Lesson 6 – CONTRACTOR, EQUIPMENT & PILES ARRIVE ON-SITE Transcript

Welcome to the Pile Driving Inspector Course. This is Lesson 6, Contractor, Equipment and Piles Arrive On-site. To begin, select the start button or press Shift+N on your keyboard.

The learning outcomes you will achieve during this lesson:

- Verify and Document Equipment Matches Approved Pile Installation Plan
- Document Contractor Compliance with Protection of Existing Structures, Excavations, etc.
- Verify contractor compliance for transportation, handling, storage, labeling and marking of piles.
- Identify Contractor provided elevations

When the Contractor and equipment arrive on-site, the Inspector has a variety of many things to check from verifying that the Contractor has initiated their Protection of Existing Structures to verify that the equipment brought on site matches that one included in the accepted Pile Installation Plan.

Let's review the specifications regarding the protection of existing structures. When the plans require excavations or foundation construction operations in close proximity to existing structures, take all reasonable precautions to prevent damage to such structures.

Survey and monitor structures for settlement in a manner approved by the Engineer, recording elevations to 0.001 foot. Employ a qualified Specialty Engineer to inspect and document the condition of structures prior to and after construction of excavations and foundation construction. Inspect and monitor the following structures:

(1) As shown in the plans.

(2) …

(3) …

(4) within 200 feet of sheet pile installation and extraction operations

For projects with pile driving operations, inspect and document the condition of all structures within a distance, in feet, of pile driving operations equal to 0.25 times the square root of the impact hammer energy, in foot-pounds. Survey and monitor for settlement all structures within a distance, in feet, of pile driving operations equal to 0.5 times the square root of the impact hammer energy, in foot-pounds.

Obtain the Engineer's approval of the number and location of monitoring points. Record elevations:
(1) before beginning construction,
(2) daily during the driving of any casings, piling, or sheeting,
(3) weekly for two weeks after stopping pile driving,
(4) during excavation,
(5) during blasting,
(6) or as directed by the Engineer.

Notify the Engineer of any movements detected and immediately take any remedial measures required to prevent damage to the existing structures.

Here is a graphical representation of the settlement monitoring requirements for pile driving. Structures within the radius given by the equation must be monitored for settlements.

This is a graphical representation of the inspection requirements for pile driving. Structures within the radius given by the equation must be inspected prior and after construction operations.
Note: In previous versions of the specifications Inspection of Structures was called as "surveying" of structures.

The Department will make the necessary arrangements to provide right-of-way entry to the existing structures.

When shown in the Contract Documents, employ a qualified Specialty Engineer to monitor and record vibration levels during the driving of casings, piling, sheeting, or blasting operations. Provide vibration monitoring equipment capable of detecting velocities of 0.1 in/s or less. There is no equation based on Energy to monitor vibrations. The need for monitoring vibrations needs to be spelled out in the plans.

Upon detecting settlement or heave of 0.005 foot, vibration levels reaching 0.5 in/s, levels otherwise shown in the Contract Documents, or damage to the structure, immediately stop the source of vibrations, backfill any open drilled shaft excavations, and contact the Engineer for instructions.

When shown in the Contract Documents or when authorized by the Engineer, install the piling to the depth required to minimize the effects of vibrations or ground heave on adjacent structures by approved methods other than driving (preformed holes, predrilling, jetting, etc.). In the event the Department authorizes the use of preformed pile holes to meet this requirement, the Department will pay for this work as described in 455-5.9.3

Please resolve the following review questions. A hammer has a rated energy of 99,400 ft. lbs.
Structures within what distance should be monitored for settlement by the Contractor? (add a Continue button)
Click brings in answer 1.

Distance is equal to 0.5 times the square root of the rated energy of the hammer in foot pounds. This would result in 157.6 ft.
Click

Structures within what distance should be inspected and monitored for settlement by the Contractor? (add a continue button) Click brings in answer 2.

Distance is equal to 0.25 times the square root of the rated energy of the hammer in foot pounds. This would result in 78.8 ft.

Please resolve the following review questions. A hammer has a rated energy of 106,020 ft. lbs..

