STANDARD CONSTRUCTION SPECIFICATIONS
520 – PILE FOUNDATIONS

1 GENERAL

1.1 These Structural Construction Specifications are adopted by Railroad and are supplemental and complimentary to the requirements of the Contract issued by Railroad to Contractor for the purpose of performing construction and maintenance of Railroad's Structure as specified in the Contract Documents.

1.2 They apply to Contractor, its employees, agents, invitees and subcontractors.

1.3 These specifications shall govern the furnishing, driving, building up and cutting off of timber, concrete and steel piles in accordance with the lines, grades, and locations shown on the plans or as directed by Engineer.

1.4 Contractor is responsible for performing all pile operations in compliance with the current state, federal, local, FRA and OSHA regulations (including the equivalent Canadian regulations), specifically with respect to fall protection.

1.5 When shown on the plans or when directed by Engineer, test piles shall be driven to determine the necessary lengths of piles to be ordered for the work.

1.5.1 The number and location of test piles to be driven shall be as shown on the plans or as established by Engineer; in general, at least two test piles shall be driven at each structure.

1.6 Unless otherwise directed by Engineer, the embankment at bridge ends shall be constructed to grade and thoroughly compacted to the full amount required by the Contract Documents prior to the driving of piling in the embankment area.

1.7 Foundation piling shall not be driven until the excavation is complete.

2 MATERIALS

2.1 Timber Piles:

2.1.1 Timber piles shall be First Class in accordance with the requirement of Section 1.9 – Specifications for Timber Pile of Chapter 7 – Timber Structures of the AREMA Manual for first-class piles with a minimum tip circumference of 25 inches.

2.1.1.1 The butt and tip circumference shall meet the requirements of Tables 7-1-2 and 7-1-3 of the AREMA Manual.

2.1.1.2 The ratio of "out of round" maximum to minimum diameter at the butt or the tip of any pile shall not exceed 1.2.

2.1.1.3 All circumference measurements must be taken under the bark.

2.1.1.4 The circumference at the butt may not exceed the circumference at 3 feet from the butt by more than 8 inches.

2.1.1.5 A straight line from the center of the butt to the center of the tip of the pile shall lie entirely within the body of the pile.

2.1.1.6 Piles shall be free from short crooks that deviate more than 2 ½ inches from straightness in any 5 foot length.

2.1.1.7 Piles shall be cut above the ground swell and have continuous and reasonably uniform taper from butt to tip.

2.1.2 Piles may be of any species which will satisfactorily withstand driving and support the superimposed loads and shall be of sound wood, free from defects which may impair their strength or durability as piles such as decay, red heart, marine borer attack, or insect attack..

2.1.2.1 Cedar and cypress piles may have a pipe or stump rot hole not more than 1 ½ inches in diameter.

2.1.2.2 Cypress piles may have peck aggregating not more than the limitation for holes.

2.1.2.3 Piles having sound turpentine scars shall not have damage from insects.

2.1.2.4 Sound knots shall be no larger than one sixth the circumference of the pile located where the knot occurs. Cluster knots shall be considered as a single knot. The sum of knot diameters in any 1 foot length of pile shall not exceed one third of the circumference at the point where they occur.

2.1.2.5 Unsound knots shall not exceed half the permitted size of a sound knot, provided that the unsoundness extends to not more than a 1 ½ inch depth, and that the adjacent areas of the trunk are not affected.

2.1.2.6 Piles shall be free from holes or damage caused by decay, marine borers, or insects.

2.1.2.7 Piles shall be free from holes larger than ½ inch in average diameter. Holes less than ½ inch in average diameter shall be permitted provided that the sum of average diameters of all holes in any square foot of pile surface does not exceed 1 ½ inch, and the depth of any hole does not extend to more than 1 ½ inch.

2.1.2.8 Piles shall be free of splits longer than the butt diameter.

2.1.2.9 The length of any shake or combination of shakes, measured along the curve of the annual ring, shall not exceed one-third of the pile's butt circumference.

2.1.3 Piles specified in the Plans to have high heartwood content shall exhibit a heartwood diameter at the butt not less than eight-tenths of the diameter of the pile.

