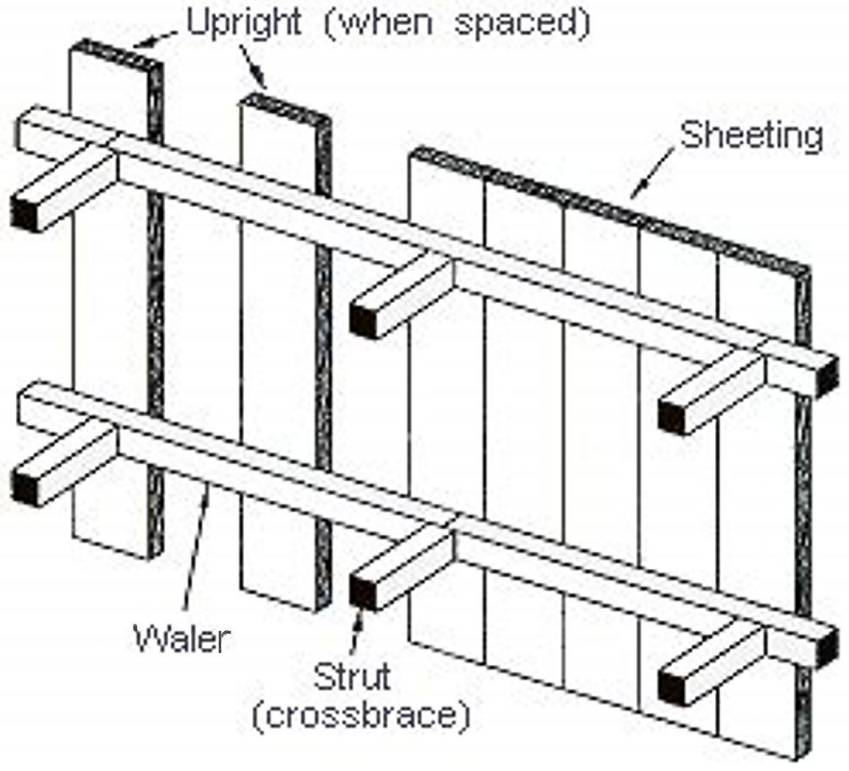
CHAPTER 2

Cal/OSHA OVERVIEW



Chapter 2: Cal/OSHA Overview

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2-1 Introduction

The California Division of Occupational Safety and Health, better known as Cal/OSHA, reports that more construction deaths occur during work in trenches than in any other form of construction work. This is despite a number of trench and excavation failures that go unreported. It is evident from this that continued diligence must be given to the planning, construction, monitoring, and supervisory aspects of excavations and trenching.

The information in this chapter is current as of the date of publication. It will be the responsibility of the reader to determine up-to-date applicable requirements. A summary of the most applicable Cal/OSHA references for excavations is located on the Caltrans Structure Construction (SC) intranet page under the "Safety" tab, and is titled *Cal/OSHA Standards for Excavations*[1].

Cal/OSHA adopted the Federal OSHA safety regulations pertaining to the protection of workers in excavations, effective September 25, 1991. These are embodied in the California Code of Regulations (CCR), Title 8; references to various sections and safety orders can be assumed to evolve from this file path, unless noted otherwise.

This chapter contains outlines of major portions of the adopted safety regulations that pertain to safety in conjunction with excavations. Major considerations, or requirements of the safety regulations in numerical order of the sections, are briefly outlined on the following pages. The text of most Cal/OSHA excavation requirements may be found in the *Cal/OSHA Standards for Excavations*, described above. This Cal/OSHA reference includes the following sections (§) of the Cal/OSHA Construction Safety Orders (CSO) found in CCR, Title 8, Chapter 4, subchapter 4 (hereafter referenced as Cal/OSHA CSO); § 1504, *Definitions;* § 1539, *Permits;* § 1540, *Excavations;* § 1541, *General Requirements*; § 1541.1, *Requirements for Protective Systems* (including appendices A - F); § 1542, *Shafts;* and § 1543, *Cofferdams*.