Which structures need monitoring only? (add a continue button)

Click brings golden block

Click brings 2nd golden block

Click brings 3rd golden block

For settlement monitoring the computed distance is 162.8 feet. For the inspection distance, the computed distance is 81.4 feet. Structures B, C and E are located within 162.8 feet but are located at greater distances than 81.4 feet requiring only settlement monitoring. Therefore answer is B, C and E

Click

Which structures need both inspection and settlement monitoring? (Continue button) Click brings 4th golden block

As shown before, D for inspection was computed as 81.4 feet. Structures within this distance will require both monitoring and inspection. Therefore the answer is A and D.

Let's review the specification 455-1.2 Excavation: Complete all excavation of the foundations prior to installing piles or shafts unless otherwise authorized by the Engineer. Here the specifications refer to the excavations required to construct the footers or pile cap. These need to be done prior to install the piles.

Place and compact the fill before installing end-bent piling/shafts, except when: (1) driving specified test piling in end bents or, (2) the plans show uncased piles through proprietary retaining wall fills. When installing piles/shafts or casing prior to placing fill, take necessary precautions to prevent displacement of piles/shafts during placing and compacting fill materials within 15 feet of the piles/shafts or casing. Reference and check the position of the piles/shafts or casing at three approximately equal intervals during construction of the embankment.

If the cofferdams design is not addressed in the Plans, the Contractor must employ a Specialty Engineer to design it. The Contractor must provide a diver and a safety diver equipped with voice communications devices to inspect the final conditions of the foundation enclosure.

Let us read what are the specifications requirements regarding cofferdams. Construct cofferdams as detailed in the plans. When cofferdams are not detailed in the plans, employ a Specialty Engineer to design cofferdams, and to sign and seal the plans and specification requirements. Send the designs to the Engineer for his records before beginning construction.

Provide a qualified diver and a safety diver to inspect the conditions of the foundation enclosure or cofferdam when the Contract Documents require a seal for construction. Equip these divers with suitable voice communications, and have them inspect the foundation enclosure and cofferdam periphery including each sheeting indentation and around each piling or drilled shaft to ensure that no layers of mud or other undesirable materials were left above the bottom of seal elevation during the excavation process. Also have the divers check to make sure the surfaces of the piles or drilled shafts are sufficiently clean to allow bond of the concrete down to the minimum bottom of seal elevation.

When required, ensure that there are no mounds of stone, shell, or other authorized backfill material left after placement and grading. Assist the Engineer as required to ensure that the seal is placed as specified and evaluate the adequacy of the foundation soils or rock. Correct any deficiencies found by the divers. Upon completion of inspection by the divers, the Department may also elect to inspect the work before authorizing the Contractor to proceed with subsequent construction operations. Furnish the Engineer a written report by the divers indicating the results of their underwater inspection before requesting authorization to place the seal concrete.

Now let's talk about the Inspector's responsibilities. Here is a Checklist that can assist you in performing your duties. A full size of this checklist can be found on the resources page.

The Inspector has various responsibilities, such as:

- Verifying the correct equipment is on the job.
- Verify the Delivery, Handling & Storage of Piles
- Verify the Marking & Location of Piles
- Verify Templates
- Verify that Reference Points/Elevations are provided
- Observe Jetting/Preformed Holes operations
- Observe construction of Splices
- Monitor and record Pile Driving Operations

The Contractor specified in their plan, the details on the pile driving system, including hammer, helmets and cushions. Once the plan is approved, there are to be no changes without the Engineers' approval. As Inspector, you need to verify that the equipment matches the approved plan. The hammer model, serial number, energy rating should match, as well as the cushion materials and thickness, and helmet (cap block) dimensions.

It is important to have the right external power supplies and working gauges to monitor power. The calibration frequency is typically set forth in the specifications and is generally within the last 90 days. Here is a typical control panel for a hydraulic hammer.

In air hammers a slide bar is used to set up the stroke heights. In the photo, the slide bar is set in the cog for full stroke. The other cog is for short stroke.

Here is a bounce chamber pressure gauge for closed end diesel hammers.