2.1.4 Piles for use with preservative treatment shall have sufficient sapwood to meet minimum penetration requirements.

2.1.5 Softwood piles specified in the Plans to have close grain shall show at least six annual rings per inch, over the outer three inches of the butt end cross section. Douglas-fir and pine averaging from 5 to 6 annual rings per inch shall be accepted as the equivalent of close grain if having one-third or more summerwood.

2.1.6 Butts and tips of piles shall be sawed square with the axis of the piles and shall not be out of square by more 1/10 inch per inch of diameter. All knots and limbs shall be trimmed flush with the surface of the pile.

2.1.7 Piles shall be clean peeled with at least 80 percent of the inner bark removed. No strip of remaining inner bark shall be larger than 1 by 6 inches. The sapwood of piles shall not be unnecessarily scarred or injured in the process of peeling.

2.1.8 Spiral grain of shall not exceed 180 degrees of twist when measured over any 20 foot section of the pile.

2.1.9 Piles shall be Creosote treated in accordance with Section 3.7 Specifications for Treatment of Chapter 30 – Ties of the AREMA Manual.

2.1.9.1 Creosote Coal Tar solution shall meet the requirements of American Wood Protection Association (AWPA) Standard P2 - Standard for Creosote Solutions.

2.1.9.2 Piles shall be treated in accordance with AWPA Standard C3 - Piles - Preservative Treatment by Pressure Process.

2.1.9.3 The minimum preservative retention shall be 12 pounds per cubic foot using the Empty Cell process in accordance with AWPA Standard C1 - All Timber Products - Preservative Treatment by Pressure Processes.

2.1.10 Points of piles shall be trimmed to form a truncated pyramid 4 inches to 6 inches square at the end and with length of trimming not to exceed twice the tip diameter of the pile.

2.1.10.1 If shown on the plans or directed by Engineer, timber piles shall be equipped with a cast steel reinforced driving shoe in accordance with details shown on the plans. Pile points shall be carefully trimmed to fit the shoe and obtain full and uniform bearing, and to avoid displacement of the shoe or damage to the pile or shoe.

2.1.11 Where the heads of piles tend to split when being driven, they shall be tightly wrapped with wire rope, banding, or other effective means to prevent splitting.

2.1.12 The heads of piles shall be protected while being driven with a driving cap (bonnet) of approved design. The cap shall be shaped to fit over the head of the pile to provide lateral support and to uniformly distribute the hammer blow. Pile heads shall be trimmed to fit snugly into the cap.

2.1.13 Piles shall be handled with hemp or synthetic fiber slings or wire rope encased in rubber hose whenever possible, taking care to avoid dropping, bruising, breaking or penetrating the outer fibers.

2.2 Steel Piles:

2.2.1 Steel bearing piles shall be of the section shown on the plans and shall be structural steel, containing no less than 0.2% copper, conforming to ASTM Designation A36. Piles shall not be painted before driving.

2.2.1.1 If shown on the plans or directed by Engineer, steel bearing piles shall be equipped with a cast steel reinforced driving tip in accordance with details shown on the plans. The tips shall be installed in accordance with the manufacturer's recommendations.

2.2.2 Steel sheet piles shall be of the section and length shown on the plans and shall conform to ASTM Designation A328 unless otherwise shown on the plans.

2.2.3 Steel pipe piles shall be of the outside diameter and wall thickness shown on the plans and shall conform to ASTM Designation A252, Grade 2 unless other material is specified on the plans.

2.2.3.1 Pipe pile shall be driven with closed ends as shown in the plans. Either flat plates or driving tips shall be employed as shown in the plans.

2.2.3.1.1 Flat plate ends shall be of 3/4 inch thick ASTM A36 steel plate. The plate shall have the same outside diameter as the pile and be groove welded to the pile on the tip end.

2.2.3.1.2 Conical steel reinforced driving tips shall be installed in accordance with the manufacturer's recommendations as shown on the Plans.

2.2.3.2 All concrete materials and reinforcing steel and their preparation and placement, used in filling steel pipe piles, shall be in accordance with Section 530 Cast In Place Concrete Construction. All concrete shall have a minimum compressive strength equal to that shown on the plans.

2.2.4 Piles shall not be painted before driving.

2.2.5 Piles to be stored shall be placed on skids above ground and a sufficient number used to prevent visible deflection in the stored piles. Piles shall be kept clean and fully drained at all times. The method of handling shall be such that no damage will result to the piles.