2-1.01 Excavations 20' Deep or Less without Deviations

Cal/OSHA CSO, § 1504 and § 1539 through § 1543 contain the excavation and shoring requirements. These sections provide a variety of excavation plans for worker protection in excavations. For excavations 20 feet or less in depth, the Contractor may use the sloping or benching of the soil, tables for timber or aluminum hydraulic shoring, or shields contained in these sections without a design from a professional engineer. Alternatively, the excavation plan may be designed by a registered professional engineer who is registered in the State.

[1] Caltrans internal use only

2-1.02 Excavations Over 20' Deep or with Deviations

A California registered professional engineer is required to design a protective system for excavations greater than 20 feet in depth, and when deviating from the Cal/OSHA excavation plans. For example:

1. Deviations from the sloping criteria.
2. Deviations not covered in the Cal/OSHA CSO from the timber or aluminum hydraulic shoring tables.
3. Shields to be used in a manner not recommended or approved by the manufacturer.
4. Surcharges that must be accounted for.
5. Alternate designs used.

The Contractor's engineer may base the design on manufacturer's information, on a variety of tables and charts, on the use of proprietary systems, on soils information furnished by a competent person, and in accordance with accepted professional engineering practice.

2-1.03 Maintain Design Plan at the Jobsite

Cal/OSHA CSO, § 1541.1, *Requirements for Protective Systems,* requires that at least one authorized copy of the excavation plan be maintained at the jobsite during the construction of the protective system. The excavation plan includes tabulated data, manufacturer's data, or the engineer's design. For excavation utilizing shield systems, identify the CA registered professional engineer approving the use of tabulated or manufacturer's data for the specific excavation.

2-1.04 Registered Professional Engineer

For work in California, the design engineer must be a registered professional civil engineer in California pursuant to California Streets and Highways Code § 137.6.

2-1.05 Competent Person

Cal/OSHA CSO, § 1504, *Definitions,* defines a competent person as follows (emphasis added): "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."

2-1.06 Surcharges

The figures and tables in the Appendices of Cal/OSHA CSO, § 1541.1, *Requirements for Protective Systems,* provide for a minimum surcharge equivalent to an additional soil height of 2 feet. The minimum surcharge may be considered to represent a 2-foot high soil embankment, small equipment, material storage, or other small loads adjacent to the excavation. No provision is made for nearby traffic, adjacent structure loadings, or for dynamic loadings (see Cal/OSHA CSO, § 1541.1, Appendix C, *Timber Shoring for Trenches*).

2-1.07 Tabulated Data

Tabulated data is defined in Cal/OSHA CSO § 1540, *Excavations*, as: "Tables and charts approved by a registered professional engineer and used to design and construct a protective system." Realize that tabulated tables or charts used for shoring boxes or engineered walls by design height, "H" are similar to retaining walls in the *Standard Plans*, for example Standard Plan Sheet B3-1A, *Retaining Wall Type 1*. One need not be a CA registered professional engineer for generating these manufactured systems, but a CA registered professional engineer must be used in selecting one for the site-specific excavation.

2-1.08 Worker Protection System Shop Drawing Submittal

The Contractor may submit worker protection system shop drawings, commonly called an excavation plan, using Cal/OSHA CSO standard details for sloping excavations or tabular data in the form of a letter stating which portions of the standard details are to apply to the plan. The letter should list:

1. Location of the work
2. Limits of the work
3. The times the work is to start and be in progress, and the sequence of the work
4. The applicable Cal/OSHA CSO standard details of figures and/or tables
5. Any other information pertaining to the progress or complexity of the work
6. Who will be in charge of the work
7. Who will be the designated, competent person responsible for safety.

If the Contractor elects to use the excavation plan details in the Cal/OSHA CSO, it is not necessary to have the excavation plan prepared by a registered engineer and the reviewing engineer does not have to perform a structural analysis. However, the reviewing engineer must ensure that the Contractor does the work in accordance with the Cal/OSHA CSO and the site conditions are such that the excavation plan is appropriate for the soil conditions encountered.

