On an excavation site, this might involve using other subparts, such as the crane and derrick (Subpart N) and rigging (Subpart H) subparts to make sure their equipment and pipe were hoisted in an appropriate manner. It might mean looking to the General Industry Standard to find relevant guidance for such problems as the control of energized sources (Lock-out/Tag-out) that the Construction Standard does not include, or more comprehensive guidance for problems such as the control of hazardous atmospheres. It may require incorporating or expanding upon municipal, county or state requirements not found in the OSHA Standards at all.

The employer should always be mindful that the Standards represent minimum guidelines. The problems encountered on construction sites today may be far more than minimal, and the employers should look to all sources of help and guidance to ensure that all problems present on their worksites have been adequately addressed by their job planning.

OSHA addresses the following problems in the General Requirements section, 1926.651:

**Surface
Encumbrances**

- a. All surface encumbrances that are located so as to create a hazard to employees shall be **removed** or **supported**, as necessary to safeguard employees. Proper support of such encumbrances as parallel or crossing utilities or trees may involve consulting a registered professional engineer. Appropriate standard rigging and anchoring equipment, not ‘jury’ rigging, should be employed.

**Underground
Installations**

- b. OSHA requires that the employer notify the utility owners at least 24 hours prior to the start of construction, unless a longer period required by state or local law, and that the approximate or estimated location be determined prior to opening the excavation. It is OSHA’s intention that the utility owners be given notice and the opportunity to mark their lines before construction begins. As the contractor approaches the utility, they should shut down the backhoe or trencher, and expose the lines using a safe, appropriate method such as hand digging or hydraulic or pneumatic excavating before resuming with the backhoes or trenchers.

Every state in the nation requires either 48 or 72 hours advance notice, which typically means 2-3 federal working days. *Federal holidays and weekends do not count as part of the 48 or 72 hours.* Employers should avail themselves of the services of the One-Call Notification Center’s of their state, which are formed by utility owners to provide a free notification service to excavators. As of March 10, 2005 the Federal Communications Commission has designated “811” as the 3-digit toll free number that will connect excavators with One-Call centers across the country. The requirements vary from state to state, but typically an excavator will call or email the One-Call notification 2 days to 2 weeks prior to the start of construction and provide them with contact information, the jobsite location and other pertinent information. The excavator will be provided with a receipt or ticket number which constitutes proof of notification. That number may also reference a location on the tape recording of the phone call, if one was made, so it can be referenced if needed.

The excavator should be mindful that in some states, the ticket number has an expiration date and may need to be renewed during the course of the job.

They should also be aware in some states, the public sector utility owners such as city water departments, are not required to join a One-Call system, and must be contacted directly, as must private property owners and businesses. After notification, the owners mark the lines using paint, stripes and flags. Most states require that the American Public Works Association color codes be used. They are as follows:

RED	Electrical Systems
YELLOW	Gas, oil, steam, gasoline, and other pipeline transmitted products
ORANGE	Telecommunications
BLUE	Potable water
GREEN	Sewers
PURPLE	Recycled water or slurry
PINK	Temporary survey marks
WHITE	Proposed trench line or excavation perimeter

Once in place, the utility owners typically take the responsibility for about 24" on either side of the mark for the accuracy of the location.

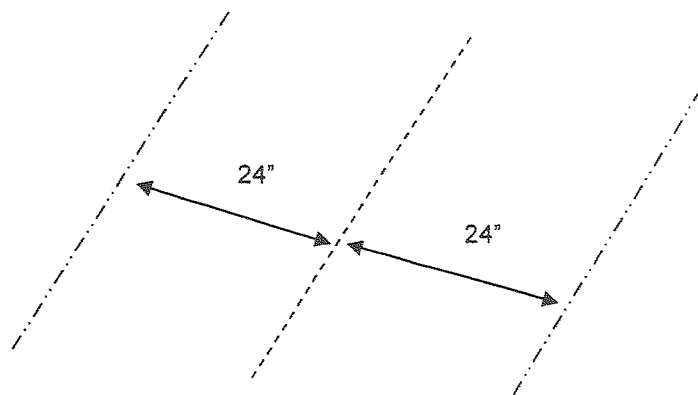


Figure 1

Usually, no information is provided about the depth. If an excavator strikes the utility 30 feet away from the mark, they would not have to pay for the repair since they were making a good faith effort to comply and the locate was inaccurate. Striking the line close to the marks, however, will result in the contractor being billed for the repair. If the utility owner cannot mark the line in the time frame allotted, or at all, the contractor should first call them again, give them the ticket number and ask for an expedited location. If they simply cannot meet the deadline, the law allows the contractor to begin excavating, but they must

locate the utilities themselves and excavate using caution and acceptable means, as the liability and responsibility passes to them.

Contractors may determine the approximate location by using maps, walking the right of way to look for manholes, vent stacks or other indicators of the position of the lines, or using ground penetrating radar, transponders, or other location equipment. The exact location is generally determined by probe rods, hand digging, or pneumatic or hydraulic excavation processes. If probe rods are used, it is advisable to use fiberglass, non-conductive rods and insulated gloves if probing near underground electrical systems to prevent electrocution.

Under no circumstances is a backhoe bucket considered a legal, appropriate means of locating an underground utility. The notion of an operator being able to “feel anything in the ground before they break or damage it” is a ludicrous myth. If a contractor strikes or believes they may have struck an underground utility, they should immediately contact the utility owner (or the One-Call system if the identity of the owner cannot be determined) and have the line inspected before covering it.

Access and Egress

- c. OSHA makes a distinction between trenches and other excavations where access and egress are concerned. Trenches by definition are excavations that are less than 15 feet wide, measured at the bottom. OSHA requires that stairways, ladders or ramps be used in trench excavations that are 4 feet or greater in depth, and that those means of egress be located so as to require no more than 25 feet of lateral travel for the employees. In other words, an employee would have to be within 25 feet of a ladder, ramp or stairway when working in a trench. This would mean there would need to be a ladder, stairway or ramp at a maximum of 50-foot intervals in areas of the trench in which workers would be present.

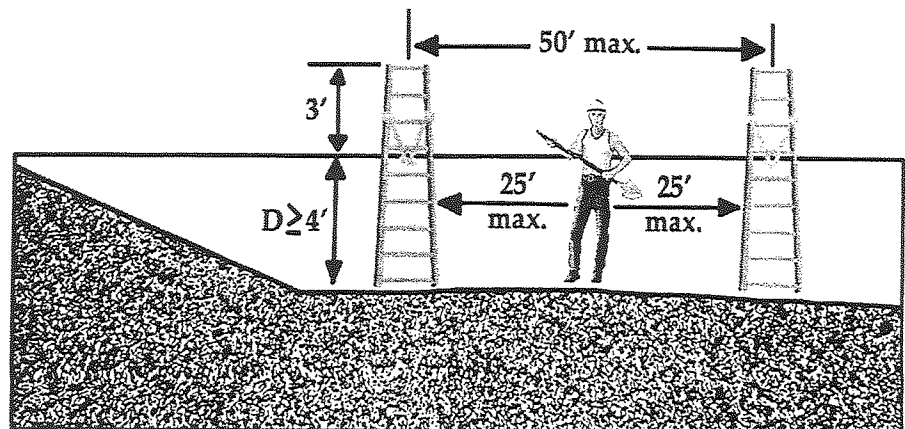


Figure 2

If the contractor wishes to use ladders, the ladder standard for construction (Subpart X) would require that the ladder rise at least 3 feet above the top of the excavation (count 3 rungs). The ladder should also be secured from shifting by tying it off or having an employee atop the excavation steady it while the employees mount, dismount, and climb it. If the contractor wishes to slope the end of the trench to create an earthen ramp for the employees to walk up and down, that would be acceptable if it were sloped to a sufficiently low angle to allow them to walk it in an upright position without assistance such as pulling on a rope or using their hands to help pull themselves upward. It would be acceptable for the contractor to use a structural ramp such as a cleated “chicken board” gangplank to help prevent slipping, as long as the cleats did not represent a trip hazard.

Structural ramps are also required to be of uniform thickness and connected in a manner so as to prevent displacement. The standard also requires that a ramp used solely by employees be designed by a competent person, and if the ramp is used to provide access and egress for equipment, the competent person should be qualified in structural design and that the ramp be constructed in accordance with the design. This requirement has created confusion that could have been eliminated if OSHA had used their term “qualified person” which means, “One, who by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project”. In many cases, the designated competent person for the excavation project might not have the expertise to design a structural ramp and would not wish to be the one charged with the responsibility, or confused with one who did and whose services might be employed for that limited responsibility. If structural ramps are to be utilized, the employer, and the designated competent person should rely upon the services of an architect or engineer, or industry standard designs to properly construct ramps to meet their requirements.

Exposure to Vehicular Traffic

- d. The standard requires that those employees exposed to **public** vehicular traffic shall be provided with and wear garments marked with reflective or high-visibility material. Since the enactment of the regulation, however, there has been a marked increase in the number of fatalities due to an employee being struck by a vehicle or piece of construction equipment in the work zone. For that reason, OSHA incorporated the “Bible” of work zone safety, the Manual of Uniform Traffic Control Devices, into Subpart G by administrative directive, to help

employers optimize the two critical elements of work zone safety; visibility and separation.

All employers should avail themselves of that guidance and provide training in appropriate flagging techniques and barricading procedures, and they should certainly ensure that their employees wear reflective vests. Employers may have noticed a trend to switch from the predominantly orange vests to the yellowish-green chartreuse vests. Work zone experts believe that there may be too much orange on some job sites, and that employees wearing orange vests might well be mistaken for orange traffic barrels. For that reason, they support the use of the yellow/green vests, whose color is the same as that used on school zone signs to help promote the association of that color with bodies as opposed to barrels.

Exposure to Falling Loads

- e. Employees are not allowed to work under buckets, hooks or loads, as there has been no shortage of fatalities and serious injuries caused by a load being dropped on those below the bucket or hook. Additionally, OSHA requires that anyone working around a vehicle being loaded either stand sufficiently far away so as not to be struck by any material that might roll off the top of the load or bed, or stay in the cab of the truck. Straight frame dump trucks are equipped with special beds that have an extension that covers the top of the cab of the truck must meet special design requirements to prevent it from being crushed down if part of the load were to fall on it. Truck drivers are notorious for getting out of the cab and engaging in some activity on the side of the truck opposite the loading process. The equipment operator should always make sure that the operator is either safely inside the cab or well away from the truck before loading or unloading it.

Warning System for Mobile Equipment

- f. OSHA is concerned that mobile equipment such as trucks and loaders could come too close to an excavation, either on approach or driving alongside. If the operator does not have a clear and direct view of the excavation, OSHA requires that some kind of warning system, such as a flagman, barricades, stop logs or alarms be used to keep them from getting too close and either driving into the excavation, or causing the wall to fail and collapse on workers below them” possibly bringing the vehicle or piece of equipment along with it. They also want the grade to be away from the excavation, if possible. This is a situation where “more than a minimum” effort should be made. Concrete mixer truck drivers are notorious for not wanting to hang any more discharge chute than is absolutely necessary. They simply back up as close to the edge as they can. Dump truck drivers will

sometimes back right up to the edge to dump select fill into an excavation, or debris or trash into a pit.

The competent person's concerns are two. The first is to prevent the driver from driving off into the excavation by using the warning systems as required. The second is to make sure the increased surcharge load does not cause a failure of the wall. If it is necessary to bring equipment alongside the edge, the competent person should make sure that the safety system can support the additional surcharge load and that the drivers or operators have some means of determining the point past which they cannot approach. It is advisable to use such warning systems even if the driver or operator **can** see their way to the edge.

Hazardous Atmospheres

- g. Hazardous atmospheres are often encountered in excavation work. If the nature of the work is the repair of a leaking gas or sewer line, or if the excavation is done in a landfill, soil contaminated by leakage from underground storage tanks, or alongside a road where traffic backs up, there is a reasonable, if not an automatic, expectation of a hazardous atmosphere being present. OSHA requires that if a hazardous atmosphere exists, or could be reasonably expected to exist, the employer must test the excavation if it is greater than 4 feet in depth to ensure that it contains no less than 19.5% oxygen, or other hazardous atmospheres, and no more than 20% of the lower flammable limit (LFL, sometimes called lower explosive limit LEL, as well) of any flammable gases. If such hazardous atmospheres exist, the employer must use such measures as respirators or ventilation to eliminate the hazard, and test as often as is necessary to ensure that the atmosphere remains safe.

OSHA further requires that rescue such as life lines and harnesses or breathing apparatus be readily available where hazardous atmospheres exist or could be expected to exist, and that the equipment be attended when in use. Finally, OSHA requires that employees entering bell-bottom pier holes or similar deep and confined footing excavations wear harnesses with a life line, which shall be separate from any line used to handle materials and that the line is individually attended while the employee is in the excavation.

The paragraphs concerning hazardous atmospheres invariably create discussion and confusion because of the overlapping areas of concern addressed by the General Industry Permit Required Confined Space Entry

Standard, 1910.146. OSHA does not define excavations as confined spaces; a letter of interpretation attests to that. The reason is that when OSHA researched confined space accidents, it was clear that most accidents occurred when employees entered vessels or sewers to perform maintenance or repair work. Those scenarios would most appropriately be addressed by the General Industry Standard, not the Construction Standard, and OSHA chose to do so in that manner.

Most accidents occur when employees enter vessels or sewers to perform maintenance or repair work.

OSHA does recognize that confined spaces exist in construction, however. In Subpart C, they define a confined space or enclosed space as one, “having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels”. They require that, “All employees required to enter into confined or enclosed spaces shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas”. Since the problems noted by those paragraphs existed in excavation work, OSHA chose to address them specifically in the excavation standard, Subpart P.

On properties such as refineries and chemical plants, where confined spaces addressed by the General Industry Standard, and excavations covered by the Construction Standard both existed, employers found themselves having to deal with two “rule books”, which often resulted in confusion and misapplication. When confronted with such a situation, most employers simply adopted the more stringent set of requirements, thereby covering all scenarios adequately and eliminating the confusion.

Construction employers familiar with confined space entry procedures typically find the General Industry Standard more helpful in providing guidance than the rather limited offering of the excavation subpart, and use it instead for that reason. For example, the excavation standard requires that employees not be exposed to atmospheres in excess of 20% of the LEL. The General Industry Standard reduces that to 10%. Most gas monitoring equipment is calibrated to alarm at 10%, and most employers prefer the convenience and increased safety of simply abiding by the more stringent requirement. Further, while the oxygen level cannot drop below the lower limit of 19.5%, no mention is made of a safe upper limit (23.5% in the Confined Space Standard), or of what is typically noted as the normal level of 20.9%.

Those familiar with monitoring equipment also know that most equipment only tests for flammability, oxygen deficiency, and the presence of hydrogen sulfide and carbon monoxide. The infiltration of a non-flammable toxic gas other than hydrogen sulfide or carbon monoxide could displace the oxygen, resulting in a reduced level recorded by the monitoring equipment. If the level were not reduced below 19.5%, the monitor would not alarm and the employee might not be aware that they were about to enter an atmosphere made hazardous by the infiltration of the toxic vapors. To provide the instruction necessary to prepare employees for such eventualities, employers typically avail themselves of the resources of the General

Industry Confined Space Entry Standard, which offers far more guidance than the limited offerings of the excavation standard.

A proposed confined space entry standard for construction is in the OSHA pipeline. It will better serve to prepare employers and employees to enter confined spaces when it is enacted. Until such time, employers should avail themselves of the resources of the General Industry Standard to prepare themselves for the threat of hazardous atmospheres.

Employers should likewise recognize that the 4-foot depth requirement for checking the atmosphere, like the 5' requirement for cave-in protective systems, is a compromise number based upon assumptions that may not be sensible on a job site. The assumption is that the employee will not bend over, stoop, sit, lie down, or do anything else that will cause their head to break the plane of the excavation and create an exposure to the hazardous atmosphere. It further assumes that the gas or vapor is heavier than air and will not rise above the plane of the excavation. Finally, it assumes that there will be no wind to push it above the plane. If an employer suspects that a hazardous atmosphere is

present, they should check the excavation at any depth, and take appropriate measure to eliminate it.

The following chart provides an “at a glance” view of the combined requirements of the two standards.

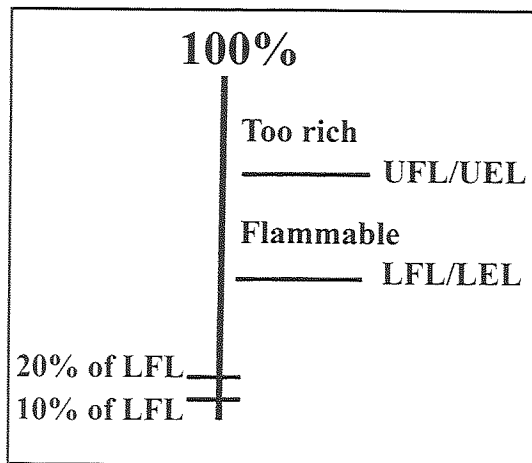


Figure 3

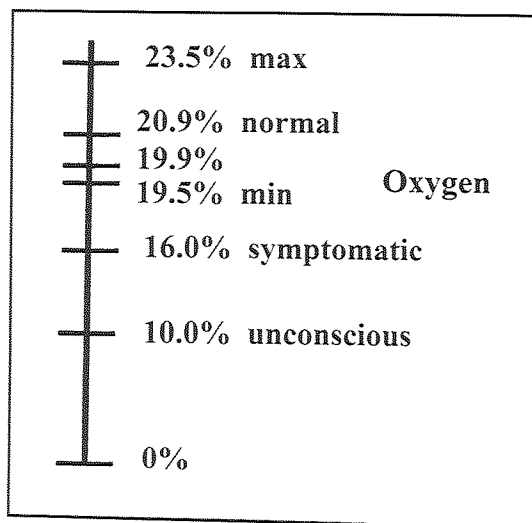


Figure 4

One exemption exists for those involved in the maintenance and construction of gas pipelines that come under the jurisdiction of the Department of Transportation. They are exempt from the paragraphs requiring no more than 20% of the LEL and rescue equipment. On a blowing leak on a transmission gas pipeline, more than 20% LEL would exist. Since it is impractical and infeasible in some cases to shut the line down to make repairs, pipeline companies devised procedures to make repairs safely in that situation, which resulted in OSHA allowing them the

exemption, and to go under the jurisdiction of the Office of Pipeline Safety, DOT, for those two paragraphs.

Protection from Hazards Associated With Water Accumulation

- h. OSHA is extremely concerned with water and its affect on soil stability. They do not want it making entry if it can be avoided. If water runs down slope toward an excavation, they direct the employer to **dam** or **divert** the water away from the excavation to prevent its entry into and accumulation into the excavation. If water accumulates in the excavation from run-off, rain, leaking mains or ground water, OSHA requires that it be removed by water removal equipment such as pumps and be monitored by a competent person. If employees are required to enter an excavation into which water has accumulated to a shallow depth, the employer shall take adequate precautions to ensure that the employees have protected against the hazards created by the water accumulation. For example, repair crews working on leaking potable water mains will often repair them under pressure, blowing, in order to prevent the system from being contaminated by the soil and organic material. If the crew used a pump to eliminate the water and a protective system, such as a shield, to protect against cave-ins, it would be permissible for them to do so.

Stability of Adjacent Structures

- i. Excavation work might cause structures such as: buildings, poles, trees, sidewalks, and driveways to be undermined and pose a threat to employees. OSHA requires that the employer use the appropriate equipment and procedures to support on underpin any such compromised structure. OSHA does not permit excavating below the level of the base of any foundation, footing or retaining wall that might pose a threat to employees unless it is done in stable rock, it is adequately supported or underpinned, a registered professional engineer has determined that the excavation does not pose a hazard to the structure or employees, or that the structure is sufficiently removed from the work so as not to be harmed, or pose harm.

Employers should always consult registered professional engineers if there is any question as to the integrity of a structure compromised by the excavation work to ensure that the measures they are taking are adequate. The engineered solutions should be in writing and the employer should be able to produce the data if so requested by OSHA. In some cases, a utility owner such as the power company may want to come stabilize their utility poles and should be contacted. Of particular concern is the support of crossing or parallel utilities. An unsupported wall may bulge, causing water, sewer or gas mains within it to rupture, discharging their contents into the excavation. Crossing utilities

should be supported using adequate structural members standard rigging equipment.

Protection of Employees From Loose Rock or Soil

- j. If the face of the excavation is sloughing off, scaling the material with the bucket, or using barricades such as silt fence should be done to protect the employees. Excavated soil and other materials should be prevented from rolling or falling back into the excavation by placing it at least two feet back from the edge or using retaining devices, or both. The 2-foot requirement is another minimum requirement that should be exceeded. When practical, the employer should place the material 3-4 feet back to give the employees more room to work on that side of the excavation, reduce the loading on the excavation wall, and give any material that should roll back that much further to stop. The spoil pile should also be sloped or retained so as to prevent any material from rolling back or falling toward the excavation.

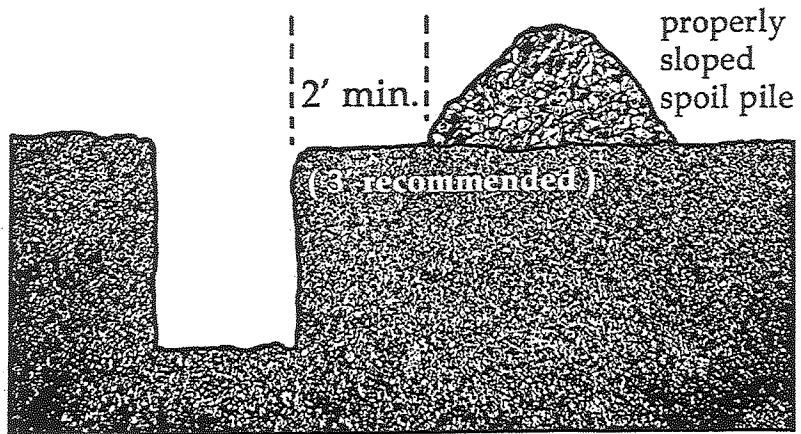


Figure 5

Inspections

- k. Conducting inspections is one of the most important duties of the competent person. They must make a daily inspection, prior to the start of work (in other words, before exposure occurs) of the excavation, adjacent areas and protective systems to make sure that the possibility of a cave-in has been eliminated and that other hazards, such as hazardous atmospheres, are not present. If conditions should change during the day as a result of something like rain or ground water infiltration, or the sudden introduction of vibration from heavy traffic diverted alongside the excavation, the competent person should re-inspect the site to make sure no that a hazard situation has not been created and that the protective system is still performing adequately. If the competent person discovers that a hazard has emerged that might cause a cave-in, or the failure of a protective system or generate a hazardous atmosphere, they should remove all personnel from the excavation until corrective measures have been taken to eliminate

the problem. This is an area in which hazard recognition training given to the employees can be especially valuable.

The employees in the excavation may be the first ones to notice the problem, particularly if the competent person is on a different part of the jobsite at that time. If they know they are to exit the excavation and find the competent person to come evaluate the problem and direct a correction, they can participate in ensuring their own safety, and the competent person will benefit from having many sets of eyes helping him. The employer will then have a competent crew as well as a competent person.

OSHA does not require that the inspections be made in writing, but it is highly advisable. First, it documents the fact that the inspections are being done. OSHA considers documentation to be an element of demonstration of a good faith effort to comply with the law. Insurers and attorneys do, as well. Second, it helps ensure that the competent person checks everything they are supposed to each day. In that sense, the inspection form functions like a pilot's pre-flight checklist. Finally, it can be an effective on-job-training tool to help train inexperienced employees on the recognition of excavation hazards and protective measures taken to eliminate them. A sample inspection form is provided on the following page.

Fall Protection

Walkways must be provided where employees-and equipment are required to pass over excavations, and they must be equipped with guardrails if the fall height from the deck of the walkway to the bottom of the excavation or a lower level is over 6 feet. Guardrails should meet the requirements of the construction standard. The competent person should make sure the walkway is constructed in accordance with industry standard practices and is designed by someone qualified to do so, such as an engineer or architect. Additionally, it is advisable to include the requirements of structural ramps used in access and egress in the construction of the walkway. Trip hazards such as overlapping planks, members of different thickness and connecting procedures that do not prevent slippage or displacement should be eliminated. Some contractors prefer to rent or buy prefabricated walkways from scaffold vendors for this purpose.

OSHA further requires that all remotely located excavations have adequate physical barricading. Temporary excavations such as pits, shafts, and wells used for exploration or other procedures should be barricaded with adequate physical barriers such as guardrails, or covered, and shall be backfilled as soon as the exploration procedures are completed.

The question of barricading the sides of an excavation often arises. OSHA does not require barricading, as it would make some construction processes infeasible or impossible (1926.501 paragraph 7). In such cases, OSHA will allow employees to work on the unguarded edge of excavation over 6 feet deep, but they must have an unobstructed view of the edge. There is also an assumption that a protective system that would prevent a cave-in from carrying the employee into the excavation would be employed, and that the employee's presence at the edge of the excavation would be required. Employers should take special care to ensure that those employees whose presence was not required, and the public, especially, be kept back by direction or barricading of some sort.

Additional Considerations

There are three additional areas not addressed by the General Requirements that the employer should take special measures to address: contact with overhead electrical lines, the sudden release of an energized source, and physical distress resulting from exertion in extreme weather conditions.

Contact with Overhead Electrical Lines

Approximately half the fatalities in hoisting, and three fourths the fatalities in concrete pumping, occur from contact with overhead electrical lines. Even though the lines are in plain sight, the operators and ground personnel are typically pre-occupied with what is occurring below ground, and simply forget about the lines until they are literally “shocked” back. Spotters, signage, induction alarms, and insulator links (on crane hooks) are all methods that can reduce the possibility of contact and electrocution. Operators should maintain at least 10 feet of clearance from overhead electrical lines, up to 50 kilovolts, and an additional .4 inches/kV past that.

Control of Energized Sources

Operators and ground personnel should also receive specific instruction on procedures to be used if contact with overhead electrical lines occurs. Operators should attempt to break contact, if they can, by booming down and swinging away. If they cannot, and if they are not in the path to ground and can remain safely in the seat, they should do so until the power company has de-energized the lines and directed them to dismount. If they must leave the machine because of fire, tipping, or other factors, they should jump to the ground, clear of the machine in a safe, controlled manner (not a leap with rolling and tumbling), then hop with their feet together, or shuffle their feet until they are at least 100 feet away from the machine, and not return to it until so authorized by the power company. Ground personnel not in the path to ground should likewise not approach the machine, but shuffle or hop back at least 100 feet from the machine to avoid electrocution from what is known as the corona effect, or equipotential grounding, and then keep all others away from the area until authorized to do so by the power company.

Energized sources represent a significant hazard to employees in and around excavations.

Energized sources represent a significant hazard to employees in and around excavations. Electrocutions can occur if electrically powered equipment is used without GCFI's, especially in wet conditions. Of special concern is the release of water, gas, or effluent by the failure of an existing utility, or the inappropriate opening of a valve, removal of a plug, or breaking of a line. As mentioned earlier, employers should take measures to ensure that the walls of an excavation do not shift or bulge, rupturing lines which could, in turn, cause the excavation to be flooded with their contents, drowning, asphyxiating, or burning the employees in the process. Lock-out/tag-out procedures borrowed from the General Industry Standard might need to be employed, and special adherence to government codes or regulations prohibiting the unauthorized operation of valves should be observed. More than one employee has been drowned due to an unauthorized employee turning a valve the wrong direction at the wrong time. Even when valves are closed, special care

should be taken to remove caps, plugs or other devices sealing the ends of pipe extensions, or when making taps, as residual pressure may reside within the lines.

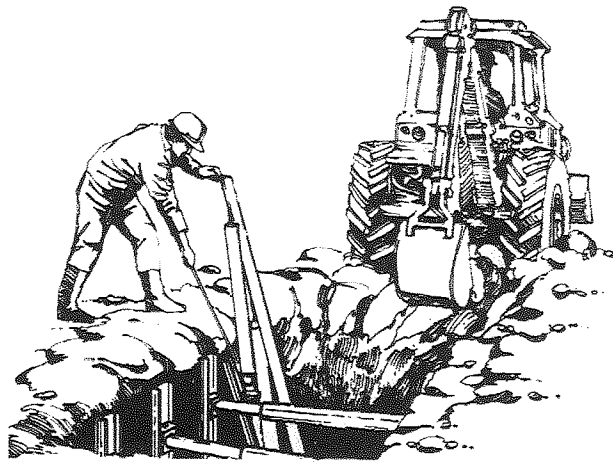
**Physical Distress in
Extreme Weather
Conditions**

Heat prostration, stroke and heart attacks can result from exertion in extreme heat, and extreme cold offers its own set of problems. Qualified medical advice should be incorporated into jobsite practice to ensure adequate hydration, and rest or rehabilitation periods in extreme weather conditions.

Engineering

TABULATED DATA

VERTICAL SHORES



ENGINEERING

SPEED  **SHORE**[®]
C O R P O R A T I O N

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WARNING

EXCAVATION PROCEDURES MAY BE VERY DANGEROUS

- A TRAINED *COMPETENT PERSON* SHALL: SUPERVISE ALL EXCAVATION OPERATIONS, ENSURE THAT ALL PERSONNEL ARE WORKING IN SAFE CONDITIONS, AND HAVE THOROUGH KNOWLEDGE OF THIS TABULATED DATA. THE *COMPETENT PERSON* SHALL HAVE THE AUTHORITY TO STOP WORK WHEN IT IS UNSAFE FOR WORKERS TO ENTER AN EXCAVATION.
- ALL PERSONNEL SHALL BE TRAINED IN CORRECT EXCAVATION PROCEDURES, PROPER USE OF THE PROTECTIVE SYSTEM AND ALL SAFETY PRECAUTIONS.
- EXCAVATIONS AND PROTECTIVE SYSTEMS SHALL BE INSPECTED AT LEAST DAILY AND WHENEVER THERE IS A CHANGE OF SOIL, WATER OR OTHER JOB SITE CONDITIONS.
- ALL LIFTING AND PULLING EQUIPMENT, INCLUDING CABLES, SLINGS, CHAINS, SHACKLES AND SAFETY HOOKS SHALL BE EVALUATED FOR SUITABILITY AND CAPACITY, AND SHALL BE INSPECTED FOR DAMAGE OR DEFECTS PRIOR TO USE.
- ALL INSTALLATION AND REMOVAL OF SHORING AND SHIELDING SHALL BE FROM ABOVE GROUND ONLY.
- DO NOT ALLOW PERSONNEL TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED OR SLOPED.
- PERSONNEL SHALL ALWAYS WORK WITHIN THE SHORING AND SHIELDING. PERSONNEL SHALL NOT STAND ON THE EDGE OF AN UNSHORED EXCAVATION.
- ALL PERSONNEL SHALL ENTER AND EXIT EXCAVATIONS ONLY WITHIN SHIELDED OR SHORED AREAS.

SPEED SHORE'S "MANUFACTURER'S TABULATED DATA" IS A GENERAL SET OF GUIDELINES AND TABLES TO ASSIST THE *COMPETENT PERSON* IN SELECTING A SAFETY SYSTEM AND THE PROPER SHORING OR SHIELDING EQUIPMENT. THE *COMPETENT PERSON* HAS SOLE RESPONSIBILITY FOR JOB SITE SAFETY AND THE PROPER SELECTION AND INSTALLATION AND REMOVAL OF THE SHORING OR SHIELDING EQUIPMENT.

THIS TABULATED DATA IS NOT INTENDED TO BE USED AS A JOB SPECIFIC EXCAVATION SAFETY PLAN, BUT SHALL BE USED BY THE *COMPETENT PERSON* TO SUPPLEMENT HIS TRAINING, HIS EXPERIENCE AND HIS KNOWLEDGE OF THE JOB CONDITIONS AND SOIL TYPE.



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ENGINEERING

TABULATED DATA

1.0 SCOPE

- 1.1 Speed Shore's Tabulated Data complies with the O.S.H.A. standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). This data shall only be used by the contractor's *competent person* in the selection of Speed Shore Vertical Shores. The *competent person* shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Vertical Shores.
- 1.2 All personnel involved in the installation, removal and use of Vertical Shores shall be trained in their use and advised of appropriate safety procedures.
- 1.3 Table VS-1, VS-2 and VS-3 is based upon requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The *competent person* shall know and understand the requirements of those parts before using this data.
- 1.4 Whenever there is a variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic or subject is not contained in this Tabulated Data, the *competent person* shall refer to CFR 29, Part 1926, Subpart P - Excavations.
- 1.5 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. In states that have their own state O.S.H.A. refer to similar regulations in the current construction rules published by the state office of Occupational Health and Safety.
- 1.6 Tables VS-1, VS-2 and VS-3 shall be used only in excavations with soil conditions as noted. Table VS-1, VS-2 and VS-3 are for depths to 25 feet. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance
- 1.7 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore and may only be used with Speed Shore manufactured products. Any modification or repair of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

- 2.1 1926.32 (f) "competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees; and who has authorization to take prompt corrective measures to eliminate them.
- 2.2 1926.32 (p) "Shall" means mandatory.
- 2.3 1926.32 (q) "Should" means recommended.

3.0 SOIL CLASSIFICATIONS

- 3.1 In order to use the data presented in Tables VS-1, VS-2 and VS-3 the soil type, or types, in which the excavation is cut shall first be determined by the *competent person* according to the O.S.H.A. soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.
- 3.2 Table VS-3 is also for use in Type C-60 soil (see 3.3 for definition).
- 3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil, which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the Vertical Shores to be properly installed. The *competent person* must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the sheeting. An alternate design for less stable Type C soil will be required where there is evidence of deterioration.



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4.0 PRESENTATION OF INFORMATION

- 4.1 Information is presented in tabular form in Tables VS-1, VS-2 and VS-3. Each table presents the maximum vertical and horizontal spacing that may be used with Vertical Shores for indicated soil types. Table VS-1 is for O.S.H.A. Type A Soil, Table VS-2 for O.S.H.A. Type B Soil and Table VS-3 is for Vertical Shore use in Type C-60 soil (see 3.3 for definition).
- 4.2 Tables VS-1, VS-2 and VS-3 are not considered adequate when loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.
- 4.3 Using the appropriate table, the *competent person* selects the horizontal spacing of the vertical shores and the sheeting required, if any. The selection is based on the depth and width of the trench in varying soil conditions. In these tables, the vertical spacing of the cylinders is held constant at a maximum of 4 feet on center. The horizontal spacing of the hydraulic cylinders is the same as the horizontal spacing of the vertical rails.

5.0 BASIS AND LIMITATIONS OF THE DATA

- 5.1 Sheeting is used only to prevent local raveling or sloughing of the trench face between the Vertical Shores. Sheeting shall be one of the following or an approved equal.
 - 5.1.1 Aluminum: Speed Shore's Aluminum Sheeting
 - 5.1.2 Steel: 0.5 inch or thicker Steel Plate
 - 5.1.3 Plywood:
 - 3/4 inch Finn Form
 - 3/4 inch Omni Form
 - 3/4 inch Combi Exterior Plywood
 - 3/4 inch Plyform American Plywood Association, Plyform, B - B, Class I Exterior
 - 3/4 inch HDO American Plywood Association, High Density Overlay, Exterior
 - 3/4 inch 14 Ply Artic White Birch
 - 1 1/8 inch CDX
 - Two sheets of 3/4 inch thick CDX Plywood.
- 5.2 When sheeting is used, it shall extend to the top the excavation and to within 2 feet of the bottom of the excavation; except in Table VS-3 for excavation depths 0 - 25 feet, where the sheeting shall extend to the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.
- 5.3 All spacings indicated are measured from center to center of the members.
- 5.4 The center line of the top hydraulic cylinder shall be a minimum of 12 inches and a maximum of 24 inches below the top of the excavation.
- 5.5 The center line of the bottom hydraulic cylinder shall be a maximum of 4 feet above the bottom of the excavation.
- 5.6 In excavations 6 feet deep or less, only 1 hydraulic cylinder (Single Shore) is required in each vertical plane. The cylinder shall be no more than 4 feet above the bottom of the excavation, and no more than 2 feet below the top of the excavation. In excavations 6 feet to 10 feet deep there shall be a minimum of 2 hydraulic cylinders in each vertical plane. The horizontal spacing shall be as shown in the tables.
- 5.7 The vertical rails directly behind each hydraulic cylinder pad must bear on firm soil or a solid and stable filler to distribute the cylinder load to the face of the excavation. Do not butt rails back to back across an excavation.
- 5.8 Two single shores may be substituted for a vertical shore.
- 5.9 The aluminum rails are designed to be used vertically, however they may be orientated horizontally or diagonally if all other provisions of this data are satisfied.
- 5.10 The maximum vertical spacing between center lines of hydraulic cylinders shall be 4 feet.



