

1
REVISION OF SECTION 502
PILING

Section 502 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

502.01 This work consists of furnishing and driving all types of piling shown in the Contract, other than sheet piling, in accordance with these specifications and at the locations shown on the plans or established.

MATERIALS

502.02 Steel Piling. Structural steel shapes used as piling shall conform to the requirements of AASHTO M 270 Grade 50.

Steel pipe shall conform to the requirements of ASTM A 252, Grade 2. Closure ends shall conform, to the requirements of AASHTO M 270 Grade 36.

Steel shell piles shall conform to the requirements of AISI C 1010 or C 1015 steel.

Closure plates, driving points, and their connecting welds shall not project beyond the perimeter of the pile tip for steel pipe and steel shell piles.

Commercial driving points may be used for end bearing piles. All steel pipe piles and steel shell piles shall be filled with Class B concrete conforming to subsection 601.02.

Steel piling may be ordered in plan lengths or in 30 to 60 foot lengths.

CONSTRUCTION REQUIREMENTS

502.03 Pile Driving Equipment.

(a) *Pile Hammers.* Steam, air, diesel, or hydraulic impact hammers may be used to drive all types of piles. Vibratory or gravity hammers shall not be used to drive bearing piles.

1. For steam, air, and diesel hammers, a minimum manufacturer's rated energy as shown in Table 502-1 shall be used.

Table 502-1

Pile Size	Area (Square Inches)	Minimum Energy (Foot-Pounds)
HP 10x42	12.4	26,000
HP 10x57	16.8	26,000
HP 12x53	15.5	26,000
HP 12x74	21.8	42,000
HP 14x89	26.1	52,000
HP 14x117	34.4	68,000

The rated energy of the hammer shall not be greater than 2500 foot-pounds per square inch of unit area. Exceptions to these limits are permissible if it is demonstrated by wave equation analysis that the piles can be safely and efficiently installed with hammers having ratings outside of these energy limits.

If more than one size of piling is designated in the Contract, the Contractor shall provide the necessary hammer or hammers to meet these requirements for all sizes of piles used.

2. Hydraulic hammers may be substituted for steam, air, and diesel hammers. The minimum energy requirement for hydraulic hammers shall meet the value specified in Table 502-1.

2
REVISION OF SECTION 502
PILING

3. When designated in the Contract, a hammer with a rated energy determined by the Wave Equation Analysis from an approved program such as WEAP shall be used. When wave equation analysis is used in the design phase of a project, a range of acceptable hammer energies will be included in the Contract.
- (b) *Hammer Cushion.* All impact pile driving equipment except hydraulic hammers shall be equipped with a suitable hammer cushion to prevent damage to the hammer or piles and to ensure uniform driving behavior. Wood, wire rope, and asbestos cushion material shall not be used. A striker plate as recommended by the hammer manufacturer shall be used. The hammer cushion may be inspected by the Engineer at any time during progress of the work. Any hammer cushion whose thickness is reduced by 10 percent or more of the original thickness shall be replaced at the Contractor's expense before driving is permitted to continue.
- (c) *Pile Driving Head.* Appropriate driving heads, mandrels, or other devices shall be provided in accordance with the driving head manufacturer's recommendations. The driving head or insert shall be capable of capturing the pile in alignment such that the center of the pile is held within 10 percent or 2 inches, whichever is less, of the center of the force of the hammer.
- (d) *Leads.* Pile driving leads shall be constructed in a manner that affords the pile hammer freedom of movement while maintaining alignment of the pile hammer and the pile to insure concentric impact for each blow. Leads may be either fixed or swinging. Swinging leads shall be fitted with a pile gate at the bottom of the leads and shall be long enough to be securely fixed at the ground at all times.
- (e) *Followers.* Followers shall be used only when specified on the plans or approved in writing by the Engineer.

502.04 Approval of Pile Driving Equipment. All pile driving equipment proposed in conformance with subsection 502.03 shall be submitted to the Engineer for approval prior to delivery to the site. Approval will be based upon pile driving equipment data, such as rated energy, impact energy, or striking ram weight, which the Contractor shall submit.

If the Contract requires hammers determined by subsection 502.03(a)3., the Contractor will be notified of the acceptance or rejection of the driving system within ten calendar days of the Engineer's receipt of the pile and driving equipment data. The approval criteria for wave equation analysis will consist of (1) the pile stress at the required ultimate pile capacity and (2) pile drivability.

The driving stresses in the pile indicated by the Wave Equation Analysis shall not exceed 90 percent of the yield stress of the steel.