2-2 Some Important Cal/OSHA Definitions

Describing or citing primary sections can condense a lot of information about the requirements in the Cal/OSHA CSO. A few important definitions are included here, but the reader is directed to the applicable Cal/OSHA CSO for excavations included in the *Cal/OSHA Standards for Excavations*[1] reference, located on the SC intranet page.

From Cal/OSHA CSO, § 1504, *Definitions*:

2-2.01 Geotechnical Specialist (GTS): A person registered by the State as a Certified Engineering Geologist, or a Registered Civil Engineer trained in soil mechanics, or an engineering geologist or civil engineer with a minimum of 3 years applicable experience working under the direct supervision of either a Certified Engineering Geologist or Registered Civil Engineer.

From Cal/OSHA CSO, § 1540, *Excavations*:

2-2.02 Accepted Engineering Practices: Those requirements which are compatible with standards of practice required by a registered professional engineer.

2-2.03 Excavation: Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. *Note that excavations are defined to include trenches.*

2-2.04 Protective System: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

2-2.05 Registered Professional Engineer: A person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

2-2.06 Shield (Shield System): 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 premanufactured or job-built in accordance with Cal/OSHA CSO, § 1541.1(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

[1] Caltrans internal use only

2-2.07 Shoring (Shoring System): A structure, such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation, and which is designed to prevent cave-ins.

2-2.08 Sloping (Sloping System): A method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away [from] the excavation 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.

2-2.09 Trench (Trench excavation): A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

2-3 Some Important Cal/OSHA Requirements

A few of the important considerations from the Cal/OSHA CSO portion of the CCR, Title 8 are listed here for quick reference. These portions of the Title 8 are summaries rather than direct quotes. The complete text of Cal/OSHA CSO, § 1541, *General Requirements*, referred to below is included in the *Cal/OSHA Standards for Excavations* reference.

2-3.01 General Requirements Section 1541

Underground utilities must be located prior to excavating. The Contractor should notify Underground Service Alert or other appropriate Regional Notification Centers a minimum of two working days prior to start of work. Excavations in the vicinity of underground utilities must be undertaken in a careful manner while supporting and protecting the utilities.

Egress provisions, which may include ladders, ramps, stairways, or other means, must be provided for excavations over 4 feet or more in depth. The maximum distance a worker must travel to exit the trench must not be more than 25 feet laterally.

Adequate protection from hazardous atmospheres must be provided. This includes testing and controls, in addition to the requirements set forth in the Cal/OSHA CSO and the General Industry Safety Orders, to prevent exposure to harmful levels of atmospheric contaminants and to ensure acceptable atmospheric conditions.

Employees must be protected from the hazards of accumulating water, from loose or falling debris, and from potentially unstable adjacent structures.

Daily inspections, inspections after rainstorms, and as otherwise required for hazardous conditions, are to be made by a competent person. Inspections must be conducted prior to the start of work and as needed throughout the shift. The competent person will need to check for potential cave-ins, indications of failure of the protective system, and for hazardous atmospheres. When the competent person finds a hazardous situation, it is important to remove the endangered employees from the area to ensure their safety, until the necessary precautions have been made.

Adequate physical barrier protection is to be provided at all excavations. This is extremely important at remotely located excavations where active construction operations are absent. All wells, pits, shafts, etc., must be barricaded and/or covered during periods when there is no active construction work. Upon completion of exploration and other similar operations, temporary shafts etc., must be backfilled.

2-3.02 Protective System Selection

Cal/OSHA CSO, § 1541.1 covers almost all of the requirements that must be considered when selecting or reviewing a shoring system. The text of this section contains general information and considerations for various shoring systems. This section describes the various shoring systems which can be used with or without the services of a registered professional engineer. Cal/OSHA classifies soils into three types: Type A, Type B, and Type C. These soil types are discussed below in Section 2-3.03, *Soil Classification*, and the Cal/OSHA definitions are found in Appendix A, *Soil Classification*, of Cal/OSHA CSO, § 1541.1. Additional information about the various shoring systems may be found in Appendix B through Appendix F of Cal/OSHA CSO, § 1541.1.