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- 5.11 The faces of the excavation must be cut near vertical and straight
- 5.12 There shall be a minimum of 3 consecutive shores in a row, at the horizontal spacing indicated (or less), to form a shoring system. In trenches over 12 feet deep, and whenever possible, a minimum of 4 shores should be used. For excavations that are too short to place 3 or 4 shores at the required spacing, the shores shall be placed at the required spacing from end to end of the excavation with a minimum of 2 shores. There shall be a shore within 2 feet of each end of the excavation
- 5.13 The ends of trenches shall be shored or sloped in accordance with Appendix B of CFR 29, Part 1926 Subpart P Excavations.
- 5.14 No vertical or lateral loads shall be applied to the cylinders.
- 5.15 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in less cohesive (weaker) soil conditions. A small amount of water, or flowing conditions, may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions, may downgrade all soils to O.S.H.A. Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the *competent person*. Example: When repairing a leak in utility lines, it is often difficult or even impossible, to keep water out of the excavation.
- 5.16 If shores are installed on the seam between 2 adjacent sheets of plywood, each plywood sheet shall bear a minimum of 4 inches on each vertical rail.
- 5.17 Tables VS-1, VS-2 and VS-3 shall be used only for selecting the spacing and excavation depths for Single Shores, Vertical Shores and Multi-Shores. Normally, a Single Shore has 1 hydraulic cylinder, a Vertical Shore has 2 hydraulic cylinders and Multi-Shores have 3 or more hydraulic cylinders. All three types may be used and may be mixed if the provisions of this Tabulated Data are followed.

6.0 INSPECTION

- 6.1 The *competent person* must evaluate the soils to assure the rated capacity of the Vertical Shores is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.
- 6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate methods, which could endanger employees utilizing this product.
- 6.3 Daily inspections of the Vertical Shores and accessories must be performed by the *competent person* and deficiencies corrected.
- 6.4 Inspections shall be conducted as necessary for hazards associated with water accumulation, changing soil conditions, or changing site weather conditions.



7.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES VS-1, VS-2 and VS-3:

Problem: Design a trench safety system using Speed Shore Vertical Shores for an excavation 8 feet deep and 4 feet wide in O.S.H.A. Type B soil.

Study tables: Select Table VS-2 for Type B soil. Look in the column "Depth of Excavation" on line 0 to 15 feet. Next, read across and find under "Hydraulic Cylinders", "Maximum Horizontal Spacing" at 8 feet and "Maximum Vertical Spacing" at 4 feet. Next, locate the hydraulic cylinder size under "Width of Excavation", 0 to 8 feet": 2 inch diameter. Finally, under "Sheeting", Notes 2 and 3 apply.

Conclusion: Install Speed Shore Vertical Shores with 2 inch diameter cylinders at 8 feet intervals with or without plywood sheeting, depending upon the *competent person's* judgment of the raveling or sloughing of the excavation face. (See Notes 2 and 3).

TABLE VS-1 TYPE "A" SOIL

Depth of Excavation FEET	HYDRAULIC CYLINDERS					Sheeting (Note 3)
	Maximum Horizontal Spacing (FEET)	Maximum Vertical Spacing (Note 6) FEET	Width of Excavation FEET			
			0 to 8	8 to 12	12 to 15	
0 to 15	8	4	2" dia.	2" dia.	2" dia. (Note 1)	(Note 2)
0 to 25	8	4	2" dia.	2" dia. (Note 1)	2" dia. (Note 1)	(Note 2)

TABLE VS-2 TYPE "B" SOIL

Depth of Excavation FEET	HYDRAULIC CYLINDERS					Sheeting (Note 3)
	Maximum Horizontal Spacing (FEET)	Maximum Vertical Spacing (Note 6) FEET	Width of Excavation FEET			
			0 to 8	8 to 12	12 to 15	
0 to 10	8	4	2" dia.	2" dia.	2" dia. (Note 1)	(Note 2)
0 to 20	6	4	2" dia.	2" dia. (Note 1)	2" dia. (Note 1)	(Note 2)
0 to 25	5	4	2" dia.	2" dia. (Note 1)	2" dia. (Note 1)	(Note 7)

TABLE VS-3 TYPE "C-60" SOIL (See 3.3 for definition of C-60 Soil)

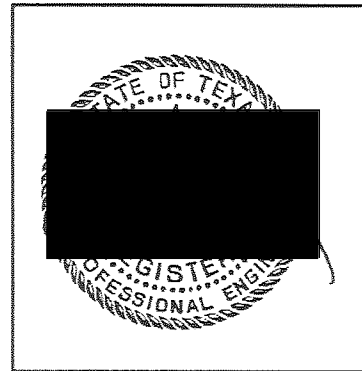
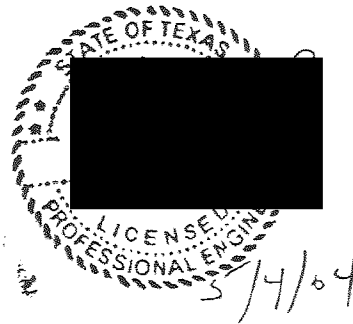
Depth of Excavation FEET	HYDRAULIC CYLINDERS					Sheeting (Note 4)
	Maximum Horizontal Spacing (FEET)	Maximum Vertical Spacing (Note 6) FEET	Width of Excavation FEET			
			0 to 8	8 to 12	12 to 15	
0 to 10	6 (Note 5)	4	2" dia	2" dia	2" dia. (Note 1)	(Note 2)
0 to 20	4	4	2" dia	2" dia. (Note 1)	2" dia. (Note 1)	(Note 7)
0 to 25	4	4	2" dia	2" dia. (Note 1)	N/A	(Note 7)

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NOTES TO TABLES VS-1, VS-2 and VS-3

1. Two inch diameter cylinders shall have a structural steel tube oversleeve 3.5 x 3.5 x 0.1875 inches extension (installed over the aluminum oversleeve extension) or a steel tube oversleeve 3 x 3 x 0.1875 inch extension (installed without the aluminum oversleeve) that extends the full retracted length of the cylinder. CAUTION: In either case, the aluminum load transfer plug and the aluminum innersleeve shall be used or a steel load transfer plug shall be welded securely in place inside the steel oversleeve to transfer the load through the steel oversleeve to the socket pad. Other Speed Shore approved oversleeves may be used.
2. The bottom of the sheeting shall extend within 2 feet of the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.
3. Four feet wide sheeting is required at each Vertical Shore if raveling or sloughing of the excavation face appears likely to occur.
4. Four feet wide sheeting shall be used.
5. When 4 feet horizontal spacing is exceeded, the open spaces between the sheeting must be monitored for sloughing and raveling of the excavation face.
6. The bottom hydraulic cylinder shall be a maximum of 4 feet above the bottom of the excavation.
7. Sheeting shall extend to the bottom of the excavation.



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EXAMPLES OF TYPICAL INSTALLATION

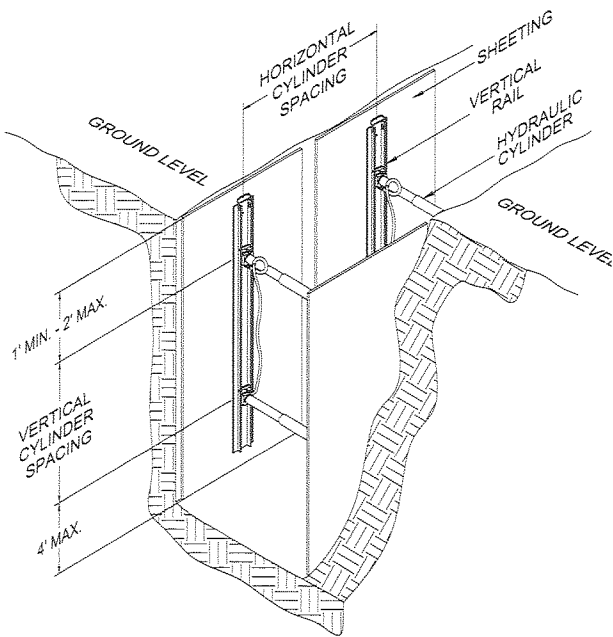


FIG. 1
WITH SHEETING

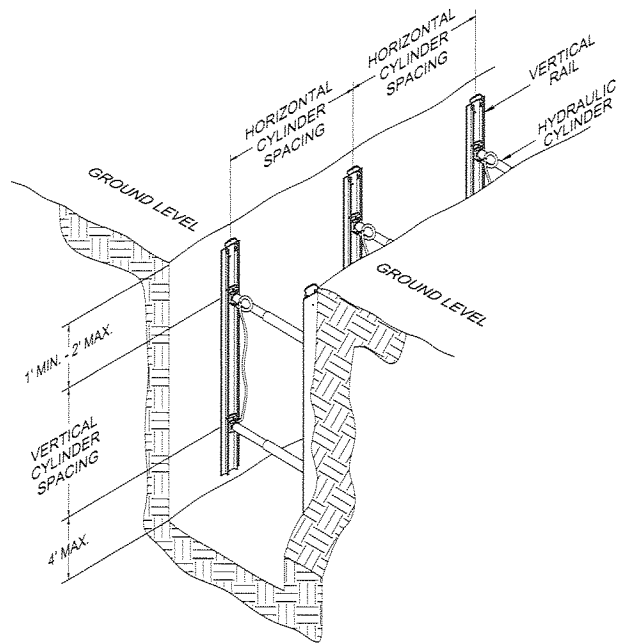


FIG. 2
WITHOUT SHEETING

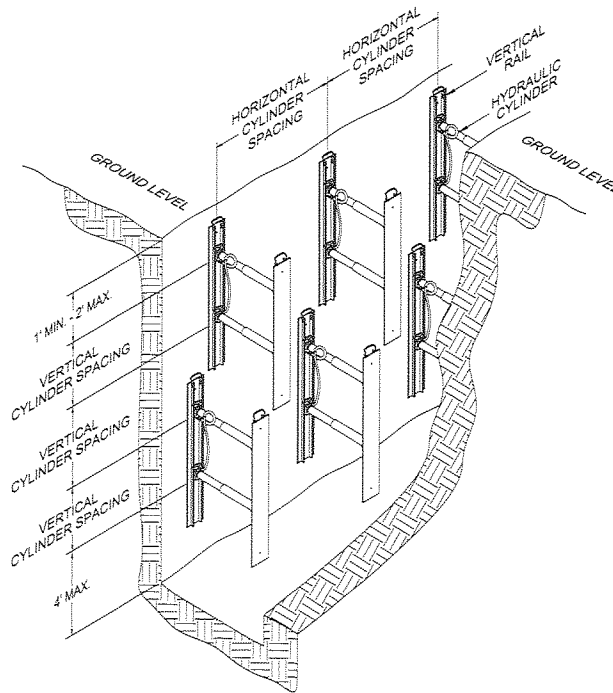


FIG. 3
STACKED

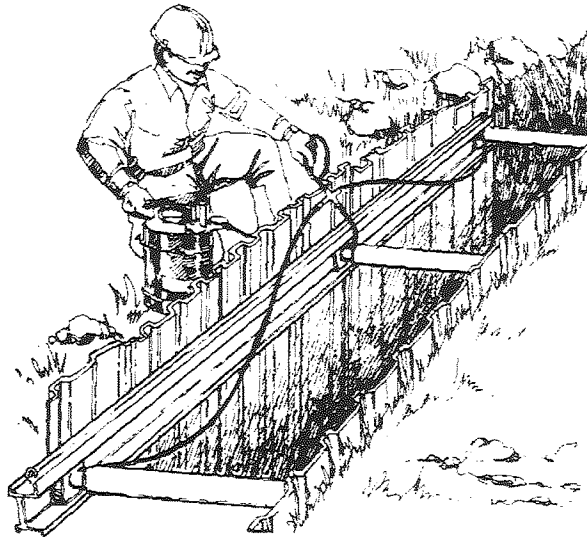
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TABULATED DATA

WALER SYSTEM



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WARNING

EXCAVATION PROCEDURES MAY BE VERY DANGEROUS

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- ALL PERSONNEL SHALL BE TRAINED IN CORRECT EXCAVATION PROCEDURES, PROPER USE OF THE PROTECTIVE SYSTEM AND ALL SAFETY PRECAUTIONS.
- EXCAVATIONS AND PROTECTIVE SYSTEMS SHALL BE INSPECTED AT LEAST DAILY AND WHENEVER THERE IS A CHANGE OF SOIL, WATER OR OTHER JOB SITE CONDITIONS.
- ALL LIFTING AND PULLING EQUIPMENT, INCLUDING CABLES, SLINGS, CHAINS, SHACKLES AND SAFETY HOOKS SHALL BE EVALUATED FOR SUITABILITY AND CAPACITY, AND SHALL BE INSPECTED FOR DAMAGE OR DEFECTS PRIOR TO USE.
- ALL INSTALLATION AND REMOVAL OF SHORING AND SHIELDING SHALL BE FROM ABOVE GROUND ONLY.
- DO NOT ALLOW PERSONNEL TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED OR SLOPED.
- PERSONNEL SHALL ALWAYS WORK WITHIN THE SHORING AND SHIELDING. PERSONNEL SHALL NOT STAND ON THE EDGE OF AN UNSHORED EXCAVATION.
- ALL PERSONNEL SHALL ENTER AND EXIT EXCAVATIONS ONLY WITHIN SHIELDED OR SHORED AREAS.

SPEED SHORE'S "MANUFACTURER'S TABULATED DATA" IS A GENERAL SET OF GUIDELINES AND TABLES TO ASSIST THE *COMPETENT PERSON* IN SELECTING A SAFETY SYSTEM AND THE PROPER SHORING OR SHIELDING EQUIPMENT. THE *COMPETENT PERSON* HAS SOLE RESPONSIBILITY FOR JOB SITE SAFETY AND THE PROPER SELECTION AND INSTALLATION AND REMOVAL OF THE SHORING OR SHIELDING EQUIPMENT.

THIS TABULATED DATA IS NOT INTENDED TO BE USED AS A JOB SPECIFIC EXCAVATION SAFETY PLAN, BUT SHALL BE USED BY THE *COMPETENT PERSON* TO SUPPLEMENT HIS TRAINING, HIS EXPERIENCE AND HIS KNOWLEDGE OF THE JOB CONDITIONS AND SOIL TYPE.



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TABULATED DATA

1.0 SCOPE

- 1.1 Speed Shore's Tabulated Data complies with the O.S.H.A. standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). This data shall only be used by the contractor's *competent person* in the selection of Wales and sheeting for Speed Shore Waler Systems. The *competent person* shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Waler Systems.
- 1.2 All personnel involved in the installation, removal and use of Waler Systems shall be trained in their use and advised of appropriate safety procedures. All operating instructions must be followed.
- 1.3 Table W-1, W-2 and W-3 are based upon requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The *competent person* shall know and understand the requirements of those parts before using this data.
- 1.4 Whenever there is a variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic or subject is not contained in this Tabulated Data, the *competent person* shall refer to CFR 29, Part 1926, Subpart P - Excavations.
- 1.5 Tables W-1, W-2 and W-3 shall be used only in typical excavations with soil conditions as noted. Table W-1, W-2 and W-3 are for depths to 20 feet. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance
- 1.6 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore Corporation and may only be used with Speed Shore manufactured products. Any modification or repair of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.
- 1.7 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. In states that have their own state O.S.H.A. refer to similar regulations in the current construction rules published by the state office of Occupational Health and Safety.
- 1.8 This Data is for Waler Systems with hydraulic cylinders only and does not include Waler Systems with Speed Struts.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

- 2.1 1926.32 (f) "competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees; and who has authorization to take prompt corrective measures to eliminate them.
- 2.2 1926.32 (p) "Shall" means mandatory.

3.0 SOIL CLASSIFICATIONS

- 3.1 In order to use the data presented in Tables W-1 and W-3 the soil type, or types, in which the excavation is cut, shall first be determined by the *competent person* according to the O.S.H.A. soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.
- 3.2 Table W-2 is also for Waler use in Type C-60 soil (see 3.3 for definition).
- 3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil, which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the Walers to be properly installed. The *competent person* must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the sheeting. An alternate design for less stable Type C soil will be required where there is evidence of deterioration.

4.0 PRESENTATION OF INFORMATION



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- 4.1 Information is presented in tabular form in Tables W-1, W-2 and W-3. Table W-1 is for O.S.H.A. Type A & B Soil, Table W-2 for Waler use in Type C-60 soil (see 3.3 for definition). Table W-3 is for Waler use in O.S.H.A. Type C soil.
- 4.2 Tables W-1, W-2 and W-3 are not considered adequate when loads imposed by structures, or by stored material adjacent to the trench, weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.
- 4.3 Using the appropriate table, the *competent person* selects the horizontal spacing of the Waler model and the sheeting required. The selection is based on the depth and width of the trench in varying soil conditions. In tables W-1, W-2, and W-3 the vertical spacing of the cylinders is held constant at a maximum of 4 feet on center.

5.0 BASIS AND LIMITATIONS OF THE DATA

- 5.1 The following sheeting materials, or approved equal, may be used as noted in Tables W-1, W-2 and W-3:
 - 5.1.1 Aluminum: Speed Shore's Aluminum Sheeting
 - 5.1.2 Timber: Sizes noted in Tables W-1, W-2, and W-3. Species shall be Douglas Fir with a minimum bending strength (F_b) of 1,500 p.s.i. or Oak with a F_b of 850 p.s.i. Douglas Fir Timber is S4S nominal dimension and Oak Timber is rough cut dimension.
 - 5.1.3 Steel: 1/2 inch or thicker Steel Plate
 - 5.1.4 Plywood:
 - 3/4 inch Finn Form
 - 3/4 inch Omni Form
 - 3/4 inch Combi Exterior Plywood
 - 3/4 inch 14 Ply Artic White Birch
 - 3/4 inch Plyform American Plywood Association, Plyform, B - B, Class I Exterior
 - 3/4 inch HDO American Plywood Association, High Density Overlay, Exterior
 - 1 1/8 inch CDX
 - Two sheets of 3/4 inch thick CDX
- 5.2 All spacing indicated is measured from center to center of the hydraulic cylinders.
- 5.3 The center line of the top Walers shall be a minimum of 12 inches and a maximum of 24 inches below the top of the excavation.
- 5.4 The center line of the bottom Waler shall be a maximum of 4 feet above the bottom of the excavation in Tables W-1, W-2. In Table W-3 the bottom Waler shall be a maximum of 4 feet above the bottom of the excavation if the sheeting is over-driven 12 inches. If the sheeting is not over-driven, the bottom Waler shall be a maximum of 2 feet, 6 inches above the bottom of the excavation.
- 5.5 The sheeting directly behind the end of each hydraulic cylinder must bear on firm soil or a solid and stable filler to distribute the cylinder load to the face of the excavation. Do not butt Waler rails back to back across an excavation.
- 5.6 When the length of the excavation is long enough to allow Walers to be placed end to end, the ends of the Walers shall not be more than 6 inches apart.
- 5.7 The maximum vertical spacing between center lines of Walers shall be 4 feet.
- 5.8 The faces of the excavation must be cut near vertical and straight.
- 5.9 In excavations 6 feet deep or less, 1 Wale is required in each vertical plane. The Wale shall be no more than 4 feet above the bottom of the excavation and no more than 2 feet below the top of the excavation. In excavations over 6 feet deep, there shall be a minimum of 2 Walers stacked one above the other as a unit. In excavation deeper than 10 feet, there shall be more than 2 Walers to comprise a vertical unit.
- 5.10 In short trenches that are only long enough for 1 Wale length the maximum horizontal length of the excavation: 8 feet for a 4 feet Waler, 10 feet for a 6 feet Waler, 12 feet for an 8 Waler, 16 feet for a 12 feet Waler, and 20 feet for a 16 feet Waler.



- 5.11 The ends of trenches shall be shored or sloped in accordance with Appendix B of CFR 29, Part 1926 Subpart P Excavations.
- 5.12 No vertical loads shall be applied to the hydraulic cylinders.
- 5.13 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and promptly remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in less cohesive (weaker) soil conditions. A small amount of water in any excavation may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions, may downgrade all soils to O.S.H.A. Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the *competent person*. Example: When repairing a leak in utility lines, it is often difficult or even impossible, to keep water out of the excavation.
- 5.14 Tables W-1, W-2 and W-3 are for standard Speed Shore Waler models W8, WM8, WH8, W12, WM12, WH12, W16, WM16 and WH16. "W" is standard Waler (section modulus 3.67 cubic inches), "WM" is medium duty Waler (section modulus 9.71 cubic inches), and "WH" is heavy duty Waler (section modulus 14.5 cubic inches). The lengths of the Walers are 8, 12 and 16 feet long.
- 5.15 Tables W-1, W-2 and W-3 do not include Wales with Speed Struts. See Tabulated Data, "Waler Systems with Speed Struts".

6.0 INSPECTION

- 6.1 The *competent person* must evaluate the soils to assure the rated capacity of the Waler Systems is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.
- 6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate methods, which could endanger employees utilizing this product.
- 6.3 Daily inspections of the Waler Systems and accessories must be performed by the *competent person* and deficiencies corrected.
- 6.4 Inspections shall be conducted as necessary for hazards associated with: water accumulation, changing soil conditions, or changing site weather conditions.

7.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES W-1, W-2 and W-3:

Problem: Design a trench safety system using Speed Shore Waler Systems with hydraulic cylinders for an excavation 8 feet deep and 4 feet wide in O.S.H.A. Type C soil.

Study tables: Select Table W-3 for O.S.H.A. Type C soils. Look in the column "Depth of Excavation" on line 0 to 12 feet. Next, read across for Maximum Vertical Spacing of 4 feet. Next, locate three alternatives under "Waler Model". WM8, WH8 and WH16. Models WM8 and WH8 has a maximum horizontal spacing of 6.5 feet and model WH16 has a maximum horizontal spacing of 7.25 feet between hydraulic cylinders. Reading further across under "Width of Excavation", 0 to 8 feet, find 2 inch diameter hydraulic cylinders for all three alternatives. Sheeting notes 9 and 10 apply.

Conclusion: Any 1 of 2 Speed Shore Waler models WH8 or WH16 may be installed with 2 inch hydraulic cylinders at 4 feet vertical spacing. Sheeting is a minimum of 3x8 timbers at close spacing (or equivalent sheeting). (See Notes 9 and 10).



WALER SYSTEMS WITH HYDRAULIC CYLINDERS
(Speed Strut models not included in these tables)

TABLE W-1 TYPE "A" AND "B" SOILS

Depth of Excavation <i>FEET</i>	WALER				HYDRAULIC CYLINDERS				Sheeting (Note 3)
	Maximum Vertical Spacing (Note 4) <i>FEET</i>	Waler Model (Note 11)			Maximum Horizontal Spacing (Note 2) <i>FEET</i>	Width of Excavation <i>FEET</i>			
		W	WM	WH		0 to 8	8 to 12	12 to 15	
0 to 12	4	8	8	8	6.50	2" dia.	2" dia.	2" dia. (Note 1)	(Note 5)
		16	16	16	7.25				
		12	12	12	10.50				
0 to 15	4	8	8	8	6.50	2" dia.	2" dia.	2" dia. (Note 1)	(Note 6)
		16	16	16	7.25				
		-	-	12	10.50				
0 to 20	4	-	8	8	6.50	2" dia.	2" dia. (Note 1)	2" dia. (Note 1)	(Note 6)
		-	16	16	7.25	2" dia.	3" dia.	3" dia.	
		-	-	12	10.50	2" dia.	2" dia. (Note 4)	2" dia. (Note 1)	

(See notes on page 7 of 8)

TABLE W-2 TYPE "C-60" SOILS (See 3.3 for definition of C-60 Soil)

Depth of Excavation <i>FEET</i>	WALER				HYDRAULIC CYLINDERS				Sheeting
	Maximum Vertical Spacing (Note 4) <i>FEET</i>	Waler Model (Note 11)			Maximum Horizontal Spacing (Note 2) <i>FEET</i>	Width of Excavation <i>FEET</i>			
		W	WM	WH		0 to 8	8 to 12	12 to 15	
0 to 12	4	8	8	8	6.50	2" dia.	2" dia.	2" dia. (Note 1)	(Note 3 and 6)
		16	16	16	7.25				
		12	12	12	10.50				
0 to 15	4	-	8	8	6.50	2" dia.	2" dia.	2" dia. (Note 1)	(Note 7)
		-	-	16	7.25	2" dia.	3" dia.	3" dia.	
		-	-	12	10.50	2" dia.	2" dia.	2" dia.	
0 to 20	4	-	-	8	6.50	2" dia.	(Note 1)	(Note 1)	(Note 8)
		-	-	16	7.25	3" dia.	3" dia.	3" dia.	
		-	-	12	10.50				

(See notes on page 7 of 8)



WALER SYSTEMS WITH HYDRAULIC CYLINDERS
(Speed Strut models not included in these tables)

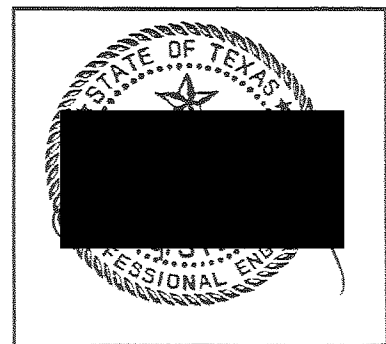
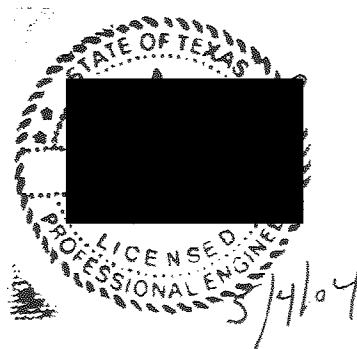
TABLE W-3 TYPE "C" SOILS

Depth of Excavation <i>FEET</i>	WALER				HYDRAULIC CYLINDERS				Sheeting
	Maximum Vertical Spacing (Note 4) <i>FEET</i>	Waler Model (Note 11)			Maximum Horizontal Spacing (Note 2) <i>FEET</i>	Width of Excavation <i>FEET</i>			
		W	WM	WH		0 to 8	8 to 12	12 to 15	
0 to 12	4	-	8	8	6.50	2" dia.	2" dia.	2" dia (Note 1)	(Notes 9 and 10)
		-	-	16	7.25	2" dia.	2" dia.(Note 1)	3" dia.	
0 to 15	4	-	-	8	6.50	2" dia.	2" dia.	2" dia (Note 1)	
		-	-	16	7.25				
0 to 20	4	-	-	8	6.50	3" dia.	3" dia.	3" dia.	

(See notes on page 7 of 8)

NOTES TO TABLES W-1, W-2 and W-3

- (1) 2 inch diameter cylinders shall have a structural steel tube oversleeve 3.5 x 3.5 x 0.1875 inch (installed over the aluminum oversleeve extension) or 3 x 3 x 0.1875 inch (installed without the aluminum oversleeve) that extends the full retracted length of the cylinder. **CAUTION:** In either case, the aluminum load transfer plug and the aluminum innersleeve shall be used or a steel load transfer plug shall be welded securely in place inside the steel oversleeve to transfer the load through the steel oversleeve to the socket pad. Other Speed Shore approved oversleeves may be used.
- (2) Dimensions shown are the maximum horizontal spacing of hydraulic cylinders within each Waler.
- (3) The bottom of the sheeting shall extend within 2 feet of the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.
- (4) The bottom Waler shall be a maximum of 4 feet above the bottom of the excavation.
- (5) Four feet wide plywood sheeting at close spacing or 2 x 8 inch timber sheeting at 2 feet on center spacing is required if raveling or sloughing of the face of the excavation appears likely to occur.
- (6) Four feet wide plywood sheeting at close spacing or 2 x 8 inch timber sheeting at close spacing is required.
- (7) 2 x 8 inch timber sheeting at close spacing shall extend to the bottom of the excavation.
- (8) 3 x 8 inch timber sheeting at close spacing shall extend to the bottom of the excavation.
- (9) The bottom Waler shall be a maximum of 4 feet above the bottom of the excavation if the sheeting is over-driven 12 inches. If the sheeting is not over-driven, the bottom Waler shall be a maximum of 2 feet, 6 inches above the bottom of the excavation.
- (10) 3 x 8 inch timber sheeting at close spacing shall be over-driven a minimum of 12 inches into the bottom of the excavation or extend to the bottom of the excavation to match the Waler spacing in Note 9.
- (11) Speed Strut models not included in these tables.



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EXAMPLES OF TYPICAL INSTALLATION

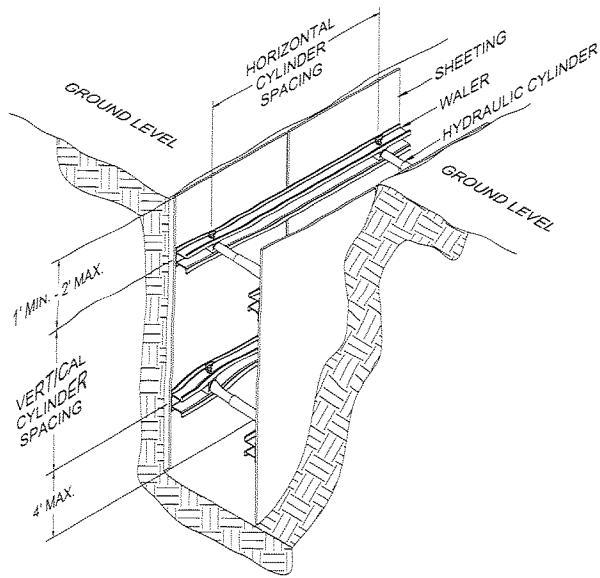


FIG. 1
WITH PLYWOOD SHEETING

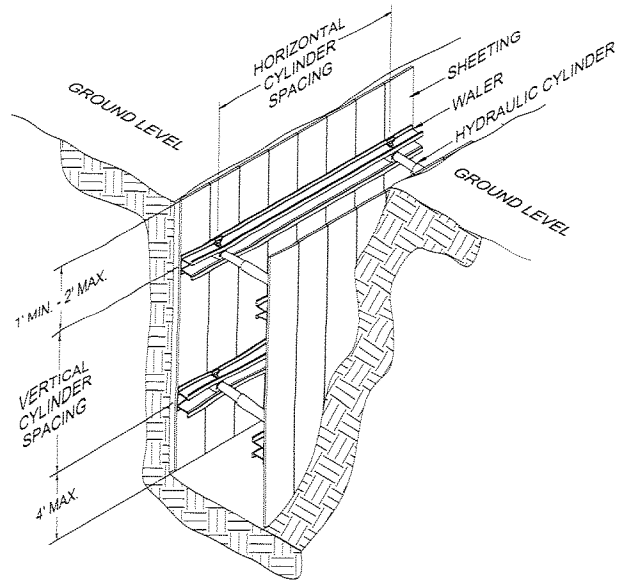


FIG. 2
WITH TIMBER SHEETING

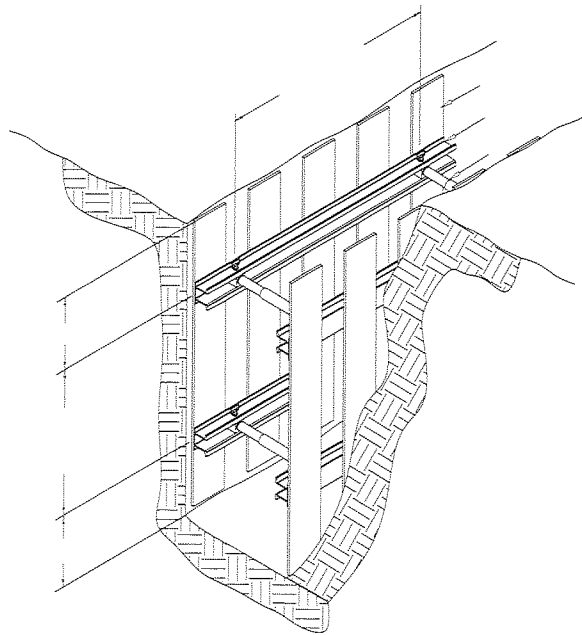


FIG. 3
WITH SPACED TIMBER SHEETING

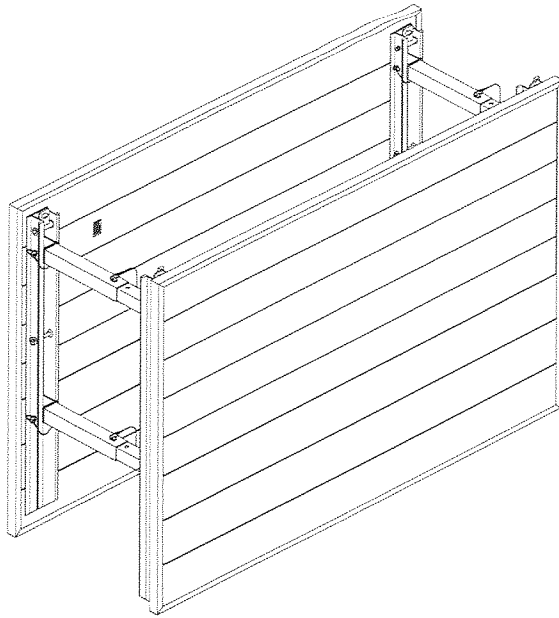
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TABULATED DATA

ALUMINUM PANEL SHIELDS



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- ALL INSTALLATION AND REMOVAL OF SHORING AND SHIELDING SHALL BE FROM ABOVE GROUND ONLY.
- DO NOT ALLOW PERSONNEL TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED OR SLOPED.
- PERSONNEL SHALL ALWAYS WORK WITHIN THE SHORING AND SHIELDING. PERSONNEL SHALL NOT STAND ON THE EDGE OF AN UNSHORED EXCAVATION.
- ALL PERSONNEL SHALL ENTER AND EXIT EXCAVATIONS ONLY WITHIN SHIELDED OR SHORED AREAS.

SPEED SHORE'S "MANUFACTURER'S TABULATED DATA" IS A GENERAL SET OF GUIDELINES AND TABLES TO ASSIST THE *COMPETENT PERSON* IN SELECTING A SAFETY SYSTEM AND THE PROPER SHORING OR SHIELDING EQUIPMENT. THE *COMPETENT PERSON* HAS SOLE RESPONSIBILITY FOR JOB SITE SAFETY AND THE PROPER SELECTION AND INSTALLATION AND REMOVAL OF THE SHORING OR SHIELDING EQUIPMENT.

THIS TABULATED DATA IS NOT INTENDED TO BE USED AS A JOB SPECIFIC EXCAVATION SAFETY PLAN, BUT SHALL BE USED BY THE *COMPETENT PERSON* TO SUPPLEMENT HIS TRAINING, HIS EXPERIENCE AND HIS KNOWLEDGE OF THE JOB CONDITIONS AND SOIL TYPE.