2.3 Concrete Piles:

2.3.1 Precast concrete piles shall be of the type, size and length shown on the plans.

2.3.1.1 All concrete materials and steel reinforcing and their preparation and placement shall be in accordance with Section 534 Precast Concrete Construction. All concrete shall have a minimum compressive strength equal to that shown on the plans.

2.3.2 Prestressed concrete piles shall meet the requirements, and shall be of the type, size, and length shown on the plans, manufactured in accordance with Section 534 Precast Concrete Construction.

2.3.3 Defects and Breakage: Piles cracked in the process of curing, handling or driving, which in the opinion of Engineer can be satisfactorily repaired, shall be repaired at Contractor's expense and under the direction of Engineer. If repair is not possible in the opinion of Engineer, the piles shall be replaced at Contractor's expense.

2.3.4 Piles shall be stored above ground on adequate blocking located within 1 foot of the pick-up points marked on the pile that will prevent undue stresses in the piles. When piles are only partially supported during hauling, the overhang shall not exceed the lengths permitted for pick-up. If piles are stacked for storage, blocking for all layers shall be in the same vertical plane.

2.3.5 Piles shall be handled in a manner to minimize the danger of fracture by impact or undue bending stresses. Unless otherwise provided, piles shall be handled by means of a suitable bridle or sling attached to the pile at the pick-up points marked on the pile. Use of rubberized cables is also acceptable. The use of chain slings shall not be permitted.

3 SUBMITTALS

3.1 Prior to the start of construction Contractor shall submit a pile driving plan for approval by Engineer.

3.2 This plan shall provide detailed information on Contractor’s proposed means and methods and shall include the following minimum information:

3.2.1 Contractor’s proposed means and methods including weights of pile hammer, power plant, leads, pile cushion, cap block and helmet.

3.2.2 Name and experience of personnel in responsible charge of the pile driving.

3.2.3 Roster of proposed equipment.

3.2.4 Means of access for the pile driving equipment to the foundation locations.

3.2.5 Details of test pile installation and interpretation of results.

3.2.6 Method for splicing piles if needed.

3.2.7 Procedures for accommodating existing power lines, fiber optic and other buried utilities on the project site.

3.3 Prior to construction, Contractor shall prepare, and submit to Engineer, a comprehensive plan of the risks to the adjacent structures and Contractor’s proposed monitoring and mitigation efforts.

3.3.1 Any temporary measures required to protect existing structures shall be designed by a Professional Engineer employed by Contractor and registered in the State where the work is performed.

3.4 Contractor shall submit material certifications for all piles supplied for the Work.

3.5 Upon completion of load tests, Contractor shall submit to Engineer a load test report including, but not limited to, a description of the pile driving equipment, driving records for each test pile, analysis of the test data, and recommended allowable design loads based on the load test results. This report shall be prepared by or under the direct supervision of a registered professional or structural engineer experienced in pile load testing and load test analysis. In Addition, a "Test Pile Record Form" shall be submitted to Engineer.

3.6 Upon completion of driving, Contractor shall submit to Engineer a complete and accurate record of each driven pile. The record shall indicate the pile location, driven length, embedded length, final elevations of tip and top, pile weight, butt and tip diameter, quantity and strength of concrete used in each pile, number of splices and locations, blows required for each foot of penetration throughout the entire length of the pile and for the final 6 inches of penetration, and the total driving time. In Addition, a "Pile Driving Summary Form" shall be submitted to Engineer.

4 EXECUTION

4.1 Piles shall be driven with the heaviest hammer that, in the judgment of the engineer, can be used to secure maximum penetration without appreciable damage to the pile.

4.2 Hammers may be driven by steam, air, or diesel power as approved by Engineer.

4.3 The minimum weight of the hammer's ram shall be 3,000 pounds. The maximum weight of the ram shall not exceed 7000 lb. unless approved by Engineer.