The design of a protective system for workers in an excavation may be selected from one of the possible options listed below per Cal/OSHA CSO, § 1541.1:

1. Entirely in stable rock - no shoring needed.
2. Excavation less than 5 feet deep - no shoring needed when an examination of the ground by a competent person provides no indication of a potential cave-in.
3. Sloping, benching, or shoring per Cal/OSHA CSO:
    a. Slope 1-1/2:1 as for Type C soil.
    Steeper slopes may be used for short term (1 day in Type A soil and 12 feet or less excavation).
    b. Slope using Table B-l, *Maximum Allowable Slopes*, or Figure B-l, *Slope Configurations*, of Appendix B, *Sloping and Benching*.
    Slopes dependent on soil type - see Appendix A, *Soil Classification*.

c. Per tables or charts identified by a California registered professional engineer approving the data.

d. Designed by a California registered professional engineer.

4. Utilizing of support systems, shield systems, or other protective systems per Cal/OSHA CSO, § 1541.1:

   a. Designed in accordance with Appendix A, or C – F:

      i. Appendix A – *Soil Classification*

      ii. Appendix C – *Timber Shoring for Trenches*

      iii. Appendix D – *Aluminum Hydraulic Shoring for Trenches*

      iv. Appendix E – *Alternatives to Timber Shoring*

      v. Appendix F – *Selection of Protective Systems*.

5. Engineered systems:

   a. Designed using manufacturer's data (shields for example):

      i. Data includes specifications, limitations, and/or other tabulated data (tables or charts).

   b. Designed using other tabulated data (tables or charts):

      i. Identified by a California registered professional engineer approving the data. (Approving engineer implies the California professional engineer designing or submitting the excavation plan.)

   c. Designed by a registered professional engineer:

      i. Identified by a California registered professional engineer authorizing the plan. (Authorizing engineer applies to the California professional engineer other than the registered professional engineer designing or submitting the excavation plan.)

Protective system designs (including manufacturer's data) other than those selected directly from tables in Cal/OSHA CSO, § 1541.1, Appendices A - F, will need to be posted at the jobsite during construction of the protective system.

Damaged materials or equipment will need to be reevaluated for use by a competent person or by a registered professional engineer before being put back into use.

Shield systems, including individual members of support systems, must not be subjected to loads exceeding those which they are designed to withstand.

Excavation of material to a level no greater than 2 feet below the bottom of the members of a support system is allowed, but only if the system is designed to resist the forces calculated for the full depth of the excavation so no loss of soil is possible.

2-3.03 Soil Classification

Appendix A, *Soil Classification*, of Cal/OSHA CSO, § 1541.1 contains the soil classification information that may be used for the proper selection of a shoring system. This appendix describes when soil classification information may be used as well as defines soil and soil types (A, B, or C). The section also covers the basics of soil classification, who can classify soil, and how soil classification is to be done by using visual and manual tests.

A competent person or a testing lab must make soil classification determinations by at least one visual and one manual test to classify rock or soil for the proper selection, or for the design, of a shoring system. Classification of the soil is necessary to determine the effective active soil pressures that the shoring system may be subjected to. The tables for the selection of sloping, timber shoring, or aluminum hydraulic shoring, are based on one of three types of soil (A, B, or C).

The three soil types in the Cal/OSHA CSO are described below:

2-3.03A Type A

Cohesive soil with unconfined compressive strength of 1.5 tons per square foot (tsf) or greater.

Examples of this soil type are: clay, silty clay, sandy clay, clay loam, silty clay loam, sandy clay loam, and cemented soils like caliche or hardpan.

