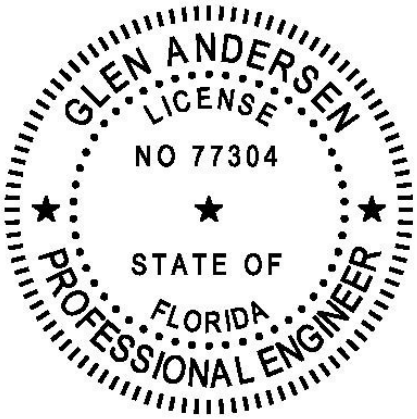
SECTION 31 41 16

METAL SHEET PILING

APPROVAL STATUS							
PREPARED BY:	GA	DATE	27July2021	CHECKED BY:	DD	DATE	27July2021
APPROVED BY:	DB	DATE	27July2021				

REVISION STATUS						
REV	ISSUED FOR	REVISED BY	CHECKED BY	APPROVAL	APPROVAL	DATE
0	Bidding	GA	ML			13Sept2021

Engineer's Seal



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GLEN ANDERSEN P.E., STATE OF FLORIDA, PROFESSIONAL ENGINEER, LICENSE NO. 77304.

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SECTION 31 41 16

METAL SHEET PILING

PART 1 GENERAL

1.1 DESCRIPTION

Design, furnish, test, and install metal sheet piles at the locations indicated on the drawings and specified herein. Implement a probe pile program at production pile locations as selected by the Contractor and approved by the Engineer.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2017a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A328/A328M	(2013; R 2018) Standard Specification for Steel Sheet Piling
ASTM A572/A572M	(2018) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A690/A690M	(2013a; R 2018) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM A857/A857M	(2007; R 2013) Standard Specification for Steel Sheet Piling, Cold-Formed, Light Gage
ASTM B221	(2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM E329	(2020) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E548	(1994; E 1995) Standard Guide for General Criteria Used for Evaluating Laboratory Competence
FLORIDA DEPARTMENT OF TRANSPORTATION	
DIVISION 1 AND 2	(2021) STANDARD SPECIFICATIONS

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures and Hammer Selection

Testing Agency Qualifications

Probe Pile Testing Program

Instrumentation and Monitoring Program Report

SD-02 Shop Drawings

Metal Sheet Piling

Pile Splicing

Pile Placement

As-Driven Survey

SD-03 Product Data

Driving

Pile Driving Equipment

Sheet Pile Joint Sealant System

Procedure for Insufficient Pile Length

SD-06 Test Reports

Materials Tests

SD-07 Certificates

Pile Shoe

Welding Certifications

Steel Plant Certificate

SD-11 Closeout Submittals

Pile Driving Record

1.4 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein. Develop and submit plans for the delivery, storage, and handling of piles. Submit delivery, storage, and handling plans for piles at least 30 days prior to delivery of piles to the job site.

1.4.1 Delivery and Storage

Materials delivered to the site must be new and undamaged and must be accompanied by certified test reports. Provide the manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion protection prior to installation.

1.4.2 Handling

Lift piles to ensure that the maximum permissible curvature is not exceeded. Holes may be burned above the cutoff length for lifting piles into the leads. If there is evidence of pile damage during driving due to the holes, Owner’s Representative may forbid the burning of holes. Do not damage piles when dragging piles across the ground or barge deck.

Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Straightness of the sections of piles must conform to AWS D1.5M/D1.5, Section 3.5.1.1. Piles having excessive curvature will be rejected.

1.4.3 Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Engineer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work in the opinion of the Engineer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Owner.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods for the pile in question following approval by the Engineer:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile;
b. One or more replacement piles are driven adjacent to the defective pile; or,
c. A Pile Driving Analyzer Test and/or low strain pile integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the damaged pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods following approval by the County and the Engineer of Record:

a. The pile is spliced (if approved); or,
b. Other method proposed by Contractor.

A pile driven out of its proper location or out of plumb, must be corrected by one of the following methods following approval by the County and the Engineer of Record:

a. One or more replacement piles are driven next to the pile in question; or,
b. Other method proposed by Contractor.

