

SECTION 31 62 21

COMPOSITE SHEET PILES

07/16

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM D2343	(2009) Standard Test Method for Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics
ASTM F 436	(2010) Hardened Steel Washers
ASTM F 844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-02 Shop Drawings

Composite sheet piles;; G

Submit drawings for approval prior to start of the work or ordering materials. Details shall show complete piling dimensions and details, splices, and location/layout of installed piling. Detail drawings shall include details and dimensions of templates and other temporary guide structures for installing piling. Detail drawings shall provide details of the method of handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

SD-03 Product Data

MSDS sheets for all reactive materials that will be handled

on-site during installation

Technical data sheets and manufacturer's instructions for all materials used in the fabrication of the FRP sheet pile and other components. Technical data sheets shall, at a minimum be provided for the following constituent materials:

Fiber reinforcement used in the fabrication of the FRP plates and other components.

Resins used to fabricate the FRP plates and other components.

Additives incorporated into the resin, such as pigments or UV inhibitors

Alkali protective coating; G

SD-06 Test Reports

Test Reports; G

Test reports summarizing mechanical properties of the laminates used in the fabrication. Included with the reports shall be a summary of the statistical parameters (number of test specimens, average, and standard deviation) for each mechanical property.

Test reports summarizing the results of environmental exposure testing. Included with reports shall be the tested values of the control and exposed specimens and the calculated environmental reduction factors for each mechanical property.

Test reports summarizing the results of the mechanical properties of the materials. Included with the reports shall be a summary of the statistical parameters (number of test specimens, average, and standard deviation) for each mechanical property.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

Procedures for storing, handling, and installing the FRP sheet pile.

SD-07 Certificates

Qualifications of Supplier; G

Pile pulling method

Material certificates; G

Submit for each shipment certificates and identified with specific lots prior to installation piling. Identification data should include piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

Pile driving equipment; G

Submit descriptions of pile driving equipment to be employed in the work to the Contracting Officer for approval. Description information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, templates, and jetting equipment.

1.3 REQUIREMENTS

1.3.1 Basis of Bids

Base bids on pile sections and lengths as indicated. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment in the contract price and time for completion will be made. No additional payment will be made for withdrawn, damaged, rejected, or misplaced piles; for any portion of a pile remaining above the cut-off elevation; for backdriving; for cutting off piles, or for any cut off length of piles.

1.4 DELIVERY AND STORAGE

Handle piling using handling holes or lifting devices. Handle long length piles with care to prevent damage. Support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Supports between multiple lifts shall be in a vertical plane. Protect piling to prevent damage to coatings prior to installation.

1.5 QUALITY ASSURANCE

1.5.1 Composite Sheet Piles

The selected composite materials shall be manufactured in accordance with the requirements of this specification and shall be standard commercial products. Additional or better features which are not specifically prohibited by this specification, but which are a part of manufacturer's standard commercial product, shall be included in the material being furnished.

All composite sheet piles provided under this Section shall be furnished only by manufacturers having experience in the design and manufacture of the type of product. The manufacturer shall demonstrate an experience record of at least three (3) previous, separate, similar successful installations in the last five (5) years. The manufacturer shall have in place a Quality Assurance Program that will ensure the sheet pile is in conformance with the ASTM and other specifications cited in this document.

1.5.2 Qualifications of Supplier

The Supplier shall demonstrate experience in the fabrication of FRP structures using the pultrusion process. Specifically, the supplier shall meet the following requirements:

Material shall be furnished by an ISO-9001:2008 certified manufacturer of proven ability who is regularly engaged in the manufacture, fabrication and installation of FRP systems.

The Supplier shall have a minimum of 5 years of experience in the fabrication of FRP structures using the pultrusion process.

1.5.2.1 Material Certificates

Certified materials tests reports showing that sheet piling and appurtenant materials meet the specified requirements shall be submitted for the approval of the Contracting Officer prior to shipping and installing materials. Tests, as detailed herein, shall be performed by a state certified independent laboratory, and certified by a Registered Professional Engineer.