No soil is Type A if:

1. The soil is fissured.
2. Vibratory or dynamic loads will be present.
3. The soil has been previously disturbed.
4. Sloped four horizontal to one vertical (4H:1V or greater) where layers dip into the excavation.
5. Other factors preclude Type A classification.

2-3.03B Type B

1. Cohesive soil with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf, or
2. Granular cohesionless soils including: angular gravel, silt, silty loam, sandy loam, or maybe silty clay loam and sandy clay loam, or
3. Previously disturbed soils not classified as Type C, or
4. Soil that meets the requirements of Type A, but is fissured or subject to vibration, or
5. Dry rock that is not stable, or

6. Type B soil that has sloped (4H:1V or less.) layers that dip towards the excavation.

2-3.03C Type C

1. Cohesive soil with unconfined compressive strength of 0.5 tsf or less, or
2. Granular soil including gravel, sand, and loamy sand, or
3. Submerged soil, or soil from which water is freely seeping, or
4. Submerged rock that is not stable, or
5. Material sloped towards the excavation 4H:1V or steeper in a layered system.

Tables in the Cal/OSHA *CSO* for timber shoring systems consider the effective lateral pressures (**PA**) for a depth (**H**) due to the three different soil types as follows:

Type A: PA = 25H + 72 psf (2 ft. Surcharge)

Type B: PA = 45H + 72 psf (2 ft. Surcharge)

Type C: PA = 80H + 72 psf (2 ft. Surcharge)

Manual testing of soils includes tests for plasticity, dry strength, thumb penetration, and the use of a pocket penetrometer or hand-operated vane shear tester. Samples of soil can be dried to determine relative cohesive content. A few of these tests may be used to determine compressive strength; the other tests may be used to determine relative cohesive properties of the soil. The test procedures are outlined in the complete text of Cal/OSHA CSO*,* § 1541.1, Appendix A. Note that expansive clays are not mentioned and may need special consideration.

2-3.04 Sloping or Benching Systems

Cal/OSHA CSO*,* § 1541.1, Appendix B, *Sloping and Benching,* contains specifications for sloping and benching options, including visual diagrams, for excavations 20 feet or less. A registered professional engineer may design alternate configurations. Slopes may be laid back in conformance with the figures in Cal/OSHA CSO*,* § 1541.1, Appendix B, providing there is no sign of distress, and surcharge loads will not be a factor. Signs of distress include: caving-in of the soil, development of fissures, subsidence, bulging or heaving at the bottom of the excavation, or spalling or raveling at the face of the excavation.

When there is any sign of distress, the slope must be laid back to at least 1/2 horizontal to 1 vertical less than the maximum allowable slope as outlined below.

When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person must determine the degree to which the actual slope must be reduced below the maximum allowable slope and must assure that such reduction is achieved. If site conditions are outside the scope and applications of the

figures of Appendix B, an alternative shoring system needs to be designed by a California registered professional engineer.

When surcharge loads from structures are present, underpinning or bracing will be required; otherwise, the structure must be on stable rock or a California registered professional engineer must determine that the excavation work will not pose a hazard to employees.

Cal/OSHA CSO, Appendix B of § 1541.1, Table B-1, *Slope Configurations,* lists the following maximum allowable slopes (H:V) for excavations less than 20 feet deep for the various soil types as shown in Table 2-1.

Table 2-1. Maximum allowable slopes (H:V) for excavations less than 20 feet deep

Soil or Rock Type	Maximum Allowable Slopes (H:V) for Excavations Less Than 20 Feet Deep
Stable Rock	Vertical
Type A	3/4:1
Type B	1:1
Type C	1-1/2:1

Cal/OSHA provides some exceptions and variations to the allowable slopes above. See Appendix B for additional details.