Once approved, changes in the pile driving equipment shall not be made without additional approval, and will be considered only after the Contractor has submitted the necessary information for a revised Wave Equation Analysis. The approval process outlined above shall be applied to the revised driving equipment.

All pile hammers delivered to the job site which the Engineer determines, either by observation or by Pile Driving Analyzer (PDA), are not in good working condition will be rejected.

502.05 Driving Piles. Foundation piles shall not be driven until the excavation is complete unless authorized by the Engineer. After driving is complete, all loose and displaced material shall be removed from around the piling before pouring any concrete.

Piles shall be driven with a variation of not more than ¼ inch per foot from the vertical or from the batter shown in the Contract. Foundation piles shall not be more than 6 inches out of the position shown in the Contract after driving.

3
REVISION OF SECTION 502
PILING

A minimum pile penetration of 10 feet in natural ground is required for all piles. This requirement may be waived by the Engineer if the subsurface material at the pile tip location is bedrock or other acceptable bearing material provided that the bearing elevation is below scour depth.

If a minimum pile tip elevation is specified in the Contract, all piles shall be driven to or below this elevation unless otherwise approved in writing. If the pile cannot be driven to the minimum tip elevation, the Engineer will determine if pre-drilling is required. Any pre-drilling not required by the Contract and ordered by the Engineer will be paid for in accordance with subsection 109.04. The depth of the pre-drilling will be determined by the Engineer.

Unless otherwise specified in the Contract, a minimum of two piles per structure will be monitored, each at a separate foundation element (abutment or pier foundation). Monitoring will be conducted using a PDA to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the pile, and to establish the pile driving criteria. Monitoring will be conducted by the Engineer or the Contractor's Engineer. The Plans will designate the party responsible for monitoring. The PDA measurement equipment takes approximately one hour per pile to install. All necessary work performed by the Contractor associated with the dynamic monitoring will not be paid for separately but shall be included in the work. If the Engineer requests additional piles to be monitored, or requests the Contractor to monitor the pile or piles, all necessary time required and work performed by the Contractor will be paid for in accordance with subsection 109.04.

If piles are monitored by the Contractor, the Contractor shall provide to the Engineer a written pile driving summary from the Contractor's Engineer. The summary shall detail the driving criteria including driving resistance and driving stresses based on the wave equation analysis using program such as WEAP and the pile capacity criteria based upon signal matching analysis using an approved program such as CAPWAP. The criteria shall be approved by the Engineer prior to the driving of additional piles.

Piles shall be driven to refusal in natural ground as determined by the PDA, at or below the estimated minimum tip elevations specified on the plans. Refusal criteria will be established by the Engineer after PDA monitoring has been performed. If refusal criteria has been reached in natural ground and piles have not been driven to the estimated tip elevation but have been driven below minimum tip elevation, the Engineer may order the driving to be continued for 40 additional blows. If changes are made to the pile driving system (hammer, fuel setting, piling, cushioning, etc.) after the PDA monitoring has been completed and refusal criteria established, new refusal criteria shall be determined using the PDA. New criteria shall be determined at the Contractor's expense.

Water jets may be used in conjunction with the hammer to obtain the specified penetration only with approval. The last 3 feet of penetration shall be obtained by driving without the use of water jets. Test blows to determine average penetration shall be applied after the jets have been removed. The use of water jets will not modify any of the requirements of this section.

502.06 Drilling Holes to Facilitate Pile Driving. Holes to facilitate pile driving shall be drilled at all locations shown on the plans and to elevations shown.

When test piles are shown on the plans they shall be used to determine if drilling holes to facilitate pile driving is required.

If the test pile or piles do not reach the estimated tip elevation as specified in subsection 502.05, holes shall be drilled to facilitate pile driving.

If the test pile or piles reach the estimated tip elevation shown on the plans and develop the required bearing capacity as determined in subsection 502.05, drilling holes will not be required and the remainder of the piles shall be driven in the normal manner.

The drilling of holes shall be done in such manner that the piling will stand accurately positioned as shown on the plans.

REVISION OF SECTION 502
PILING

The diameter of the drilled holes and the material used to fill oversize holes shall be as stipulated herein unless otherwise designated on the plans.

The diameter of the drilled holes shall be 1 to 3 inches larger than the outside diameter of steel pipe piles. The minimum diameter of the drilled holes shall be 1 to 3 inches larger than the diagonal web depth for H piles.

If the maximum diameter of the drilled hole is exceeded due to sloughing, drifting, over-drilling, or other causes, the void area between the driven pile and the edge of the hole shall be filled with sand or pea gravel at the Contractor's expense.

The Engineer will determine if shooting holes with explosives or redesign is necessary when piles cannot be driven or holes drilled.