A pile not achieving the design tip elevation must be corrected by one of the following methods following approval by the County and the Engineer of Record:

a. Install grout plug to the target tip elevation to create the full-depth seepage barrier (jet grout or similar); or,
b. Other method proposed by Contractor.

1.5 MATERIAL CERTIFICATES

For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

PART 2 PRODUCTS

2.1 METAL SHEET PILING

Submit detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

a. Include in the drawings details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

b. Metal sheet piling must be hot-rolled steel sections conforming to ASTM A572/A572M, Grade 60

c. For protection of sheet piling, coat it in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES

d. Full length piles shall be used

2.1.1 Interlocks

The interlocks of sheet piling must be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

2.1.2 General Requirements

Provide sheet piles with minimum section modulus, moment of inertia, shape, and size as specified in the drawings. Sheet piling including special fabricated sections must be full-length sections of the dimensions shown. Provide fabricated sections conforming to the requirement and the piling manufacturer's recommendations for fabricated sections. Fabricated tees, wyes and cross pieces must be fabricated of piling sections with a minimum web thickness of 1/2 inch. Provide sheet piling with standard lifting holes. Metalwork fabrication for sheet piling must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.3 SHEET PILE SEALANT SYSTEM

Provide a sheet pile sealant system rated for a minimum head pressure of 60 feet in a permanent application for all piles. Sealant system manufacturer shall have a minimum of 10 years successful installation history.

2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer's standards and to the requirements specified in the respective sheet piling standards.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide manufacturer's steel plant certificate for Engineer of Record review and approval.

2.3.1 Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials. Material test reports must meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials must be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties must be performed after the completion of all rolling and forming operations. Testing of sheet piling must meet the requirements of ASTM A6/A6M.

2.4 PILE DRIVING EQUIPMENT

Submit complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances, prior to commencement of work. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements. Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work.

2.4.1 DRIVING HAMMERS

Hammers must be steam, air, or diesel drop, single-acting, double-acting, differential-acting, or vibratory type. The driving energy of the hammers must be selected to meet the minimum requirements for driving in the soils identified in the GBDs and selected to prevent excessive movement of the existing structures and the embankment. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Pile Length Markings

Mark each pile prior to driving with horizontal lines at one foot intervals. Mark the interval number on pile every 5 feet from pile tip.

3.2 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Backfill as indicated.

3.3 PROBE PILE PROGRAM

Install a minimum of four probe piles at production pile locations identified by the Contractor and approved by the County and the Engineer of Record. Use this probe pile program to evaluate installation methods, anticipated driving resistance, potential refusal, vibrations from pile driving,

predrilling requirements, and potential grouting requirements. Adjust installation procedures and hammer selection to meet requirements of the ~~Plans~~project documents.

3.3 INSTALLATION

3.3.1 Sheet Pile Sealant System

Sheet pile joint sealant system should be factory applied or applied onsite in accordance with the manufacturer's installation limitations and requirements prior to driving.

3.3.2 Placing and Driving

3.3.2.1 Placing

Submit a written description of the site-specific pile installation procedures for Engineer of Record review and approval. Pile placement installation drawings and details must also be provided.

Any excavation required within the area where sheet pilings are to be installed must be completed prior to placing sheet pilings. Pilings properly placed and driven must be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

a. Pilings must be located as indicated. Pilings must be installed with tolerances that will permit the installation of the structural steel bracing. Manipulation of previously driven piles to force them into position will not be permitted. Check all piles for heave prior to cut-off and following adjacent pile driving. Re-drive all heaved piles to the required tip elevation.

b. Provide temporary wales, templates, master pilings or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved.

3.3.2.2 Driving

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. The format for driving records must be as directed. Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line must indicate the profile of the bottom elevation of installed pilings and potential problem areas can be identified by abrupt changes in its elevation. Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer. Caution must be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages.