2-3.05 Timber Shoring for Trenches

Cal/OSHA CSO*,* § 1541.1, Appendix C, *Timber Shoring for Trenches*, contains information and tables that the Contractor may utilize to shore trenches that do not exceed 20 feet in depth with rough or finished timbers in any of the three types of soil. Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber, having a minimum $\mathbf{F_b}$ of 850 psi. Tables C-2.1 through C-2.3 list timber members as nominal dimensions, finished (S4S) timbers, having a minimum $\mathbf{F_b}$ of 1500 psi. There is one table for each soil type for each of the timber grading sizes.

CSO*,* § 1541.1, Appendix C, Item (d)(2), *Limitation of application*, provides a list of conditions when the tables will not be adequate. Thus, either another protective system is to be selected, or an alternative shoring system needs to be designed by a registered professional engineer. Some of the limitations include:

1. Material surcharge loads adjacent to the trench will exceed the load from a 2-foot surcharge. (Adjacent is defined as within the horizontal distance from the edge of the trench equal to the depth of the trench.)
2. Vertical loads on the center of crossbraces exceed 240 pounds.

3. Adjacent surcharge loads from equipment weighing over 20,000 pounds are present.
4. Only the lower portion of a trench is shored, and the remaining portion is sloped or benched unless:
   a. The sloping portion is sloped less than 3H:1V, or
   b. The shoring is selected for full depth excavation.

It is necessary to understand the notes associated with these Cal/OSHA tables which describe their use and additional constraints. The excerpts below are paraphrased from Cal/OSHA CSO, § 1541.1, Appendix C, Item (g), *Notes for all Tables*.

1. When conditions are saturated or submerged, use tight sheeting. Tight sheeting refers to tongue and groove timbers at least 3 inches thick, steel sheet piling, or similar materials able to resist imposed lateral loads including water. Close sheeting refers to placing planks side-by-side as close together as possible.
2. All spacings indicated are center-to-center.
3. Wales are to be installed with greatest dimension horizontal.
4. If the vertical distance from the center of the lowest cross brace to the bottom of the trench is to exceed 2.5 feet, uprights are to be firmly embedded [in the soil], or a mudsill is to be used. A mudsill is a waler placed at the bottom of the trench.

   Maximum distance from lower brace to bottom of trench:

   a. 36 inches for embedded sheeting.
   b. 42 inches when mudsills are used.
5. Trench jacks may be used in place of or in combination with timber struts.
6. Placement of crossbraces: when the vertical spacing of crossbraces is 4 feet, place the top crossbrace no more than 2 feet below the top of the trench. When the vertical spacing of crossbraces is 5 feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

Cal/OSHA CSO, § 1541.1, Appendix C, also contains four example problems demonstrating selection of shoring from the tables.

2-3.06 Aluminum Hydraulic Shoring for Trenches

Cal/OSHA CSO, § 1541.1, Appendix D, *Aluminum Hydraulic Shoring for Trenches*, contains typical installation diagrams, tables, and information for the use of aluminum hydraulic shoring in trenches that do not exceed 20 feet in depth. Tables D-1.1 and D-1.2 are for vertical shores in Type A and B soils. Tables D-1.3 and D-1.4 are for horizontal waler systems in Type B and Type C soils. Type B soils may require sheeting, whereas Type C soils always require sheeting.

For hydraulic cylinder specifications refer to the Cal/OSHA CSO, § 1541.1, Appendix D, Item (d)(2), *Hydraulic cylinders specifications*.

When any of the following conditions exist, the tabular data will not be valid:

1. When vertical loads exceeding 100 pounds will be imposed on the center of hydraulic cylinders.
2. When adjacent surcharge loads are present from equipment weighing in excess of 20,000 pounds.
3. Only the lower portion of a trench is shored, and the remaining portion is sloped or benched unless:
    a. The sloping portion is sloped less than 3H:1V, or
    b. The shoring is selected for full depth excavation.

Footnotes for the aluminum hydraulic shoring will be found in Item (g) of Appendix D to Section 1541.1, immediately preceding the figures. As with the timber tables above, it is necessary to review and understand these notes, with excerpts paraphrased below.