4.4 The minimum acceptable hammer energy for use with various pile types is as follows:

Pile Type	Minimum Energy (ft-lbs)
Timber, less than 60 ft long	8,000
Timber, more than 60 ft long	13,000
Steel Bearing and Steel Pipe	30,000
Concrete	15,000 (but not less than 1.5 ft-lb per pound of pile).
Steel Sheet	As necessary to drive piles to required depth without damage

4.5 Steel piles may be driven with vibratory hammers under conditions approved by Engineer.

4.6 The use of drop hammers shall not be permitted.

4.7 The hammer shall be operated at all times at pressures and speeds recommended by the manufacturer. If steam or air hammers are used, boiler or air compressor capacity shall be adequate to maintain full rated pressure throughout the driving period of any pile. The boiler or air compressor shall be equipped with an accurate pressure gage at all times.

4.8 Pile drivers shall be equipped with leads which are constructed in such a manner as to afford freedom of movement of the hammer and to provide adequate support of the pile during driving. The longitudinal axis of the leads and hammer shall coincide with the longitudinal axis of the pile.

4.8.1 Except where piles are driven through water, the leads shall be long enough so that a follower will not be necessary.

4.8.2 Where a follower is required for driving piles underwater, one pile in each group of ten shall be long enough to permit driving without a follower. This pile shall be used as a test pile for proper correlation of the follower-driven piles bearing capacity.

4.9 After driving is completed, the piles shall be cut off as shown on the plans and at the elevation approved by Engineer.

4.10 Driving Tolerances:

4.10.1 Piles for bent construction shall be driven with a degree of accuracy that will permit framing into bents with a minimum of pulling or jacking. Under ordinary conditions, timber piles, after driving and before framing, shall not vary from the vertical or from the required batter by more than 1/4 inch per foot of pile above finished ground. Other types of piles shall not vary from the vertical or from the required batter by more than 1/8 inch per foot of pile above finished ground, except that under ordinary conditions, the maximum deviation of the top of the pile from the plan location shall be 2 inches in the direction of the structure centerline and 4 inches in the direction along the centerline of the bent.

4.10.2 Foundation piles shall be driven to the vertical or batter line shown on the plans and the top of the completed pile shall not be more than 4 inches in any direction from the position shown on the plans. The center of gravity of the completed pile group shall not vary by more than 3 inches from the center of gravity determined from plan location.

4.11 Protection of Pile Heads:

4.11.1 A steel driving head suitable for the type and size of piles being driven shall be used. Steel bearing piles and steel sheet piles shall be driven with a driving head compatible with the specific pile shape driven.

4.11.2 For concrete piles, a cushion block shall be provided between the driving head and the top of the pile. Wood cushion blocks, wire rope mat, belting, or other suitable material shall be used, subject to the approval of Engineer, to prevent damage to the pile. Cushion blocks shall be changed as necessary to maintain an effective cushion.

4.12 Pile Damage and Misalignment:

4.12.1 Care shall be exercised to avoid damage to piles from overdriving.

4.12.2 Any pile that is damaged to the extent that, in the opinion of Engineer, it will not perform its design function; any pile that is driven off location or alignment beyond the allowable tolerances; or any timber pile that is driven below cut-off elevation shall be pulled, if possible, or cut off below ground line and another pile driven as close as possible to the proper location.

4.12.3 Splicing of timber piles shall not be permitted.

4.13 Pile Penetration:

4.13.1 All piles shall be driven to a penetration satisfactory to Engineer. The length of the piles shown on the plans is the length which is estimated to give the minimum required penetration and bearing, and is for estimating purposes only.

4.13.2 Actual pile lengths and penetration required shall be established by Engineer on the basis of the test pile data. These lengths and elevation of pile tips shall supersede requirements shown on the plans.

4.13.3 Unless otherwise shown on the plans or directed in writing by Engineer for cases where piles penetrate into competent rock, foundation piles shall be driven to a penetration of a minimum 10 feet below bottom of footing, and other piles to a penetration of at least 15 feet below natural or finished ground line, whichever is lower.

4.13.4 Piles in streambeds or on the banks of streams, where marked erosion is expected, shall be driven to such penetration as Engineer deems necessary for protection against scour.

4.13.5 When the specified penetration cannot be obtained without overdriving the piles, Contractor shall provide either pilot holes or jetting equipment or a combination of both, as directed by Engineer.

4.14 Jetting:

4.14.1 For jetting operations, sufficient power shall be provided to operate the hammer and to supply water volume sufficient to freely erode the material adjacent to the pile.