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TABULATED DATA

1.0 SCOPE

- 1.1 Speed Shore's Tabulated Data complies with the O.S.H.A. standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). This data shall only be used by the contractor's *competent person* in the selection of Speed Shore Trench Shields. The *competent person* shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Aluminum Panel Shields.
- 1.2 All personnel involved in the installation, removal and use of Aluminum Panel Shields shall be trained in their use and advised of appropriate safety procedures.
- 1.3 Tables APS-1 and APS-2 is based upon requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The *competent person* shall know and understand the requirements of those parts before using this data.
- 1.4 Whenever there is a variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic or subject is not contained in this Tabulated Data, the *competent person* shall refer to CFR 29, Part 1926, Subpart P - Excavations.
- 1.5 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. In states that have their own state O.S.H.A. refer to similar regulations in the current construction rules published by the state office of Occupational Health and Safety.
- 1.6 Tables APS-1 and APS-2 shall be used only in excavations with soil conditions as noted. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance
- 1.7 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore and may only be used with Speed Shore manufactured products. Any modification of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

- 2.1 1926.32 (F) "competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees; and who has authorization to take prompt corrective measures to eliminate them.
- 2.2 1926.32 (p) "Shall" means mandatory.

3.0 SOIL CLASSIFICATIONS

- 3.1 In order to use the data presented in Tables APS-1 and APS-2 the soil type, or types, in which the excavation is cut shall first be determined by the *competent person* according to the O.S.H.A. soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.
- 3.2 Tables APS-1 and APS-2 are also for use in Type C-60 soil (see 3.3 for definition).
- 3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil, which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shields to be properly installed. The *competent person* must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the Aluminum Panel Shields. An alternate design for less stable Type C soil may be required where there is evidence of deterioration.



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- 3.4 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and promptly remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in the less cohesive (weaker) soil conditions. A small amount of water, or flowing conditions may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions will downgrade all soils to O.S.H.A. Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the *competent person*. Example: When repairing a leak in utility lines, it is often difficult or even impossible to keep water out of the excavation.

4.0 PRESENTATION OF INFORMATION

- 4.1 Information is presented in tabular form in Tables APS-1 and APS-2 are for use in O.S.H.A. Type A, B and C soils, and for use in Type C-60 soil (see 3.3 for definition).
- 4.2 Tables APS-1 or APS-2 is not considered adequate when loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.
- 4.3 Using Tables APS-1 and APS-2, the *competent person* determines the maximum depth the Aluminum Panel Shields may be used.
- 4.4 Table APS-1 is used when only the sides of the Aluminum Panel Shields are loaded. Table APS-2 is used when there is end panels attached and there is side and end loading on the Aluminum Panel Shield.

5.0 ASSEMBLY

- 5.1 Aluminum Panel Shields shall be inspected by a *competent person* before assembly.
- 5.2 All damage shall be evaluated and repairs made under the direction of a registered professional engineer. All missing or damaged components shall be replaced with genuine Speed Shore parts.
- 5.3 All lifting and pulling equipment, (including cables, slings, chains, shackles and safety hooks) used to handle shields or components shall be evaluated for lifting capacity, and inspected for damage or defects, prior to use, by experienced operators and shall meet O.S.H.A. requirements.
- 5.4 Tag lines or other approved safety devices shall be utilized to keep employees away from loads handled by lifting equipment.
- 5.5 Spreaders, pins with keepers and accessories shall be in place before using the Aluminum Panel Shields.
- 5.6 Two spreaders are required at each end of all shields.
- 5.7 All spreaders shall be pinned at each end with 1-inch diameter pins furnished by Speed Shore.
- 5.8 Assembly instructions:
- 5.8.1 Lay the first panel on ground, spreader sockets up.
 - 5.8.2 Insert spreaders into the vertical walers and insert pins with keepers.
 - 5.8.3 Lower second panel onto spreader and insert pins with keepers.
 - 5.8.4 Adjustable spreaders shall be pinned to the width of the excavation to prevent lateral movement of the shield
 - 5.8.5 Attach 4-point lifting sling to lifting brackets.
 - 5.8.6 Stand APS shield up, attach tag lines and install into trench properly.



6.0 INSPECTION

- 6.1 The competent person must evaluate the soils to assure the rated capacity of the Aluminum Panel Shields is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.
- 6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate methods, which could endanger employees utilizing this product.
- 6.3 Daily inspections of the Aluminum Panel Shields and accessories must be performed by the *competent person* and deficiencies corrected.
- 6.4 Inspections shall be conducted as necessary for hazards associated with water accumulation, changing soil conditions, or changing site weather conditions.
- 6.5 Stacked shields shall be monitored to assure that each panel is secured to the one below it.

7.0 SAFETY SPECIFICATIONS

- 7.1 Employees shall be protected from loose or falling material. Aluminum Panel Shields must always be used in a manner that loose or falling soil cannot enter over the top or through the end of the shield. End plates may be required. Spoil piles must be kept back from the edge of the excavation at least 2 feet.
- 7.2 Employees shall not enter or exit shields through unprotected areas and shall remain in shields at all times while working.
- 7.3 Employees shall not be in or under a shield while it is being lifted or moved.
- 7.4 Bottom of shields may be a maximum of 2 feet above the bottom of the trench if there are no signs of deterioration of the trench face below or at the end of the shield.
- 7.5 Use of the spreader system for any purpose other than supporting the sidewall panels and Speed Shore-designed End Panels, or for pulling them forward is prohibited without written permission from the manufacturer.
- 7.6 The sides of the excavation should be cut vertical and narrow to prevent lateral movement of the shield. The width of the excavation shall be no wider than the width of the shield plus 12 inches.
- 7.7 Use Speed Shore supplied standard spreaders.
- 7.8 Water shall be prevented from entering the excavation and any water that does accumulate in the excavation shall be pumped out.
- 7.9 Contact Speed Shore for any non-typical use of the Aluminum Panel Shields.

8.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES APS-1 and APS-2:

Problem: A trench is 8 feet deep in soil that has been classified by the *competent person* to be O.S.H.A. Type C-60. For pipe joint purposes, 12 feet long shields are required. Which Aluminum Panel Shields may be used?

Studying Table APS-1 shows that an APS-0812 is adequate down to 14 feet.

TABLE APS-1

MODEL	CAPACITY P.S.F.	MAXIMUM DEPTH RATING FOR SPOIL TYPE (FEET)					VERTICAL PIPE CLEARANCE INCHES	WEIGHT APPX. POUNDS
		A-25	B-35	B-45	C-60	C-80		
APS-0406	4,190	25	25	25	25	25	18	525
APS-0408	2,050	25	25	25	25	25	18	640
APS-0410	1,210	25	25	25	21	16	18	750
APS-0412	800	25	22	18	14	11	18	860
APS-0414	570	21	16	13	10	8	18	975
APS-0416	420	15	12	10	8	6	18	1,085
APS-0606	2,330	25	25	25	25	25	30	755
APS-0608	1,750	25	25	25	25	25	30	925
APS-0610	1,210	25	25	25	21	16	30	1,090
APS-0612	800	25	22	18	14	11	30	1,250
APS-0614	570	21	16	13	10	8	30	1,420
APS-0616	420	15	12	10	8	6	30	1,580
APS-0806	1,650	25	25	25	25	21	36	985
APS-0808	1,240	25	25	25	20	16	36	1,205
APS-0810	990	25	25	21	16	13	36	1,425
APS-0812	800	25	22	18	14	11	36	1,640
APS-0814	570	21	16	13	10	8	36	1,860
APS-0816	420	15	12	10	8	6	36	2,080

Notes to table APS-1.

- (1) If a specific model APS trench shield is not shown in Table APS-1, the competent person must refer to the trench shield certification to determine capacity and working depths. All other aspects of this tabulated data applies to any APS shield not shown in Table APS-1.
- (2) Weights are approximate.
- (3) Depth ratings include a surcharge loading of approximately 300 p.s.f. on the earth's surface next to the excavation.



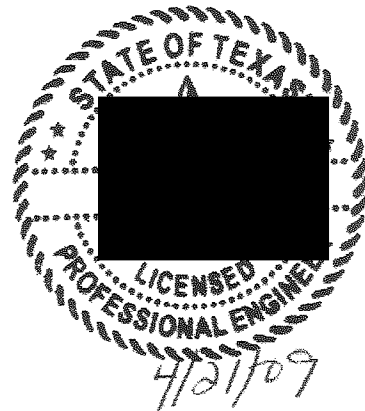
TABLE APS-2

END LOADING CAPACITY

MODEL	CAPACITY P.S.F.	MAXIMUM DEPTH RATING FOR SPOIL TYPE (FEET)				
		A-25	B-35	B-45	C-60	C-80
APS-0406	1,820	25	25	25	25	25
APS-0408	1,820	25	25	25	25	25
APS-0410	1,210	25	25	25	21	16
APS-0412	800	25	22	18	14	11
APS-0414	570	21	16	13	10	8
APS-0416	420	15	12	10	8	6
APS-0606	1,120	25	25	25	19	15
APS-0608	1,120	25	25	25	19	15
APS-0610	1,120	25	25	25	19	15
APS-0612	800	25	22	18	14	11
APS-0614	570	21	16	13	10	8
APS-0616	420	15	12	10	8	6
APS-0806	880	25	24	19	14	11
APS-0808	880	25	24	19	14	11
APS-0810	880	25	24	19	14	11
APS-0812	800	25	22	18	14	11
APS-0814	570	21	16	13	10	8
APS-0816	420	15	12	10	8	6

Notes to table APS-2.

- (1) Heavy-duty adjustable spreaders required for end loading.
- (2) Sheeting supported by spreaders may be:
 - a. ¼ in. Finn-Form plywood or equal.
 - b. Speed Shore corrugated aluminum sheeting.
 - c. Speed Shore 2 ½ in. x 12 in. extruded aluminum sheeting.
 - d. Steel sheet piling
 - e. 1 ½ in. thick timber
 - f. ½ in thick steel plate
- (3) Depth ratings include a surcharge loading of approximately 300 p.s.f. on the earth's surface next to the excavation.



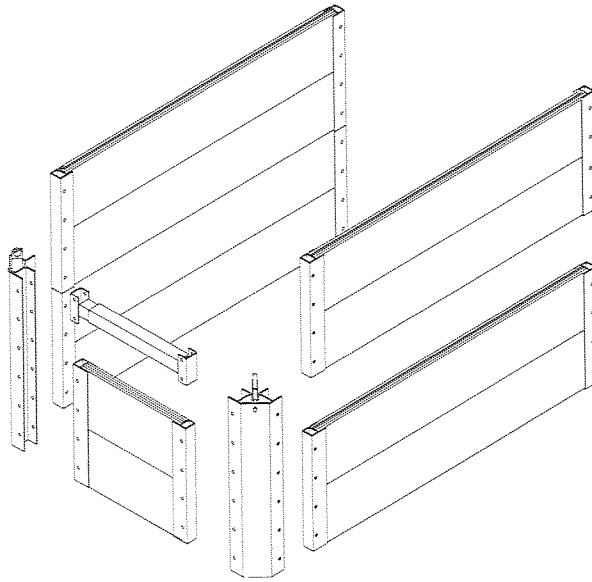
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TABULATED DATA

MODULAR ALUMINUM PANEL SHIELDS - "MAPS"



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WARNING

EXCAVATION PROCEDURES MAY BE VERY DANGEROUS

- A TRAINED *COMPETENT PERSON* SHALL: SUPERVISE ALL EXCAVATION OPERATIONS, ENSURE THAT ALL PERSONNEL ARE WORKING IN SAFE CONDITIONS, AND HAVE THOROUGH KNOWLEDGE OF THIS TABULATED DATA. THE *COMPETENT PERSON* SHALL HAVE THE AUTHORITY TO STOP WORK WHEN IT IS UNSAFE FOR WORKERS TO ENTER AN EXCAVATION.
- ALL PERSONNEL SHALL BE TRAINED IN CORRECT EXCAVATION PROCEDURES, PROPER USE OF THE PROTECTIVE SYSTEM AND ALL SAFETY PRECAUTIONS.
- EXCAVATIONS AND PROTECTIVE SYSTEMS SHALL BE INSPECTED AT LEAST DAILY AND WHENEVER THERE IS A CHANGE OF SOIL, WATER OR OTHER JOB SITE CONDITIONS.
- ALL LIFTING AND PULLING EQUIPMENT, INCLUDING CABLES, SLINGS, CHAINS, SHACKLES AND SAFETY HOOKS SHALL BE EVALUATED FOR SUITABILITY AND CAPACITY, AND SHALL BE INSPECTED FOR DAMAGE OR DEFECTS PRIOR TO USE.
- ALL INSTALLATION AND REMOVAL OF SHORING AND SHIELDING SHALL BE FROM ABOVE GROUND ONLY.
- DO NOT ALLOW PERSONNEL TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED OR SLOPED.
- PERSONNEL SHALL ALWAYS WORK WITHIN THE SHORING AND SHIELDING. PERSONNEL SHALL NOT STAND ON THE EDGE OF AN UNSHORED EXCAVATION.
- ALL PERSONNEL SHALL ENTER AND EXIT EXCAVATIONS ONLY WITHIN SHIELDED OR SHORED AREAS.

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TABULATED DATA

1.0 SCOPE

- 1.1 Speed Shore's Tabulated Data complies with the OSHA Excavation Standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). The contractor's competent person in the selection of Speed Shore Modular Aluminum Panel Shields, MAPS, shall only use this data. The *competent person* shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Aluminum Panel Shields.
- 1.2 Employers shall train all personnel involved in the installation, removal and use of MAPS and advised of appropriate safety procedures.
- 1.3 Table MAPS-1 is based upon safety requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The *competent person* shall know and understand the requirements of those standards before using this data.
- 1.4 Whenever there is a variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic, subject, or issue is not contained in this Tabulated Data, the *competent person* shall refer to CFR 29, Part 1926, Subpart P - Excavations.
- 1.5 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. Where states have their own state OSHA plan, refer to similar regulations in the current construction rules published by the state office of Occupational Health and Safety.
- 1.6 Table MAPS-1 shall be used only in excavations with soil conditions as noted. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance
- 1.7 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore and may only be used with Speed Shore manufactured products. Any modification of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

- 2.1 1926.32 (F) "competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees; and who has authorization to take prompt corrective measures to eliminate them.
- 2.2 1926.32 (p) "Shall" means mandatory.

3.0 SOIL CLASSIFICATIONS

- 3.1 In order to use the data presented in Table MAPS-1 the soil type, or types, in which the excavation is cut shall first be determined by the *competent person* according to the OSHA soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.
- 3.2 Table MAPS-1 are also reference Type C-60 soil (see 3.3 for definition).
- 3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil, which does not fit into the OSHA Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shields to be properly installed. The *competent person* must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the MAPS. An alternate design for less stable Type C soil may be required where there is evidence of deterioration.



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- 3.4 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and promptly remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in the less cohesive (weaker) soil conditions. A small amount of water, or flowing conditions may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions will downgrade all soils to O.S.H.A. Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the *competent person*. Example: When repairing a leak in utility lines, it is often difficult or even impossible to keep water out of the excavation.

4.0 PRESENTATION OF INFORMATION

- 4.1 Information presented in tabular form in Table MAPS-1 is for use in OSHA. Types A, B and C soils, and for use in Type C-60 soil (see 3.3 for definition).
- 4.2 Table MAPS-1 is not considered adequate when loads imposed by structures or by stored material adjacent to the excavation weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the excavation equal to the depth of the excavation.
- 4.3 Using Table MAPS-1, the *competent person* determines the maximum depth the MAPS may be used.

5.0 ASSEMBLY

- 5.1 A competent person before assembly shall inspect all MAPS components.
- 5.2 Any damage shall be evaluated and repairs made under the direction of a registered professional engineer. All missing or damaged components shall be replaced with genuine Speed Shore parts.
- 5.3 All lifting and pulling equipment, (including cables, slings, chains, shackles and safety hooks) used to handle shields or components shall be evaluated for lifting capacity, and inspected for damage or defects, prior to use, by experienced personnel and shall meet OSHA requirements.
- 5.4 Tag lines or other approved safety devices shall be utilized to keep employees away from loads handled by lifting equipment.
- 5.5 PINS: Each two foot high panel shall be pinned to each end member using two pins, unless a horizontal joint occurs in the end member at the panel.
- 5.6 END MEMBERS: All horizontal joints in the end members shall occur at the mid-height of a two-foot panel. The two foot high panel shall be pinned to the two butting end members using two pins above the joint and two pins below the joint.
- 5.7 MAPS PANELS: A system shall consist of 2, 3 or 4-sided configurations.
- 5.8 Adjustable legs or end members can be used for supporting the shield to a maximum of 2' height off the bottom of the trench. See section 7.4 for limitations
- 5.9 End Members can be stacked to increase the height of the system. Panels must be staggered across the stacked End Members to bridge the system.
- 5.10 Spreaders can be vertically spaced up to a maximum of three feet.
- 5.11 All assembly of the MAPS system shall be done in a safe area. This can be the area adjacent to the excavation or assembly of the MAPS system from the top down in the excavation. No personnel shall be in an unprotected area of the excavation during assembly.

6.0 INSPECTION

- 6.1 The competent person must evaluate the soils to assure the rated capacity of the MAPS is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.
- 6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate methods, which could endanger employees utilizing this product.
- 6.3 The *competent person* must perform daily inspections of the MAPS and accessories. Any deficiencies must be promptly corrected with out exposure to personnel.
- 6.4 Inspections shall be conducted as necessary for hazards associated with water accumulation, changing soil conditions, or changing site weather conditions.

7.0 SAFETY SPECIFICATIONS

- 7.1 Employees shall be protected from loose or falling material. MAPS must always be used in a manner that loose or falling soil cannot enter over the top or through the end of the shield. End protection may be required. Spoil piles must be kept back from the edge of the excavation at least 2 feet.
- 7.2 Employees shall not enter or exit shields through unprotected areas and shall remain in shields at all times while working.
- 7.3 Employees shall not be in or under a shield while it is being lifted or moved.
- 7.4 Bottom of MAPS may be a maximum of 2 feet above the bottom of the trench if there are no signs of deterioration of the trench face below or at the end of the shield. This may be accomplished by the use of the adjustable legs furnished with the MAPS, END MEMEBERS, or as per O.S.H.A. standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652 (g)(2).
- 7.5 Use of the spreader system for any purpose other than supporting the sidewall panels, or for pulling them forward is prohibited without written permission from the manufacturer.
- 7.6 The sides of the excavation should be cut vertical and narrow to prevent lateral movement of the MAPS. The width of the excavation shall be no wider than the width of the shield plus 12 inches. If soil conditions do not allow the sides of the excavation to be cut vertical and narrow, the competent person shall install the shield in a safe manner to restrict lateral movement or other hazardous movement of the shield in the event of the application of sudden lateral loads. The competent person shall make the final determination to ensure lateral movement of the shield has been controlled.
- 7.7 Only use Speed Shore supplied standard spreaders.
- 7.8 Water shall be prevented from entering the excavation and any water that does accumulate in the excavation shall be pumped out. See sections 3.4 and 6.4.
- 7.9 Contact Speed Shore for any non-typical use of the MAPS.

8.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES MAPS-1:

Problem: The excavation for water tap is 6 feet deep in soil that has been classified by the competent person to be Type C-60 soil. The contractor requires four-sided protection, area of 6' x 10'. Which MAPS may be used?

Studying Table MAPS-1 shows that an MAPS-0210 is adequate down to 16' deep and MAPS-0206 to 45' deep. Using four 8' end members, 6 each MAPS 0210 and 6 each MAPS-0206, the contractor will be able to assemble a 6' x 10' four sided box that is rated to 16' deep in C-60 soil.



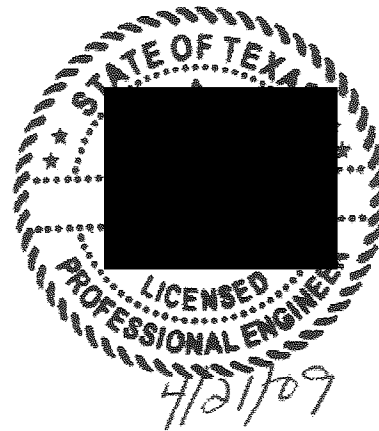
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TABLE MAPS-1

MODEL	PANEL SIZE (FEET)		PANEL CAPACITY P.S.F.	MAXIMUM DEPTH RATING FOR SPOIL TYPE (FEET)				PANEL WEIGHT APPX. POUNDS
	HEIGHT	LENGTH		A-25	B-45	C-60	C-80	
MAPS-0203	2	3	12,000	50	50	50	50	36
MAPS-0204	2	4	6,400	50	50	50	50	49
MAPS-0205	2	5	4,500	50	50	50	50	62
MAPS-0206	2	6	2,700	50	50	45	34	76
MAPS-0208	2	8	1,500	50	33	25	19	102
MAPS-0210	2	10	960	36	21	16	12	129
MAPS-0212	2	12	660	24	14	11	8	155
MAPS-0214	2	14	570	21	12	9	7	180
MAPS-0216	2	16	420	15	9	7	5	205

Notes to table MAPS-1.

- (1) This table is applicable to 4-sided boxes, 3-sided boxes, and 2-sided boxes. Open sides must be supported by spreaders.
- (2) Maximum bottom spreader clearance for 2-sided and 3-sided boxes is 34". Spreader shall be spaced apart vertically no more than 36" on center.
- (3) Weights are approximate.



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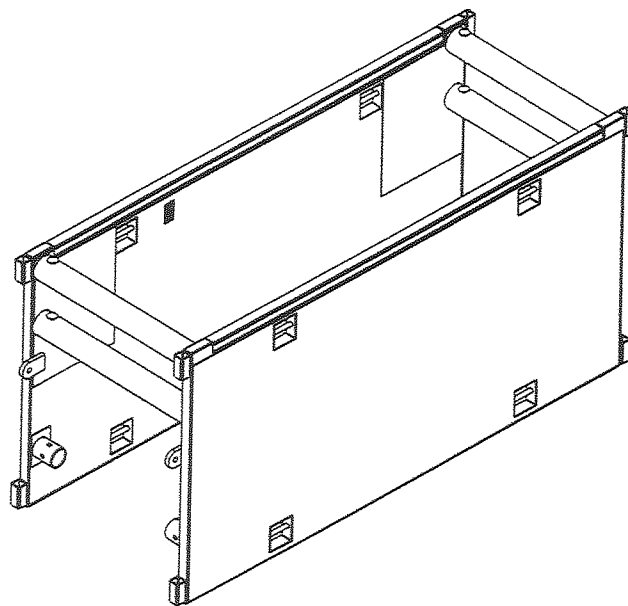


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TABULATED DATA

STEEL TRENCH SHIELDS

"DW" MODELS



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- DO NOT ALLOW PERSONNEL TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED OR SLOPED.
- PERSONNEL SHALL ALWAYS WORK WITHIN THE SHORING AND SHIELDING. PERSONNEL SHALL NOT STAND ON THE EDGE OF AN UNSHORED EXCAVATION.
- ALL PERSONNEL SHALL ENTER AND EXIT EXCAVATIONS ONLY WITHIN SHIELDED OR SHORED AREAS.

SPEED SHORE'S "MANUFACTURER'S TABULATED DATA" IS A GENERAL SET OF GUIDELINES AND TABLES TO ASSIST THE *COMPETENT PERSON* IN SELECTING A SAFETY SYSTEM AND THE PROPER SHORING OR SHIELDING EQUIPMENT. THE *COMPETENT PERSON* HAS SOLE RESPONSIBILITY FOR JOB SITE SAFETY AND THE PROPER SELECTION AND INSTALLATION AND REMOVAL OF THE SHORING OR SHIELDING EQUIPMENT.

THIS TABULATED DATA IS NOT INTENDED TO BE USED AS A JOB SPECIFIC EXCAVATION SAFETY PLAN, BUT SHALL BE USED BY THE *COMPETENT PERSON* TO SUPPLEMENT HIS TRAINING, HIS EXPERIENCE AND HIS KNOWLEDGE OF THE JOB CONDITIONS AND SOIL TYPE.



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ENGINEERING

TABULATED DATA

1.0 SCOPE

- 1.1 Speed Shore's Tabulated Data complies with the O.S.H.A. standards as stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). This data shall only be used by the contractor's *competent person* in the selection of Speed Shore Trench Shields. The *competent person* shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Trench Shields.
- 1.2 All personnel involved in the installation, removal and use of Trench Shields shall be trained in their use and advised of appropriate safety procedures.
- 1.3 Tables TS-1 and TS-2 are based upon requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The *competent person* shall know and understand the requirements of those parts before using this data.
- 1.4 Whenever there is a variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic or subject is not contained in this Tabulated Data, the *competent person* shall refer to CFR 29, Part 1926, Subpart P - Excavations.
- 1.5 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. In states that have their own state O.S.H.A. refer to similar regulations in the current construction rules published by the state office of Occupational Health and Safety.
- 1.6 Tables TS-1 and TS-2 shall be used only in excavations with soil conditions as noted. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance.
- 1.7 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore and may only be used with Speed Shore manufactured products. Any modification of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

- 2.1 1926.32 (F) "*competent person*" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees; and who has authorization to take prompt corrective measures to eliminate them.
- 2.2 1926.32 (p) "Shall" means mandatory.

3.0 SOIL CLASSIFICATIONS

- 3.1 In order to use the data presented in Tables TS-1 and TS-2 the soil type, or types, in which the excavation is cut shall first be determined by the *competent person* according to the O.S.H.A. soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.
- 3.2 Tables TS-1 and TS-2 are also for use in Type C-60 soil (see 3.3 for definition).
- 3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shields to be properly installed. The *competent person* must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the Trench Shield. An alternate design for less stable Type C soil may be required where there is evidence of deterioration.
- 3.4 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and promptly remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in the less cohesive (weaker) soil conditions. A



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small amount of water, or flowing conditions may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions will downgrade all soils to O.S.H.A. Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the *competent person*. Example: When repairing a leak in utility lines, it is often difficult or even impossible to keep water out of the excavation.

4.0 PRESENTATION OF INFORMATION

- 4.1 Information is presented in tabular form in Tables TS-1 and TS-2 for use in O.S.H.A. Type A, B and C soils, and for use in Type C-60 soil (see 3.3 for definition).
- 4.2 Tables TS-1 and TS-2 are not considered adequate when loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.
- 4.3 Using Tables TS-1 and TS-2 and after determining the soil type, the *competent person* determines the maximum depth the Trench Shield may be used.

5.0 ASSEMBLY

- 5.1 Shields shall be inspected by a *competent person* before and after assembly.
- 5.2 All damage shall be evaluated and repairs made under the direction of a registered professional engineer. All missing or damaged components shall be replaced with genuine Speed Shore parts.
- 5.3 All lifting and pulling equipment, (including cables, slings, chains, shackles and safety hooks) used to handle shields or components shall be evaluated for lifting capacity, and inspected for damage or defects, prior to use, by experienced operators and shall meet O.S.H.A. requirements.
- 5.4 Tag lines or other approved safety devices shall be utilized to keep employees away from loads handled by lifting equipment.
- 5.5 Spreaders, arched spreaders, pins with keepers and accessories shall be in place before using the shields.
- 5.6 Standard Spreader Requirements: Diameter 8" schedule 80, 20' Maximum Spreader Length
- 5.7 Two spreaders are required at each end of all shields. Shields with 3 spreader sockets at the front end shall have spreaders at any 2 of the 3 sockets.
- 5.8 All spreaders shall be singled or doubled pinned at each end, based on number of holes in the spreader sockets, with 1.5-inch diameter pins furnished by Speed Shore.
- 5.9 Assembly instructions:
 - 5.9.1 Lay first panel on ground, spreader sockets up.
 - 5.9.2 Stand spreaders over sockets and insert pins with keepers.
 - 5.9.3 Lower second panel onto spreader tubes and insert pins with keepers.
 - 5.9.4 Attach 4-point lifting sling to lifting brackets.
 - 5.9.5 Stand shield up, attach tag lines and install into trench properly.
- 5.10 Trench Shields may be stacked utilizing stacking socket and appurtenances providing the allowable designed depth rating for each shield is not exceeded in the tables TS-1 and TS-2.

6.0 INSPECTION

- 6.1 The *competent person* must evaluate the soils to assure the rated capacity of the Trench Shields is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.
- 6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate methods, which could endanger employees utilizing this product.
- 6.3 Daily inspections of the Trench Shield and accessories must be performed by the *competent person* and deficiencies corrected.
- 6.4 Inspections shall be conducted as necessary for hazards associated with: water accumulation, changing soil conditions, or changing site weather conditions.



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6.5 Stacked shields shall be monitored to assure that each panel is secured to the one below it.

7.0 SAFETY SPECIFICATIONS

- 7.1 Employees shall be protected from loose or falling material. Trench Shields must always be used in a manner that loose or falling soil cannot enter over the top or through the end of the shield. End plates may be required. Spoil piles must be kept back from the edge of the excavation at least 2 feet.
- 7.2 Employees shall not enter or exit shields through unprotected areas and shall remain in shields at all times while working.
- 7.3 Employees shall not be in or under a shield while it is being lifted or moved.
- 7.4 Bottom of shields may be a maximum of 2 feet above the bottom of the trench if there are no signs of deterioration of the trench face below or at the end of the shield.
- 7.5 Use of the spreader system for any purpose other than support for the sidewall panels, or for pulling them forward is prohibited without written permission from the manufacturer.
- 7.6 The sides of the excavation should be cut vertical and narrow to prevent lateral movement of the shield. The width of the excavation shall be no wider than the width of the shield plus 12 inches. If soil conditions do not allow the sides of the excavation to be cut vertical and narrow, the competent person shall install the shield in a safe manner to restrict lateral movement or other hazardous movement of the shield in the event of the application of sudden lateral loads. The competent person shall make the final determination to ensure lateral movement of the shield has been controlled.
- 7.7 A Speed Shore supplied arch spreader may be used in place of standard spreaders.
- 7.8 Water shall be prevented from entering the excavation and any water that does accumulate in the excavation shall be pumped out.
- 7.9 Contact Speed Shore for any non-typical use of the Trench Shield.

8.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES TS-1 AND TS-2:

Problem: A trench is 16 feet deep in soil that has been classified by the *competent person* to be O.S.H.A. Type B. For pipe joint purposes, 20 feet long shields are required, and stacking 2 identical 8 feet high shields is desired. Which Trench Shields may be used?

Studying Table TS-1 shows that an 820DW4 is adequate down to 22 feet. Further down the table is an 820DW6, which is adequate down to 31 feet. Studying Table TS-2 shows an 820DW8 is also adequate to 44 feet.

Either of these 3 shields may be used.



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TABLE TS-1

"DW" MODELS
DOUBLE SKIN PLATE WALLS

MODEL	CAPACITY P.S.F.	MAXIMUM DEPTH RATING FOR SOIL TYPES FEET					VERTICAL PIPE CLEARANCE INCHES	WEIGHT APPX. POUNDS
		A-25	B-35	B-45	C-60	C-80		
TS-0408DW4	5,540	50	50	50	50	50	20	2,430
TS-0410DW4	3,510	50	50	50	50	45	20	2,700
TS-0412DW4	2,365	50	50	50	40	31	20	3,125
TS-0416DW4	1,282	50	37	29	22	17	20	3,910
TS-0420DW4	803	31	23	18	14	11	20	4,595
TS-0424DW4	550	21	16	13	10	8	20	5,450
TS-0608DW4	4,240	50	50	50	50	50	42	3,150
TS-0610DW4	3,392	50	50	50	50	45	42	3,850
TS-0612DW4	2,353	50	50	50	41	32	42	4,350
TS-0616DW4	1,276	50	37	30	23	18	42	5,775
TS-0620DW4	889	36	26	21	17	13	42	7,475
TS-0624DW4	609	24	18	15	12	10	42	8,850
TS-0808DW4	2,275	50	50	50	41	32	62	3,950
TS-0810DW4	1,820	50	50	43	33	26	62	4,450
TS-0812DW4	1,517	50	45	36	28	22	62	5,290
TS-0816DW4	1,256	50	38	30	24	19	62	7,400
TS-0820DW4	899	37	27	22	18	14	62	9,650
TS-0824DW4	615	26	20	16	13	11	62	11,260
TS-1010DW4	1,105	46	35	28	22	18	86	5,950
TS-1012DW4	921	39	29	24	19	16	86	6,890
TS-1016DW4	761	33	25	20	16	14	86	9,460
TS-1020DW4	609	26	20	17	14	12	86	12,700
TS-1024DW4	507	22	17	15	12	10	86	15,240
TS-0412DW6	3,890	50	50	50	50	50	20	3,550
TS-0416DW6	2,109	50	50	47	36	27	20	4,500
TS-0420DW6	1,320	50	38	30	23	18	20	5,475
TS-0424DW6	904	35	26	20	16	12	20	6,350
TS-0428DW6	657	25	19	15	12	9	20	7,300
TS-0612DW6	3,814	50	50	50	50	50	42	5,050
TS-0616DW6	2,068	50	50	47	36	28	42	6,650
TS-0620DW6	1,295	50	38	30	23	18	42	8,150
TS-0624DW6	978	39	29	23	18	14	42	9,875
TS-0628DW6	711	29	21	17	14	11	42	11,260
TS-0812DW6	2,649	50	50	50	47	36	65	6,250
TS-0816DW6	2,047	50	50	48	37	29	65	8,350
TS-0820DW6	1,282	50	39	31	24	19	65	9,950
TS-0824DW6	980	40	30	24	19	15	65	12,400
TS-0828DW6	804	33	25	20	16	13	65	15,650
TS-1012DW6	1,629	50	49	40	31	24	86	7,390
TS-1016DW6	1,311	50	40	33	26	20	86	10,150
TS-1020DW6	1,049	44	33	27	21	17	86	12,150
TS-1024DW6	874	37	28	23	18	15	86	14,500
TS-1028DW6	749	32	24	20	16	13	86	17,200

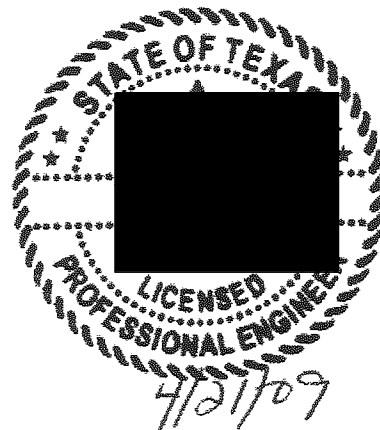
TABLE TS-2

**"DW" MODELS
DOUBLE SKIN PLATE WALLS**

MODEL	CAPACITY P.S.F.	MAXIMUM DEPTH RATING FOR SOIL TYPES FEET					VERTICAL PIPE CLEARANCE INCHES	WEIGHT APPX. POUNDS
		A-25	B-35	B-45	C-60	C-80		
TS-0420DW8	1,969	50	50	44	34	26	20	6,300
TS-0424DW8	1,343	50	38	30	23	18	20	7,525
TS-0428DW8	975	38	28	22	17	13	20	8,500
TS-0430DW8	845	33	24	19	15	12	20	9,075
TS-0432DW8	740	29	21	17	13	10	20	9,550
TS-0620DW8	1,935	50	50	44	34	26	42	9,200
TS-0624DW8	1,320	50	39	31	24	19	42	11,000
TS-0628DW8	1,086	44	32	26	20	16	42	13,000
TS-0630DW8	941	38	28	22	17	14	42	13,900
TS-0632DW8	824	33	24	20	16	12	42	14,850
TS-0820DW8	1,874	50	50	44	34	27	65	11,400
TS-0824DW8	1,279	50	38	31	24	19	65	13,250
TS-0828DW8	1,268	50	38	31	24	19	65	18,675
TS-0830DW8	1,161	48	35	28	22	18	65	19,950
TS-0832DW8	962	40	29	24	19	15	65	20,850
TS-1020DW8	1,347	50	41	33	26	21	86	14,200
TS-1024DW8	1,123	47	35	28	23	18	86	16,850
TS-1028DW8	962	41	30	25	20	16	86	18,900
TS-1030DW8	957	40	30	25	20	16	86	21,640
TS-1032DW8	897	38	29	23	19	15	86	24,490

Notes

- (1) If a specific model DW trench shield is not shown in Table TS-1 or TS-2, the competent person must refer to the trench shield certification to determine capacity and working depths. All other aspects of this tabulated data applies to any DW shield not shown in Tables TS-1 or TS-2.
- (2) Weights are approximate.
- (3) Standard spreader sizes for DW trench shields as shown in Table TS-1 or TS-2 are 8" schedule 80 pipe, maximum length of 20'. For models not listed or custom shields, please see the serialized certification for each shield for spreader requirements.



