

SECTION 02160 – EXCAVATION SUPPORT SYSTEMS

PART 1 – GENERAL

1.1 WORK OF THIS SECTION

- A. The work of this Section includes support of temporary open excavations by means of sheet pilings, soldier piles and lagging, structural steel walls and struts, liner plates, and timber. The CONTRACTOR shall be responsible for the design and selection of methods in conformance with the design criteria as specified herein.
- B. The work of this Section applies to temporary excavation support systems for demolition, installation of buried pipelines, and all other excavations.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Record Drawings and Submittals

1.3 CONTRACTOR SUBMITTALS

- A. The following shall be submitted in compliance with the standard specifications:
 - 1. The proposed excavation support system for each construction component where excavation support systems will be used.
 - 2. Arrangement and details for each excavation support system, supporting design calculations, and construction methods to be used for the installation of each system.
 - 3. Soldier pile installation methods, connection details, bracing preloading, and jacking procedures.
 - 4. Depths below the main excavation bottom elevation to which the support system will be installed.
 - 5. Elevations of ground surface, struts, and shores, as applicable.
 - 6. Permissible depth to which excavation may be carried before supports must be installed and preloaded.
 - 7. Full excavation depth load to be carried by various support system members.
 - 8. Bracing loads for various stages of excavation, bracing removal, and concrete placement.
 - 9. Preloads as required.
 - 10. Proposed sequence of strut and shore removal as applicable and as related to concrete placement and backfilling operations.
 - 11. The proposed method of installing sheet piling including sequence of installation, template, and equipment description.
 - 12. Contingency plan for alternative procedures to be implemented if the excavation support system is found to perform unfavorably.
- B. The above Shop Drawings shall be coordinated with other shop drawing submittals for work specified elsewhere in which support of excavation is required.

1.4 QUALITY ASSURANCE

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- A. Support of excavation shall be designed, and Shop Drawings and calculations stamped and signed, by a Professional Engineer, licensed to practice in the State of California and experienced in the design of excavation support systems. All design drawings and calculations shall be checked and initialed by a checker.

1.5 DESIGN CRITERIA

- A. Shop Drawings with supporting calculations for the various excavation support systems shall be prepared in accordance with the following criteria:
 - 1. Design the excavation support system and all components to support the earth pressures, unrelieved hydrostatic pressures, utility loads, equipment, traffic, and construction loads including impact, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures, to minimize ground movement or settlement, and to prevent damage to or movement of adjacent buildings, structures, roadways and utilities.
 - 2. Design support members to resist the maximum loads expected to occur during the excavation and support removal stages.
 - 3. Design for staged removal shall conform to construction concrete placement, and backfill sequence shown. Design shall consider provisions for future construction, and limits on bracing level elevations as shown on the plans.
 - 4. Maximum vertical center-to-center spacing of supports shall be 16 feet between top 2 support levels and 12 feet below second support level unless otherwise approved. If decking beams are not required, install the uppermost bracing tier at a vertical distance of not more than 6 feet below the top of excavation.
 - 5. Where water flows from the face of excavation, the maximum height of unsupported excavation shall not exceed 15 inches.
 - 6. In running sand and silt, provide positive means for securing timber lagging to the soldier piles to avoid shifting or falling off of the lagging, and positive means for containing such material behind lagging.
 - 7. Review of the CONTRACTOR's Shop Drawings and methods of construction by the AGENCY does not relieve the CONTRACTOR of responsibility for the adequacy of the excavation support systems.
 - 8. No portion of the excavation support system's vertical face will be permitted to penetrate the design lines as indicated on the Drawings for the permanent concrete structure to be constructed within the excavation.
 - 9. Vertical support capacity shall be provided for wall systems and internal bracing elements, for loads due to vertical force components of tieback anchors, the weight of the structural systems themselves, and live load on any portion of the system.
- B. Steel Components:
 - 1. Design and fabrication of steel components shall be as specified in this Specification.
- C. Timber Support Systems and Members:

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1. Basis for determination of minimum allowable working stress: The latest version of the Uniform Building Code Chapter 23.
2. The minimum thickness of timber lagging between soldier piles spaced 5 to 7 feet center-to-center shall be 3 inches for excavations up to 25 feet in depth, and 4 inches for excavations deeper than 25 feet.
3. For other conditions and types of lagging, design calculations shall be submitted.

1.6 SAFETY

- A. Except as otherwise indicated, the following codes apply to the work of this Section:
 1. Title 8, California Administrative Code, Chapter 4, Subchapter 4, Construction Safety Orders, Article 6, Excavations.
 2. Standard Specifications for Public Works Construction, "Greenbook" Section 306-4.

1.7 PROJECT CONDITIONS

- A. Utility agencies shall be notified and caution exercised while exposing utility facilities by hand or other methods approved by utility owner.
- B. If existing utility facilities interfere with the proposed method of support, the method shall be modified in a manner that will protect the facility and accommodate the proposed work. Shop Drawings shall be revised and resubmitted along with design calculations required to account for the modified support method and to show the actual location of the existing utilities.
- C. Provisions shall be made for contingencies as follows:
 1. Monitor performance of support system components, for both vertical and horizontal movement, daily.
 2. Provide contingency plan for alternative procedures to be implemented if unfavorable performance is evidenced.
 3. Keep on hand materials and equipment necessary to implement contingency plan.
- D. Elements of the support system shall not be spliced unless submitted to and approved by the AGENCY.

