Supplemental Technical Specification for

TIMBER PILES

SCDOT Designation: SC-M-711-1 (01/23)

APPROVED:
Division Administrator

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FEDERAL HIGHWAY ADMINISTRATION

1.0 GENERAL

1.1 Furnish timber piles meeting the general quality requirements and physical characteristics as herein specified. Use treated Southern Yellow Pine timber piles that have been treated in accordance with **Section 707** of the Standard Specifications for Highway Construction (latest edition) (Standard Specifications). Unless otherwise specified on the Plans or in the Special Provisions, untreated timber piles shall not be used. Dual treatment of marine piling is not required unless specified on the Plans or in the Special Provisions.

2.0 MATERIALS

2.1 Timber piles shall conform to the requirements of ASTM D25 – *Standard Specification for Round Timber Piles*, latest edition and the requirements contained herein. Use piles cut from sound, live trees, except that fire killed, blight killed or wind felled timber may be used if not attacked by decay or insects. Ensure that trees for piles are cut above the ground swell and with sound tip and butt ends.

2.2 Sound knots no larger than 1/6 the circumference of the pile where the knot occurs are allowed. Consider cluster knots as a single knot. Do not allow the entire cluster greater in size than permitted for a single knot. Do not allow the sum of knot diameters in any 1-foot length of pile to exceed 1/3 of the circumference at the point where they occur. Determine the size of a knot by measuring its diameter at right angles to the length of the pile.

2.3 Unsound knots not exceeding half the permitted size of a sound knot are allowed if the unsoundness extends to not more than 1½ inches in depth and the adjacent areas of the trunk are not affected.

2.4 A check is defined as a lengthwise separation of the wood across the rings of normal growth, extending from the surface toward the pith, but not extending through the piece. Do not use piles with checks that extend to the pith. Do not use piles with any 2 or more checks extending to the pith that become contiguous at the pith, except as modified under splits.

2.5 A shake is defined as a circumferential separation of the rings of normal growth. Ensure that the length of any shake or combination of shakes in the outer 1/2 of the radius of the butt of the pile, when measured along the curve of the annual ring, does not exceed 1/3 of the circumference of the butt of the pile.

2.6 A split is defined as a lengthwise separation of the wood across the rings of normal growth, extending from one surface through the piece to the opposite surface. Do not use piles with splits longer than the butt diameter.

2.7 Holes less than ½-inch average diameter are allowed, provided the sum of the average diameters of all holes in any 1 square foot of pile surface does not exceed 1½ inches, and the

depth of any hole does not extend to more than 1½ inches. Sound turpentine scars undamaged by insects are allowed.

2.8 Ensure that piles for use with preservative treatment contain a minimum of 1½ inches of sapwood. Ensure that piles designated for treatment are peeled of bark, including the inner skin, as soon as possible after cutting so that piles are smooth and clean. Take care to remove as little sapwood as possible while peeling the bark. Do not injure the sapwood by unnecessary axe cuts. Ensure that piles are peeled until all of the rough bark and at least 80% of the inner bark along the pile length is removed. Ensure that no piece of inner bark that remains is over ½ inch in width or over 6 inches in length, and there is 6 inches of clean wood surface between any 2 strips of inner bark.

2.9 Use piles that have a gradual taper from the point of butt measurement to the tip. Cut knots and limbs flush with the surface of the pile in a manner to prevent fiber breaks around the knot. Hand-trim knots flush with the surface of the swell surrounding the knot. Saw the butt and tip square with the axis of the pile to an accuracy of 1/10 inch per inch of diameter.

2.10 Ensure that spiral grain does not exceed 180 degrees of twist when measured over any 20-foot section of the pile.

2.11 Ensure that all piles are straight to the extent that a line drawn from the center of the butt end to the center of the tip end lies within the middle third of the body of the pile at all points. Ensure that piles are free from short crooks in which the surface deviation from straightness in any 5 feet of length exceeds 1½ inches at any location as determined by a straight edge.

2.12 As determined by circumference measurement, ensure that the diameters of piles measured under the bark conform to the requirements shown in Table 1, subject to a permissible variation of minus ½ inch in any diameter and in not more than 20% of the piles of that diameter.

Table 1 - Diameter of Pile

Length (feet)	Diameter at 3 Feet from Butt (inches)		Minimum Diameter of Tip (inches)
	Minimum	Maximum	
< 25	12	20	8
≤ 25 to < 45	12	20	8
≤ 45 to < 55	12	20	7
≤ 55 to < 75	13	20	7
≤ 75 to < 90	13	20	6
≤ 90	13	20	6

2.13 In cases where the tree is not exactly round, determine the diameter of a pile by measuring the circumference and dividing the number of inches by 3.14. The “out of round” ratio shall be determined by measuring the maximum and minimum diameters at the butt and tip. The “out of round” ratio at the butt and tip shall not exceed 1.2.