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EXAMPLES OF TYPICAL INSTALLATIONS

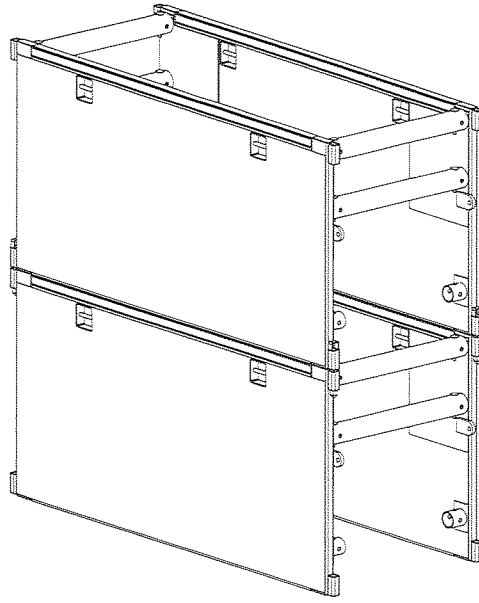


FIG 1 – TWO FLAT BOTTOM SHIELDS STACKED. PLEASE NOTE TOP SHIELD MAY BE INVERTED AND PINNED TO THE BOTTOM SHIELD

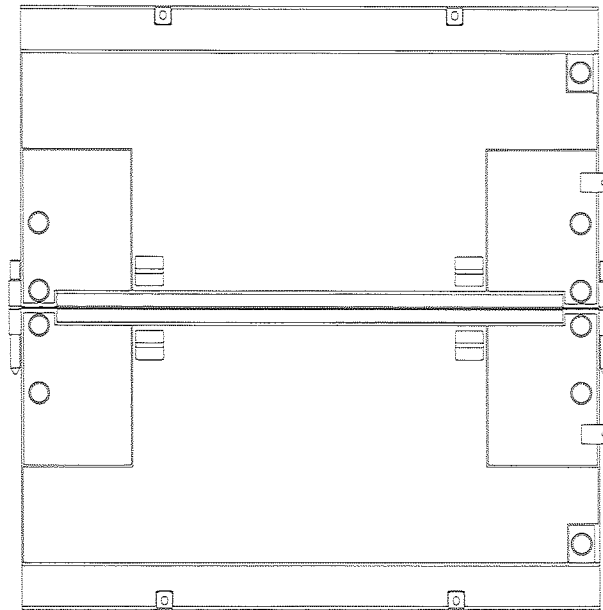
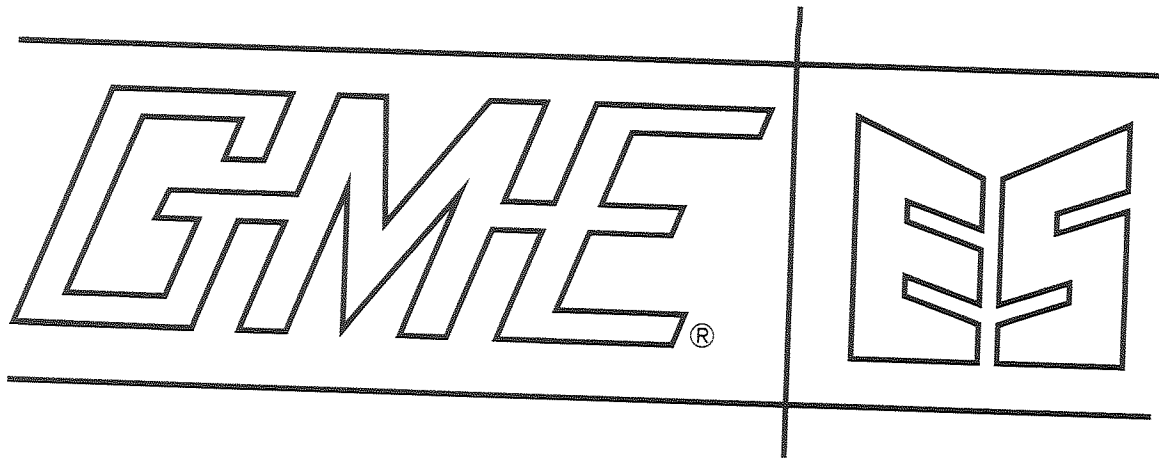


FIG 2 – TWO KNIFE EDGE SHIELDS STACKED

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Tabulated Data
**Modular Slide Rail
System**

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CAUTION

EXCAVATION PROCEDURES MAY CAUSE INJURY OR DEATH!

A COMPETENT PERSON WHO SATISFIES THE DEFINITION AND INTENT OF THE 1926 CONSTRUCTION STANDARD SUBPART P EXCAVATIONS SHALL: ENSURE THAT ALL EMPLOYEES ARE WORKING IN SAFE CONDITIONS AND THAT ALL EMPLOYEES HAVE BEEN TRAINED IN CORRECT EXCAVATION PROCEDURES AND THE PROPER USE OF THE PROTECTIVE EQUIPMENT CHOSEN.

EXCAVATIONS AND PROTECTIVE EQUIPMENT SHALL BE INSPECTED A MINIMUM OF ONCE EACH WORKING DAY AND WHENEVER THERE IS A CHANGE IN THE SOIL CONDITIONS AND/OR OTHER CHANGES SUCH AS AN INCREASE OR DECREASE IN WATER OR VIBRATIONS.

EMPLOYEES SHALL NOT BE ALLOWED TO ENTER AN EXCAVATION THAT IS NOT PROPERLY SHORED, SHIELDED, OR SLOPED.

EMPLOYEES SHALL ALWAYS ENTER, WORK, AND EXIT WITHIN THE SHORED, SHIELDED, OR SLOPED AREAS OF THE EXCAVATION AND/OR TRENCH.

ALL LIFTING AND PULLING EQUIPMENT, INCLUDING CABLES, SLINGS, CHAINS, SHACKLES AND SAFETY HOOKS SHALL BE INSPECTED FOR DAMAGE OR DEFECTS PRIOR TO USE AND SHALL BE EVALUATED FOR SUITABILITY AND CAPACITY.

THIS GME TABULATED DATA PROVIDES A GENERAL SET OF GUIDELINES TO ASSIST THE COMPETENT PERSON IN THE SELECTION OF A PROTECTIVE SYSTEM FOR EMPLOYEE SAFETY. THE RESPONSIBILITY FOR JOB SITE SAFETY AND THE PROPER SELECTION, INSTALLATION AND REMOVAL OF THE SHORING EQUIPMENT BELONGS TO THE COMPETENT PERSON DESIGNATED FOR THAT JOBSITE. THIS TABULATED DATA IS NOT INTENDED TO BE USED AS A JOB SPECIFIC EXCAVATION/TRENCHING SAFETY PLAN, BUT SHALL BE USED BY THE COMPETENT PERSON. TABULATED DATA IS INTENDED AS A SUPPLEMENT TO HIS/HER TRAINING, EXPERIENCE AND KNOWLEDGE OF SAFE PROCEDURES, JOB SITE CONDITIONS AND SOIL TYPES. TABULATED DATA IS INTENDED TO ASSIST HIM IN THE SELECTION OF AN APPROPRIATE PROTECTIVE SYSTEM FOR EMPLOYEE SAFETY.

MODULAR SLIDE RAIL SYSTEM TABULATED DATA

General:

1. This data has been prepared by a Registered Professional Engineer as required by the OSHA standard 29 CRF, Part 1926, Subpart P, Excavations.
2. This data is to be used by the "competent person" for the proper use of the GME Slide Rail System.
3. "Competent person" is one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
4. When there is a discrepancy concerning the use of protective systems between this tabulated data and the OSHA standard, this data shall take precedence. Any topic not covered by this data shall be governed by the OSHA standard.
5. GME shall not be liable for damage or injury resulting from improper use of the GME Slide Rail System. Improper use of or modifications to the GME Slide Rail System, or use of components not specifically authorized by GME without the written consent of GME shall void this data and all manufacturers warranty.
6. This data is valid for GME Slide Rail Components in structurally sound condition. Any significant damage will void this data, and all manufacturers warranty. The damaged component shall not be used.

Soil Classification

1. See the OSHA regulations for descriptions of Type A25, B45, and C80 soils.
 2. Type C60 soil is a soft cohesive or moist granular soil that is not flowing or submerged and has an Equivalent Fluid Pressure (EFP) of 60 PSF per foot of depth. The competent person must monitor the excavation for signs of deterioration that may alter soil pressures and produce the Soil Type C80 condition. Such signs are indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the system.
-

MODULAR SLIDE RAIL SYSTEM TABULATED DATA

System Specifications:

1. All personnel involved with the use of the GME Slide Rail System shall be trained in the proper use and installation procedures and other applicable safety requirements.
 2. Depth Ratings for Slide Rail Components are based on examples of homogeneous soil conditions. Actual soil pressures should be verified to be sure that the systems structural capacity is not exceeded.
 3. Surcharge loads are not included in the Depth Ratings of the Slide Rail Components. Surcharge loads are possible due to heavy equipment, vibrations, or soil piles adjacent to the excavation. (Adjacent is defined as within a distance equal to the depth of the excavation.) Surcharge loads may cause damage and permanent deformation to Slide Rail Components.
 4. The GME Slide Rail System may be utilized in two, three or four sided configurations. See Fig. 1.1 for the definition of Slide Rail Components.
 5. The Depth Ratings for Slide Rail Panels are defined in Fig 2.1 and 2.2. Panel Depth Ratings shall meet or exceed the depth at which the panels are used.
 6. If Linear Rails are to be utilized, a minimum of two struts are required for Linear Rails 23 ft. in length or shorter. If Linear Rail lengths exceed 23 ft, a minimum of three struts shall be required. **Additional Struts may be required to reduce Vertical Clearance and increase the System's Capacity.**
 7. If single struts are utilized, they shall be spaced at 5 ft. o.c. \pm 6 in.
 8. Linear Rail Vertical Clearance shall not exceed the values indicated Fig. 3.1, 3.2, 3.3, or 3.4. Vertical Clearance is defined as the distance from the bottom of the Linear Rail to the bottom of the lowest Strut or from the top of the Slide Rail Panels to the top of the highest Strut.
 9. Slide Rail Strut size shall be determined in accordance with Fig. 4.1, 4.2, 4.3, and 4.4.
 10. Slide Rail Panels may extend a maximum of 2 ft. beyond the bottom of Corner Rails or Linear Rails.
 11. Slide Rail Panels may be held a maximum of 2 ft. above the bottom of the excavation.
-

notes for use of Tabulated Data:

The following recommended guidelines are intended to demonstrate how to determine the adequacy of Slide Rail System Components for a particular application.

1. Determine the required depth of the application and Soil Type as define by this Tabulated Data.
2. Check the Depth Rating of the required Slide Rail Panels to be utilized with Fig. 2.1. If depth ratings are exceeded, shorter panels may be required.
3. If Linear Rails are to be utilized, check Fig 3.1, 3.2, 3.3 or 3.4 to see that the maximum vertical clearance will not be exceeded for the application.
4. If Linear Rails are to be utilized, use Fig 4.1, 4.2, 4.3 or 4.4 to determine the required Strut Size for the application.

See Fig. 5.1 for **Application Example**.

Notes for Figures 3.1 - 3.4 and 4.1 - 4.4:

If adjoining panels of different lengths are to be utilized with Linear Rails, an interpolated Equivalent Panel Length (EPL) value shall be determined as follows:

$$EPL = (\text{Panel Length A} + \text{Panel Length B}) / 2$$

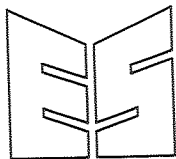
This value may then be used to determine Maximum Vertical Clearance and the Strut size.

PANEL DEPTH RATINGS (FIG. 2.2)

PANEL	CAPACITY (PSF)	DEPTH RATING (FT)			
		A25	B45	C60	C80
URI 410 L	2,280	93	53	40	31
URI 410 M	2,280	93	53	40	31
URI 410 H	2,280	93	53	40	31
URO 410 L	2,280	93	53	40	31
URO 410 M	2,280	93	53	40	31
URO 410 H	2,280	93	53	40	31
URI 412 L	1,973	81	46	35	27
URI 412 M	2,280	93	53	40	31
URI 412 H	2,280	93	53	40	31
URO 412 L	1,842	76	43	33	25
URO 412 M	2,280	93	53	40	31
URO 412 H	2,280	93	53	40	31
URI 414 L	1,537	63	36	28	21
URI 414 M	2,280	93	53	40	31
URI 414 H	2,280	93	53	40	31
URO 414 L	1,446	60	34	26	20
URO 414 M	2,169	89	50	38	29
URO 414 H	2,280	93	53	40	31
URI 415 L	1,231	51	29	23	17
URI 415 M	1,847	76	43	33	25
URI 415 H	2,280	93	53	40	31
URO 415 L	1,166	49	28	21	17
URO 415 M	1,749	72	41	31	24
URO 415 H	2,280	93	53	40	31
URI 417 L	989	42	24	18	14
URI 417 M	1,483	61	35	27	21
URI 417 H	2,150	88	50	38	29
URO 417 L	899	38	22	17	13
URO 417 M	1,348	56	32	24	19
URO 417 H	2,047	84	47	36	28
URI 419 L	685	29	17	13	11
URI 419 M	1,028	43	25	19	15
URI 419 H	1,677	69	39	30	23
URO 419 L	627	27	16	12	10
URO 419 M	940	40	23	18	14
URO 419 H	1,534	63	36	28	21

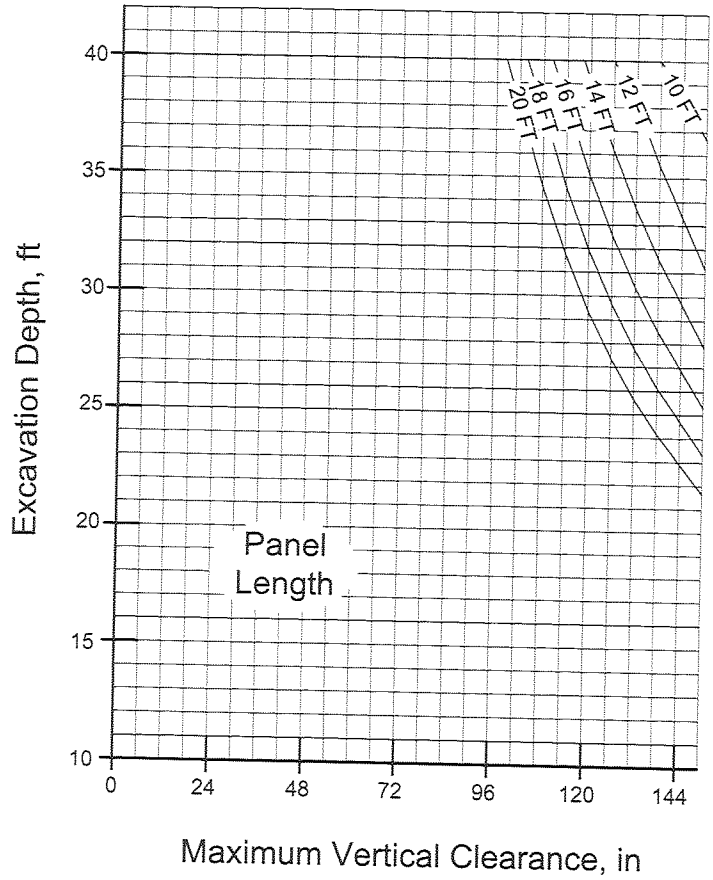
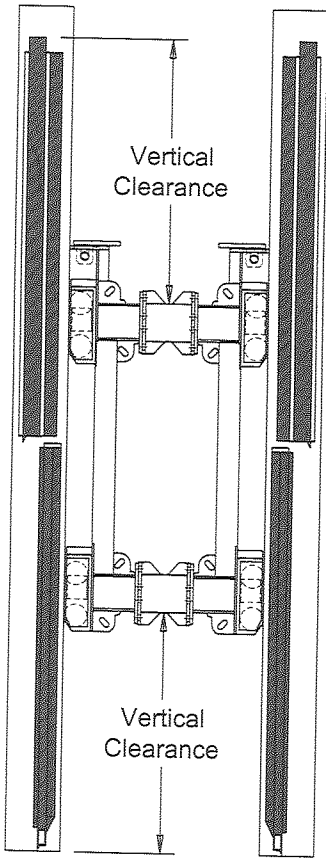
PANEL	CAPACITY (PSF)	DEPTH RATING (FT)			
		A25	B45	C60	C80
URI 810 L	2,160	90	52	40	31
URI 810 M	2,160	90	52	40	31
URI 810 H	2,160	90	52	40	31
URO 810 L	2,160	90	52	40	31
URO 810 M	2,160	90	52	40	31
URO 810 H	2,160	90	52	40	31
URI 812 L	1,794	76	44	34	26
URI 812 M	2,160	90	52	40	31
URI 812 H	2,160	90	52	40	31
URO 812 L	1,674	71	41	32	25
URO 812 M	2,160	90	52	40	31
URO 812 H	2,160	90	52	40	31
URI 814 L	1,398	60	35	27	21
URI 814 M	2,160	90	52	40	31
URI 814 H	2,160	90	52	40	31
URO 814 L	1,315	57	33	26	20
URO 814 M	2,049	86	50	38	30
URO 814 H	2,160	90	52	40	31
URI 815 L	1,120	49	29	23	18
URI 815 M	1,744	74	43	33	26
URI 815 H	2,160	90	52	40	31
URO 815 L	1,060	46	28	22	17
URO 815 M	1,652	70	41	32	25
URO 815 H	2,160	90	52	40	31
URI 817 L	899	40	24	19	15
URI 817 M	1,401	60	35	27	22
URI 817 H	2,082	87	50	39	30
URO 817 L	856	38	23	18	15
URO 817 M	1,312	56	33	26	20
URO 817 H	1,983	83	48	37	29
URI 819 L	654	30	19	15	12
URI 819 M	1,001	44	26	21	17
URI 819 H	1,657	70	41	32	25
URO 819 L	598	28	17	14	11
URO 819 M	915	41	24	19	15
URO 819 H	1,516	65	38	29	23

ENGINEERING



SLIDE RAIL
SYSTEM
TABULATED
DATA

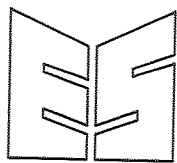
VERTICAL CLEARANCE - TYPE A25 SOIL (FIG. 3.1)



Notes:

- 1) Project horizontal line from Excavation Depth to Required Panel Length.
- 2) Project vertical line from Panel Length downward to determine the Maximum Vertical Clearance of the application.

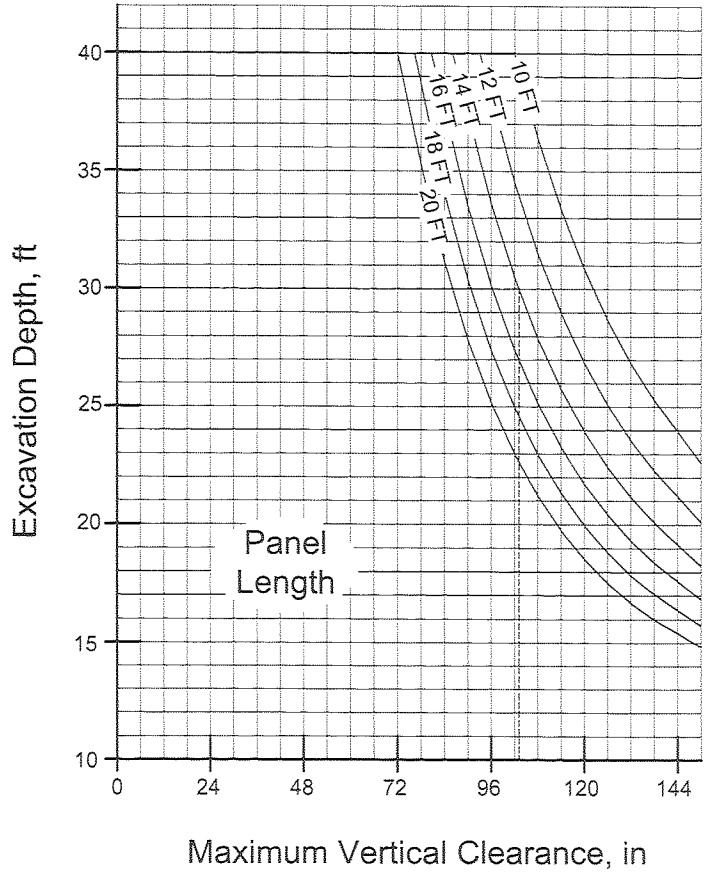
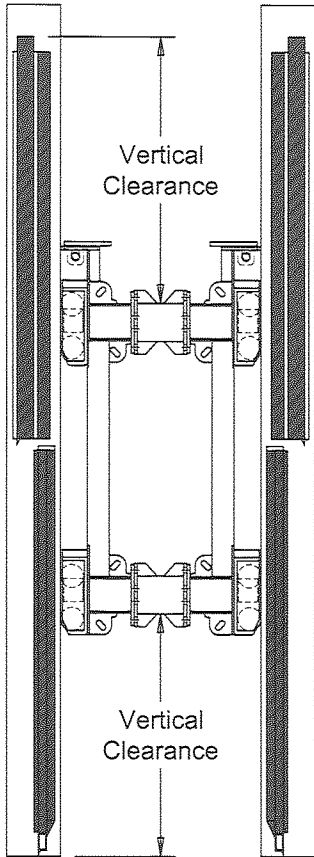
MAXIMUM VERTICAL CLEARANCE A25 SOIL (FIG. 3.1)



**SLIDE RAIL SYSTEM
TABULATED
DATA**

ENGINEERING

VERTICAL CLEARANCE - TYPE B45 SOIL (FIG. 3.2)

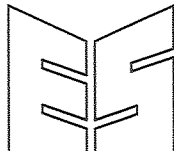


Notes:

- 1) Project horizontal line from Excavation Depth to Required Panel Length.
- 2) Project vertical line from Panel Length downward to determine the Maximum Vertical Clearance of the application.

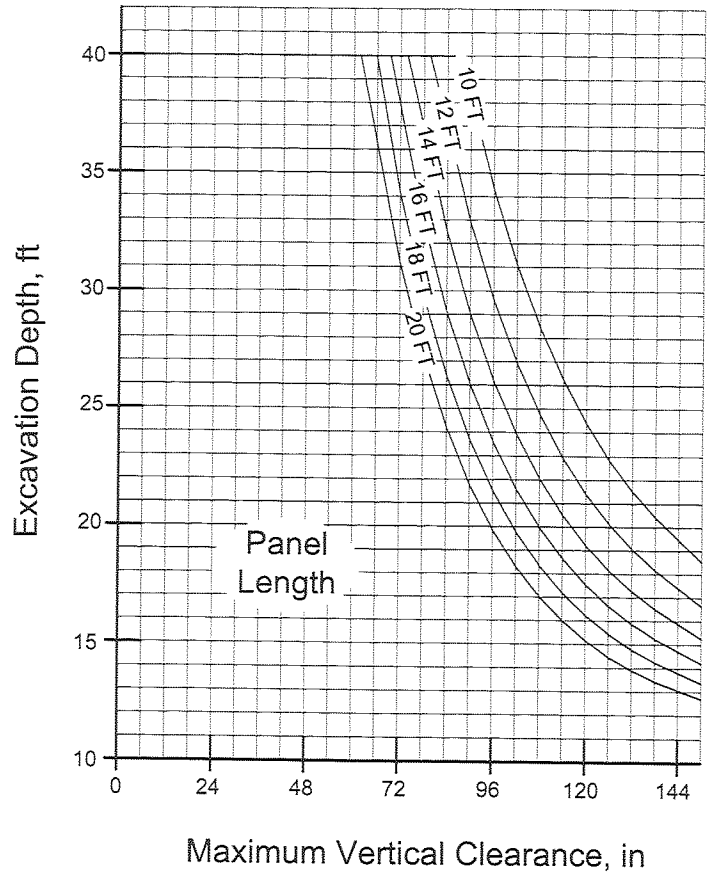
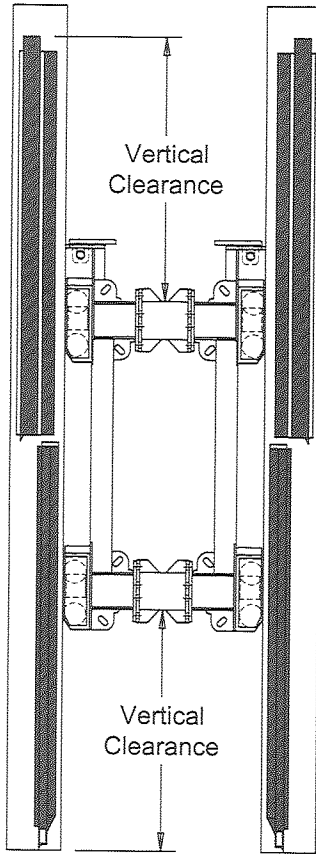
MAXIMUM VERTICAL CLEARANCE B45 SOIL (FIG. 3.2)

ENGINEERING



SLIDE RAIL SYSTEM
TABULATED DATA

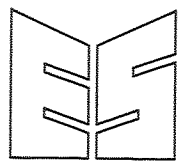
VERTICAL CLEARANCE - TYPE C60 SOIL (FIG. 3.3)



Notes:

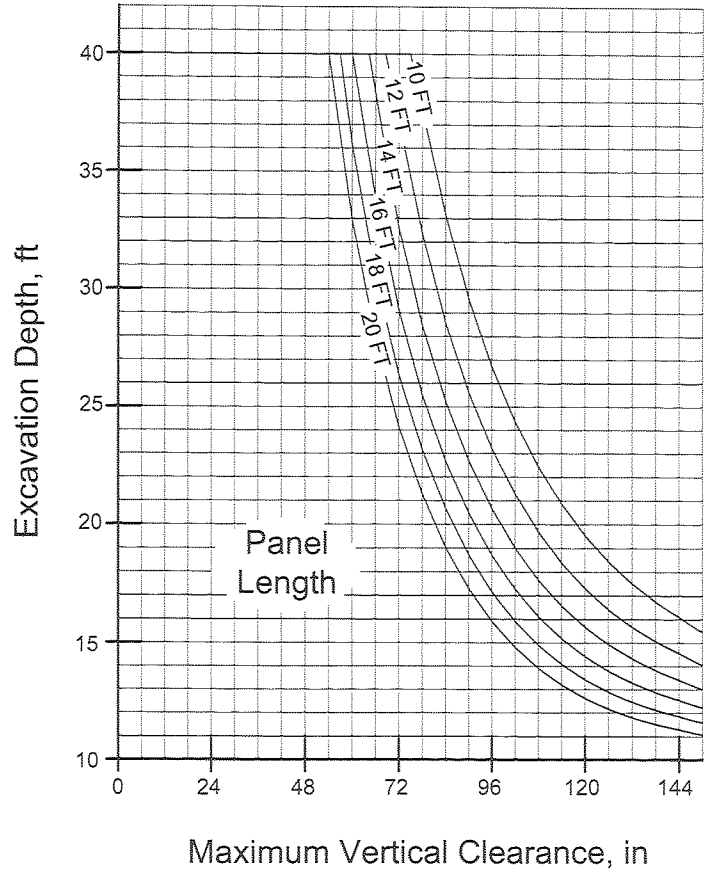
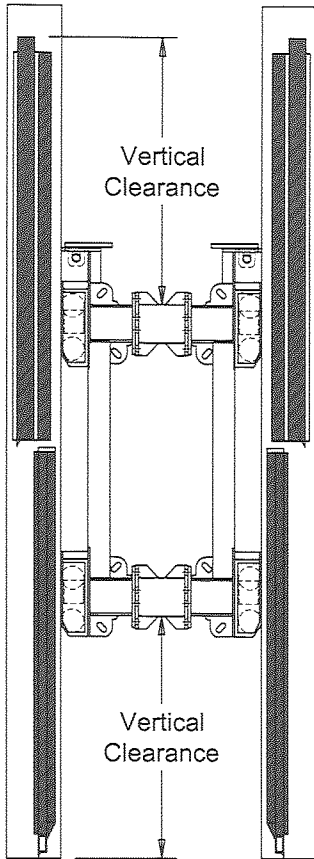
- 1) Project horizontal line from Excavation Depth to Required Panel Length.
- 2) Project vertical line from Panel Length downward to determine the Maximum Vertical Clearance of the application.

MAXIMUM VERTICAL CLEARANCE C60 SOIL (FIG. 3.3)



**SLIDE RAIL SYSTEM
TABULATED
DATA**

VERTICAL CLEARANCE - TYPE C80 SOIL (FIG. 3.4)

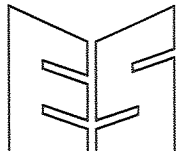


Notes:

- 1) Project horizontal line from Excavation Depth to Required Panel Length.
- 2) Project vertical line from Panel Length downward to determine the Maximum Vertical Clearance of the application.

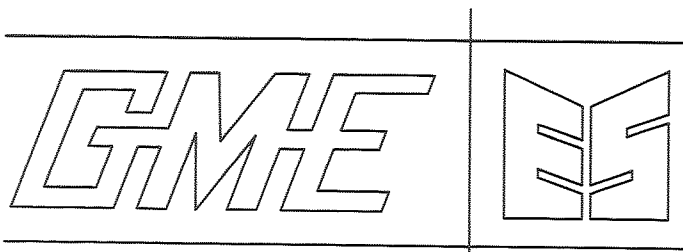
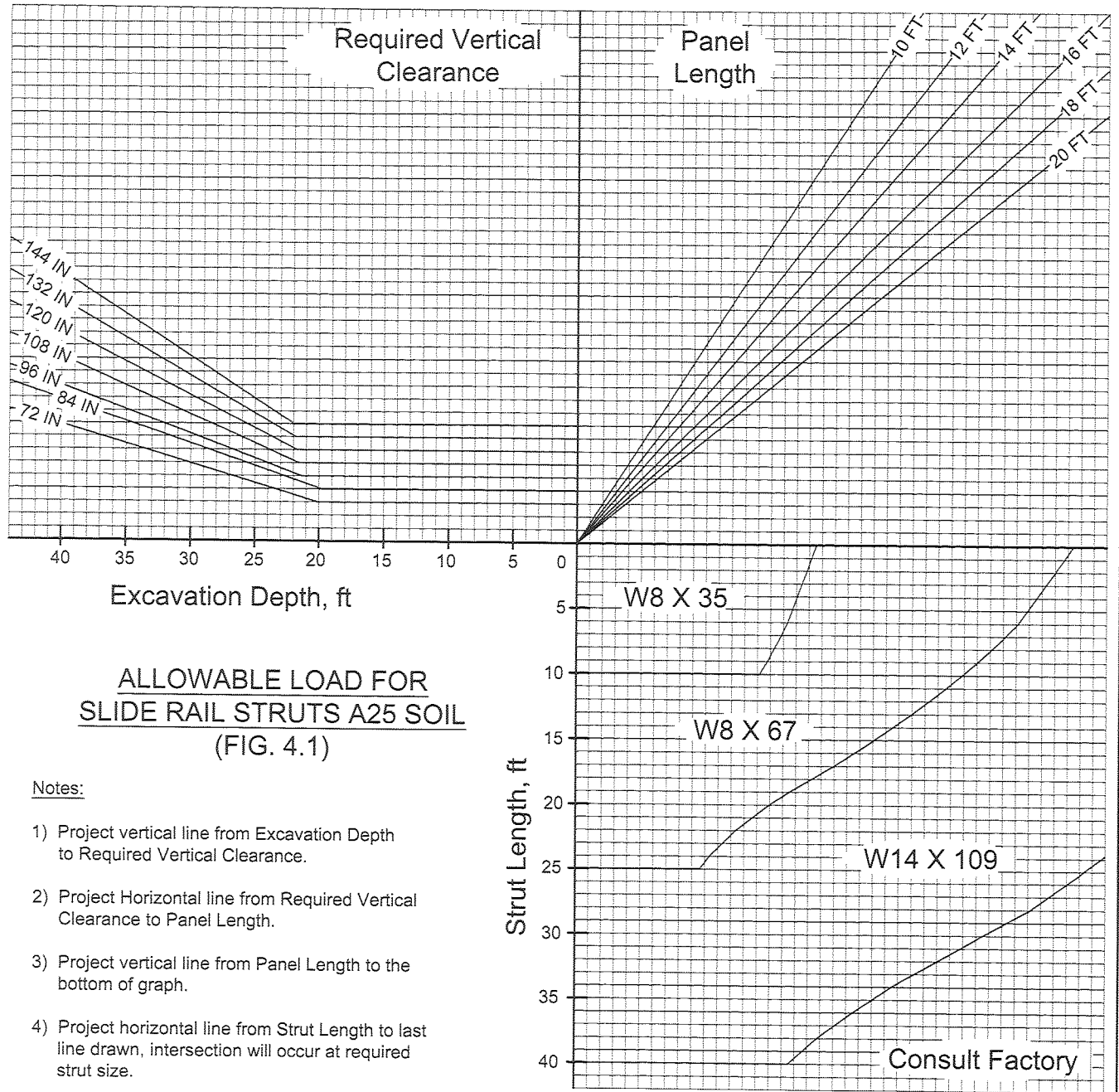
MAXIMUM VERTICAL CLEARANCE C80 SOIL (FIG. 3.4)

ENGINEERING



SLIDE RAIL SYSTEM
TABULATED DATA

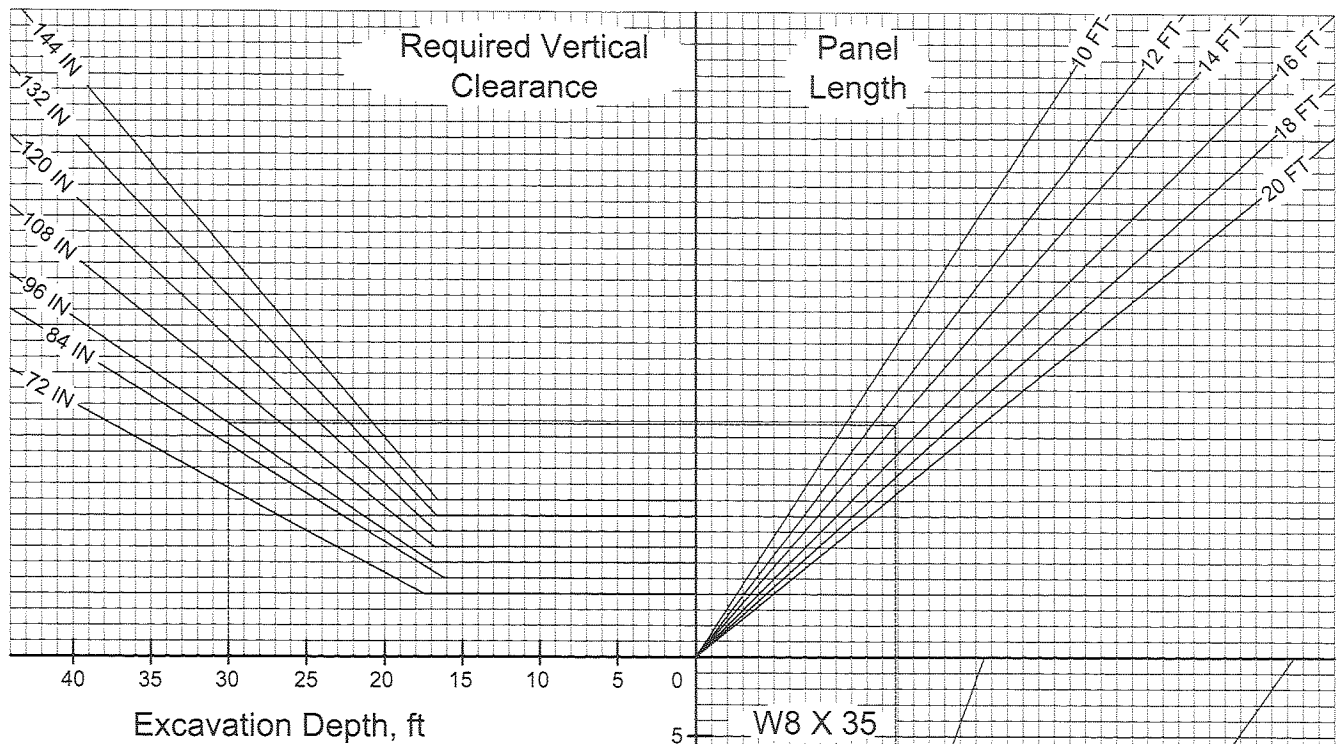
STRUT SIZE - TYPE A25 SOIL (FIG. 4.1)



SLIDE RAIL SYSTEM
TABULATED DATA

ENGINEERING

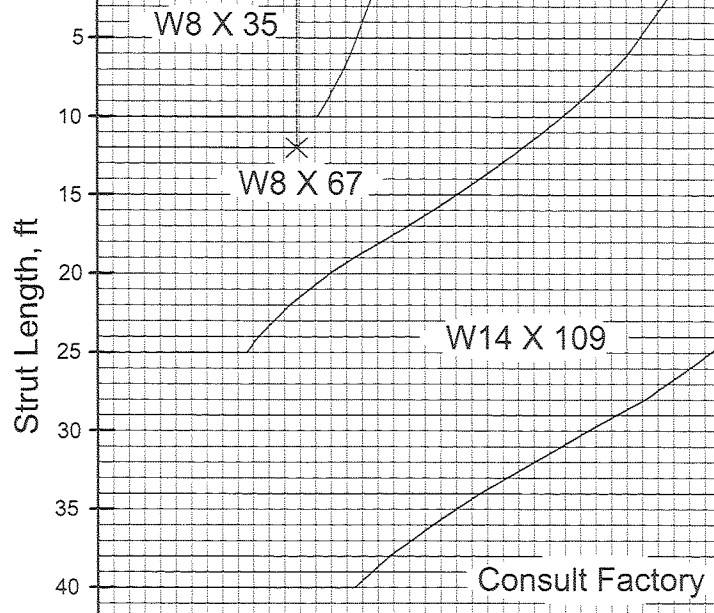
STRUT SIZE - TYPE B45 SOIL (FIG. 4.2)



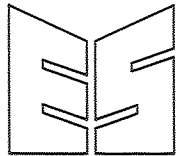
ALLOWABLE LOAD FOR SLIDE RAIL STRUTS B45 SOIL (FIG. 4.2)

Notes:

- 1) Project vertical line from Excavation Depth to Required Vertical Clearance.
- 2) Project Horizontal line from Required Vertical Clearance to Panel Length.
- 3) Project vertical line from Panel Length to the bottom of graph.
- 4) Project horizontal line from Strut Length to last line drawn, intersection will occur at required strut size.