Discontinue the use of vibratory hammers and employ impact hammers e when the penetration rate due to vibratory loading is one foot or less per minute.

b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. Contractor may consider the use cast steel shoe to prevent damage to the tip of the sheet piling. Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense. Store Owner furnished pilings, damaged during driving, at the site as directed.

c. Drive pilings without the aid of a water jet.

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven must be driven to the required depth and tapered pilings must be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures must be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling must be 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall must be driven alternately in increments of depth to the required depth or elevation. No piling will be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile must not be more than 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per inch, the tip of any sheet pile must not be more than 2 feet below any adjacent sheet pile. If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling.

f. Pilings must be driven to depths shown for seepage cutoff purposes and must extend continuous up to the elevation indicated for the top of pilings or as necessary for the Contractor’s Engineer design if it is modified from the project documents. A tolerance of +- 6 inches from the indicated tip elevation will be permitted. Pilings must not be driven within 100 feet of concrete less than 7 days old.

g. Pre-augering and spudding of piles may be used at no additional cost to the Owner. Discontinue pre-augering or advancing the spud piles no closer than 5-feet above the indicated pile tip elevation. Drive the pile the final 5-feet of penetration. If pre-augering is performed within the final 5 feet of penetration, jet grouting or similar method will be required to create a low permeability zone at the bottom of the pile and at no additional cost to the County.

3.3.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance must be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving must be extended as required to reach the top elevation by splicing when directed at no additional cost to the Owner. Submit procedure for insufficient pile

length. Provide pile splicing information and details for Owner review and approval prior to installation in the field. If directed, pilings must be spliced as required to drive them to depths greater than shown and extend them up to the required top elevation.

a. Pile splicing will not be permitted without approval by the Engineer.
b. Pilings adjoining spliced pilings must be full length unless otherwise approved. Ends of pilings to be spliced must be squared before splicing to eliminate dips or camber. Pilings must be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings must be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices must conform to the approved Shop Drawings provided by the Contractor. Shop and field welding, qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M. Submit welding certifications for all welders and welding operators for Owner review and approval.
c. The tops of pilings excessively battered during driving must be trimmed when directed, at no cost to the Owner. Piling cut-offs will become the property of the Contractor and must be removed from the site.
d. Cut holes in pilings for bolts, rods, drains or utilities in a neat and workmanlike manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling must be drilled. Holes other than bolt holes must be reasonably smooth and the proper size for rods and other items to be inserted. All holes in steel pilings on the wet side of cofferdams must be made watertight by welding steel plates over the holes after the piling installation is completed. Do not use explosives for cutting.

3.3.4 Piles Not Achieving Required Tip Elevation

Sheetpiles not achieving the required tip elevation of -20 ft will not be adequate for long-term seepage control. Contractor will need to provide a low permeability zone to El -20 ft using jet grouting or similar at no additional cost to the County.

3.3.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Engineer of Record. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock must be removed and replaced at the Contractor's expense. Use divers to inspect underwater interlocked joints of cofferdam sheet piling. The inspection of cofferdams must be performed after driving is completed.

3.3.5 Pulling and Redriving

The pulling of piles will not be permitted without the Engineer’s approval.

3.3.6 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548, and approved by the Engineer of Record.

3.3.7 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Engineer of Record with an as-driven survey showing actual location and top elevation of each pile. Submit an as-driven survey showing actual location and top elevation of each production pile within 7 calendar days of completing the pile installation. Do not proceed with placing concrete until the Engineer of Record has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest half inch. Survey must be prepared and certified by a land surveyor licensed in Florida.

3.4 INSTALLATION RECORDS

Maintain a pile driving record for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per foot for each foot of penetration, final driving resistance in blows for final 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations, and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Engineer of Record.

3.5 VIBRATION CONTROL

Refer to Specifications 31 62 16.13 Steel Pipe Piles, Paragraph 3.5 Vibration Control.

3.6 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

Refer to Specifications 31 62 16.13 Steel Pipe Piles, Paragraph 3.6 Construction Instrumentation and Monitoring Program.

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