502.07 Capping Piles. Steel pipe or shell piles will be inspected after all adjacent piles within a 5 foot radius have been driven. The Contractor shall supply suitable lights for the inspection of the insides of these piles. Water or other foreign material shall be removed and the pipe or shell shall be filled with concrete.

The tops of all steel piles shall be cut off square and embedded in the concrete as shown on the plans.

502.08 Extensions and Splices. There will not be a limit placed on the number of splices allowed for steel piles; however, payment will be limited to two splices per pile. Commercial splices may be used if approved by the Engineer.

Steel piling shall be spliced with a square-groove butt-joint weld using a $\frac{1}{8}$ inch root opening. Weld deposition on pipe piles shall be made in two separate passes around the outside perimeter of the pile. Weld deposition on steel "H" piles shall be made in two passes. The first pass shall be made from one side of the part being welded and shall penetrate one-half the thickness of the member. The second pass shall be made on the side opposite from the first. For both types of piles, the slag left by the first pass shall be completely removed before making the second pass. All cuts at splices are to be made normal to the longitudinal axis of the pile. The cut-off portion may be driven to start the next pile or it may be welded to previously driven piles to provide the necessary extension length. Splices must be authorized.

Welding shall conform to the applicable requirements of ANSI/AWS D1.1.

Welders shall be prequalified in accordance with the standard qualification procedure of the American Welding Society and follow the required welding procedures specified in the plans. The Engineer may consider a welder qualified when the Welders' Certificate states that the welder has been doing satisfactory welding of the required type within a one year period previous to the subject work. A certification shall be submitted for each welder and for each project, stating the name of the welder, the name and title of the person who conducted the examination, the kind of specimens, the position of welds, the results of the tests and the date of the examination. Such certification of pre-qualification may also be accepted as proof that a welder on field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose. Approved commercial splices may be used as an alternate for welded splices.

502.09 Defective Piling. Piles damaged in driving by reasons of internal defects or improper driving; driven out of their proper location; or driven below the elevation specified on the plans without approval shall be corrected at the Contractor's expense by one of the following approved methods:

- (1) The pile shall be withdrawn and replaced by a new, and if necessary, longer pile.
- (2) A second pile shall be driven adjacent to the defective pile.
- (3) The pile shall be spliced or built up.
- (4) A sufficient portion of the footing shall be extended to properly embed the pile.

5
REVISION OF SECTION 502
PILING

All piles pushed up by the driving of adjacent piles shall be driven down again.

502.10 Pile Tips. Pile tips shall be placed on piles when shown on the plans. Pile tips and details for fastening tips to piles shall be in accordance with the plans or approved. If difficult driving conditions are encountered, the Engineer may order the Contractor to furnish and attach pile tips even though tips are not required by the plans. In that event, the tips will be paid for in accordance with subsection 109.04.

502.11 Painting Steel Piles. The exposed portion of steel piles not embedded in concrete, including 2 feet below the stream bed or ground line, shall be painted as described in Section 509.

METHOD OF MEASUREMENT

502.12 Piling will be measured by the linear foot in place. Measurement shall be from the tip to the cut-off elevation.

The length of pile cut-off to be measured will be those random lengths of piling which result from cutting off the tops of driven piles and which are not used in the work.

Where piling is driven to within 1 foot of the elevation of cut-off, butt ends will be included in the length measured for piling actually driven.

Measurement of splices will be limited to two per steel pile, except when extra splices are ordered.

Splices for piles will be measured as additional length of pile. The additional length for each splice will be as follows: steel "H" piles, 3 linear feet; steel pipe piles, 3 linear feet.

Pile tips and end closure plates for steel pipe piles will be measured by the actual number used.

Drilled holes to facilitate pile driving will be measured by the linear foot, to the nearest foot.

BASIS OF PAYMENT

502.13 The accepted quantities will be paid for at the contract unit price per unit of measurement for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	Pay Unit
Steel Piling (size)	Linear Foot
Steel Pipe Piling (size)	Linear Foot
Steel Shell Piling (size)	Linear Foot
Drilling Hole to Facilitate Pile Driving	Linear Foot
End Plate	Each
Pile Tip	Each

Steel cut-offs 10 feet or less in length will be paid for at the contract unit price less 20 percent. These cut-offs shall become the property of the Contractor.

Pile cut-offs greater than the above specified lengths will not be paid for.

Authorized jetting, blasting, or other work necessary to obtain the specified penetration of piles will be paid for in accordance with subsection 104.03.

Concrete used to fill steel pipe will not be measured and paid for separately, but shall be included in the work.