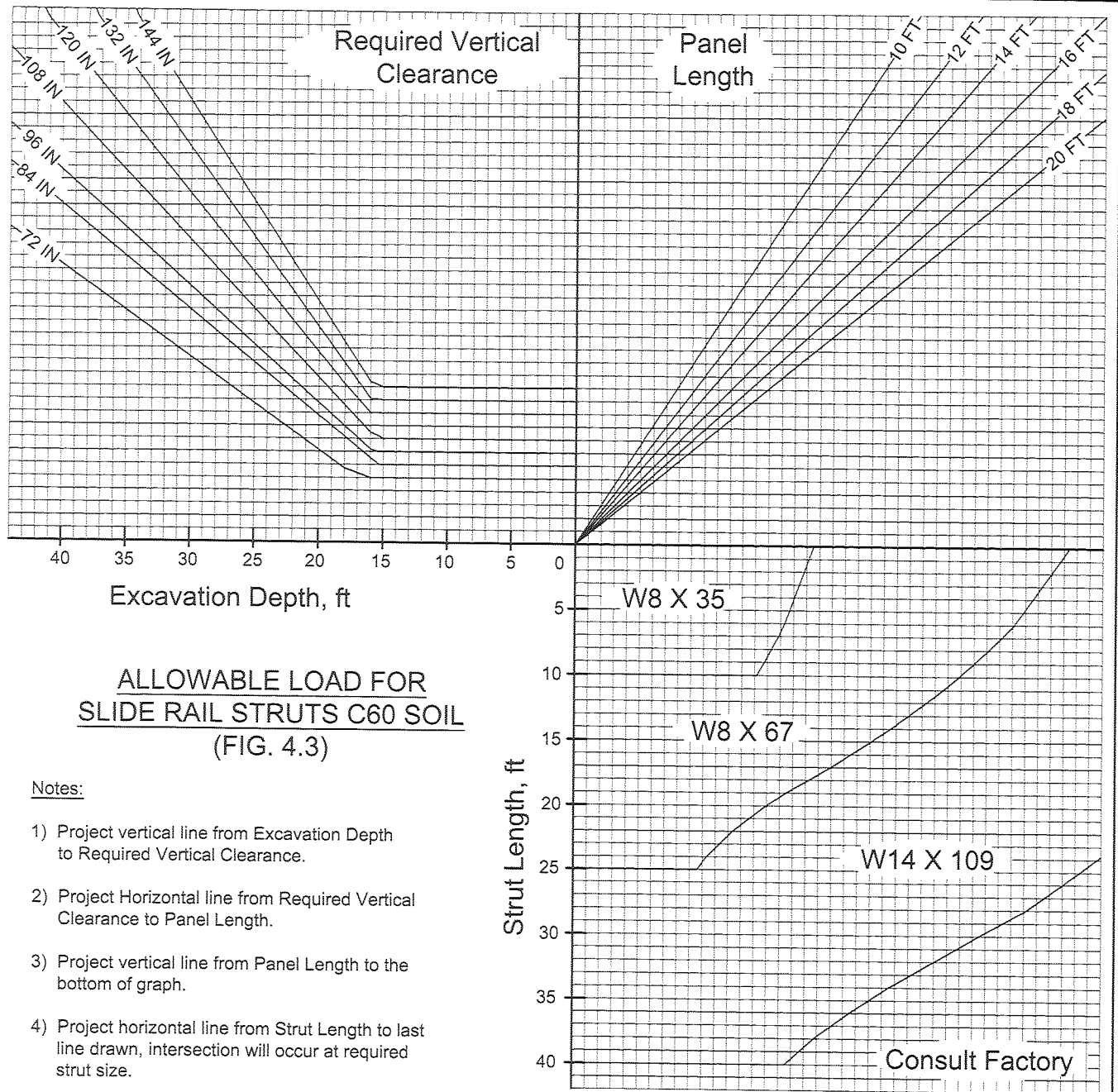


ENGINEERING



SLIDE RAIL SYSTEM
TABULATED DATA

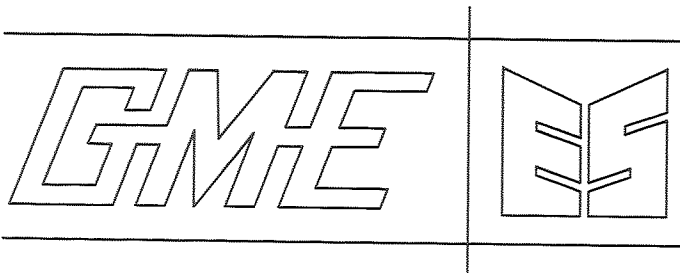
STRUT SIZE - TYPE C60 SOIL (FIG. 4.3)



ALLOWABLE LOAD FOR SLIDE RAIL STRUTS C60 SOIL (FIG. 4.3)

Notes:

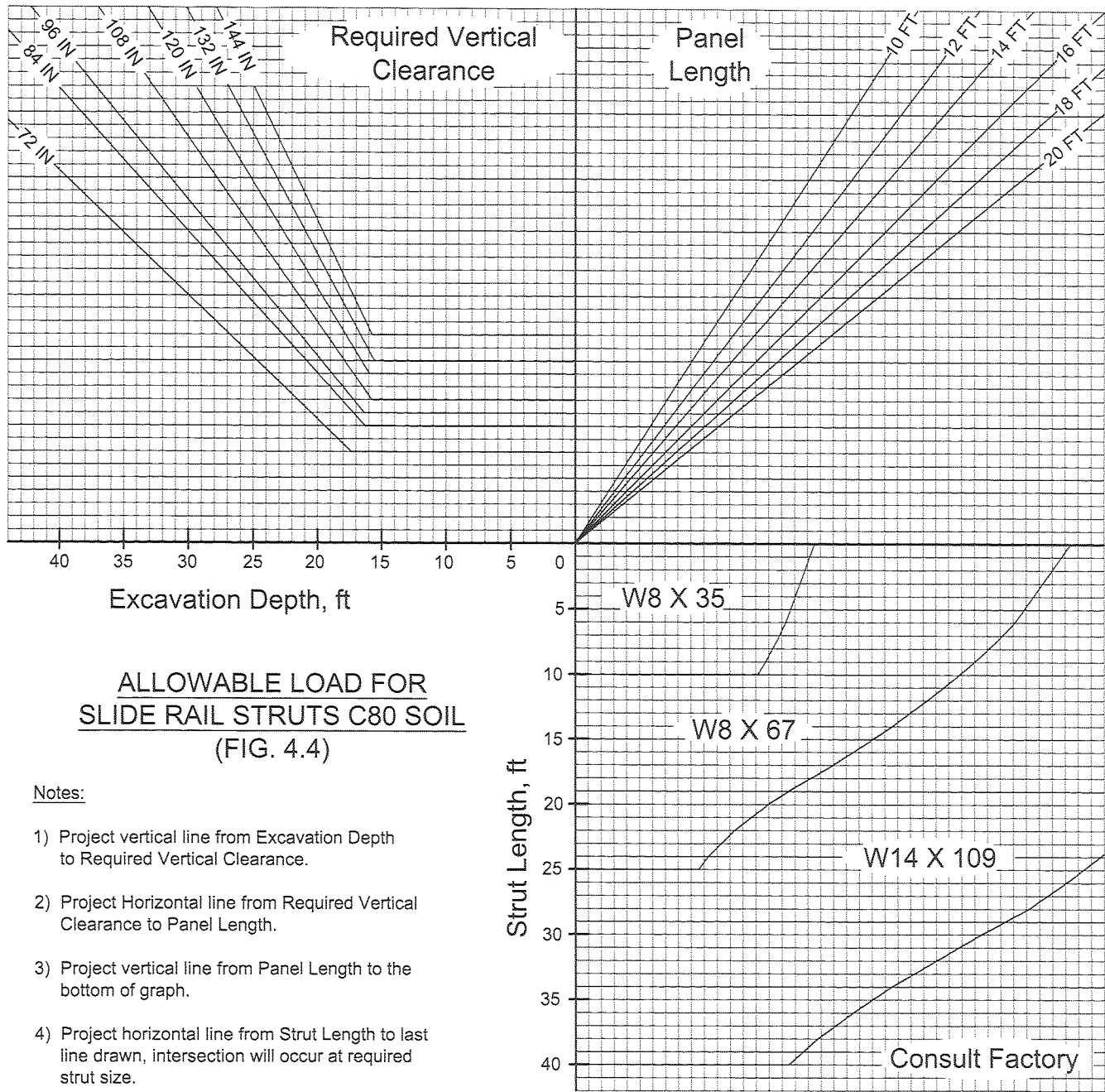
- 1) Project vertical line from Excavation Depth to Required Vertical Clearance.
- 2) Project Horizontal line from Required Vertical Clearance to Panel Length.
- 3) Project vertical line from Panel Length to the bottom of graph.
- 4) Project horizontal line from Strut Length to last line drawn, intersection will occur at required strut size.



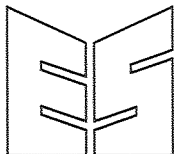
SLIDE RAIL SYSTEM
TABULATED DATA

ENGINEERING

STRUT SIZE - TYPE C80 SOIL (FIG. 4.4)

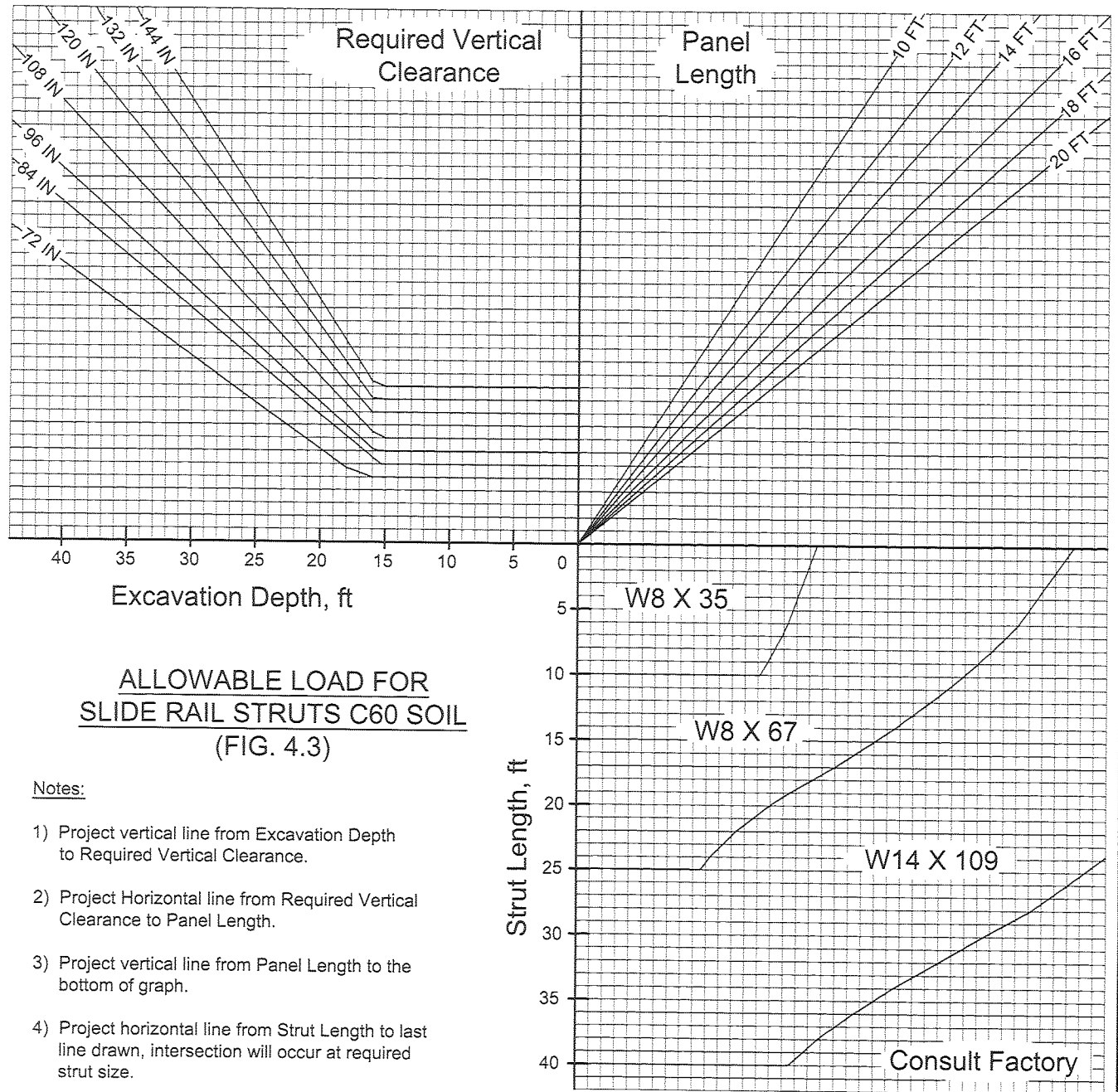


ENGINEERING



SLIDE RAIL SYSTEM
TABULATED DATA

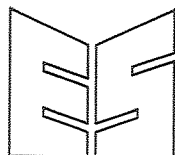
STRUT SIZE - TYPE C60 SOIL (FIG. 4.3)



ALLOWABLE LOAD FOR SLIDE RAIL STRUTS C60 SOIL (FIG. 4.3)

Notes:

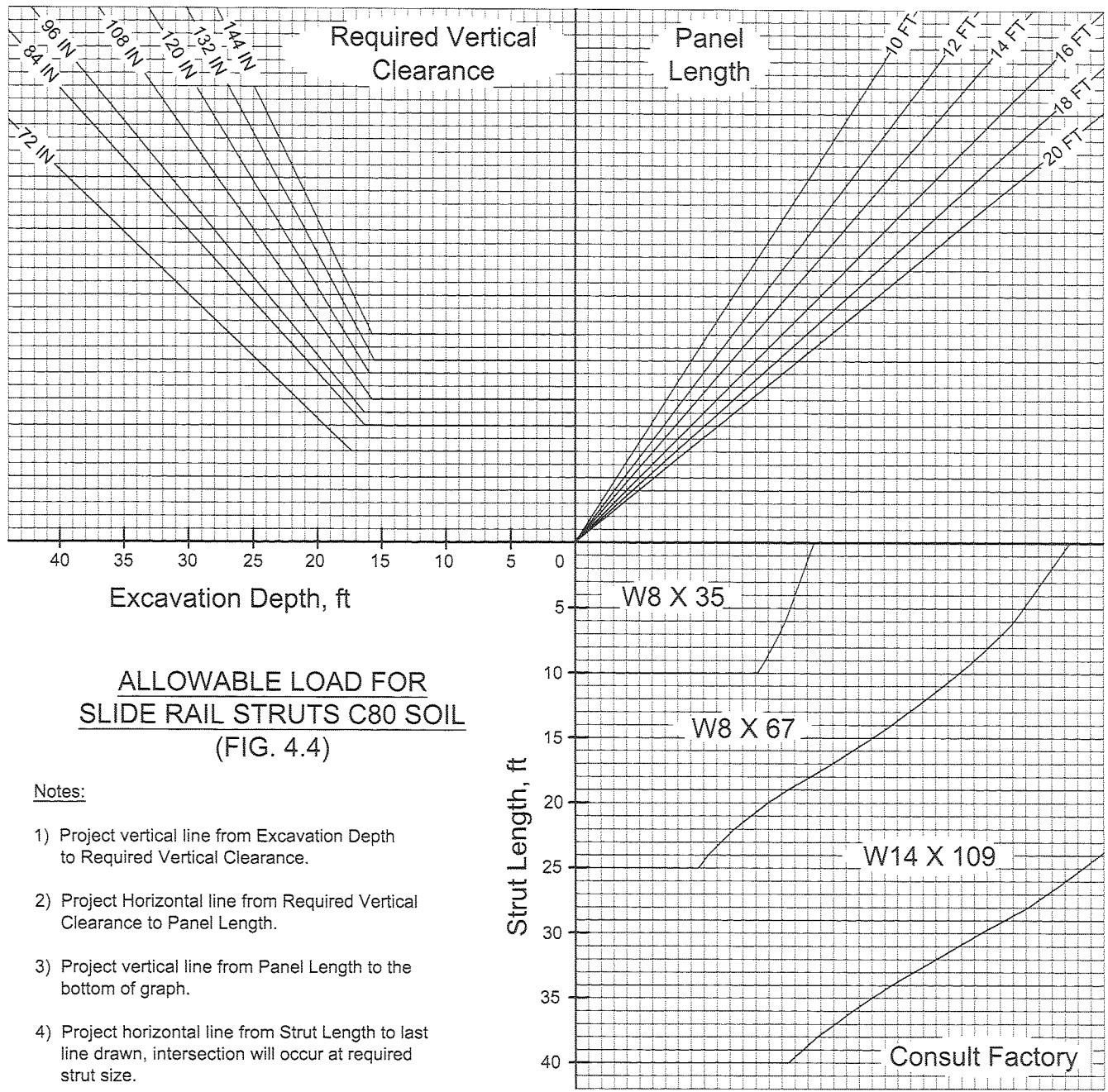
- 1) Project vertical line from Excavation Depth to Required Vertical Clearance.
- 2) Project Horizontal line from Required Vertical Clearance to Panel Length.
- 3) Project vertical line from Panel Length to the bottom of graph.
- 4) Project horizontal line from Strut Length to last line drawn, intersection will occur at required strut size.



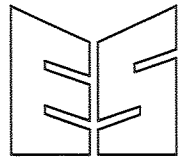
SLIDE RAIL SYSTEM
TABULATED DATA

ENGINEERING

STRUT SIZE - TYPE C80 SOIL (FIG. 4.4)

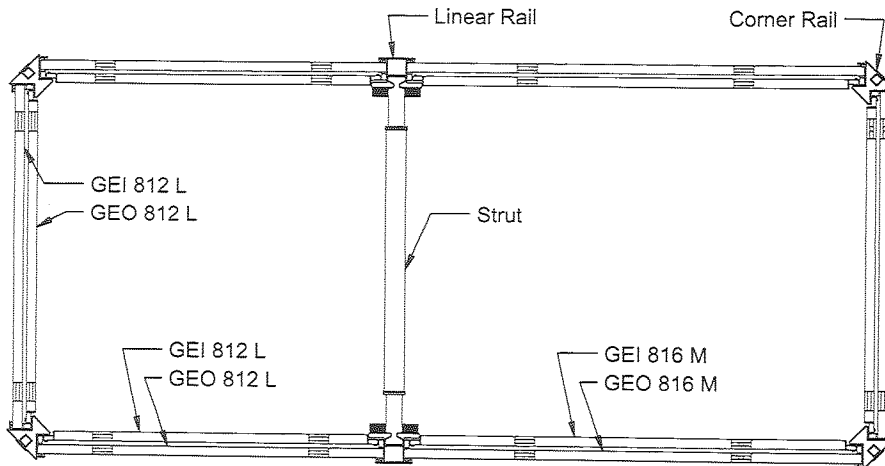


ENGINEERING

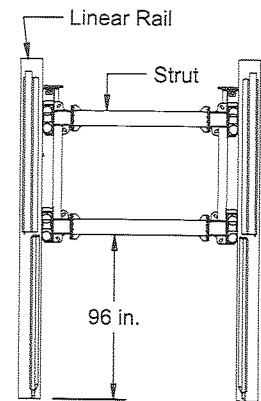


SLIDE RAIL
SYSTEM
TABULATED
DATA

SAMPLE APPLICATION (FIG. 5.1)



PLAN VIEW



SECTION VIEW

Given:

Excavation Size: H = 16 ft, W = 12 ft, L = 28 ft.
 Total Excavation Depth = 30 ft.
 Soil Type = B45
 Required Vertical Clearance = 96 in.

Check Slide Rail Panels:

Inside Panels must be rated for the full excavation depth. From Figure 2.1,

GEI 812 L = 44 ft. B45 Soil > 30 ft. (OK)
 GEI 816 M = 37 ft. B45 Soil > 30 ft. (OK)

Outside Panels can be rated for the depth at which they are located:

Depth = Excavation Depth - Inside Panel Height
 = 30 ft - 8 ft
 = 22 ft

From Figure 2.1,

GEI 812 L = 41 ft. B45 Soil > 22 ft. (OK)
 GEI 816 M = 37 ft. B45 Soil > 22 ft. (OK)

Check Vertical Clearance:

Determine Equivalent Panel Length (EPL):

$$\begin{aligned} \text{EPL} &= \text{Panel Length A} + \text{Panel Length B} \\ &= (12 \text{ ft.} + 16 \text{ ft.}) / 2 \\ &= 14 \text{ ft. (Use 14 ft. Panel)} \end{aligned}$$

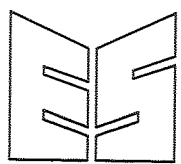
Using Figure 3.2 at an Excavation Depth of 30 ft,

Maximum vertical Clearance = 99 in. > 96 in. (OK)

Determine Strut Size:

Using Figure 4.2 at an Excavation Depth of 30 ft, 96 in. Vertical Clearance, an Equivalent Panel Length = 14 ft. (see above), and a Strut Width = 12 ft:

Required Strut Size = W8 x 35



**SLIDE RAIL
 SYSTEM
 TABULATED
 DATA**

Site

Specific

Trench Safety

Engineering

Plans



EXCAVATION SHORING QUESTIONNAIRE

Salesman _____ Quote Number _____
 Contractor _____
 Contact _____ Contact Phone _____
 Contact E-Mail _____ Contact Fax _____
 Is Job Bidding _____ Bid Date _____
 Project Name _____
 Project City, State _____
 Dodge Number _____

GENERAL INFORMATION

What is being constructed (Pipeline, lift station....) _____
 Soils information: Borelogs Geotechnical Report Other
 If other, explain _____
 Will contractor dewater to base of cut behind shoring _____
 If not, what are dewatering plans if any _____
 Adjacent building structures _____
 Description and distance from shoring _____
 Adjacent railroad tracks/how many _____
 Distance from centerline of tracks to closest edge of shoring _____
 Any utilities crossing shoring _____
 Depth, size and angle to shoring _____
 Any overhead obstructions _____
 Access on all sides of pit _____
 Is deflection of shoring a concern (if so, explain) _____
 Any special provisions in project specs regarding shoring _____
 Customers equipment for installing shoring _____
 Any contaminated soils on this project (Yes, No, Details) _____

TRENCH QUESTIONS

Max cut depth _____
 If benching/shoring - total cut depth _____ shoring depth _____
 What is being constructed _____
 Pipe diameter/structure dimensions _____
 Pipe/structure joint lengths _____
 Width of trench _____
 Required vertical clearance from base of trench _____
 Required horizontal clearance between struts _____
 Pouring base slab or can sacrificial struts be used _____

ENGINEERING

PIT QUESTIONS

Max cut depth _____
If benching/shoring - total cut depth _____ shoring depth _____
What is being constructed _____
Outside dimensions of structure _____
Outside dimensions of structure base slab _____
Min inside dim. of shoring (clear to shoring or wales) _____
Base slab being placed (if so, dimensions) _____
Lift heights of walls (if applicable for phasing) _____
Can bracing be phased and removed as soils is backfilled against walls _____

BORE/REC. PIT QUESTIONS

Max cut depth _____
If benching/shoring - total cut depth _____ shoring depth _____
Requested pit size _____
Required clearance to strut (if applicable) _____
How much vertical clearance from base of cut _____
Is base slab or base rock being placed _____

WHAT SHORING OPTIONS ARE BEING CONSIDERED (CHECK APPLICABLE)

Slide Rail Trench Shields
Vertical Shores Manhole Braces
Cantilever Beam and Plate Cantilever Sheet Pile
Braced Beam and Plate Braced Sheet Pile
GF Mega Brace GF Super Mega
NES Mega Brace NES Shore Brace
GF Shore Brace
Other _____

SHEETING AND MEGA BRACE QUESTIONS

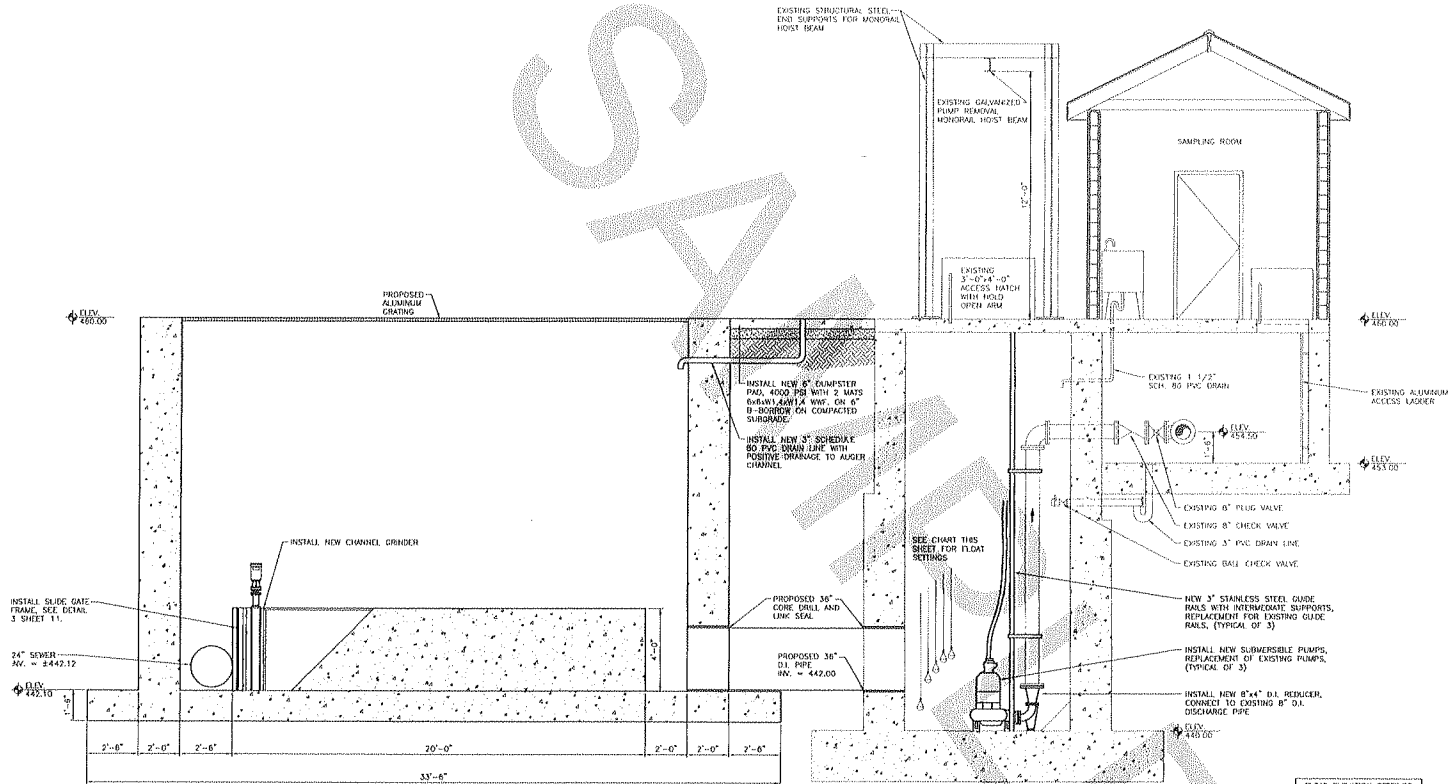
Is phasing and removing/relocating bracing or struts possible _____
Describe phasing _____
Limitations on equipment availability _____
Sheet piles for purchase/rent _____
Desired sheet pile sizes _____
Sheet piles to be abandoned _____

Customer agrees that all information outlined in this questionnaire is true and accurate to the best of their knowledge, and will contact United Rentals if new information is obtained, or changes observed

Customer (Sign)

Customer (Print)

Date



FLOAT ELEVATION SETTINGS	
LEAD PUMP OFF	441.00
LEAD PUMP ON/ LAG PUMP 1 OFF	442.35
LAG PUMP 1 ON/ LAG PUMP 2 OFF	442.83
LAG PUMP 2 ON	443.35
HIGH WATER ALARM	443.50

PROPOSED LIFT STATION SECTION
SCALE: 3/8"=1'-0"

REVISIONS		
LTR	DESCRIPTION	BY

Proposed Lift Station Section

DRAWN BY K.E.W. CHECKED BY DATE FEBRUARY 22, 2010 SCALE AS SHOWN SHEET <div style="text-align: center; font-size: 24pt; font-weight: bold;">10</div>	2000-2001
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LOG OF BORING B-6

Sheet 1 of 1

PSI Job No.: 0016-127
 Project: Proposed Plant One Upgrades
 Location:

Drilling Method: 3 1/4" I.D. Hollow Stem Auger
 Sampling Method: Shelby Tube/Split Spoon
 Hammer Type: CME Automatic
 Boring Location:

WATER LEVELS

White Drilling 6 Feet
 Upon Completion 6 Feet
 N/A N/A

Elevation, (feet)	Depth, (feet)	Graphic Log Sample Type	Sample No.	Recovery (Inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch	Moisture, %	STRENGTH, tsf	Additional Remarks
0					6 inches of TOPSOIL					
	0	X	1/SS	18	SILTY CLAY - and sand - trace gravel - stiff - brown	CL	9-6-7 N=13	24	X	>>*
	5	X	2/SS	18			9-5-7 N=12	18	X	*
		X	3/SS	18	SILTY FINE TO COARSE SAND - trace gravel - loose to medium - wet - brown	SM	5-3-4 N=7			
	10	X	4/SS	18			5-6-7 N=13			
	15	X	5/SS	13	SILTY CLAY - and sand - trace gravel - stiff to very stiff - gray	CL	5-6-6 N=12	18	*	X
	20	X	6/SS	18			6-9-17 N=23	9	X	
	25	X	7/SS	8	SILTY CLAY - and sand - trace gravel - stiff - gray	CL	7-9-13 N=22	15	X	>>*
	30	X	8/SS	18			6-7-9 N=16	14		
	35	X	9/SS	18	Cave depth at 29 feet after removal of augers. BORING TERMINATED AT 40 FEET		5-6-9 N=15	20	*	X
	40	X	10/SS	18			7-8-8 N=17	18		

ENGINEERING

Completion Depth: 40.0 ft
 Date Boring Started: 7/10/08
 Date Boring Completed: 7/10/08
 Logged By: EJB
 Drilling Contractor: PSI, Inc.

Sample Types:

Auger Cutting	Shelby Tube
Split-Spoon	Grab sample
Rock Core	DCP

Latitude:
 Longitude:
 Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG OF BORING B-7

Sheet 1 of 1

PSI Job No.: 0016-127
 Project: Proposed Plant One Upgrades
 Location:

Drilling Method: 3 1/4" I.D. Hollow Stem Auger
 Sampling Method: Shelby Tube/Split Spoon
 Hammer Type: CME Automatic
 Boring Location:

WATER LEVELS	
▽ While Drilling	18 Feet
▽ Upon Completion	17 Feet
▽ N/A	N/A

Elevation, (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (Inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch	STANDARD PENETRATION TEST DATA		Additional Remarks
									N in blows/ft	Moisture, %	
0						6 inches of TOPSOIL					
	5		1/SS	18		SILTY CLAY - and sand - trace gravel - stiff - brown	CL	5-6-7 N=13	10	X ⊙	>>*
	5		2/SS	17			CL	4-5-8 N=13	10	X ⊙	>>*
	10		3/SS	13			CL	2-3-4 N=7	15	⊙ X*	
	10		4/SS	13			CL	3-3-3 N=6	16	⊙ X*	
	15		5/SS	17			CL	2-3-4 N=7	12	⊙ X*	
	20		6/SS	8		SILTY CLAY - and sand - trace gravel - with occasional sand seams - medium to very stiff - gray	CL	3-7-13 N=20	15	X* ⊙	
	25		7/SS	18			CL	6-7-13 N=20	15	X ⊙	>>*
	30		8/SS	18			SM	6-13-17 N=30			
	35		9/SS	18		SILTY FINE TO COARSE SAND - trace gravel - medium to dense - wet - gray	SM	13-17-24 N=41			
	40		10/SS	18		SILTY FINE TO COARSE SAND - trace gravel - medium - wet - gray Cave depth at 29 feet after removal of augers. BORING TERMINATED AT 40 FEET	SM	6-7-9 N=16			

Completion Depth: 40.0 ft
 Date Boring Started: 7/10/08
 Date Boring Completed: 7/10/08
 Logged By: EJB
 Drilling Contractor: PSI, Inc.