4.14.2 Jetting shall be stopped a minimum of 2 feet above the desired tip elevation and the final penetration shall be obtained by driving without jetting.

4.14.3 In silty soils it is possible that jetting may loosen the soil around piles already driven. If such a condition is considered possible, piles shall be redriven after all jetting within 25 feet has been completed.

4.15 Pilot Holes

4.15.1 If piles cannot be driven to the required penetration and the material is not suitable for jetting, Engineer may permit pilot holes to be drilled to facilitate driving. Engineer shall approve the diameter and depth of the drilled hole. Ordinarily, the following drill diameters will be satisfactory:

12 inches for timber piles

4 inches less than the diagonal of square piles

2 inches less than the diagonal of octagonal piles

1 inch less than the diameter of round piles

4.15.2 Where pilot holes are required in granular material which cannot be sealed off by ordinary "mudding" drilling methods, a casing pipe of sufficient diameter shall be placed around the boring device. The casing shall be of sufficient length to extend through the loose materials and shall be held in position until the pile is placed and ready for driving.

4.15.3 If the hard material extends below the desired penetration, the drilling shall be stopped 1 foot above that level and the pile driven the remaining distance if it is possible to do so without damaging the pile.

4.15.4 If the pile does not completely fill the pilot hole, the space between the pile and the wall of the hole shall be filled with dry granular material prior to driving as approved by Engineer.

4.16 Shooting Pilot Holes:

4.16.1 The use of explosives for drilling of pilot holes shall not be permitted.

4.17 Bearing Capacity:

4.17.1 All piles shall be driven to the ultimate bearing capacity specified on the plans, in the special provisions, or by Engineer. The bearing values shall be determined using the wave equation method or the following formula as directed by Engineer:

$$Ru = \frac{12eE}{s + c} \times \frac{W + n^2P}{W + P}$$

Where:

Ru = Ultimate dynamic pile resistance (pounds)

e = Hammer efficiency = 0.9

E = Hammer energy per blow = Wh for single acting steam or air hammer or open cylinder Diesel hammer.

s = Penetration of pile per hammer blow (inches)

c = Average temporary compression (inches). The value of c shall be determined from test pile rebound graphs or as approved by Engineer.

W = Weight of striking parts of hammer (pounds)

h = Hammer ram stroke (feet) average during 1 inch of pile penetration

n = Coefficient of restitution = 0.7

P = Weight being driven (pounds) includes pile and pile follower, anvil, drive cap and adapter as applicable

4.17.2 When measuring penetration per blow to determine if adequate bearing capacity has been obtained, the hammer shall be running freely and at the speed specified by the manufacturer for full rated energy output.

4.17.3 If, for some unavoidable reason, driving must be interrupted before final penetration is reached, the penetration per blow to determine bearing capacity shall not be measured until 12 inches of penetration or refusal has been obtained after driving has been resumed.

4.18 Pile Driving Near Fresh Concrete

4.18.1 Piles shall not be driven within 150 feet of concrete that was placed within the previous 24 hours.

4.18.2 If piles are driven within 150 feet of concrete that has not attained its specified 28-day strength, the following distances, based on the concrete strength and pile hammer rated energy, shall be maintained between the concrete and the nearest pile.

% of 28 Day	Hammer Energy (ft-lb)		
Strength	<40k	40k-60k	>60k
20	60 feet	70 feet	85 feet
40	35 feet	45 feet	50 feet
60	25 feet	25 feet	30 feet
80	10 feet	15 feet	15 feet

4.19 Test Piles:

4.19.1 The furnished length of test piles shall be a minimum of 10 feet longer than the estimated length of the permanent piles shown on the plans or as directed by Engineer.

4.19.2 Wherever possible, test piles shall be driven in a location such that they can become part of the permanent structure. If not so used, test piles shall be cut off or extracted as directed by Engineer. Extraction of test piles shall be considered incidental to the test pile item, and no separate compensation shall be made for this work.

4.19.3 Ground elevations shall be brought to finished grade wherever possible prior to driving test piles so that the test piles will be comparable to the piles used in the permanent structure.

4.19.4 Equipment used for driving test piles shall be adequate for handling the lengths provided without splicing. The hammer used shall be the same make and model as that to be used in driving the permanent piles.