2.14 The Department specifies timber piles in multiples of 5 feet. For piles 40 feet and shorter,

the length may exceed the specified length by 1 foot. For piles 45 feet and longer, the length may exceed the specified length by 2 feet.

2.15 Use full-length piling. Do not splice timber piling. Retain possession of pile cut-offs and dispose of cut-offs away from the site.

2.16 The lengths of timber piling shown in the Plans are approximate and are used solely for comparison of bids. Determine and submit the length of timber piling required to achieve the bearing resistance indicated in the Plans while maintaining the structure factored resistance of the timber piling. Further, submit any other data used in determining such length, to the BCE for review before such piling is ordered. Do not construe such review in any way as relief of the responsibility for obtaining piling of proper length.

2.17 Ship and store treated wood products by acceptable commercial methods that prevent damage before use in the work.

2.18 Replace piling that does not meet all of the requirements of these specifications with piling that complies with the requirements of these specifications at no additional compensation.

2.19 Ensure that the method of transporting, storage, and handling timber piling avoids damage to the piling. Avoid breaking or damaging the surface of treated piling. Do not use cant-dogs, hooks, or pike-poles for handling piling. Field treat unavoidable cuts or breaks made in the surface of treated piling in accordance with the current American Wood Protection Association (AWPA) M4, which requires that the repair material be the same as the original treatment or may be copper naphthenate regardless of original treatment.

2.20 Store piling to be air-seasoned by segregating according to size and length, and separate each layer using 2-inch strips so that there is an air space of 2 inches or more underneath and between each layer. Reverse the ends of piling in alternate layers in order to keep the stack level. Leave alleys at least 3 feet wide between rows of stacks. Keep the space under and between the stacks free at all times of rotting wood, weeds, or rubbish. Ensure that the yard is drained so that no water will stand under the stacks or in their immediate vicinity.

3.0 CONSTRUCTION

3.1 Pile Hammers for Timber Piling

3.1.1 Drive timber piling by means of a gravity, single-acting air, steam, diesel, double-acting diesel or hydraulic hammers.

3.1.2 Drive timber piling with the aid of a metal casting that securely holds the pile in position during driving and distributes the load on the head of the pile to prevent splitting or brooming. Use a flexible and adjustable metal collar, accepted by the BCE, tightly strapped around the head of the pile below the cap casting to further prevent splitting of the pile during driving.

3.1.3 Do not allow the stresses in the timber pile due to driving as indicated by the Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D4945), to exceed the driving stress requirement determined using the following formula.

$$\sigma_{dr} = \varphi_{da}(2.6F_{co}) \qquad \text{Equation 1}$$

3.1.3.1 Where,

σ_{dr} = Driving stress, compression or tension, ksi
φ_{da} = Resistance factor use,
0.90 compression parallel to grain
0.80 tension parallel to grain
F_{co} = 1.20 ksi, Southern Pine

3.1.4 Do not use water jets, predrilling, etc. to obtain penetration if considered unnecessary by the BCE.

3.2 Minimum Penetration

3.2.1 Drive piling to the minimum tip elevation shown in the Plans, or the depth at which the required ultimate bearing has been achieved, whichever is greater unless directed otherwise by the BCE. Do not include penetration through fill material as part of the determination of the ultimate bearing.

3.2.2 If the required ultimate bearing value are obtained before the top of pile is to grade, continue driving 2 feet or until the pile reaches grade, whichever is less. To avoid cutting off timber piles, the Contractor may elect, at his/her risk, to continue driving the pile until the pile reaches the required elevation.

3.2.3 After the minimum penetration and minimum bearing value requirements have been obtained and if the RCE so directs and the length of pile in the leads will permit, continue driving timber piling to 125% of the minimum bearing specified where a gravity hammer is used and to 150% where a mechanical hammer is used.

3.2.4 Immediately stop any extended driving beyond the required ultimate bearing value and minimum penetration as specified above if damage to the pile occurs or if the RCE determines that further driving would damage the pile. Also, stop such extended driving if the recommendations on the driving criteria are exceeded or if the pile reaches practical refusal. Practical refusal is defined as 5 blows in ½-inch at full stroke or equivalent multiples thereof. If practical refusal or pile damage is encountered before reaching the minimum penetration or the minimum tip elevation, stop pile driving and notify the BCE.

