

A group from the South Carolina PDCA Chapter inspects timber piles prior to treatment



Quality Driven

Quality Control and Quality Assurance for treated timber, Precast/Prestressed Concrete Piles, and Steel Piles

Introduction to the Quality Control and Quality Assurance of the Manufacturing Process for Driven Piles

The slogan for the Pile Driving Contractors Association is “A Driven Pile is a Tested Pile.” Unlike some competing products that are produced entirely on the job site, driven piles are made and tested before they reach the job site, and then on-site quality controlled driving procedures assure that the manufactured pile is installed properly.

Common driven pile types are timber, precast/prestressed concrete and steel. Each of these is made in a controlled manufacturing environment to strict industry standards. In the paragraphs that follow, we will review quality control procedures for the manufacture of these driven pile types.

Treated Timber Quality Control and Quality Assurance

Treated timber piles are subject to a minimum of 10 different quality inspections prior to delivery of the material to the job site. This assures the pile driver, the design group, and the owner of a product will consistently meet the design

requirements established by the latest edition of the ASTM D25 standard.

The initial quality control inspection is done while the tree is still standing in the woods. Each tree is viewed individually for straightness and any surface imperfections that would eliminate it for use as a treated pile.

Once the tree has been selected for harvest it is marked, felled, and delivered to a facility designed to remove the bark. As the trees are being unloaded, the loader operator is inspecting the load for straightness, surface condition, and natural taper from butt to tip. Any problems found at this point result in the piles being re-loaded on the truck and sent back to the producer.

After acceptance at the peeling facility, the piles are machine peeled. As the bark is being removed the peeler operator is inspecting the surface of the pile for any scars or other imperfections that may have been hidden by the bark.

When the bark has been removed, the pile will be measured for size and length. The grader, or inspector, has the responsibility to inspect for adequate size and taper of each individual pile. Anything that is too small or that has too

much taper will be cut back to a shorter length, or will be made into another product. At this point, the piling is identified and inventoried by size and length.

Framing is the next inspection step. At this point, piles of like size and length are sorted for straightness. The straighter piles are selected for house piling that will typically have an exposed section above the ground. The less straight piles are used as foundation piling that will be driven to grade. As the piles are being sorted they are also being cleaned and hand-peeled of any bark remaining after the machine peeling.

As the framing is completed the piles are loaded onto kiln trams for



Steel piles are manufactured in a variety of shapes and sizes

kiln drying. Drying is necessary to remove the naturally occurring moisture from the wood to allow for the introduction of the treating solution. The time associated with the cycle varies according to size, but it is generally completed in approximately 72 hours. Once the drying cycle is complete another inspection is made to determine moisture content. Moisture content of between 25 and 29 percent is required to allow proper penetration and retention of the preservative.

Following kiln drying, the piles are treated by a pressure process designed to impregnate the piles with a wood preservative to protect against naturally occurring conditions and organisms that attack wood. Inspection at this point is done to determine that the required penetration and retention specifications are met; taking core samples from each charge treated, testing for penetration, and running an assay for retention achieves this.

Upon passing inspection for penetration and retention, the piles are off-loaded and placed into inventory. As

this is being done the loader operators inspect for any mechanical damage that may have occurred during the drying/ treating process.

Shipments are made from inventory as orders are received. The piles are once again inspected for mechanical damage as they are being loaded for delivery. Final inspection occurs as the piles are delivered to the job site. Most piles are off-loaded by mechanical means to reduce the chance of breakage. Boom operators provide one last inspection for any damage that may have occurred during loading, transport, or unloading. If damage is found, the piles are re-loaded and returned to the treatment facility.

Based on the 10 different quality control steps outlined above, treated timber piling does in fact provide quality assurance and give credence to the PDCA mantra that a driven pile is a tested pile. Treated timber piling can be specified and driven with the knowledge that they have been thoroughly tested and inspected to meet the design requirements.


Precast/Prestressed Concrete Piles Quality Control and Quality Assurance

Precast/Prestressed Concrete Piles (PSC) are made in a controlled manufacturing environment with strict quality control procedures. A primary source of quality control procedures for this product is the Precast/Prestressed Concrete Institute (PCI). PCI outlines every step of the pile manufacturing process from beginning to end. Pile manufacturing plants model their quality control procedures in accordance with the PCI "Manual for Quality Control." Many plants choose to participate in PCI's plant certification program. Others may set up quality control standards in accordance with the PCI model and have the quality control procedures reviewed by an independent professional engineering firm at regular intervals during production. Specifications typically reference PCI along with American Concrete Institute (ACI) and American Society for Testing and Materials (ASTM) standards for all of the raw material components of PSC piles. For discussion purposes, we will review the process for manufacturing prestressed concrete piles.

Smooth, straight, and clean forms are used in the casting process. The forms are normally made of steel of sufficient strength to resist deflection during the prestressing process. Before the reinforcing steel is placed, the casting beds are inspected.

Reinforcing steel (prestressing strands and spiral wire) is precisely placed, tensioned, and tied in accordance with the approved shop drawings. Templates referred to as headers ensure that the longitudinal reinforcing (prestressing strands) are precisely placed. Lateral reinforcing encases the prestressing strands and is tied at precise pitch or spacing. Proper concrete coverage of the steel reinforcing is a critical component of a pile that is assured with a prestressed concrete pile.