4.19.5 Driving of a test pile shall continue until a penetration and bearing capacity is obtained which is satisfactory to Engineer. Typically, test piles shall be driven to not less than 125% of the ultimate pile capacity required for permanent piles in the structure.

4.20 Timber Piles:

4.20.1 Preparation:

4.20.1.1 When the furnished length is much longer than the required length, Engineer may permit shortening the tip end before driving so as to have the desired diameter at the cut-off.

4.20.1.2 Pile tips shall be cut perpendicular to the axis of the pile.

4.20.1.3 The piles for bents shall be matched as much as possible in diameter to facilitate framing and bracing.

4.20.2 Cut-offs:

4.20.2.1 Piles which are to be encased in concrete shall be cut-off square to the elevation shown on the plan or established by Engineer. The pile heads shall then be swabbed with preservative in accordance with Part 3 – Construction, Maintenance and Inspection of Timber Structures of Chapter 7 – Ties of the AREMA Manual.

4.20.2.2 Piles which are to support steel or timber caps shall be brought into final position and held while cut-off is made. Any chains or jacks used in positioning the piles shall be arranged so that the surface of the pile below cut-off is not damaged. Cut-off shall be made to a true plane and to the exact elevation shown on the plans or established by Engineer so that the cap will bear on the entire cross section of each pile.

4.20.2.3 Piles shall show a solid head at the plane of the cut off.

4.20.2.4 No shims shall be permitted between the pile and the cap.

4.20.2.5 Useable cut-off portions of piles and shall be hauled to and stockpiled at a location designated by Engineer.

4.20.2.6 Unusable cut-off portions of piles shall be disposed of by Contractor in accordance with all applicable environmental laws and regulations.

4.20.3 Framing:

4.20.3.1 After the cut-off has been made, the tops of treated piles shall be saturated with hot preservative, followed by two coats of hot sealing compound. The sealing compound shall be a mixture of creosote coal-tar pitch, mixed to about the consistency of Vaseline, and brushed thoroughly into the wood.

4.20.3.2 The treated pile cut-off may be covered with plastic cement used with or without a fabric layer and topped with a ½ inch neoprene pad. The use of roofing material or sheet metal to cover the cut-off has is not acceptable.

4.20.3.3 Caps shall be placed while the piles are held in correct position. Where drift bolts are used for making connections, the caps and tops of piles shall be bored the same diameter as the drift bolt and to a depth of 3 inches less than its length.

4.20.3.4 Piles shall not be trimmed or cut to facilitate the framing of sway or longitudinal bracing. Where necessary, filler blocks shall be used between the pile and brace to establish the bracing in a true plane.

4.20.3.5 Holes for bolts shall be bored the same diameter as the bolt.

4.20.3.6 Holes for drive spikes shall be 1/8 inch less than the nominal diameter of the spike.

4.20.3.7 When holes are bored in treated piles, caps or bracing in the field, the entire hole shall be pressure treated or swabbed with hot preservative and sealing compound just before the bolt is placed.

4.20.3.8 Bolts shall be cleaned of rust and scale, and dipped in hot sealing compound before placing.

4.20.3.9 All unused holes shall be plugged at each end with tight fitting treated wooden plugs.

4.20.4 Treatment of Damaged Surfaces:

4.20.4.1 Any pile surface below cut-off that has been scuffed, torn or otherwise disturbed shall be treated with a liberal quantity of hot preservative followed by two applications of hot sealing compound.

4.21 Steel Bearing and Steel Sheet Piles:

4.21.1 Splices and Build-ups:

4.21.1.1 The length of steel bearing piles and steel sheet piles shown on the plans or ordered by Engineer may be built up in sections either before or during driving operations.

4.21.1.2 The sections, unless otherwise shown on the plans, shall be of identical cross-section.

4.21.1.3 Pile splices shall be made by full penetration butt welding of the entire cross-section or as otherwise shown on the plans.

4.21.1.4 All welding shall be in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

4.21.1.5 Care shall be taken to properly align the sections connected so that the axis of the pile will be straight.

4.21.1.6 Pile splices above a point 15 feet below finished ground line shall be reinforced as shown on the plans, unless otherwise directed by Engineer.