PART 2 – MATERIALS

2.1 MATERIALS

- A. Steel sheet piling shall be continuous interlocking type ASTM A 328 of appropriate shape and provided with at least one 2-1/2-inch-diameter handling hole on the centerline of the web located at least 6 inches from each end of the sheet pile.

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- B. Fabricated connections and accessories, steel H-piles, WF shapes, and other structural steel shall conform to the requirements of ASTM A 36, unless otherwise approved.
- C. Concrete shall be as specified below:
 - 1. For encasement of steel soldier piles below the final level of excavation, a minimum of 2,500 psi shall be used.
 - 2. For encasement of soldier piles above the final level of excavation, lean concrete shall be used, the strength of which shall be adequate to protect the excavated faces of the augured hole.
- D. Wood lagging shall be dimension lumber with minimum allowable stress of 1100 psi.
 - 1. The stress grade of the lagging shall be in conformance with the allowable stresses of the UBC, Chapter 25.
 - 2. Lumber shall be grade marked by WWPA or WCLIB with species and grade conforming to those shown on approved Shop Drawings.

PART 3 – EXECUTION

3.1 GENERAL

- A. The support system shall extend the main excavation bottom elevation to a depth adequate to prevent lateral movement and to adequately support applied vertical loads. In areas where additional excavation is required below the main excavation subgrade provisions shall be made to prevent movement of main excavation supports. Damage to existing utilities during installation of excavation support system shall be avoided.

3.2 SOLDIER PILES

- A. Soldier piles shall be installed by preboring or other approved pre-excavation methods to tip elevation shown on approved Shop Drawings. Prevent pre-bored or other pre-excavated holes from collapsing.
- B. Prebored hole shall be filled with lean concrete from bottom of hole to subgrade dependent upon analysis of vertical support requirements.
- C. Remaining pile length shall be filled with lean concrete, completely encasing the pile.
- D. Concrete shall be placed from the bottom of the hole upwards by means of a flexible pipe connected to a hopper.

3.3 SHEETING AND LAGGING

- A. Sheeting and lagging shall be installed with no gap between the boards unless specifically approved. As installation progresses, the voids between the excavation

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face and the lagging or sheeting shall be backfilled with sand or soil and rammed into place. Materials such as hay or burlap shall be used where necessary to allow drainage of groundwater without loss of soil or packing material. If gaps in the lagging are allowed, the gap width between lagging boards shall be limited to 1/2 inch maximum.

- B. If unstable material is encountered, suitable measures shall be taken to retain it in place or to otherwise prevent soil displacement.
- C. Extend lagging down to final subgrade.
- D. A sufficient quantity of material shall be on hand for sheeting, shoring, bracing, and other operations for protection of work and for use in case of accident or emergency.

3.4 STEEL SHEET PILING

- A. Steel sheet piling may be used only where existing subsurface conditions are suitable for installation of sheet piling to the full depth of penetration required, and to proper alignment and plumbness, specified herein, without damage to the sheet piling or rupture of its interlocks. The use of steel sheet piling will not be permitted where sheeting would be required to penetrate boulders, rock or other materials which may prevent the proper installation of sheet piling.
- B. Steel sheet piling shall be installed in plumb position with each pile interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground. Install sheeting to depth required for design. Exercise care during installation so that interlocking members can be extracted, if required, without injury to adjacent ground. The installation equipment shall be suitable to the type and nature of the subsurface materials anticipated to be encountered. The equipment and methods of installation, cutting, and splicing shall conform to the approved Shop Drawings.
- C. Liner plate shall be installed to proper line and grade and dimensions which will enable final liner to be placed in accordance with tolerances specified by the AGENCY. Annular void, if present by method of ground support shall be filled with tunnel grout as specified by the AGENCY.

3.5 INTERNAL BRACING SUPPORT SYSTEM

- A. All bracing support members shall be installed and maintained in tight contact with each other and with the surface being supported.
- B. Bracing members shall be preloaded by jacking the struts and shores in accordance with loads, methods, procedures, and sequence as described on the approved Shop Drawings. Coordinate excavation work with bracing installation and preloading. Use steel shims and steel wedges welded or bolted in place to maintain the preloading force in the bracing after release of the jacking equipment pressure. Use procedures so as to produce uniform bracing member loading without appreciable eccentricities, overstressing, or support member distortion.

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- C. Struts shall be provided with intermediate bracing as needed to enable them to carry their maximum design load without distortion or buckling. Provide diagonal bracing as necessary to maintain the stability of the system. Web stiffeners, plates, or angles shall be provided as needed to prevent rotation, crippling, or buckling of connectors at points of bearing between structural steel members. Allow for eccentricities resulting from field fabrication and assembly.
- D. Excavations shall be to a depth no more than 2 feet below the elevation of the support member about to be placed. The support member shall be installed and preloaded immediately after installation and prior to continuing excavation.

3.6 REMOVAL OF SUPPORT SYSTEMS

- A. Where removal is required wholly or in part, such removal shall be performed in a manner that will not disturb or damage adjacent new or existing construction or utilities. Fill all voids immediately with lean concrete, or other approved means.
- B. All elements of support systems shall be removed to a minimum depth of 6 feet below final ground surface. However, when a structure poured against the sheeting system extends above the 6-foot limit, removal of the sheeting system shall be to the top of the structure.
- C. All damage to property resulting from removal shall be promptly repaired at no cost to the AGENCY. The AGENCY shall be the sole judge as to the extent and determination of the materials and methods for repair.

****END OF SECTION****