Redi-mixed concrete is supplied from an approved source, using a tested and approved mix design. Before the concrete is placed in the forms, slump measurements are made to make certain it is within tolerance. The concrete is placed in the prepared forms, properly



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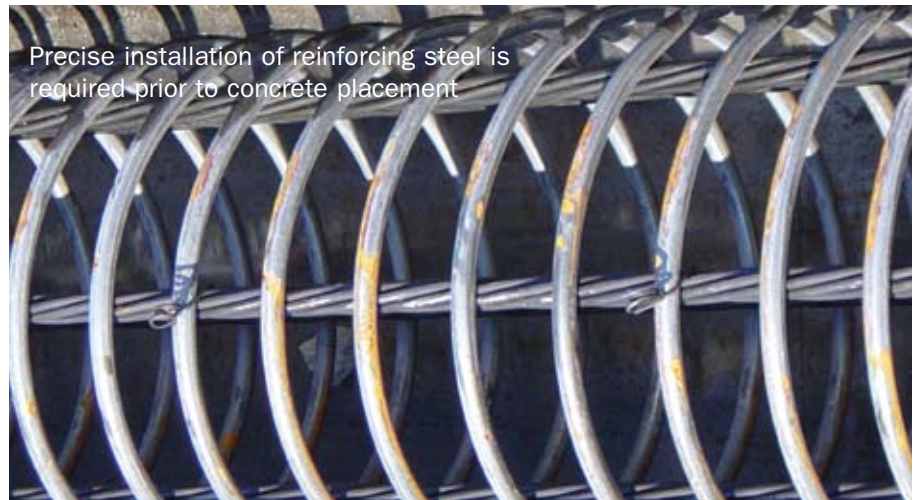

consolidated (vibrated), and finished. Concrete samples are taken as test cylinders to be cured in the same environment as the piles.

Piles are allowed to cure in place until a specified strength is reached prior to allowing detensioning of the prestressing strands. This strength is verified by breaking concrete test cylinders in accordance with ACI standards. The piles will not be detensioned until the specified strength is reached. The piles are then removed from the forms using lift points precisely placed during the casting process in order to maintain the pile in perfect alignment as it is handled. They are then stored at the manufacturing plant until the specified strength for transport and installation is reached — again verified by breaking of concrete cylinders.

Once concrete strength is achieved, the piles are visually inspected then loaded onto a barge or flat trailer of sufficient length to enable the pile to be properly supported for delivery to the job site. At the job site, they are unloaded in a similar manner and inspected again. The piles are then ready to be driven. Once installed, structural integrity of a prestressed concrete pile can be easily verified through dynamic pile testing. There is no guesswork with a driven prestressed concrete pile.

Steel Pile Quality Control and Quality Assurance

Steel piles (H-piles, sheet piles, and pipe piles) are also made in a controlled environment and meet rigid ASTM standards. Depending on the desired application, steel H-piles and sheet piles are manufactured to meet one or more of several ASTM specifications. The most common standard for sheet piles in previous years was ASTM A-328, $F_y = 39$ ksi. This standard met most needs and many piles manufactured to this specification are still in use. Today, most sheet piles and H-piles are manufactured to meet ASTM A-572-Grade 50, $F_y = 50$ ksi, which provides additional strength, allowing for potentially higher geotechnical capacity. A572 steel can also be manufactured in Grade 60 and Grade 65, $F_y = 60$ ksi and 65 ksi, respectively. Also available are steel piles that



meet the ASTM A-588 to provide for improved atmospheric weathering and steel piles that meet the ASTM A-690 for increased corrosion resistance in marine environments, both of which have a yield stress of 50 ksi.

The American Institute of Steel Construction (AISC) awards fabricator certifications for steel manufacturers. Companies that earn these certifications are evaluated by AISC and subject to an annual inspection to ensure that their level of quality meets their stringent standards.

In the manufacture of steel H-piles and steel sheet piles, molten steel is poured via continuous caster into a mold and drawn downward through water-cooled walls of the mold. This molten steel, derived from either iron ore or scrap steel, is closely monitored to ensure the proper chemical composition to meet the desired specification and grade. By the time the steel is extruded from the caster it has solidified into a semi-finished product, or blank, which is used to form the finished product. The blank is then further processed via a set of specific rollers into the various structural H and sheet sections, which are then cut to the desired lengths. They are precisely manufactured to meet specified tolerances to ensure consistency and uniformity of size and shape.

Most steel pipe that is utilized for piling conforms to another ASTM specification, A-252, which includes three grades: 1 – $F_y = 30$ ksi, 2 – $F_y = 35$ ksi and 3 – $F_y = 46$ ksi. There are three primary methods of manufacture for steel pipe used as piling: Seamless, Electric Resistance Weld (ERW), and Double Submerged Arc Weld (DSAW).

In addition to pipe meeting the standard ASTM A-252, pipe manufactured for high-strength applications, such as oil well casings, can also be utilized as piles. As an option to the typical cylindrical shape, steel pipe piles can also be manufactured in a tapered shape, similar in form to a timber pile.

Steel piles are manufactured in a variety of shapes, sizes, and lengths. When combined with the variety of available material specifications and grades, the designer and contractor are provided with a great deal of flexibility. Steel piles can be selected to meet a wide range of environmental and loading conditions. Shop-applied coatings can also enhance the service life and appearance of steel piles.

Summary

One of the great benefits of driven piles is that they are manufactured to meet specified criteria, and the manufacturing process is open and available for inspection throughout. Material test reports are also available for review. A final visual inspection can be made just prior to installation and, through the use of dynamic and integrity testing, the end user can be assured that each pile is properly installed and capable of performing as desired. No other deep foundation solution is so thoroughly tested during manufacture and installation. A driven pile truly is a tested pile. ▼

Don Surrency of Cox Industries, Harry Robbins of Palmetto Piledriving, Gerry McShane of Skyline Steel and Bill Buckland of Mandal Pipe Company all contributed to this article.