1.6 EQUIPMENT

1.6.1 Pile Driving Equipment

Submit descriptions of pile driving equipment to be employed in the work to the Contracting Officer for approval. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, templates, and jetting equipment.

PART 2 PRODUCTS

2.1 COMPOSITE SHEET PILES

Provide a fiberglass reinforced plastic composite system manufactured by the pultrusion process.

The sheet pile shall have a ball and socket or 'T' shaped interlock. The composite sheet pile shall be gray in color unless approved otherwise by the Contracting Officer.

The sheet piling shall be manufactured from UV-inhibited, weatherable materials; shall have an integral surface veil for added UV protection, and shall meet or exceed the properties listed in the paragraphs below.

All exposed surfaces shall be smooth and true to form, consistent with ASTM D4385.

2.1.1 Resin

Provide vinyl ester (VE).

2.1.2 Fiber Reinforcement

Provide electrical grade E-glass reinforcements in the form of unidirectional roving, Continuous Filament Mat (CFM) and stitched fabric mats. All E-glass reinforcements meet a minimum tensile strength of 290 ksi per ASTM D2343.

2.1.3 Dimensional Requirements

Per ASTM D3917.

2.1.4 Configuration

2.1.5 Material Properties

Property	Minimum Composite Sheet Pile Physical Properties	
	<u>Value</u>	<u>Units</u>

Section Modulus	18.4	in ³ /ft
Moment of Inertia	101.4	in ⁴ /ft
Depth of Sheet	10.00	in
Width of Sheet	24.00	in

Minimum Composite Sheet Pile Mechanical Properties			
Property		<u>Value</u>	<u>Units</u>
Tensile Modulus (LW)	(ASTM D638)	3.90	Msi
Tensile Modulus (CW)	(ASTM D638)	1.85	Msi
Compression Modulus (LW)	(ASTM D6641)	3.65	Msi
Compression Modulus (CW)	(ASTM D6641)	1.75	Msi
Tensile Strength (LW)	(ASTM D638)	70.85	ksi
Tensile Strength (CW)	(ASTM D638)	16.50	ksi
Compression Strength (LW)	(ASTM D6641)	49.70	ksi
Compression Strength (CW)	ASTM D6641)	19.70	ksi
Inplane Shear Strength	(ASTM D5379)	12.51	ksi
Inplane Shear Modulus	(ASTM D5379)	0.50	Msi
Short Beam Shear Strength	(ASTM D2344)	4.33	ksi
Moment Capacity	(ASD*)	54,600	lb-ft/ft
Shear Capacity	(ASD*)	47,200	lb-ft/ft

(*Ultimate Capacity based on ASTM D7290-06 Characteristic Values. These values have not been reduced by safety factors.)

2.2 STEEL PLATES

Structural steel plates for splices and other fabrication appurtenances shall conform to ASTM A 36, hot dip galvanized in accordance with ASTM A 123/A 123M.

2.3 BOLTS, NUTS, AND WASHERS

Bolts shall meet ASTM A 307, Grade A. Nuts shall meet ASTM A 563. Washers shall meet ASTM F 844 or ASTM F 436. All bolts, nuts, and washers shall be hot dip galvanized in accordance with ASTM A 153/A 153M.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Pile Hammer

Use a pile hammer having a delivered force or energy suitable for the total weight of the pile and the character of subsurface material to be encountered, as recommended by the piling manufacturer. Operate hammer at the rate(s) recommended by the manufacturer throughout the entire driving period. Order sheets 6" longer to allow for cut-off of sheet pile which may display signs of abrasion or mushrooming at the top due to the clamp pressure and vibration of the vibratory hammer. Most contractors will add some length of sheet and cut the sheets to grade after they have been installed.

3.1.2 Templates

Prior to driving, provide template or driving frame suitable for aligning, supporting, and maintaining sheet piling in the correct position during setting and driving. 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. Provide at least two levels of support, at third points. Templates shall not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means must be used to keep the sheet pile vertical along its leading edge.

3.1.3 Pile Driving

Obstruction may be present than could damage the FRP sheet pile. Prior to driving the FRP sheet, the contractor shall drive a steel mandrel, fabricated to mimic the profile of the sheet. If obstructions restrict driving a piling to the specified penetration, the obstructions shall be removed or penetrated with a chisel beam.