4.21.1.7 Field splices shall be avoided for pile lengths under 60 feet.

4.21.2 Cut-Offs:

4.21.2.1 Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by Engineer.

4.21.2.2 Where caps are required, piles shall be brought into final position and held while cut off is made. The end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inch between pile and pile cap.

4.22 Steel Pipe Piles:

4.22.1 Splices and Build-ups:

4.22.1.1 The length of a steel pipe pile may be built up in sections either before or during the driving operation.

4.22.1.2 The minimum length of a section measured between welded splices shall be 5 feet, and between drive splices shall be 30 feet.

4.22.1.3 Only one welded splice and no drive splices shall be permitted in that portion of the pile exposed above ground line or normal water line.

4.22.1.4 Drive splices shall be 15 feet below the ground line, unless directed by Engineer.

4.22.1.5 Care shall be taken to properly align the sections to be spliced to insure a straight axis. The sections shall be spliced together in accordance with details shown on the plans.

4.22.1.6 All welding shall be in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

4.22.2 Cut-Offs:

4.22.2.1 Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by Engineer.

4.22.2.2 Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inch between pile and cap.

4.22.3 Placement of Concrete:

4.22.3.1 After all driving, splicing, and positioning of pile is completed, the pile shall be free from buckles, splits, distortions, water or other foreign matter.

4.22.3.2 Contractor shall provide equipment, lighting, and facilities necessary for the proper inspection of the piles.

4.22.3.3 Any damaged, improperly driven, or otherwise defective pile shall be removed and replaced at Contractor's expense.

4.22.3.4 The tops of piles shall be kept covered after driving until the concrete is placed.

4.22.3.5 No concrete shall be placed until Engineer has inspected the completed pile and reinforcing steel, when required, and given his approval to proceed.

4.22.3.6 No concrete shall be placed in the piles in any unit until the driving of all piles in that unit has been completed. A unit is defined as a pier, bent or abutment.

4.22.3.7 Concrete shall be placed in a continuous operation taking care to prevent segregation. Special placing devices shall be used if necessary.

4.23 Precast and Prestressed Concrete Piles:

4.23.1 Build-ups:

4.23.1.1 Build-ups shall be made in accordance with the details shown on the plans or provided by Engineer.

4.23.1.2 The concrete used for the build-up shall be of the same quality as that used originally in the pile.

4.23.1.3 Just prior to placing the concrete, the top of the pile shall be coated with an epoxy bonding compound approved by Engineer.

4.23.1.4 When additional driving of precast non-prestressed piles is required, the built-up portion shall obtain a compressive strength equal to the design compressive strength of the original pile prior to redriving.

4.23.2 Cut-Offs:

4.23.2.1 Concrete at the end of a pile terminating in cast-in-place concrete shall be cut back the required amount leaving the reinforcing steel or prestressing steel exposed.

4.23.2.2 The final cut of the concrete shall be normal to the axis of the pile.

4.23.2.3 Any damage to the pile below the plan cut-off elevation shall be remedied by further cut-back and built-up.

5 MEASUREMENT AND PAYMENT

5.1 Measurement:

5.1.1 Piles driven of the various kinds, sizes, types, and weights shall be measured to the nearest 1/10 lineal foot of net length of pile in place after all cut-offs and build-ups have been made.

5.1.1.1 Steel sheet piles shall be measured by the square foot of acceptable pile in place.

5.1.1.2 That portion of piles driven below the elevation at which the minimum penetration and bearing requirements were first obtained shall not be measured for payment.

5.1.2 Timber Piles broken during driving shall not be measured for payment.

5.1.3 Concrete Piles:

5.1.3.1 Two feet shall be added to the length of concrete piles, measured for payment in accordance with the above, for each authorized build-up made, other than those made necessary by improper casting, handling or driving.

5.1.4 Test piles:

5.1.4.1 Test piles that do not become a part of the permanent structure shall be measured by the lineal foot of pile in the leads and driven in accordance with the Contract Documents and approved by Engineer.

5.1.4.2 Test piles that become a part of the permanent structure, shall be measured by the lineal foot of acceptable pile in place after all cut-offs and build-ups have been made in accordance with the provisions of Paragraph 5.1 covering the various kinds of piles.