Sample Types:
 Auger Cutting
 Split-Spoon
 Rock Core
 Shelby Tube
 Grab sample
 DCP

Latitude:
 Longitude:
 Remarks:

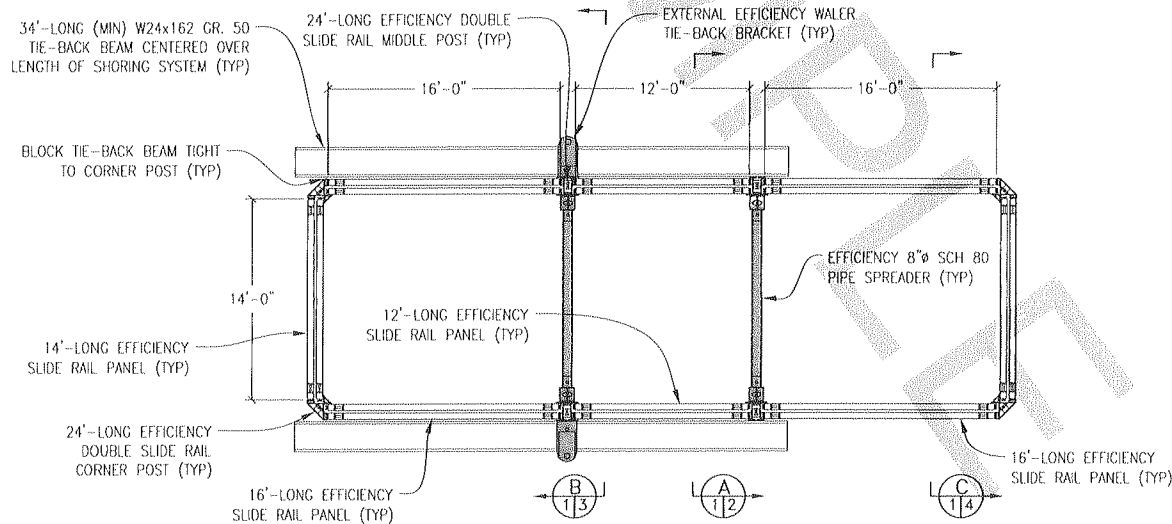
The stratification lines represent approximate boundaries. The transition may be gradual.

ENGINEERING

SHORING DESIGN PLAN - BORE PIT #4
WEST SIDE DIVERSION
UNDERGROUND SEWER TUNNEL
DAVENPORT, IA
UNITED RENTALS - TRENCH SAFETY

NOTES:

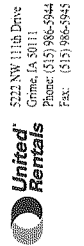
- SHORING DESIGN BASED ON SITE SOILS CONSISTING OF MEDIUM CLAY AS OUTLINED IN PROJECT BORING NO. 37 DATED 10-21-04 PREPARED BY TERRACON AND PROVIDED BY THE CONTRACTOR. CONTACT SHORING ENGINEER IF LESS COMPETENT MATERIALS ARE ENCOUNTERED.
- THIS SHORING PLAN HAS BEEN DESIGNED SPECIFICALLY FOR (1) EXCAVATION AT "BORE PIT #4". USE OF THIS PLAN ON ALTERNATE OR ADDITIONAL EXCAVATIONS IS STRICTLY PROHIBITED WITHOUT WRITTEN APPROVAL FROM D.H. CHARLES ENGINEERING, INC.
- SLIDE RAIL SYSTEM SHALL BE CERTIFIED EFFICIENCY ASSEMBLIES. TABULATED DATA SHALL BE PROVIDED AT JOBSITE, AND MANUFACTURER'S TABULATED DATA APPLIES EXCEPT AS IS NOTED HERE.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ACCESS, BARRICADING, AND FALL PROTECTION, IN ACCORDANCE WITH ALL OSHA GUIDELINES.
- SHORING MUST BE PROPERLY INSTALLED PRIOR TO WORKERS ENTERING EXCAVATION. WORKERS MAY ONLY ENTER, EXIT, AND WORK WITHIN SHORED AREAS.
- STEEL I-BEAMS TO BE ASTM A572 OR A992 GR. 50, MIN. Fy = 50 KSI. STEEL PIPE TO BE ASTM A53 GRADE B, MIN. Fy = 35 KSI.
- TIE-BACK BEAMS AND STRUTS SHALL BE IN GOOD CONDITION AND SHALL BE FREE OF ANY HOLES OR VISUAL DEFECTS, UNLESS APPROVED IN WRITING BY THE SHORING ENGINEER.
- TIE-BACK ASSEMBLIES SHALL BE BY EFFICIENCY, RATED FOR AT LEAST 100,000 LBS. EACH, AND INSTALLED IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE MANUFACTURER.
- CONTRACTOR MUST CAREFULLY FOLLOW SEQUENCING OUTLINED ON THESE PLANS, AND CONTACT ENGINEER IF ANY VARIANCES ARE REQUIRED TO PERFORM WORK.
- ALL VOIDS BETWEEN THE EXCAVATED SOIL AND THE FACE OF THE SHORING SYSTEM MUST BE BACKFILLED WITH EXCAVATED SOIL OR OTHER APPROVED BACKFILL PRIOR TO WORKERS ENTERING THE EXCAVATION. FOR EXCAVATIONS ADJACENT TO TRAFFIC LOADING, ALL VOIDS SHALL BE BACKFILLED WITH SAND OR CLASS II AGGREGATE BASE MATERIAL.
- GROUNDWATER LEVEL MUST BE MAINTAINED AT OR BELOW THE MINIMUM LEVEL SHOWN ON THESE PLANS AT ALL TIMES. IF DEWATERING SYSTEM IS NECESSARY TO ACHIEVE THIS, IT IS THE CONTRACTOR'S RESPONSIBILITY FOR DEVELOPING, INSTALLING, AND MONITORING DEWATERING SYSTEM, AND VERIFYING THAT THE GROUNDWATER LEVEL BEHIND THE SHORING WALLS HAS BEEN LOWERED AT LEAST TO THE MINIMUM LEVEL SHOWN ON THESE PLANS AT ALL TIMES. IF CONTRACTOR IS UNABLE TO LOWER THE GROUNDWATER TO THE LEVEL SHOWN, CONTACT THE SHORING ENGINEER IMMEDIATELY.
- D.H. CHARLES ENGINEERING, INC. WILL NOT SUPERVISE, DIRECT, CONTROL OR HAVE AUTHORITY OVER OR BE RESPONSIBLE FOR CONTRACTOR'S MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES OF CONSTRUCTION, OR THE SAFETY PRECAUTIONS AND PROGRAMS INCIDENT THERETO, OR FOR ANY FAILURE OF CONTRACTOR TO COMPLY WITH LAWS AND REGULATIONS APPLICABLE TO THE FURNISHING OR PERFORMANCE OF WORK.
- THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE ACCURACY OF ALL DIMENSIONS FOR BOTH EXISTING AND PROPOSED WORK, AND SHALL VERIFY THAT REQUIRED CLEARANCES ARE OBTAINED PRIOR TO COMMENCEMENT OF THE WORK.
- THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING THE EXCAVATION.
- D.H. CHARLES ENGINEERING, INC. BEARS NO RESPONSIBILITY OR LIABILITY FOR ANY SETTLEMENT, MOVEMENT, OR DAMAGE OF ANY KIND THAT MAY OCCUR TO SURROUNDING SOILS, EXISTING BUILDING STRUCTURES, OR UTILITIES DUE TO SHORING INSTALLATION, DEFLECTION, REMOVAL, OR OTHER CONSTRUCTION ACTIVITIES.



PLAN VIEW - BORE PIT #4
SCALE: 1/8"=1'-0"

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN -
BORE PIT #4
WEST SIDE DIVERSION
UNDERGROUND SEWER TUNNEL
DAVENPORT, IA
UNITED RENTALS - TRENCH
SAFETY



DATE:	03-08-10
DRAFTER:	ISM
CHECKED BY:	JCY
SHEET 1 OF 4	REV 0
DRAWING NO.:	10A-178

SHORING DESIGN PLAN - BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH SAFETY

SETBACK TABLE	
CRANE TO 30 TON MAX	X = 8'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
CAT 345 EXCAVATOR	X = 14'
3 CY LOADER	X = 5'
5 CY LOADER	X = 5'
DUMPIRUCK	X = 5'
SPOIL PILE (6'-TALL)	X = 4'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 50'
RAILROAD TRACKS	X = 100'
STREET TRAFFIC	X = 6'

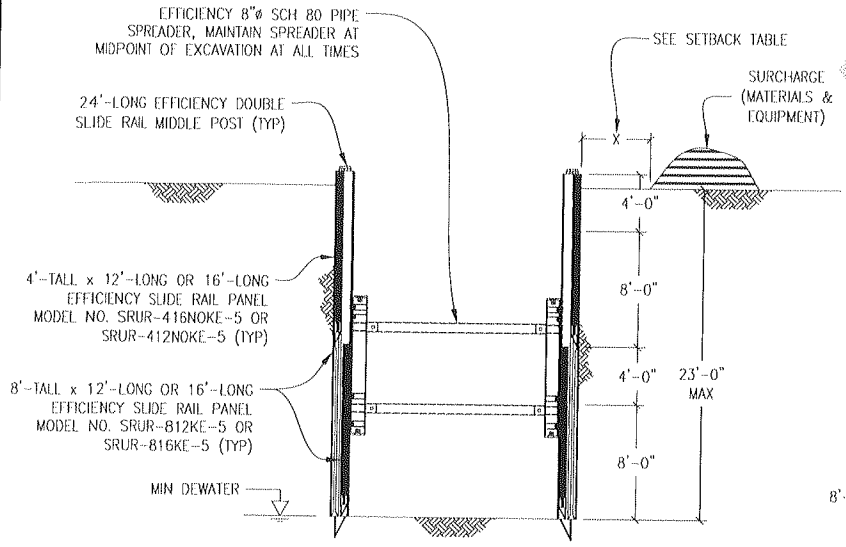
REVISIONS	
NO.	DATE

SHORING DESIGN PLAN -
 BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH
 SAFETY

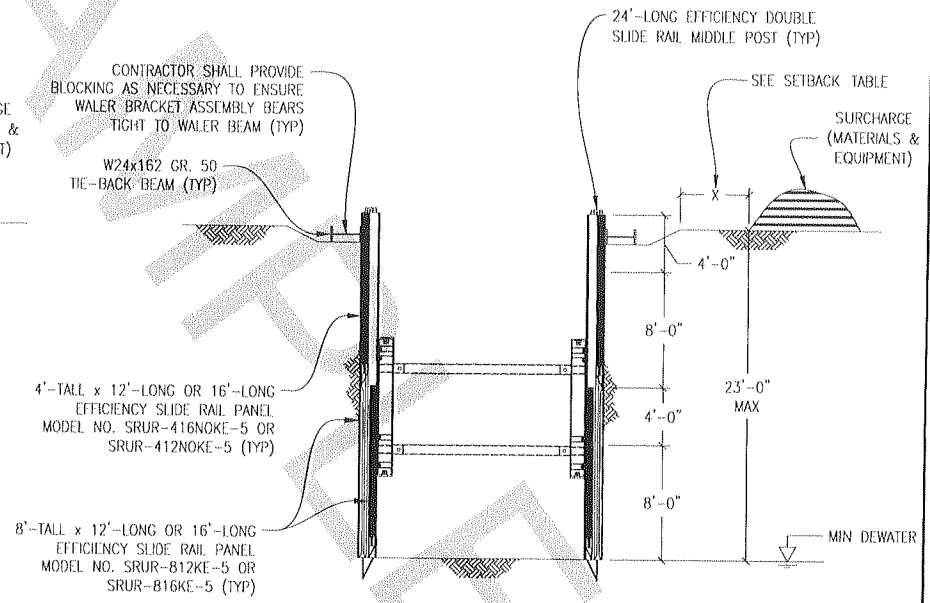
5222 NW 111th Drive
 Grimes, IA 50111
 Phone: (515) 986-5944
 Fax: (515) 986-5945


DATE: 03-08-10
 DRAFTER: TSM
 CHECKED BY: JCY
 SHEET 2 of 4
 DRAWING NO.: 10A-178
 REV: 0

PAGE 179



A
 1/2 SECTION - PHASE 1
 SCALE: 1/8"=1'-0"



A
 1/2 SECTION - PHASE 2
 SCALE: 1/8"=1'-0"

SAMPLE - SLIDE RAIL

ENGINEERING

SHORING DESIGN PLAN - BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH SAFETY

SETBACK TABLE	
CRANE TO 30 TON MAX	X = 8'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
CAT 345 EXCAVATOR	X = 14'
3 CY LOADER	X = 5'
5 CY LOADER	X = 5'
DUMPTRUCK	X = 5'
SPOIL PILE (6'-TALL)	X = 4'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 50'
RAILROAD TRACKS	X = 100'
STREET TRAFFIC	X = 6'

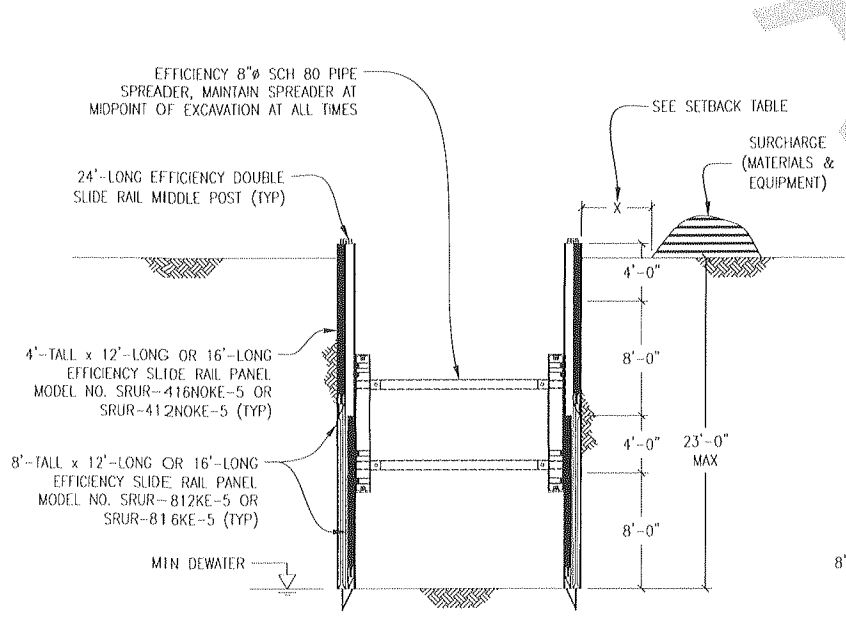
REVISIONS	
NO	DATE

SHORING DESIGN PLAN -
 BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH
 SAFETY

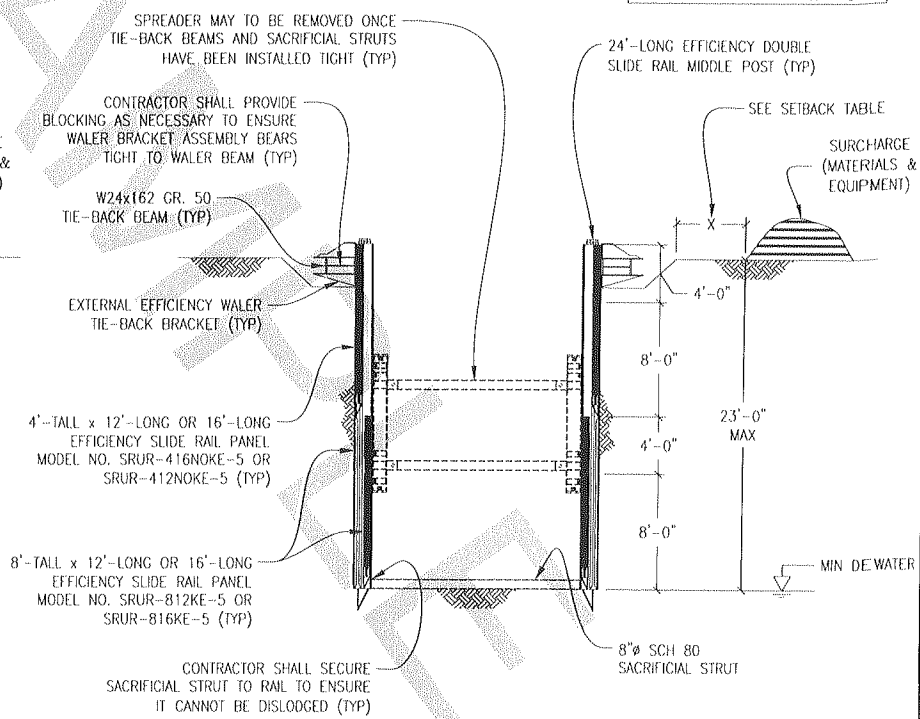
322 NW 11th Drive
 Clinton, IA 50111
 Phone: (515) 986-5944
 Fax: (515) 986-5945



PAGE 180



B SECTION - PHASE 1
 1/3 SCALE: 1/8"=1'-0"



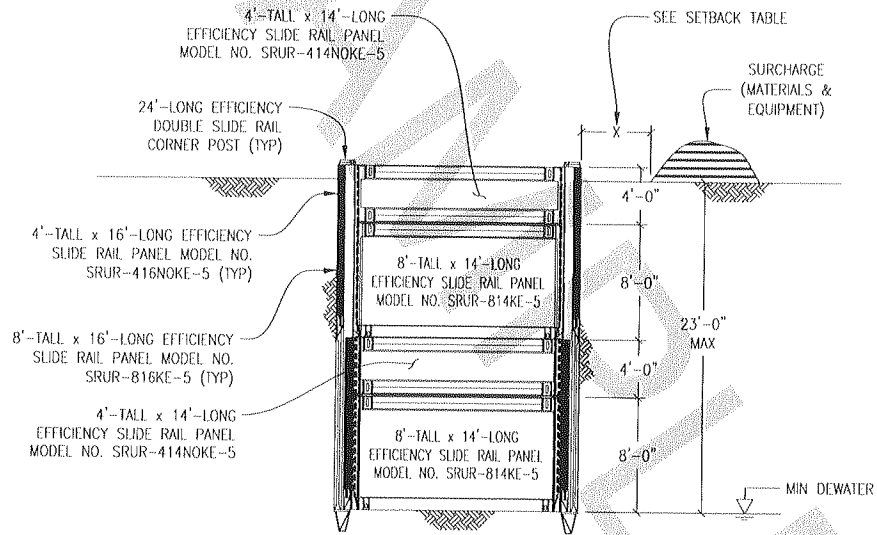
B SECTION - PHASE 2
 1/3 SCALE: 1/8"=1'-0"

SAMPLE - SLIDE RAIL

DATE:	03-08-10
DRAWN BY:	TSM
CHECKED BY:	JCY
SHEET:	3 OF 4
DRAWING NO.:	10A-178
REV:	0

SHORING DESIGN PLAN - BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH SAFETY

SETBACK TABLE	
CRANE TO 30 TON MAX	X = 8'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
CAT 345 EXCAVATOR	X = 14'
3 CY LOADER	X = 5'
5 CY LOADER	X = 5'
DUMPTRUCK	X = 5'
SPOIL PILE (6'-TALL)	X = 4'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 50'
RAILROAD TRACKS	X = 100'
STREET TRAFFIC	X = 6'



C
1/4 SECTION
SCALE: 1/8"=1'-0"

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN -
 BORE PIT #4
 WEST SIDE DIVERSION
 UNDERGROUND SEWER TUNNEL
 DAVENPORT, IA
 UNITED RENTALS - TRENCH SAFETY

5222 NW 111th Drive
 Grand, IA 50111
 Phone: (515) 986-5944
 Fax: (515) 986-5945

United Rentals

DATE: 03-08-10
 DRAFTER: TSM
 CHECKED BY: JCY
 SHEET 4 OF 4
 DRAWING NO.: 10A-178 REV 0

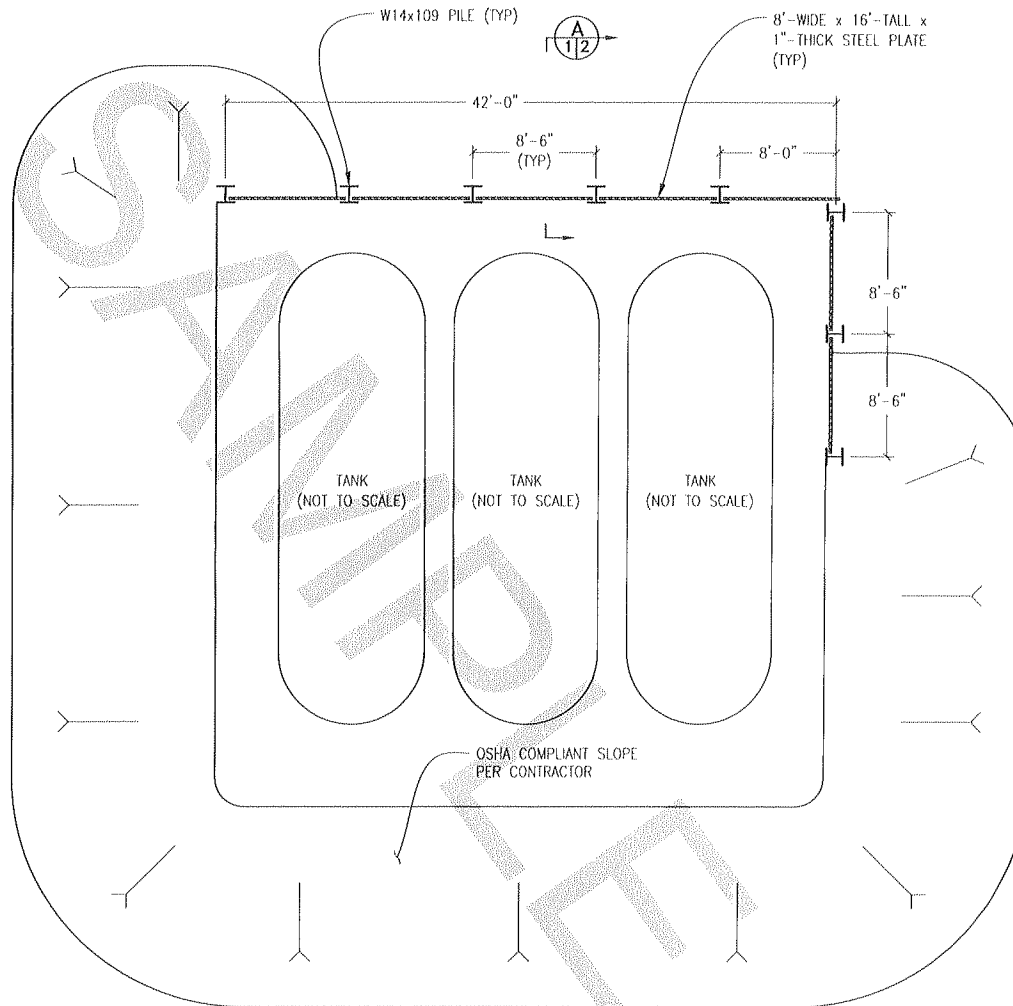
SAMPLE - SLIDE RAIL

SHORING DESIGN PLAN

UNITED RENTALS - TRENCH SAFETY

NOTES:

- SHORING DESIGN IS BASED ON SITE SOILS CONSISTING OF UNIFORM AND VERY STIFF CLAY THROUGHOUT ENTIRE LENGTH OF 30'-LONG PILE. CONTRACTOR MUST TAKE SPECIAL CARE DURING DRILLING, AND EXCAVATION OF PIT TO VERIFY SITE SOILS ARE STIFF CLAYS, OTHERWISE CONTACT ENGINEER IMMEDIATELY IF ANY LESS COMPETENT MATERIALS ARE ENCOUNTERED.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ACCESS, BARRICADING, AND FALL PROTECTION, IN ACCORDANCE WITH ALL OSHA GUIDELINES.
- ALL STEEL BEAMS MUST BE ASTM A572 OR A992 GR. 50 STEEL, MIN Fy = 50 KSI, UNLESS OTHERWISE NOTED. STEEL PLATES MAY BE ASTM A36, MIN. Fy = 36 KSI.
- SHORING MUST BE PROPERLY INSTALLED PRIOR TO WORKERS ENTERING EXCAVATION. WORKERS MAY ONLY ENTER, EXIT, AND WORK WITHIN SHORED AREAS.
- DRIVE/VIBRATE PILES OR PRE-DRILL 24" DIAMETER HOLES FOR PILES AND BACKFILL WITH ANGULAR BACKFILL SUCH AS 3/4" CRUSHED AGGREGATE OR ANGULAR PEA GRAVEL.
- ALL STEEL BEAMS USED FOR PILES SHALL BE IN GOOD CONDITION AND SHALL BE FREE OF ANY HOLES OR VISUAL DEFECTS IN THE FLANGES AND WEBS.
- ALL VOIDS BETWEEN THE EXCAVATED SOIL AND THE FACE OF THE SHORING SYSTEM MUST BE BACKFILLED WITH EXCAVATED SOIL OR OTHER APPROVED BACKFILL PRIOR TO WORKERS ENTERING THE EXCAVATION.
- GROUNDWATER LEVEL MUST BE MAINTAINED AT OR BELOW THE MINIMUM LEVEL SHOWN ON THESE PLANS AT ALL TIMES. IF DEWATERING SYSTEM IS NECESSARY TO ACHIEVE THIS, IT IS THE CONTRACTOR'S RESPONSIBILITY FOR DEVELOPING, INSTALLING, AND MONITORING DEWATERING SYSTEM, AND VERIFYING THAT THE GROUNDWATER LEVEL BEHIND THE SHORING WALLS HAS BEEN LOWERED AT LEAST TO THE MINIMUM LEVEL SHOWN ON THESE PLANS AT ALL TIMES. IF CONTRACTOR IS UNABLE TO LOWER THE GROUNDWATER TO THE LEVEL SHOWN, CONTACT THE SHORING ENGINEER IMMEDIATELY.
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PLAN VIEW
SCALE: 1/8"=1'-0"

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN

UNITED RENTALS - TRENCH SAFETY

3700 Manchester Traffic Way
Kansas City, MO 64129
Phone: (816) 921-4141
Fax: (816) 921-4242

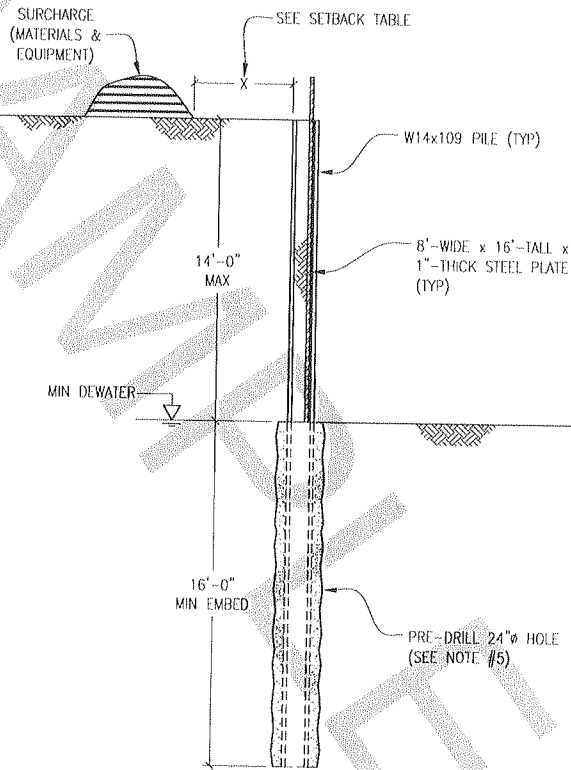
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DRAWN BY:	CMY
CHECKED BY:	JBC
SHEET	1 OF 2
DRAWING NO.	10A-125
REV	0

SHORING DESIGN PLAN

UNITED RENTALS - TRENCH SAFETY

PAGE 183

SETBACK TABLE	
CRANE TO 30 TON MAX	X = 12'
CAT 315 EXCAVATOR	X = 8'
CAT 325 EXCAVATOR	X = 12'
CAT 345 EXCAVATOR	X = 15'
3 CY LOADER	X = 8'
5 CY LOADER	X = 8'
DUMPTRUCK	X = 8'
SPOIL PILE (6'-TALL)	X = 8'
CONCRETE TRUCK	X = 12'
BUILDING STRUCTURES	X = 40'
RAILROAD TRACKS	X = 100'
STREET TRAFFIC	X = 15'



A SECTION
1/2 SCALE: 3/16"=1'-0"

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN
UNITED RENTALS - TRENCH SAFETY

3500 Manchester Traffic Way
Kansas City, MO 64129
Phone: (816) 921-4141
Fax: (816) 921-4242



DATE:	02-16-10
DRAFTER:	CMY
CHECKED BY:	JBC
SHEET	2 OF 2
DRAWING NO.:	10A-125
REV	0

SAMPLE - BEAM AND PLATE

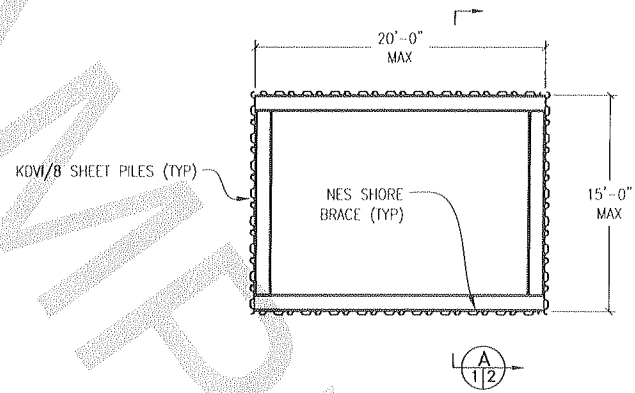
ENGINEERING

SHORING DESIGN PLAN
CENTRAL CORRIDOR LRT
ST. PAUL, MN

UNITED RENTALS - TRENCH SAFETY



GENERAL NOTES:

- SHORING DESIGN BASED ON SITE SOILS CONSISTING OF MEDIUM TO STIFF CLAY PER INFORMATION PROVIDED BY THE CONTRACTOR, CONTACT SHORING ENGINEER IF LESS COMPETENT MATERIALS ARE ENCOUNTERED.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ACCESS, BARRICADING, AND FALL PROTECTION, IN ACCORDANCE WITH ALL OSHA GUIDELINES.
- SHEET PILES TO BE ASTM A992 OR A572 GRADE 50 STEEL, MIN Fy = 50 KSI, UNLESS OTHERWISE NOTED.
- SHORING MUST BE PROPERLY INSTALLED PRIOR TO WORKERS ENTERING EXCAVATION. WORKERS MAY ONLY ENTER, EXIT, AND WORK WITHIN SHORED AREAS.
- ALL SHORE BRACE WALERS SHALL BE CERTIFIED NES ASSEMBLIES WITH A MINIMUM YIELD STRENGTH OF 52 KSI, AND MUST BE ASSEMBLED, SUSPENDED, INSTALLED TIGHT TO SHEETING, AND USED IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE MANUFACTURER. NES IS RESPONSIBLE FOR LOCATING JOINTS IN SHORE BRACE FRAME TO ENSURE THAT NEGATIVE MOMENT DOES NOT OCCUR AT JOINTS.
- COMPLETELY INSTALL NES SHORE BRACES PRIOR TO EXCAVATION PROCEEDING BEYOND TWO FEET BELOW THE BOTTOM OF THE WALE LEVEL.
- DURING REMOVAL OF SHORING, CONTRACTOR SHALL PLACE COMPACTED BACKFILL TO WITHIN TWO FEET OF THE VERTICAL CENTERLINE OF EACH BRACING LEVEL PRIOR TO REMOVING EACH LEVEL OF BRACING. THE BACKFILL MATERIAL SHALL BE PLACED AND COMPACTED, SO IT HAS AT LEAST THE SAME STRENGTH AND DENSITY AS THE ORIGINAL SOIL. REFER TO PROJECT BORELOGS FOR ORIGINAL SOIL STRENGTH OR CONTACT SHORING ENGINEER.
- ALL SHORING MATERIALS SHALL BE IN GOOD CONDITION AND SHALL BE FREE OF ANY HOLES OR VISUAL DEFECTS UNLESS APPROVED IN WRITING BY THE SHORING ENGINEER.
- ALL SHEET PILES SHALL BEAR FULLY AGAINST BRACING. IF GAPS EXIST BETWEEN SHEET PILES AND BRACING, CONTRACTOR SHALL PROVIDE SOLID PACKING (SHIMS/BLOCKING) ACROSS THE FULL HEIGHT OF THE BRACING WITH A MINIMUM WIDTH OF FOUR INCHES PER SHEET PILE PAIR TO FILL THE GAPS.
- ALL VOIDS BETWEEN THE EXCAVATED SOIL AND THE FACE OF THE SHORING SYSTEM MUST BE BACKFILLED WITH EXCAVATED SOIL OR OTHER APPROVED BACKFILL PRIOR TO WORKERS ENTERING THE EXCAVATION. FOR EXCAVATIONS ADJACENT TO TRAFFIC LOADING, ALL VOIDS SHALL BE BACKFILLED WITH SAND OR CLASS II AGGREGATE BASE MATERIAL.
- CONTRACTOR IS RESPONSIBLE FOR INSTALLING A DEWATERING SYSTEM, IF NECESSARY, AND VERIFYING THAT THE GROUNDWATER LEVEL BEHIND THE SHORING WALLS HAS BEEN LOWERED AT LEAST TO THE MINIMUM LEVEL SHOWN ON THE SECTION VIEW. IF CONTRACTOR IS UNABLE TO LOWER THE GROUNDWATER TO THE LEVEL SHOWN, CONTACT THE SHORING ENGINEER TO CHECK IF THE HIGHER LEVEL IS ACCEPTABLE OR TO REDESIGN THE SHORING SYSTEM, IF NECESSARY.
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PLAN VIEW
SCALE: 1/8"=1'-0"

PROFESSIONAL ENGINEER
I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINT NAME: Jaime R. Calera
SIGNATURE: 
DATE: 4/22/10 LICENSE # 

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN
CENTRAL CORRIDOR LRT
ST. PAUL, MN

UNITED RENTALS - TRENCH SAFETY

12505 KENWOOD AVE. S.
SAVAGE, MN 55378
Phone: (952) 882-6067
Fax: (952) 882-6068

United Rentals

DATE: 04-22-10
DRAFTER: TSM
CHECKED BY: NLB
SHEET 1 OF 2
DRAWING NO.: 09A-462L REV 0

SHORING DESIGN PLAN
CENTRAL CORRIDOR LRT
ST. PAUL, MN

UNITED RENTALS - TRENCH SAFETY

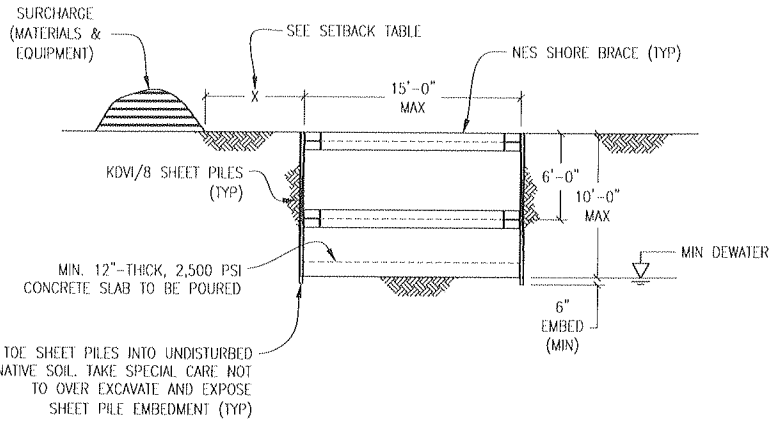
SETBACK TABLE	
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CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
5 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 25'

REVISIONS	
NO.	DATE

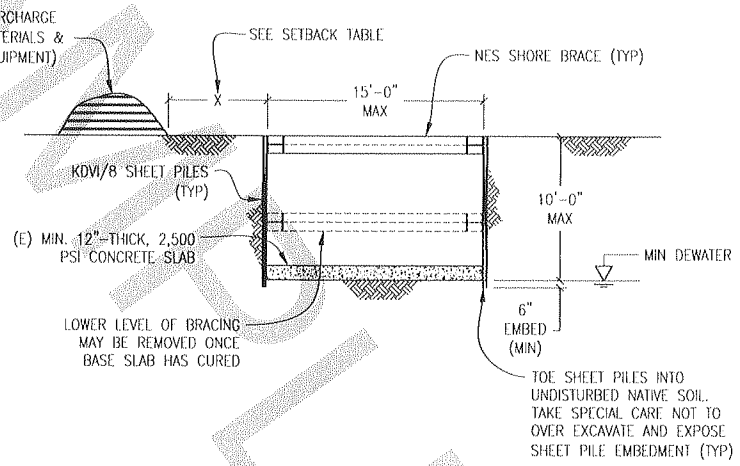
SHORING DESIGN PLAN
CENTRAL CORRIDOR LRT
ST. PAUL, MN
UNITED RENTALS - TRENCH SAFETY

1505 NEWWOOD AVE. S.
SAVAGE, MN 55378
Phone: (952) 862-6667
Fax: (952) 862-6068
United Rentals

PAGE 185



A
1/2 SECTION - PHASE 1
SCALE: 1/8"=1'-0"



A
1/2 SECTION - PHASE 2
SCALE: 1/8"=1'-0"

PROFESSIONAL ENGINEER
I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINT NAME: [REDACTED] P. [REDACTED]
SIGNATURE: [REDACTED]
DATE: 4/22/10 LICENSE # [REDACTED]

DATE: 04-22-10
DRAFTER: TSM
CHECKED BY: NLB
SHEET 2 OF 2
DRAWING NO. 09A-462L REV 0

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

SHORING DESIGN PLAN

PERRYMAN OUTFALL

TULSA, OK

SHERWOOD CONSTRUCTION CO., INC.