3.3 Determination of Bearing Values

3.3.1 Pile bearing will be determined by the BCE in consultation with the Geotechnical Engineer of Record, based on the wave equation analysis or Dynamic Pile Analyzer Test (ASTM D4945). If a pay item for Dynamic Pile Analyzer Test Set-up is provided, then use the Dynamic Pile Analyzer. If conditions warrant, the Department reserves the right to require Dynamic Pile Analyzer Tests even if not provided for in the Plans. Unless otherwise specified on the Plans or in the Special Provisions, determine the allowable pile bearing for timber piles by the Dynamic Formula in Subsection 3.4.

3.4 Dynamic Formula

3.4.1 Ensure that timber piling has the minimum bearing value required by the Plans or in the Special Provisions. In the absence of requirements on the Plans or in the Special Provisions, use a minimum bearing value of 35 tons. Determine the bearing value by the following formulas based on English units of measure:

3.4.1.1 For gravity hammers,

$$P = \frac{2WH}{S+1.0} \qquad \text{Equation 2}$$

Use a fall of 14 feet in testing the capacity of pile using a gravity hammer

3.4.1.2 For single acting steam, air, diesel hammers,

$$P = \frac{2WH}{S+0.1} \qquad \text{Equation 3}$$

3.4.1.3 For double acting steam hammers,

$$P = \frac{2H[W+(A*p)]}{(S+0.1)} \qquad \text{Equation 4}$$

3.4.1.4 Where,

P = Bearing value, pounds.
W = Weight of falling parts of hammer, pounds
H = Height of fall, feet
A = Area of piston in square inches.
p = Mean effective steam pressure, pounds per square inch at the hammer.
S = The average penetration in inches per blow for the last 3 to 10 blows for gravity hammers, and the last 10 or more blows for steam, air or diesel hammers.

3.4.2 The above formulas are applicable only when:

- Hammer has a free fall, and
- Head of the pile is free from broomed or crushed wood fiber, and
- Penetration is at a reasonably quick and uniform rate, and
- There is no sensible bounce after the blow

3.5 Timber Piling Heads

3.5.1 Saw-off the tops of all timber piling to a true plane at the elevation indicated on the Plans or as approved by the RCE. Saw piling that support timber caps to the exact plane of the superimposed structure and fit it exactly. Before the roofing pitch and galvanized metal or aluminum sheet are applied on such pile heads, temporarily set the timber cap and correct all misfits in an approved manner. Withdraw broken, split, or misplaced piling and properly replace. Withdraw piling driven below the cut-off grade and replace with new, and if necessary, longer piling at no additional expense to the Department. Drive down piling raised by heaving during the

process of driving adjacent piling unless this requirement is waived in writing by the BCE.

3.5.2 After a timber piling head has been cut-off, field treat the sawn surface by heavy applications of preservative treatment as recommended by the latest edition of AWPA M4. Apply the preservative until there is visible evidence that penetration has ceased. Cover the pile head with a heavy application of coal-tar roofing cement meeting ASTM D5643 specifications. Next, place a covering of 20-gauge galvanized metal or aluminum sheet. Bend the metal or sheet down neatly over the sides of the pile and firmly secure thereto with large-headed galvanized nails or a galvanized wire band. Pile heads that are to be encased in concrete do not require the galvanized metal or aluminum cap.

4.0 MEASUREMENT OF TIMBER PILING

4.1 The quantity for the pay item Treated Timber Piling is the length of piling furnished and driven in the finished structure and is measured by the linear foot (LF), complete, and accepted. A cut-off of less than 3 feet is not included in the measurement. An allowance of 0.4 linear foot per linear foot of cut-off in excess of 3 feet is included in the measurement. These measurements do not include piling that is not installed in accordance with the Plans and specifications, piling driven for falsework, or piling used in bracing.

5.0 PAYMENT OF TIMBER PILING

5.1 Payment for the accepted quantity of Timber Piling, measured in accordance with Subsection 4.0, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and installing treated timber piling as specified or directed and includes providing the necessary length, driving, and cutting-off treated timber piling, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.

5.2 The payment for the necessary hardware is in accordance with the requirements in **Section 708** of the Standard Specifications.

5.3 The cost of furnishing metal shoes for timber piling when directed by the BCE is paid for in a Change Order, but the placing thereof is included in the contract price for Treated Timber Piling.

Item No.	Pay Item	Pay Unit
7110010	Pile Driving Set-Up	EA
7119000	Untreated Timber Piling	LF
7119100	Treated Timber Piling	LF
7119101	Pile Load Test - Treated Timber Piling	EA