5.1.5 Cut-off portions of piles shall not be measured for payment.

5.1.6 Pile splices are considered incidental to pile driving and shall not be measured for payment.

5.1.7 Reinforced Pile Tips are considered incidental to pile driving and shall not be measured for payment.

5.1.8 Pilot holes are considered incidental to pile driving and shall not be measured for payment.

5.1.9 Jetting is considered incidental to pile driving and shall not be measured for payment.

5.2 Payment:

5.2.1 Piles driven shall be paid for at the contract unit price per lineal foot or square foot, as measured in accordance with Paragraph 5.1.

5.2.1.1 This price shall include full compensation for furnishing all labor, materials, tools, equipment, jetting, pilot holes, splicing, points and incidentals necessary to drive and cut-off the piles and complete the work.

5.2.1.2 Contractor shall accept the contingencies of driving greater or lesser length of piles or other changes of features in construction which this may involve, all without modification of the unit price fixed by the contract.

5.2.2 The contract price per lineal foot of acceptable timber pile shall also include full compensation for preparing the piles, disposing of the pile heads, treating the pile tops, and the treating of damaged surfaces, splits, and checks.

END OF SECTION

REVISION HISTORY

The following is the revision history for this standard:

5/2/2013 – Initial Issue

1 GENERAL

1.1 Contractor shall document all test and production pile driving on the following forms.

1.2 Upon approval by Engineer, Contractor may use his standard form provided it contains the essential elements of information contained in the attached.

TEST PILE RECORD FORM

Railroad: ________________________ Subdivision: ____________________________ Bridge: _________________

Bent/Pier/Abut No.: __________ Row No.: __________ Pile No.: __________ Pile Type: ____________________

Hammer Model: _____________________ Energy Rating: ___________ (ft-lbs) Ram Weight: _______________ lbs.

Cushion Material(s) – Types & Thicknesses: ____

Total Pile Length (w/ Follower): _________ft. Date/Time Start: __________ Date/Time End: __________

Distance R/L to T/T: __________ft. Above or Below Distance T/T to G/L: __________ft.

Distance T/T To P/T At End Of Driving: ____________ft. Distance T/T To Splice At End Of Driving: ___________ft.

G/L = Groundline P/T – Pile Tip R/L = Reference Line T/T = Top of Tie BPM = Hammer Blows per Minute

R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM

Foreman/Inspector: _______________________ Date: __________ Page ___ of ___

PRODUCTION PILE RECORD FORM

Railroad: ________________________ Subdivision: ____________________________ Bridge: ________________

Bent/Pier/Abut No.: __________ Row No.: __________ Pile No.: __________ Pile Type: ____________________

Hammer Model: _____________________ Energy Rating: ___________ (ft-lbs) Ram Weight: _______________ lbs.

Cushion Material(s) – Types & Thicknesses: ____

Total Pile Length (w/ Follower): _________ft. Date/Time Start: __________ Date/Time End: __________

Distance R/L to T/T: __________ft. Above or Below Distance T/T to G/L: __________ft.

Distance T/T To P/T At End Of Driving: ____________ft. Distance T/T To Splice At End Of Driving: ___________ft.

G/L = Groundline P/T – Pile Tip R/L = Reference Line T/T = Top of Tie BPM = Hammer Blows per Minute

R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM	R/L To P/T	# Blows	Stroke or BPM

Foreman/Inspector: ________________________ Pile Record __ of __

PILE DRIVING SUMMARY

Railroad: ________________________ Subdivision: ____________________________ Bridge: _________________

Hammer Model: _____________________ Energy Rating: ___________ (ft-lbs) Ram Weight: _______________ lbs.

Cushion Material(s) – Types & Thicknesses: ____

G/L = Groundline P/T – Pile Tip T/T = Top of Tie BPM = Hammer Blows per Minute Ru = Ultimate Resistance

Date	Bent # / Pier # & Row #	Pile No.	Length of Pile (Ft.)		Last Foot (or Inch) of Penetration *				Remarks
			Penetration (GL to Tip)	T/T to G/L	Stroke Or BPM	No. Blow	Resistance Ru (Tons)	Required Ru (Tons)	

* Last Foot for friction pile, last inch for bearing on rock.

Foreman/Inspector: ________________________ Date: ___________ Page ___ of ___