PREPARED FOR:


UNITED RENTALS TRENCH SAFETY

REVISIONS	
NO.	DATE

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK

UNITED RENTALS TRENCH SAFETY

2114 South 8th Street
 Rogers, AR 72758
 Phone: (479) 636-3055
 Fax: (479) 621-8806

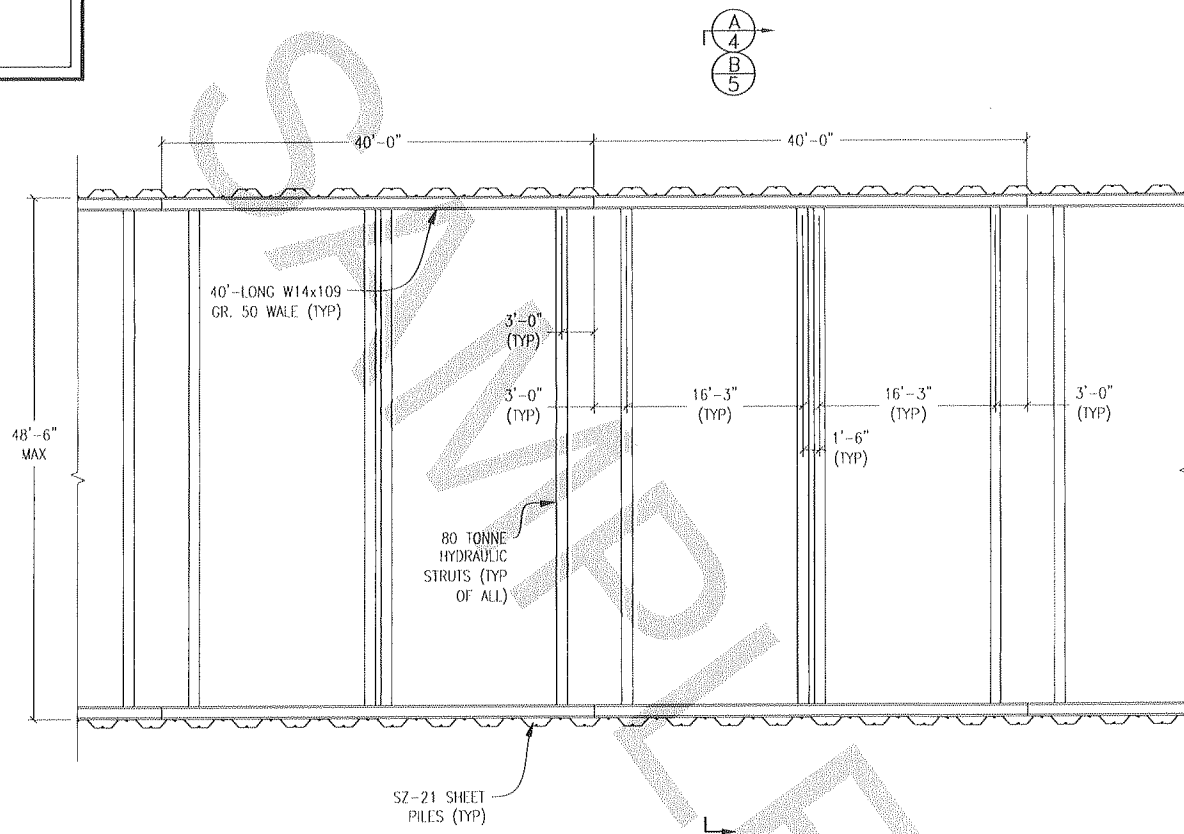


DATE	01-13-09
DRAWER	KTC
CHECKED BY	JBC
SHEET	1 of 11
DRAWING NO.	09A-015
REV	1

NOTES:

- SHORING DESIGN BASED ON SITE SOILS CONSISTING OF LOOSE TO MEDIUM DENSE SILTY SAND OR BETTER, AS OUTLINED IN PROJECT BORELOGS PROVIDED BY THE CONTRACTOR. CONTACT SHORING ENGINEER IF LESS COMPETENT MATERIALS ARE ENCOUNTERED.
- CONTRACTOR IS RESPONSIBLE FOR PROVIDING ACCESS, BARRICADING, AND FALL PROTECTION, IN ACCORDANCE WITH ALL OSHA GUIDELINES.
- SHORING MUST BE PROPERLY INSTALLED PRIOR TO WORKERS ENTERING EXCAVATION. WORKERS MAY ONLY ENTER, EXIT, AND WORK WITHIN SHORED AREAS.
- ALL SHEET PILES TO BE ASTM A572 GRADE 50 STEEL, MIN Fy = 50 KSI.
- ALL STEEL SHAPES TO BE ASTM A572 OR A992 GRADE 50 STEEL, MIN Fy = 50 KSI, UNLESS OTHERWISE NOTED.
- ALL GROUND FORCE MEGA BRACE WALERS TO HAVE A MINIMUM YIELD STRENGTH Fy = 65 KSI.
- ALL MEGA BRACE WALERS AND HYDRAULIC STRUTS SHALL BE CERTIFIED GROUND FORCE ASSEMBLES, AND MUST BE INSTALLED, ANCHORED, AND USED IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE MANUFACTURER. GROUND FORCE IS RESPONSIBLE FOR LOCATING JOINTS IN MEGA BRACE FRAME TO ENSURE THAT NEGATIVE MOMENT DOES NOT OCCUR AT JOINTS.
- PER GROUND FORCE, ALL MEGA BRACE STRUTS TO HAVE A MINIMUM FACTOR OF SAFETY OF 2.0 BASED ON LISTED LOAD RATINGS, AND ARE RATED IN TONNES (2,200 LB. = 1 TONNE)
- USE E70 XX ELECTRODES. ALL WELDING SHALL BE PERFORMED BY A CERTIFIED WELDER IN ACCORDANCE WITH LATEST EDITION OF THE AWS D1.1.
- CRANE SURCHARGE ANALYSIS BASED ON MAXIMUM TRACK PRESSURE DIAGRAMS PROVIDED BY LINK-BELT DATED 1/9/09, DUE TO A MAXIMUM REACH OF 75' AND PICK OF 7,000 LB. CONTRACTOR RESPONSIBLE FOR MONITORING USE OF CRANE TO ENSURE REACH AND PICKS ARE NOT EXCEEDED AT ANY TIME. ENSURE TRACKS ARE ALWAYS PARALLEL TO SHORING, DO NOT ALIGN WITH TIPS FACING SHORING AT ANY TIME.
- COMPLETELY INSTALL WALLES AND STRUTS PRIOR TO EXCAVATION PROCEEDING BEYOND 2 FEET BELOW THE BOTTOM OF EACH WALE LEVEL.
- USE E70 XX ELECTRODES. ALL WELDING SHALL BE PERFORMED BY A CERTIFIED WELDER IN ACCORDANCE WITH LATEST EDITION OF THE AWS D1.1.
- DURING REMOVAL OF SHORING, CONTRACTOR SHALL PLACE COMPACTED BACKFILL TO WITHIN TWO FEET OF THE VERTICAL CENTERLINE OF EACH BRACING LEVEL PRIOR TO REMOVING EACH LEVEL OF BRACING. THE BACKFILL MATERIAL SHALL BE PLACED AND COMPACTED, SO IT HAS AT LEAST THE SAME STRENGTH AND DENSITY AS THE ORIGINAL SOIL. REFER TO PROJECT BORELOGS FOR ORIGINAL SOIL STRENGTH OR CONTACT SHORING ENGINEER.
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- ALL SHEET PILES SHALL BEAR FULLY AGAINST WALLES. IF GAPS EXIST BETWEEN SHEET PILES AND WALLES, CONTRACTOR SHALL PROVIDE SOLID PACKING (SHIMS/BLOCKING) ACROSS THE FULL HEIGHT OF THE WALE FLANGE WITH A MINIMUM WIDTH OF FOUR INCHES CENTERED ON EACH OF THE TWO PILE FLANGES PER SHEET PILE PAIR TO FILL THE GAPS.
- ALL VOIDS BETWEEN THE EXCAVATED SOIL AND THE FACE OF THE SHORING SYSTEM MUST BE BACKFILLED WITH EXCAVATED SOIL OR OTHER APPROVED BACKFILL PRIOR TO WORKERS ENTERING THE EXCAVATION. FOR EXCAVATIONS ADJACENT TO TRAFFIC LOADING, ALL VOIDS SHALL BE BACKFILLED WITH SAND OR CLASS II AGGREGATE BASE MATERIAL.
- CONTRACTOR IS FULLY RESPONSIBLE FOR INSTALLING A DEWATERING SYSTEM, IF NECESSARY, AND VERIFYING THAT THE GROUNDWATER LEVEL BEHIND THE SHORING WALLS HAS BEEN LOWERED AT LEAST TO THE MINIMUM LEVEL SHOWN ON THE SECTION VIEW. IF CONTRACTOR IS UNABLE TO LOWER THE GROUNDWATER TO THE LEVEL SHOWN, CONTACT THE SHORING ENGINEER TO CHECK IF THE HIGHER LEVEL IS ACCEPTABLE OR TO REDESIGN THE SHORING SYSTEM, IF NECESSARY. ALL MEANS AND METHODS ASSOCIATED WITH DEWATERING SYSTEM IS THE RESPONSIBILITY OF THE CONTRACTOR.
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- THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE ACCURACY OF ALL DIMENSIONS FOR BOTH EXISTING AND PROPOSED WORK, AND SHALL VERIFY THAT REQUIRED CLEARANCES ARE OBTAINED PRIOR TO COMMENCEMENT OF THE WORK.
- THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING THE EXCAVATION.
- UNITED RENTALS AND D.H. CHARLES ENGINEERING, INC. BEAR NO RESPONSIBILITY OR LIABILITY FOR ANY SETTLEMENT, MOVEMENT, OR DAMAGE OF ANY KIND THAT MAY OCCUR TO EXISTING BUILDING STRUCTURES OR UTILITIES DUE TO SHORING INSTALLATION, DEFLECTION, REMOVAL, OR OTHER CONSTRUCTION ACTIVITIES.

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



PLAN VIEW - MAIN TRENCH - OPTION 1
 SCALE: 3/32"=1'-0"

REVISIONS	
NO.	DATE

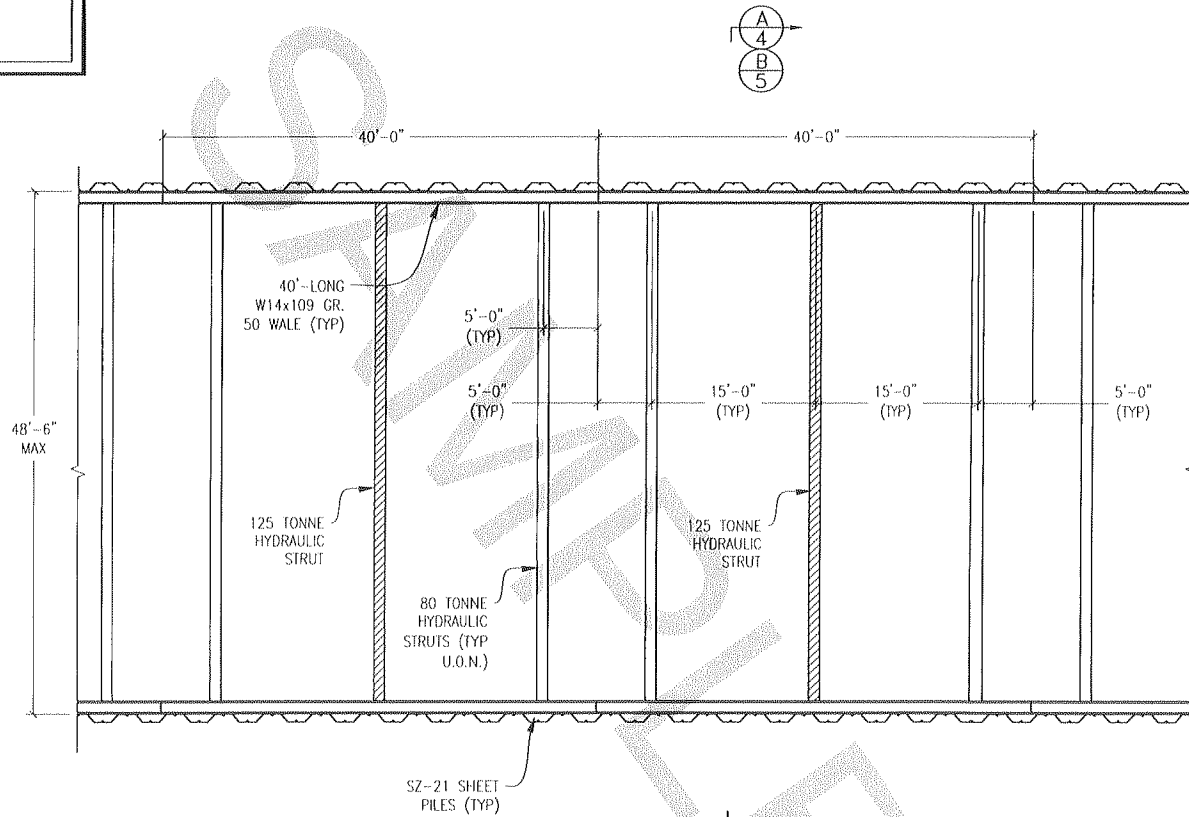
SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH
 SAFETY

2314 South 8th Street
 Rogers, AR 72758
 Phone: (479) 636-5055
 Fax: (479) 621-8806



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DRAWING NO. 09A-015	REV 1

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



PLAN VIEW - MAIN TRENCH - OPTION 2
 SCALE: 3/32"=1'-0"

REVISIONS	
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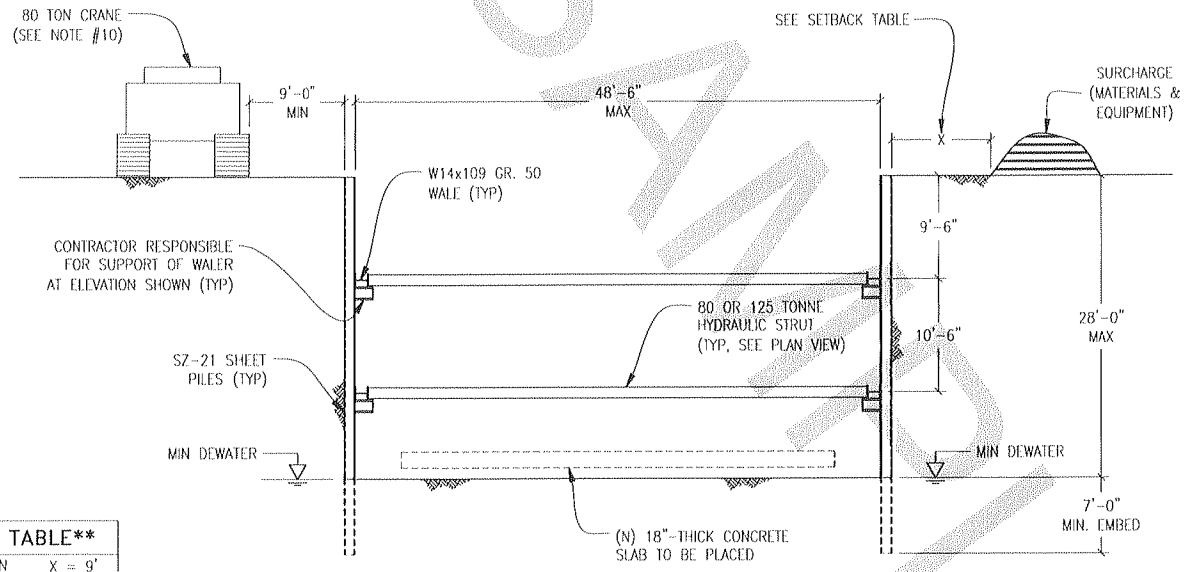
SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH
 SAFETY

2114 South 8th Street
 Rogers, AR 72758
 Phone: (479) 636-6055
 Fax: (479) 631-8806

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SHEET	3 OF 11
DRAWING NO.:	09A-015
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SAMPLE - SHEETING AND BRACING

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



SETBACK TABLE**

CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

A SECTION - MAIN TRENCH - PHASE 1
 SCALE: 3/32"=1'-0"

REVISIONS

NO.	DATE

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

2314 South 8th Street
 Rogers, AR 72758
 Phone: (479) 636-5055
 Fax: (479) 621-8806

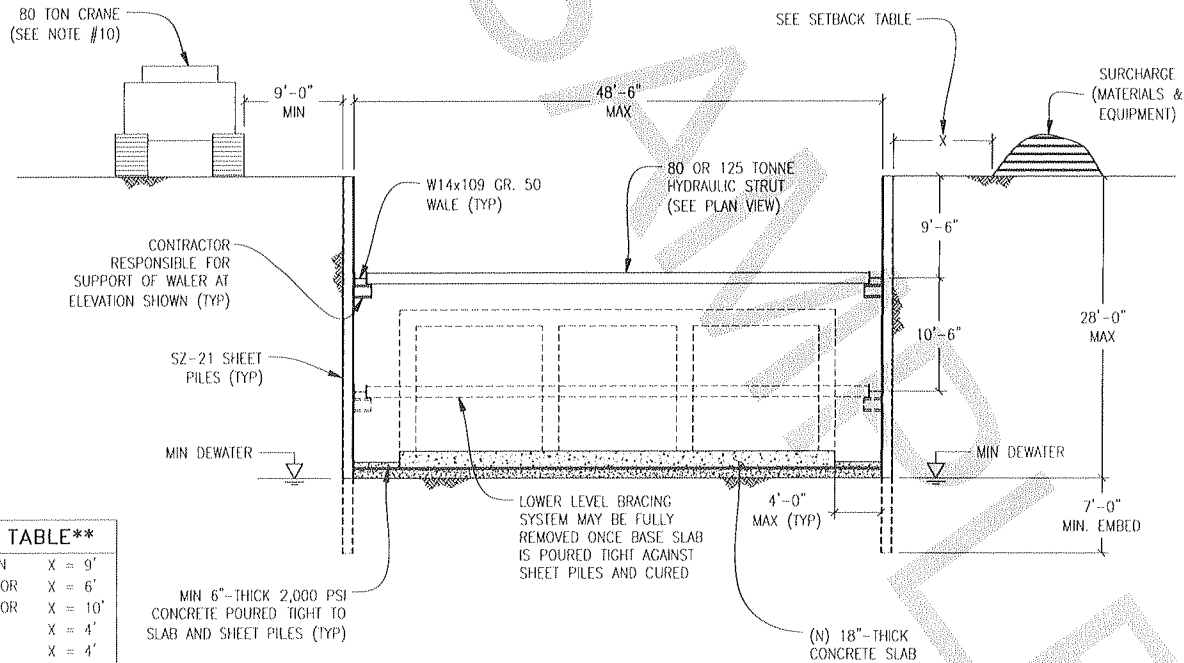


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SHEET	4 OF 11
DRAWING NO.:	09A-015
REV	1

SAMPLE - SHEETING AND BRACING



SHORING DESIGN PLAN
PERRYMAN OUTFALL
TULSA, OK
UNITED RENTALS TRENCH SAFETY



SETBACK TABLE**	
CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

B SECTION - MAIN TRENCH - PHASE 2
5 SCALE: 3/32"=1'-0"

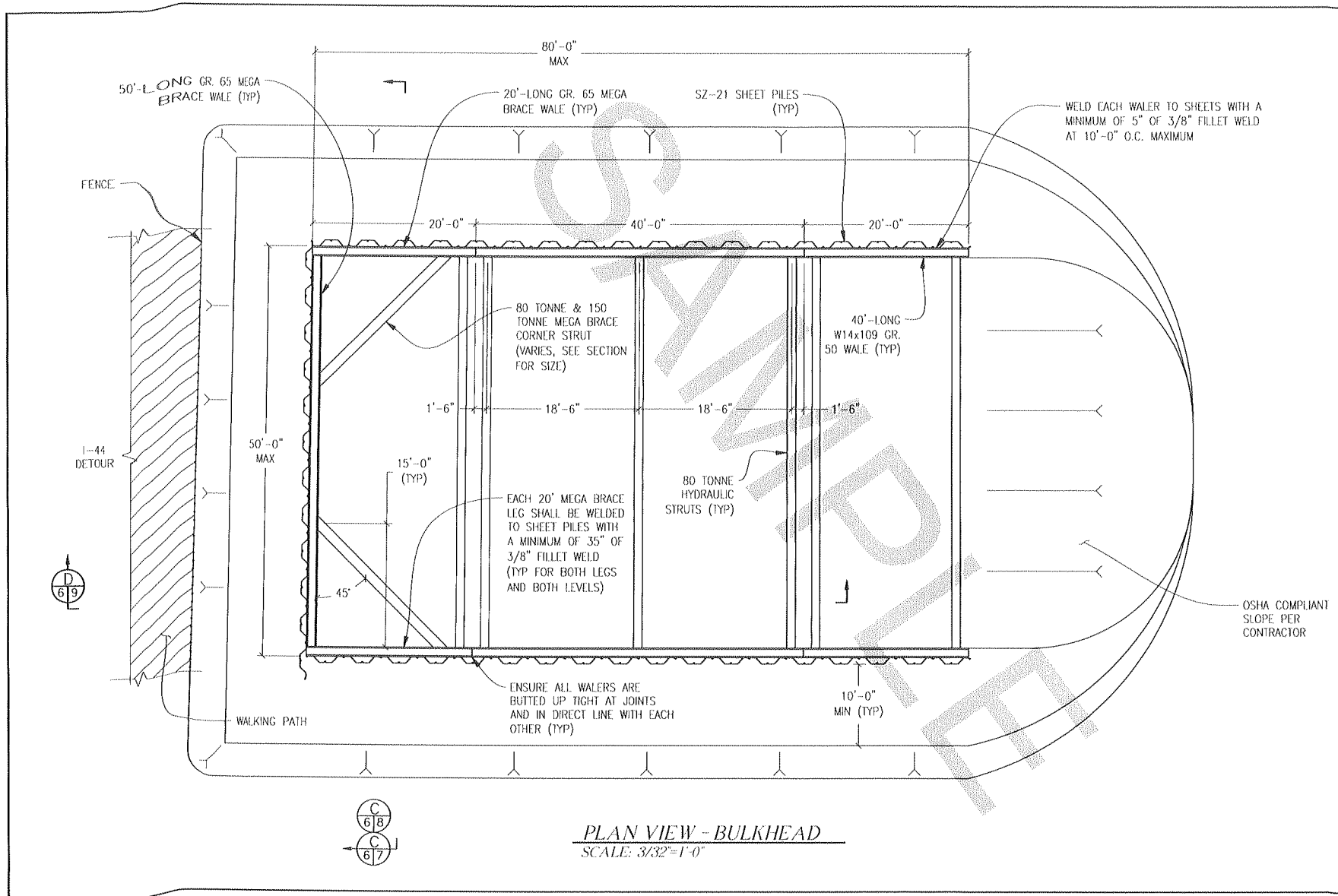
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SHORING DESIGN PLAN
PERRYMAN OUTFALL
TULSA, OK
UNITED RENTALS TRENCH SAFETY

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Rogers, AR 72758
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Fax: (479) 621-8806
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SAMPLE - SHEETING AND BRACING



REVISIONS	
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1	02-27-09

SHORING DESIGN PLAN PERRYMAN OUTFALL TULSA, OK	UNITED RENTALS TRENCH SAFETY
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 Oklahoma City, OK 73108
 Phone: (405) 656-5055
 Fax: (405) 621-8086

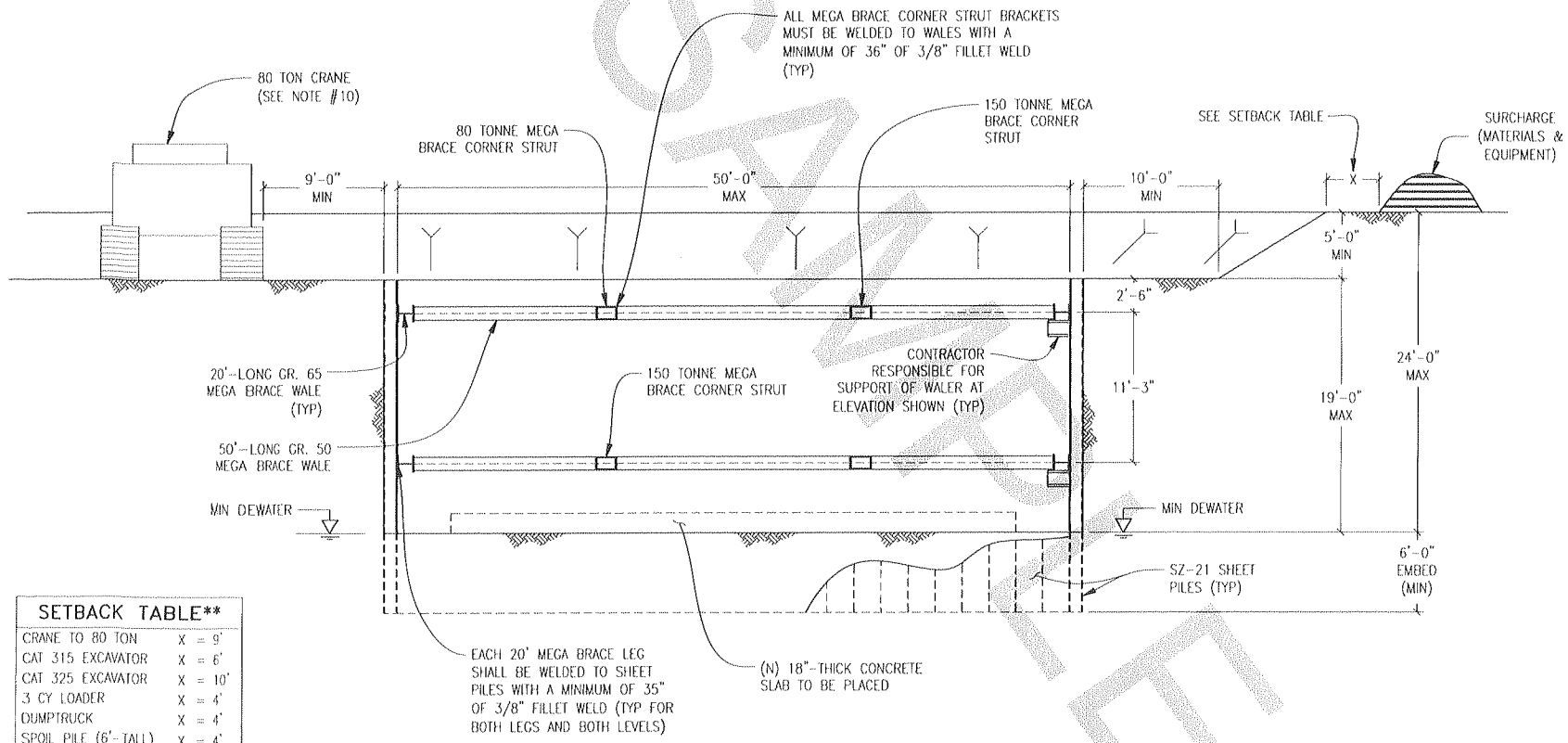
United Rentals

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SAMPLE - SHEETING AND BRACING



SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



REVISIONS	
NO.	DATE
1	02-27-09

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

2114 South 8th Street
 Rogers, AR 72758
 Phone: (479) 636-3055
 Fax: (479) 621-8806

United Rentals

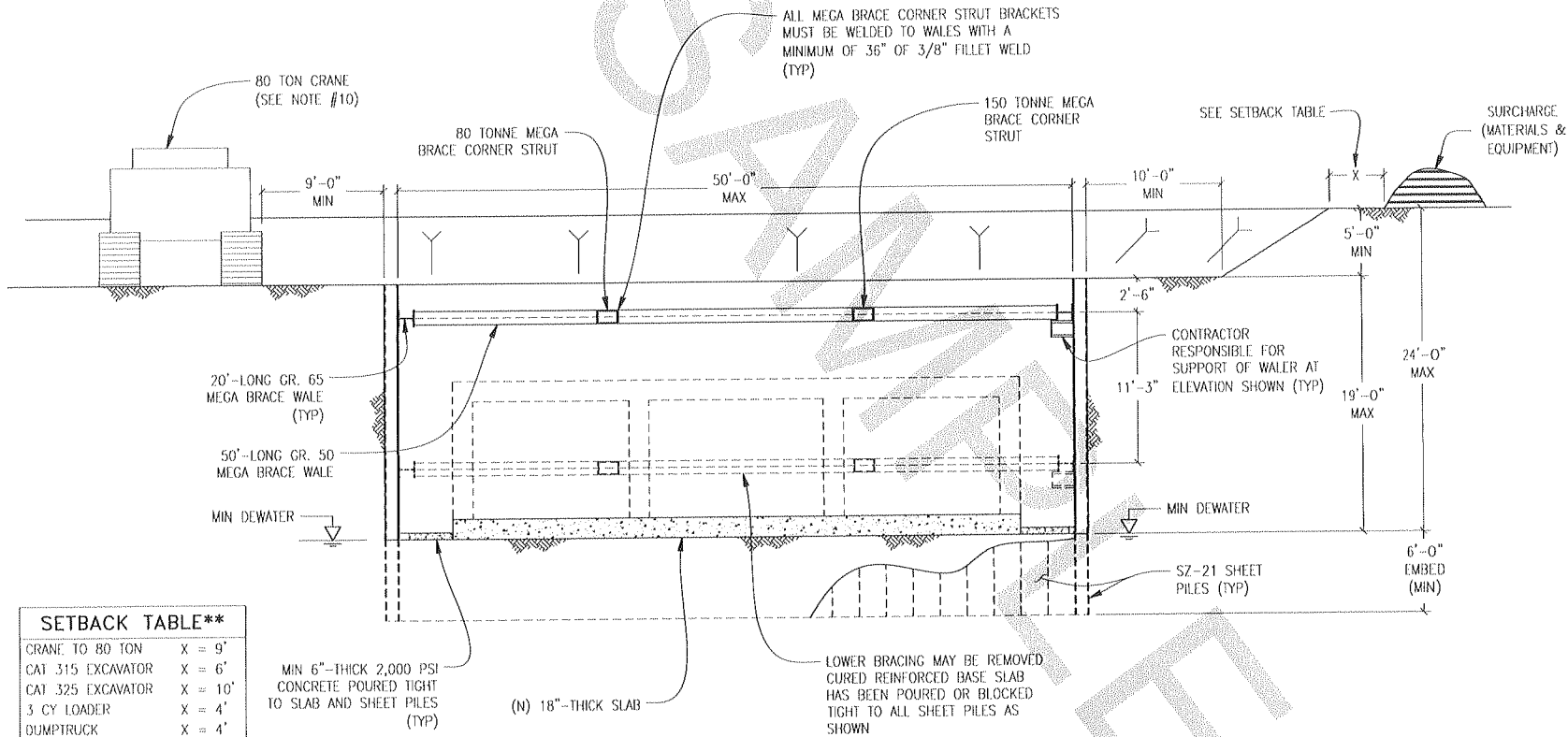
DATE:	01-13-09
DRAFTER:	KTC
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SHEET	7 OF 11
DRAWING NO.:	09A-015
REV	1

SETBACK TABLE**	
CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

C
 6/7 SECTION - BULKHEAD - PHASE 1
 SCALE: 1/8"=1'-0"

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



SETBACK TABLE**

CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

SECTION - BULKHEAD - PHASE 2
 SCALE: 1/8"=1'-0"

REVISIONS

NO.	DATE
1	02-27-09

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

2314 South 8th Street
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 SHEET 8 of 11
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 REV 1

SHORING DESIGN PLAN
PERRYMAN OUTFALL
TULSA, OK

UNITED RENTALS TRENCH SAFETY

SETBACK TABLE**

CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

REVISIONS

NO.	DATE
1	02-27-09

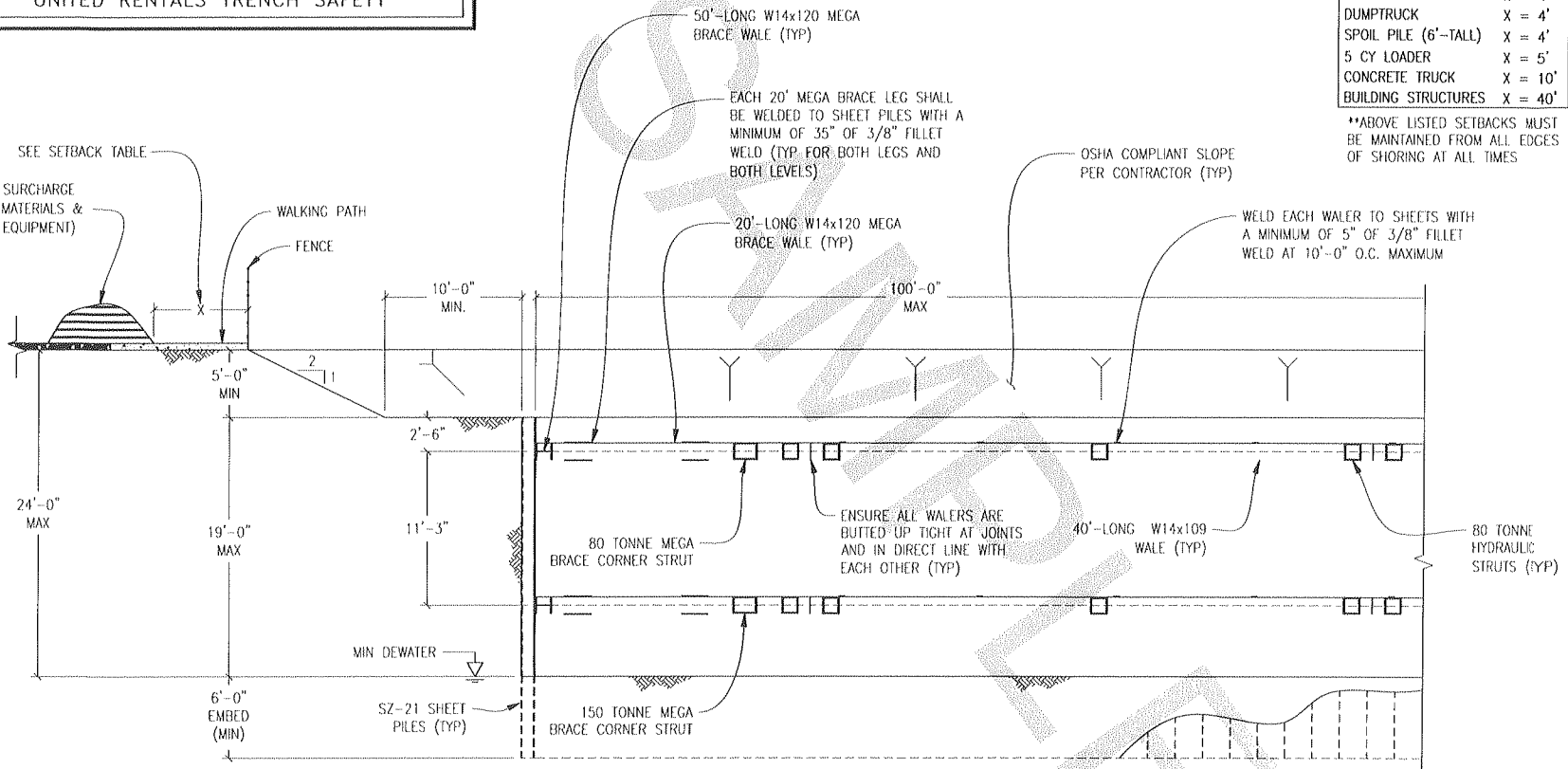
SHORING DESIGN PLAN
PERRYMAN OUTFALL
TULSA, OK