If the Contractor demonstrates that removal or penetration is impractical, the Contractor shall make changes in the design alignment of the piling structure as directed to insure the adequacy and stability of the structure.

Maintain piling vertical during driving. Drive piles in such a manner as to prevent damage to the piles and to provide a continuous closure. Where possible, drive sheet 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. Incrementally sequence driving of individual piles such that the tip of any sheet pile shall not be more than 4 feet below that of any adjacent sheet pile.

Caution shall be taken when a hard driving condition is encountered to avoid interlock-melt or damages. A protecting cap shall be employed in driving to prevent damage to the tops of pilings. Pilings damaged during driving or driven out of interlock shall be removed and replaced at the Contractor's expense.

Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. A tolerance of 1 inch above the indicated top elevation will be permitted.

3.1.4 Splicing

Splicing of sheet piles shall not be permitted.

3.1.5 Cutting

The Contracting Officer shall approve any cut prior to cutting any pile. Any cut edge shall be coated in accordance with paragraph titled "alkali Protective Coating". Pile cut-offs shall become the property of the Contractor and shall be removed from the site. Use a straight edge in cutting to avoid abrupt nicks. Bolt holes in composite material shall be drilled or reamed by approved methods which will not damage the surrounding material. Holes shall be reasonably smooth and the proper size for rods or

other items to be inserted.

3.1.6 Alkali Protective Coating

Coat all surfaces in contact with concrete with a manufacturer recommended, alkali protective coating. Coat all cuts and frayed or split ends to protect against alkaline degradation.

3.2 INSPECTION

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 Contracting Officer.

3.2.1 Inspection of Driven Piling

The Contractor shall inspect the interlocks of the portion of driven piles that extend above ground. Remove and replace piles found to be out of interlock.

3.2.1.1 Tolerances in Driving

Drive all piles with a variation from vertical of not more than 1/4 inch per foot. Place the pile so the face will not be more than 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off shall be within 1/2 inch horizontally and 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Redrive all heaved piles to the required tip elevation.

3.2.2 Pulling and Redriving

The Contractor may be required to pull selected piles after driving to determine the condition of the underground portions of piles. The pile pulling method must be approved by the Contracting Officer. Remove and provide new sheet pile, at the Contractor's expense, any pile pulled and found to be damaged to the extent that its usefulness in the structure is impaired. Redrive piles pulled and found to be in satisfactory condition.

3.3 Rejection of Sheets Due to Damage

Minor fraying, cracking, or indentations due to clamping or driving equipment in the top 3 inches of the sheet is not an issue and so long as the damage is embedded within the concrete pile cap, and coated in accordance with paragraph titled "Alkali Protective Coating". Crushing or shearing of sheets in any area due to excessive clamp pressure or driving equipment is unacceptable.

Fraying or isolated breaches in the bottom few inches of the sheets (driving end) does not warrant replacement. However, redriving may prove more difficult and many result in a crack propagating up the sheet length while being driven into the soil. The Contractor may trim the driving end to create a "neat" end. Total trimming should not compromise the required length of the sheet pile.

Crushing of interlocks is unacceptable (except within the top 3 inches of sheet that are embedded within the concrete cap).

Cracks (breaks) propagating through the entire thickness of the sheet in

any area (except within the top 3 inches of sheets that are embedded within the concrete cap) are unacceptable. Any hairline crack longer than 1 inch is unacceptable.

The Contractor may elect to supply sheets longer than the identified bid length to avoid the total rejection of the sheet due to damage, which may occur at the top or bottom of the sheets. All costs associated with this additional length, cut-off of damaged area cut-off to obtain final elevation, additional driving, and disposal shall be included within the Contractor's original bid and be at no additional cost to the Government.

3.4 TESTS, INSPECTIONS AND VERIFICATIONS

Materials tests shall conform to the following requirements. Sheet piling and appurtenant materials shall be tested and certified by an independent, state certified laboratory to meet the specified properties, which shall be subject to acceptance by the Contracting Officer prior to delivery to the site.

-- End of Section --