1. Minimum thickness plywood of 1-1/8 inch or 3/4-inch-thick 14-ply arctic white birch (Finland form) may be used in conjunction with aluminum hydraulic shoring to prevent raveling but may not be used as structural members.
2. The tables consider two cylinder sizes with minimum safe working capacities as follows: 2-inch inside diameter with 18,000 pounds axial compressive load at maximum extension, or 3-inch inside diameter with 30,000 pounds axial compressive load at maximum extensions, and as recommended by the product manufacturer.

Cal/OSHA CSO, § 1541.1, Appendix D, also contains four example problems demonstrating selection of shoring from the tables.

2-3.07 Shield Systems

Cal/OSHA CSO, § 1541.1, Appendix E, *Alternatives to Timber Shoring,* Figure 4, *Trench Shields*, contains a few diagrams of manufactured trench shields in various configurations.

The reviewing engineer should be aware that manufacturers will normally furnish engineering data to a supplier who, in turn, will furnish the data to the Contractor. An excavation plan for specific use of the shield must be prepared. The Engineer will determine forces, including surcharges, that are to be resisted, and then make comparisons with manufacturer's data, or with the submitting engineer's computations that define the capacity of the shoring system.

2-4 Manufactured Products

Manufactured trench shoring and worker protection products include screw jacks, hydraulic shores, screw or hydraulic operated frames, work shields, and other devices used to shore a trench and/or protect workers.

The maximum loading which may be applied per Cal/OSHA CSO, § 1541.1, Item (c)(2), *Option (2) – Designs Using Manufacturer's Tabulated Data*, to a manufactured product must not exceed the capacities as given by the manufacturer. These are usually shown in a catalog or brochure published by the manufacturer, or in the form of a letter from the manufacturer pertaining to the use of their product for specific job conditions. This declaration of capacities may be shown on a shop drawing or included in a letter. To be acceptable, it must be signed by the manufacturer, not the Contractor. When professional engineering data accompanies manufactured products, that data may be used with minimum supplemental review.

Be aware that some manufacturer's catalogs do not always present enough engineering data; they may only be sales brochures. Be sure to review the conditions that apply to the data submitted. This is necessary to ascertain that "capacity ratings" and other information were established utilizing the minimum loads (such as surcharges) required by the CCR, Title 8. It may be necessary to request the Contractor to furnish additional engineering data from the manufacturer.

The maximum allowable safe working load, as recommended by the manufacturer, will be based on the use of new or undamaged used material. If the product or its components are not in good condition, it must be determined if the product can function as intended, or if the safe working loads should be reduced. It is the responsibility of the Contractor to furnish proof of load capacity.

In the case of manufactured products which cannot be found in any catalog and the manufacturer is unknown or unable to recommend a safe working load, a load test is required to establish the safe load carrying capacity of that product or device. A load test should be conducted to a predetermined value or to failure. It is recommended to test the device to failure, in which case the safe working load may be taken as 1/2 the ultimate load. This will provide a safety factor of 2 with respect to failure, which is consistent with manufacturer's ratings for concrete form accessories. If it is not possible to test to failure, the working load used for the design should not exceed 1/2 of the maximum load carried during the test.

A non-commercial product generally has less quality control during its fabrication relative to a manufactured product. As such, non-commercial material should have a safety factor of 3.

Load tests witnessed by the Engineer should be documented in the project records and a copy submitted to Structure Construction Headquarters with the authorized excavation plans.

Materials must be properly identified on the excavation plan shop drawing and verified in the field. This is very important when analyzing aluminum members as there are many different alloys.

2-5 Information About Text Formatting in the Construction Safety Orders

In the CCR, Title 8, all subtopics are usually indented the same amount only on the first line of type. The subjects and subheadings format generally conforms to the following example:

Subchapter Title

Article No. Major Heading

Section Number Heading

(a) Lower case letter used for first subtopic.

(1) Number used for subtopic to lower case letter.

(A) Upper case letter used for subtopic to number.

1. Number used for subtopic to uppercase letter.

Another Heading.