UNITED RENTALS TRENCH SAFETY

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Rogers, AR 72758
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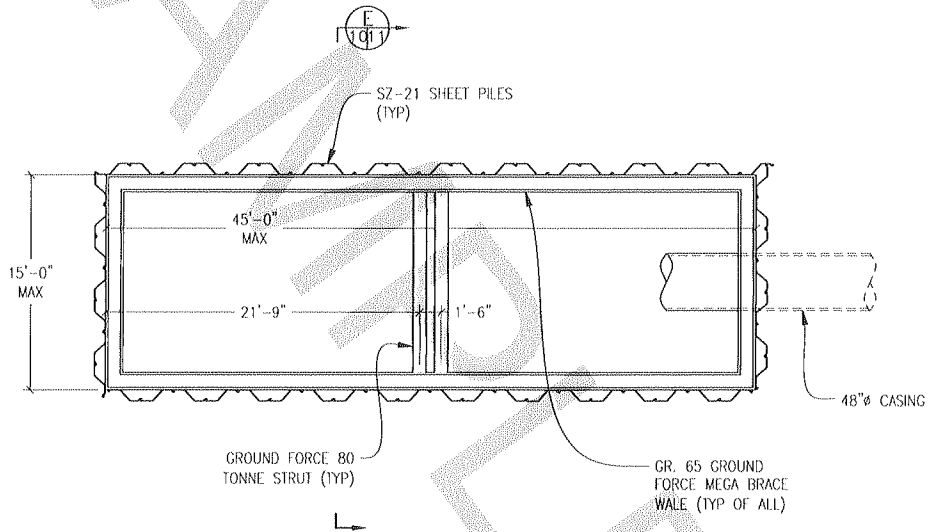
DATE: 01-13-09
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CHECKED BY: JBC
SHEET 9 of 11
DRAWING NO: 09A-015 REV 1



SECTION - BULKHEAD
SCALE: 1/8"=1'-0"

SAMPLE - SHEETING AND BRACING

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



PLAN VIEW - BORE PIT
 SCALE: 1/8"=1'-0"

REVISIONS	
NO.	DATE
1	02-27-09

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

2314 South 5th Street
 Rogers, AR 72758
 Phone: (479) 636-5055
 Fax: (479) 621-8806

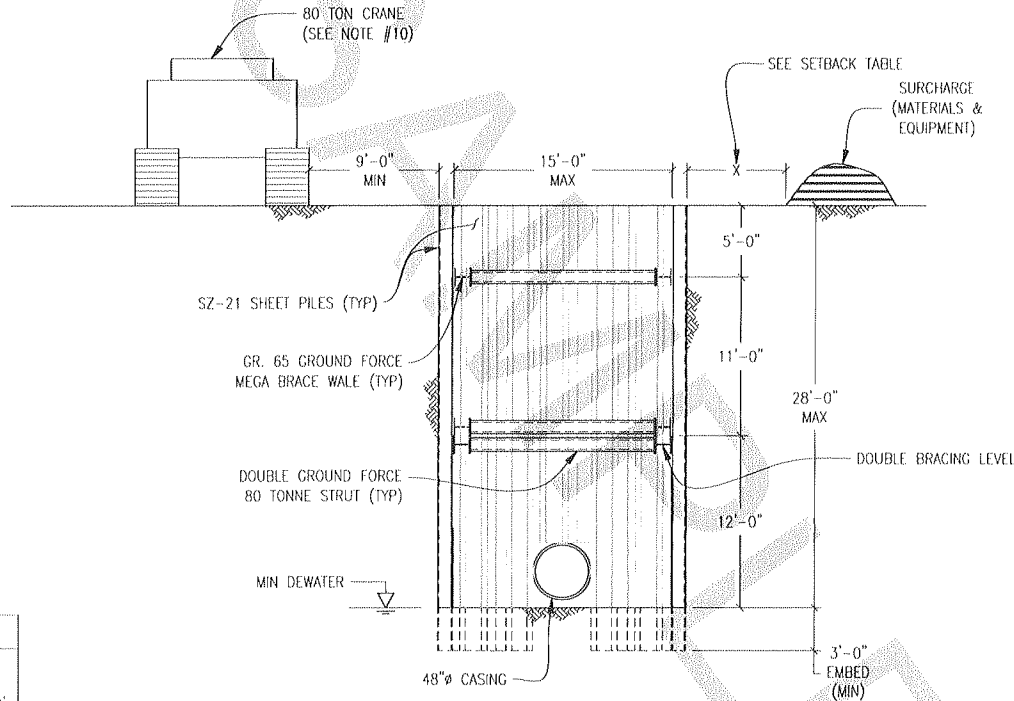


DATE:	01-13-09
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SHEET	10 of 11
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SAMPLE - SHEETING AND BRACING



SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY



SETBACK TABLE**	
CRANE TO 80 TON	X = 9'
CAT 315 EXCAVATOR	X = 6'
CAT 325 EXCAVATOR	X = 10'
3 CY LOADER	X = 4'
DUMPTRUCK	X = 4'
SPOIL PILE (6'-TALL)	X = 4'
5 CY LOADER	X = 5'
CONCRETE TRUCK	X = 10'
BUILDING STRUCTURES	X = 40'

**ABOVE LISTED SETBACKS MUST BE MAINTAINED FROM ALL EDGES OF SHORING AT ALL TIMES

E
 10/11 SECTION - BORE PIT
 SCALE: 1/8"=1'-0"

REVISIONS	
NO.	DATE
1	02-27-09

SHORING DESIGN PLAN
 PERRYMAN OUTFALL
 TULSA, OK
 UNITED RENTALS TRENCH SAFETY

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SAMPLE - SHEETING AND BRACING

Additional Resources

C-60 Soil Classification

There is a soil type not listed in the Excavation Standard that falls between the lower range of a Type B soil to the middle range of a Type C soil. This soil type has been identified as a C-60 soil and is defined as

... a moist, cohesive soil or a moist dense granular soil which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shoring to be properly installed.

SPEED SHORE TECHNICAL DATA SHEET

NUMBER: SS 011492

Subject: C-60 SOIL CLASSIFICATION; ITS USE AND IMPORTANCE

History of O.S.H.A. soil classifications:

The present O.S.H.A. soil classification system is based on a study by the National Bureau of Standards titled: Soil Classification For Construction Practice In Shallow Trenching, N.B.S. Building Science Series 121, which was prepared specifically for O.S.H.A. Also considered were the comments of engineers and contractors during the review period of the latest excavation regulation. Both the N.B.S. study and the comments of engineers and contractors indicated the need for a four part classification of soils rather than the simplified three part classification system that O.S.H.A. adopted.

The three O.S.H.A. soil classifications are each a range of soil stability conditions with Type C being the widest range, and the least stable. Soon after the present regulation went into effect it became apparent that Speed Shore Corporation's Manufacturer's Tabulated Data would make shoring safer and more economical if a soil classification from least stable Type B soil to middle range Type C were added instead of designing all Type C soil shoring for the least stable condition. The following Type C-60 definition was developed.

Speed Shore definition of Type C-60 soil:

C-60 is a moist, cohesive soil or a moist dense granular soil which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shoring to be properly installed. The Competent Person must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the sheeting.

Speed Shore's check list for Type C-60 soil:

Included with this Technical Data Sheet is a check list to help the Competent Person determine if job site soil conditions fit into the C-60 soil classification.

Other definitions and use of C-60 soil classification:

The Trench Shoring and Shielding Association and the major manufacturers of shoring and trench shields have either defined a Type C-60 soil classification or have limited their tabulated data to a Type C soil that is comparable to Speed Shore's Type C-60.

Reference Material:

Speed Shore Corporation has on file a report by Robert C. Davis, Ph.d., P.E., Senior Geotechnical Engineer with Trinity Engineering Testing Corporation, in which he concludes that Speed Shore's C-60 soil check list is in agreement with the O.S.H.A. Excavation regulation and the N.B.S. study 121. This report is on file and available from Speed Shore Corporation.

Also, recommended reading is the National Bureau of Standards, Building Science Series 121, Soil Classification For Construction, pages 12 through 17, and 38 through 54, and the Federal Register, vol. 54, no. 209, October 31, 1989 - Excavations; pages 45936 through 45942.

Discussion:

Several decades of good safe field practice has shown that if the excavation will stand long enough to get the shoring safely into place, the shores will support the lateral earth pressures. If the soil is flowing or submerged it must be supported with sheet piling or caissons.

The N.B.S. study 121 has tables on pages 41, 49, and 53 showing that granular soils that are not flowing or submerged are Type B, and have an equivalent weight effect (w_e) of 40 p.c.f. or less, and only a very soft clay would have an equivalent weight effect of more than 60 p.c.f. The very soft clays with an equivalent weight effect higher than 60 p.c.f. will not stand vertical long enough to place the shoring. For a very soft clay to develop an equivalent weight effect in the 80 p.c.f. range, it will have to be about 20 ft. deep.

If a sand is very dry and has no clay, silt or cementing material, it will be a flowing sand and will not stand vertical long enough to shore.

On pages 53 and 38, the N.B.S. study 121 states that “Analysis of traditional timber shoring leads to the conclusion that actual field conditions for shallow trenches produce pressures which are much lower than those predicted by analysis” and “N.B.S. study of widely used conventional limber shoring indicated that it could not resist the pressures calculated by present engineering practice”.

This discussion applies to lateral earth pressures for the design of shoring and does not apply to sloping.

Conclusion:

Each excavation should be studied to determine if it is Type A or B soil. If it is not Type A or B, and it will stand vertically long enough to place the shoring, it fits the Type C-60 classification.

For further review of Type C-60 soil, contact the Engineering Staff of the Speed Shore Corporation.

01.14.92

SPEED SHORE Corporation



C-60 SOIL CLASSIFICATION CHECKLIST

This check list is a supplement to Speed Shore Corporation's Manufacturer's Tabulated Data.

Complete the check list, and if all of the answers are yes, the soil is classified as C-60 and Speed Shore's vertical shores and shoring shields may be selected from the appropriate C-60 table and column. If any of the answers are no, another method of excavation protection may be required.

1. Has it been determined that soil is not O.S.H.A. type A or B? YES NO
2. The soil is a moist cohesive or a moist dense granular material. YES NO
3. The soil is not flowing. YES NO
4. The soil is not submerged. YES NO
5. Can the excavation be cut with near vertical sides? YES NO
6. Will the excavation stand long enough for the shoring to be safely and properly installed? YES NO
7. Do the hydraulic cylinders push against firm soil and hold at fixed extension? YES NO
8. There is no deterioration of the excavation wall around or below the shoring? YES NO
9. There are no site conditions (such as existing utilities, vibrations or surcharge loadings) in the immediate area around the excavation that cause the excavation face to be unstable and flow around the shoring. YES NO
10. The site conditions are being continually monitored by the competent person for signs of deterioration? YES NO



Reply to the attention of:

Mr. Regis M. Hallisey
General Manager
The Plank Company
Post Office Box [REDACTED]
Houston, Texas 77207

Dear Mr. Hallisey:

This is in response to your July 24 letter in which you request an interpretation from the Occupational Safety and Health Administration (OSHA) concerning the use of Manufacturer's Tabulated Data as it applies to the C-60 soil classification. We apologize for the delay in responding to your inquiry.

In response to your question whether the C-60 soil classification is an acceptable addition to the classifications set forth in the excavation standards (29 CAR 1926.650 et seq.), please be advised as follows: Option (2) - Designs Using Manufacturer's Tabulated Data, set forth in 1926.652(c)(2), allows the use of tables other than those given in the OSHA standards. However, by definition, "tabulated data" means "tables and charts approved by a registered professional engineer and used to design and construct a protective system" (emphasis added). Therefore, the C-60 soil classification you submitted may be used in the design of protective systems if the classification and subsequent designs have been approved by a registered professional engineer.

If we may be of further assistance, please contact Mr. Roy Gurnham or Mr. Dale Cavanaugh at [REDACTED].

Sincerely,

[REDACTED]
Director
Directorate of Compliance Programs

Subpart D – Occupational Health and Environmental Controls

1926.55(a)

Exposure of employees to inhalation, ingestion, skin absorption, or contact with any material or substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminants for 1970" of the American Conference of Governmental Industrial Hygienists, shall be avoided. See Appendix A to this section.

1926.55(b)

To achieve compliance with paragraph (a) of this section, administrative or engineering controls must first be implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and technical measures used for this purpose must first be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with 1926.103.

1926.55(c)

Paragraphs (a) and (b) of this section do not apply to the exposure of employees to airborne asbestos, tremolite, anthophyllite, or actinolite dust. Whenever any employee is exposed to airborne asbestos, tremolite, anthophyllite, or actinolite dust, the requirements of 1910.1101 or 1926.58 of this title shall apply.

1926.55(d)

Paragraphs (a) and (b) of this section do not apply to the exposure of employees to formaldehyde. Whenever any employee is exposed to formaldehyde, the requirements of 1910.1048 of this title shall apply.

1926.57(a)

"General." Whenever hazardous substances such as dusts, fumes, mists, vapors, or gases exist or are produced in the course of construction work, their concentrations shall not exceed the limits specified in 1926.55(a). When ventilation is used as an engineering control method, the system shall be installed and operated according to the requirements of this section.

1926.57(b)

"Local exhaust ventilation." Local exhaust ventilation when used as described in (a) shall be designed to prevent dispersion into the air of dusts, fumes, mists, vapors, and gases in concentrations causing harmful exposure. Such exhaust systems shall be so designed that dusts, fumes, mists, vapors, or gases are not drawn through the work area of employees.

1926.57(c)

"Design and operation." Exhaust fans, jets, ducts, hoods, separators, and all necessary appurtenances, including refuse receptacles, shall be so designed, constructed, maintained and operated as to ensure the required protection by maintaining a volume and velocity of exhaust air sufficient to gather dusts, fumes, vapors, or gases from said equipment or process, and to convey them to suitable points of safe disposal, thereby preventing their dispersion in harmful quantities into the atmosphere where employees work.

1926.57(d)

"Duration of operations."

1926.57(d)(1)

The exhaust system shall be in operation continually during all operations which it is designed to serve. If the employee remains in the contaminated zone, the system shall continue to operate after the cessation of said operations, the length of time to depend upon the individual circumstances and effectiveness of the general ventilation system.

Subpart E – Personal Protective and Life Saving Equipment

Note: The requirements applicable to construction work under this section are identical to those set forth at 29 CFR 1910.134 of this chapter.

[58 FR 35160, June 30, 1993; 61 FR 5507, Feb. 13, 1996; 61 FR 9227, March 7, 1996; 63 FR 1152, Jan. 8, 1998]

Subpart M – Fall Protection

1926.501(b)(1)

"Unprotected sides and edges." Each employee on a walking/working surface (horizontal and vertical surface) with an unprotected side or edge which is 6 feet (1.8 m) or more above a lower level shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems.

1926.501(b)(2)

"Leading edges."

1926.501(b)(2)(i)

Each employee who is constructing a leading edge 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, or personal fall arrest systems. Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer shall develop and implement a fall protection plan which meets the requirements of paragraph (k) of 1926.502.

Note: There is a presumption that it is feasible and will not create a greater hazard to implement at least one of the above-listed fall protection systems. Accordingly, the employer has the burden of establishing that it is appropriate to implement a fall protection plan which complies with 1926.502(k) for a particular workplace situation, in lieu of implementing any of those systems.

1926.501(b)(2)(ii)

Each employee on a walking/working surface 6 feet (1.8 m) or more above a lower level where leading edges are under construction, but who is not engaged in the leading edge work, shall be protected from falling by a guardrail system, safety net system, or personal fall arrest system. If a guardrail system is chosen to provide the fall protection, and a controlled access zone has already been established for leading edge work, the control line may be used in lieu of a guardrail along the edge that parallels the leading edge.

1926.501(b)(3)

"Hoist areas." Each employee in a hoist area shall be protected from falling 6 feet (1.8 m) or more to lower levels by guardrail systems or personal fall arrest systems. If guardrail systems, [or chain, gate, or guardrail] or portions thereof, are removed to facilitate the hoisting operation (e.g., during landing of materials), and an employee must lean through the access opening or out over the edge of the access opening (to receive or guide equipment and materials, for example), that employee shall be protected from fall hazards by a personal fall arrest system.

1926.501(b)(4)

"Holes."

1926.501(b)(4)(i)

Each employee on walking/working surfaces shall be protected from falling through holes (including skylights) more than 6 feet (1.8 m) above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes.

1926.501(b)(4)(ii)

Each employee on a walking/working surface shall be protected from tripping in or stepping into or through holes (including skylights) by covers.

1926.501(b)(4)(iii)

Each employee on a walking/working surface shall be protected from objects falling through holes (including skylights) by covers.

1926.501(b)(5)

"Formwork and reinforcing steel." Each employee on the face of formwork or reinforcing steel shall be protected from falling 6 feet (1.8 m) or more to lower levels by personal fall arrest systems, safety net systems, or positioning device systems.

1926.501(b)(6)

"Ramps, runways, and other walkways." Each employee on ramps, runways, and other walkways shall be protected from falling 6 feet (1.8 m) or more to lower levels by guardrail systems.

1926.501(b)(7)

"Excavations."

1926.501(b)(7)(i)

Each employee at the edge of an excavation 6 feet (1.8 m) or more in depth shall be protected from falling by guardrail systems, fences, or barricades when the excavations are not readily seen because of plant growth or other visual barrier;

1926.501(b)(7)(ii)

Each employee at the edge of a well, pit, shaft, and similar excavation 6 feet (1.8 m) or more in depth shall be protected from falling by guardrail systems, fences, barricades, or covers.

1926.501(b)(8)

"Dangerous equipment."

1926.501(b)(8)(i)

Each employee less than 6 feet (1.8 m) above dangerous equipment shall be protected from falling into or onto the dangerous equipment by guardrail systems or by equipment guards.

1926.501(b)(8)(ii)

Each employee 6 feet (1.8 m) or more above dangerous equipment shall be protected from fall hazards by guardrail systems, personal fall arrest systems, or safety net systems.

1926.501(b)(9)

"Overhand bricklaying and related work."

1926.501(b)(9)(i)

Except as otherwise provided in paragraph (b) of this section, each employee performing overhand bricklaying and related work 6 feet (1.8 m) or more above lower levels, shall be protected from falling by guardrail systems, safety net systems, personal fall arrest systems, or shall work in a controlled access zone.

1926.501(b)(9)(ii)

Each employee reaching more than 10 inches (25 cm) below the level of the walking/working surface on which they are working, shall be protected from falling by a guardrail system, safety net system, or personal fall arrest system.

Note: Bricklaying operations performed on scaffolds are regulated by subpart L - Scaffolds of this part.

1926.501(b)(10)

"Roofing work on Low-slope roofs." Except as otherwise provided in paragraph (b) of this section, each employee engaged in roofing activities on low-slope roofs, with unprotected sides and edges 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, personal fall arrest systems, or a combination of warning line system and guardrail system, warning line system and safety net system, or warning line system and personal fall arrest system, or warning line system and safety monitoring system. Or, on roofs 50-feet (15.25 m) or less in width (see Appendix A to subpart M of this part), the use of a safety monitoring system alone [i.e. without the warning line system] is permitted.

1926.501(b)(11)

"Steep roofs." Each employee on a steep roof with unprotected sides and edges 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems with toeboards, safety net systems, or personal fall arrest systems.

1926.501(b)(12)

"Precast concrete erection." Each employee engaged in the erection of precast concrete members (including, but not limited to the erection of wall panels, columns, beams, and floor and roof "tees") and related operations such as grouting of precast concrete members, who is 6 feet (1.8 m) or more above lower levels shall be protected from falling by guardrail systems, safety net systems, or personal fall arrest systems, unless another provision in paragraph (b) of this section provides for an alternative fall protection measure. Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer shall develop and implement a fall protection plan which meets the requirements of paragraph (k) of 1926.502.

Note: There is a presumption that it is feasible and will not create a greater hazard to implement at least one of the above-listed fall protection systems. Accordingly, the employer has the burden of establishing that it is appropriate to implement a fall protection plan which complies with 1926.502(k) for a particular workplace situation, in lieu of implementing any of those systems.

1926.501(b)(13)

"Residential construction." Each employee engaged in residential construction activities 6 feet (1.8 m) or more above lower levels shall be protected by guardrail systems, safety net system, or personal fall arrest system unless another provision in paragraph (b) of this section provides for an alternative fall protection measure. Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer shall develop and implement a fall protection plan which meets the requirements of paragraph (k) of 1926.502.

Note: There is a presumption that it is feasible and will not create a greater hazard to implement at least one of the above-listed fall protection systems. Accordingly, the employer has the burden of establishing that it is appropriate to implement a fall protection plan which complies with 1926.502(k) for a particular workplace situation, in lieu of implementing any of those systems.

1926.501(b)(14)

"Wall openings." Each employee working on, at, above, or near wall openings (including those with chutes attached) where the outside bottom edge of the wall opening is 6 feet (1.8 m) or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches (1.0 m) above the walking/working surface, shall be protected from falling by the use of a guardrail system, a safety net system, or a personal fall arrest system.

1926.501(b)(15)

"Walking/working surfaces not otherwise addressed." Except as provided in 1926.500(a)(2) or in 1926.501 (b)(1) through (b)(14), each employee on a walking/working surface 6 feet (1.8 m) or more above lower levels shall be protected from falling by a guardrail system, safety net system, or personal fall arrest system.

1926.502(b)

"Guardrail systems." Guardrail systems and their use shall comply with the following provisions:

1926.502(b)(1)

Top edge height of top rails, or equivalent guardrail system members, shall be 42 inches (1.1 m) plus or minus 3 inches (8 cm) above the walking/working level. When conditions warrant, the height of the top edge may exceed the 45-inch height, provided the guardrail system meets all other criteria of this paragraph.

Note: When employees are using stilts, the top edge height of the top rail, or equivalent member, shall be increased an amount equal to the height of the stilts.

1926.502(b)(2)

Midrails, screens, mesh, intermediate vertical members, or equivalent intermediate structural members shall be installed between the top edge of the guardrail system and the walking/working surface when there is no wall or parapet wall at least 21 inches (53 cm) high.

1926.502(b)(2)(i)

Midrails, when used, shall be installed at a height midway between the top edge of the guardrail system and the walking/working level.

1926.502(b)(2)(ii)

Screens and mesh, when used, shall extend from the top rail to the walking/working level and along the entire opening between top rail supports.

1926.502(b)(2)(iii)

Intermediate members (such as balusters), when used between posts, shall be not more than 19 inches (48 cm) apart.

1926.502(b)(2)(iv)

Other structural members (such as additional midrails and architectural panels) shall be installed such that there are no openings in the guardrail system that are more than 19 inches (.5 m) wide.

1926.502(b)(3)

Guardrail systems shall be capable of withstanding, without failure, a force of at least 200 pounds (890 N) applied within 2 inches (5.1 cm) of the top edge, in any outward or downward direction, at any point along the top edge.

1926.502(b)(4)

When the 200 pound (890 N) test load specified in paragraph (b)(3) of this section is applied in a downward direction, the top edge of the guardrail shall not deflect to a height less than 39 inches (1.0 m) above the walking/working level. Guardrail system components selected and constructed in accordance with the Appendix B to subpart M of this part will be deemed to meet this requirement.

1926.502(b)(5)

Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members shall be capable of withstanding, without failure, a force of at least 150 pounds (666 N) applied in any downward or outward direction at any point along the midrail or other member.

1926.502(b)(6)

Guardrail systems shall be so surfaced as to prevent injury to an employee from punctures or lacerations, and to prevent snagging of clothing.

1926.502(b)(7)

The ends of all top rails and midrails shall not overhang the terminal posts, except where such overhang does not constitute a projection hazard.

1926.502(b)(8)

Steel banding and plastic banding shall not be used as top rails or midrails.

1926.502(b)(9)

Top rails and midrails shall be at least one-quarter inch (0.6 cm) nominal diameter or thickness to prevent cuts and lacerations. If wire rope is used for top rails, it shall be flagged at not more than 6-foot intervals with high-visibility material.

1926.502(b)(10)

When guardrail systems are used at hoisting areas, a chain, gate or removable guardrail section shall be placed across the access opening between guardrail sections when hoisting operations are not taking place.

1926.502(b)(11)

When guardrail systems are used at holes, they shall be erected on all unprotected sides or edges of the hole.

1926.502(b)(12)

When guardrail systems are used around holes used for the passage of materials, the hole shall have not more than two sides provided with removable guardrail sections to allow the passage of materials. When the hole is not in use, it shall be closed over with a cover, or a guardrail system shall be provided along all unprotected sides or edges.

1926.502(b)(13)

When guardrail systems are used around holes which are used as points of access (such as ladderways), they shall be provided with a gate, or be so offset that a person cannot walk directly into the hole.

1926.502(b)(14)

Guardrail systems used on ramps and runways shall be erected along each unprotected side or edge.

1926.502(b)(15)

Manila, plastic or synthetic rope being used for top rails or midrails shall be inspected as frequently as necessary to ensure that it continues to meet the strength requirements of paragraph (b)(3) of this section.

Subpart X – Stairways and Ladders

1926.1053(b)(1)

When portable ladders are used for access to an upper landing surface, the ladder side rails shall extend at least 3 feet (.9 m) above the upper landing surface to which the ladder is used to gain access; or, when such an extension is not possible because of the ladder's length, then the ladder shall be secured at its top to a rigid support that will not deflect, and a grasping device, such as a grabrail, shall be provided to assist employees in mounting and dismounting the ladder. In no case shall the extension be such that ladder deflection under a load would, by itself, cause the ladder to slip off its support.



May 11, 2010

Mr. Jeremy Neill
United Rentals
14515 Meadows Boulevard
Omaha, NE 68138

(sent via email)

RE: Highway 111 Improvements, Tea, SD
Kempf Construction
EPI Project No 10.141

Dear Mr. Neill:

Project Summary

It is our understanding the excavation will consist of a ten foot deep bench with an additional 20 foot deep excavation (30 foot total depth). The width of the lower 20 feet of the trench will be eight feet. As requested, we are writing this letter to communicate the results of our analysis.

Scope of Service

Engineering Partners was contacted to determine if the proposed trench shield was capable of resisting the anticipated excavation loads. Information provided to us for this project included:

- Speed Shore Tabulated Data and Trench Shield Certification sheet for model TS-1024DW8, Serial Number 0-2256
- GME Trench Shield Manufacturer's Tabulated Data sheet for model 6M824 NKE, Serial No. M05082126
- Efficiency Production, Inc. trench shield data sheet for model HT6-24, Serial Number 129643
- Geotechnical Exploration report by GeoTek Engineering and Testing Services (project #09-B34)
- United Rentals Excavation Shoring Questionnaire

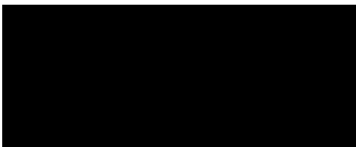
Findings

We understand the trench shields will be stacked three high at the bottom of the excavation, with the model TS-1024DW8 as the lowest trench shield, the model 6M824 NKE in the middle, and the model HT6-424 as the top trench shield. The total stacked height of the trench shield will be 22 feet. Our analysis of earth pressures based on subsurface information provided indicates the three trench shields identified above have adequate strength to resist the anticipated loads for the proposed excavation.

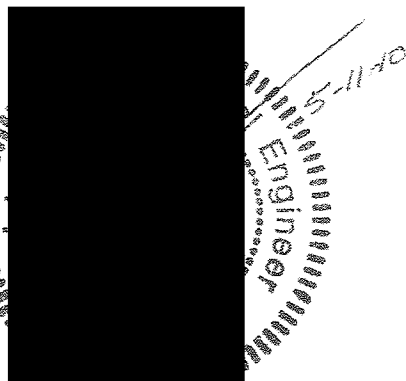
If you have any questions regarding this report please do not hesitate to contact me.

Sincerely,

Engineering Partners International LLC



Richard Greenlee, P.E.
Principal



9001 EAST BLOOMINGTON FREEWAY, SUITE 123
BLOOMINGTON, MN 55420

952.884.0481 | fax: 952.884.0491
www.engineeringpartners.net

ADDITIONAL RESOURCES

5/13/2010



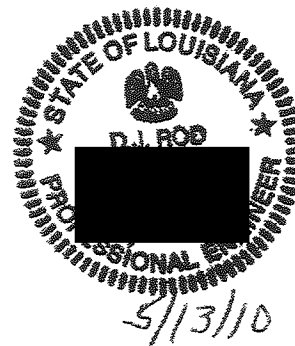
United Rentals Trench Safety
37474 Hwy 30
Gonzales, LA. 70737
(225) 744-0101
(225) 744-0212 (FAX)

Subject: End loading of Shield; 10 X 16' Or 10' X 12' With 12' Max Long Spreaders

Site: Murphy Oil, Chalmette, LA.

Soil Type – Medium Clay

It is permitted to end load the shield with 16' long sheets of section CS 69 or KD V1/8 steel sheeting. A 4' min toe is required.



STEEL CROSSING PLATE SAFETY GUIDELINES

It is the users sole responsibility to know and comply with all applicable federal, state or local regulations concerning the use of steel plates on or around roadways, and to use plates in accordance with any available Manufacturer's Tabulated Data.

In the absence of such regulations or tab data, conform to the recommendations contained in the latest edition of the "Standard Specification for Highway Bridges" by the American Association of State Highway Traffic Officials (AASHTO).

It is the users responsibility to consider all pertinent factors (excavation size, traffic loads, vehicular speeds, etc.) when specifying and placing steel plate over trenches.

WARNING



Use only pre-engineered, certified lifting devices which attach securely to plates.



All plates, welds, and all lifting devices (slings, cables, hooks, shackles, etc.) must be continuously inspected for cracks or damage. Do not use if damage is evident. The condition, capacity and use of any lifting and/or pulling device is the sole responsibility of the customer and customer's agents and/or employees.



Always use tag lines to control twisting and/or swinging of steel plates when lifting and moving. Do not put hands and fingers below or between plates when stacking or placing plates, to avoid serious injury or loss of fingers.



Always use proper personal-protection equipment (such as safety shoes, eye protection, hard-hat, hearing protection, and gloves, etc.)



No one shall be permitted under a plate while it is being lifted or moved.



Steel crossing plates must be secured from displacement and lateral movement when bridging an excavation. State and/or local regulations typically require use of one or more of the following methods: planing pavement to depth of plate, use of a proper bonding agent (such as asphalt-based cold mix), or staking or cleating to the road surface. State and/or local regulations may also require that plate edges be "ramped-up" or "feathered" from the road surface. State and/or local regulations may also require application of a permanent skid-resistant surface treatment on plates to increase traction for crossing vehicles. It is the customer's sole responsibility to know and comply with all state and local regulations.



Refer to Manufacturer's Tabulated Data or a professional engineer's site-specific design specifications for proper use of steel plate as trench sheeting.

If you are not sure of the proper operation of this equipment, discontinue use immediately and contact:



WE PROVIDE THESE SUPPLEMENTAL SAFETY GUIDELINES ONLY AS A REMINDER OF CUSTOMARY SAFE PRACTICES

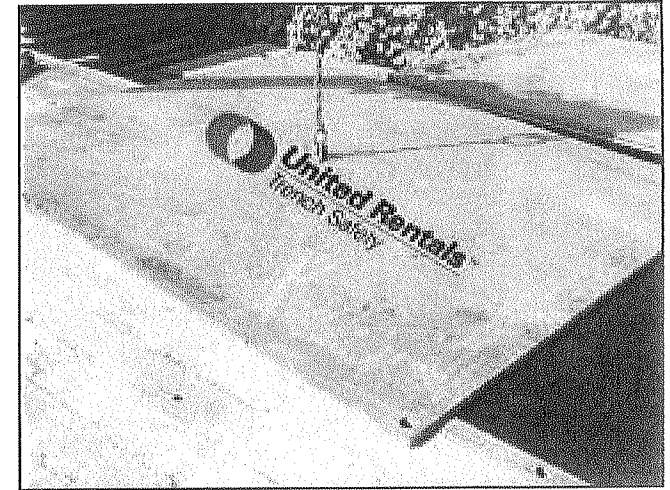
If the recipient of these guidelines is not the designated Competent Person or the sole operator, forward them to such person(s) and/or all users who will operate the equipment. THE PLANK COMPANY IS NOT RESPONSIBLE FOR IMPROPER USE OR MISAPPLICATION OF EQUIPMENT OR FOR PERSONAL INJURIES, DEATHS, OR PROPERTY DAMAGE RESULTING THEREFROM.



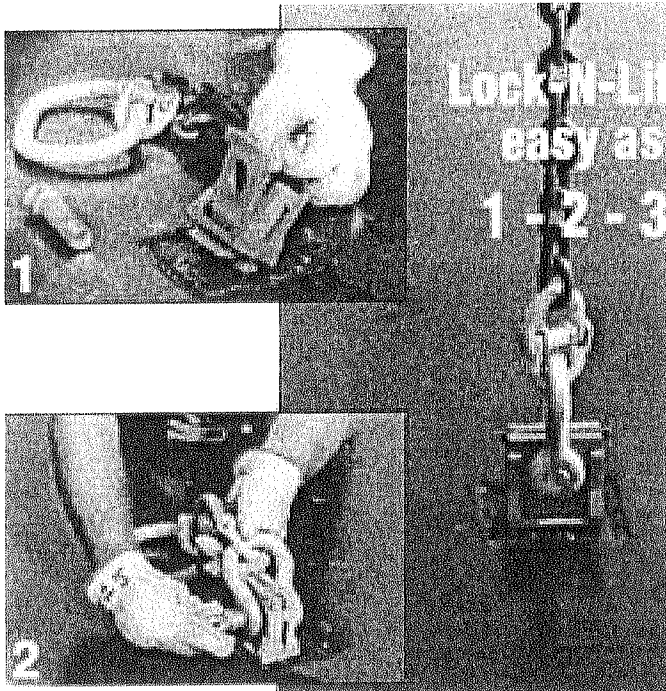
1-800-UR-RENTS

UR Trench Safety Street Crossing Plates

- Superior Strength: Lifting Lug has 52,000 pounds breakout capacity. Recommended safe working load of 8000 lbs.
- Safe & Secure Mount: Flush, positive-locking connection - no hooks or threads to allow slippage.
- Flat Stacking: Simple hookup with plates flat on the ground or stacked plate-to-plate. Never a need to reach under a plate.
- Single-Point Lift: Quick and easy connection provides centered lift for better balance and control.
- Pedestrian Safe: Specially designed plastic insert (available on request) fills the lifting hole for the safety of pedestrians, cyclists, & other crossing traffic.



There is simply no quicker, safer, more cost-effective lifting method on the market!



United Rentals is proud to continue it's tradition of providing the finest in steel crossing plates.

Available in various sizes to fit your site-specific needs, UR Trench Safety road plates are equipped with the revolutionary Lock-N-Lift system. Slightly larger than a deck of cards, the unique Lock-N-Lift tool is a lightweight, positive-locking device which provides the ultimate in safe, efficient handling of steel plates.

EXPERIENCE
THE
DIFFERENCE

of the Lock-N-Lift system
from United Rentals!