The leads perform the very important function of holding the hammer and pile in good alignment with each other. Poor alignment reduces energy transfer as some energy is then imparted into horizontal motion. Poor alignment also generally results in higher bending stresses and higher local contact stresses which can cause pile damage.

This is particularly important at end of driving when driving resistance is highest and driving stresses are generally increased. Sometimes the specifications do not allow certain lead systems or may require a certain type system. A pile gate at the lead bottom which properly centers the pile should be required, as it helps maintain good alignment.

The Inspector needs to verify that the Contractor brought the leads that were approved in the Pile Installation Plan. Was a fixed lead system, like that shown here, approved and the leads on-site are swinging, or semi-fixed? Are the leads long enough to hold the maximum pile length and hammer in alignment?

The Inspector is to verify that the weight, diameter and depth of the drive head is as presented in the Pile Installation Plan. It needs to fit loosely over the pile to be driven and also have sufficient room to accommodate

the required hammer cushion. Generally, the diameter is slightly larger than the pile diameter. Fit is more critical for concrete piles.

The Contractor's Plan and the Driving Criteria Letter, will contain hammer cushion data. Check to see that the cushions are in good condition. A single polymer cushion typically will be 2" thick.

This image shows a Micarta (phenolic canvas) cushion at your left and a hammortex cushion at your right.
If the hammer cushion is to consist of several components, for example, a Hammortex sandwiched with aluminum disks, then the "sandwich" thickness is measured and the "sandwiching" compared to the approved plan. Here is an inspector verifying the measurements of a hammer cushion.

Pile Cushions are made of plywood or oak lumber. Note in the left hand photo there are 8 pieces of plywood, which at ¾" each would provide for a 6" cushion. The Inspector needs to measure the cushion for the minimum thickness requirement. A specified thickness may be noted in the Pile installation Plan or Driving Criteria letter. If, for example, it is specified that the pile cushion is to be 6" thick, the Inspector needs to verify that thickness.

Here is a short video showing the installation of the pile cushion into the helmet.

It is extremely important that piles, specifically concrete, be lifted, transported and stored properly to ensure adequate support throughout their length. Improper lifting or storage can cause bending of the piles, and in the case of concrete can cause micro cracks. Typically, details for lifting and support (dunnage) of piles is shown in the contract documents.

Piles should be inspected as they arrive from the prestress yard.

- Look for visible damage to the pile
- Check for production dates and "Acceptance" stamp
- Match pile lengths with authorized casting lengths

- Check that lifting eyes have been removed and epoxied at the casting yard. This should include checking that the pre-stressing strands have been properly removed.
- Verify that handling and storage on-site complies with the Plan Sheets and Standard Indexes.

Here is short video showing piles on-site. The Inspector needs to check casting date, pile number, etc. Pile may have casting date and stamp as discussed earlier or may be accompanied by paperwork.

Let's talk about steel piles. For steel pipe piles, measure the diameters, wall thickness and lengths and compare to the plans. Here is a picture of steel piles being stored with dunnage.

This is an illustration of a 10 x 59 H pile (pronounce it as "10 by 59 H pile"). H Piles are typically identified by the pile depth and the flange width and weight per foot. In this slide this is a 10" x 10" pile with a linear weight of 59 lbs. per foot.

This table indicates the typical H pile sizes. In parenthesis is the designation for the metric system equivalents. A typical ticket is shown at the right of the slide.

Timber piles generally arrive at the site in the required lengths. It is not very common to splice timber piles and is prohibited by the specifications.

Let's read what the specifications say about timber piles: Materials: Meet the timber piling requirements of Section 953. Treat the piles according to the applicable provisions of Section 955. Treat all cuts and drilled holes in accordance with 470-3. Physical details for round timber piles are sometimes referred to in the ASTM pile specification, ASTM D25.

Regardless of the referenced specifications, the following items should be checked for compliance:

a) The timber should be of the specified species.

b) The piles should have the specified minimum length, and have the correct pile toe and butt sizes. The pile butt must be cut squarely with the pile axis.
c) The twist of spiral grain and the number and distribution of knots should be acceptable.
d) The piles should be acceptably straight.
e) The piles must be pressure treated as specified.
f) The pile butts and/or toe may require banding per the specifications.
g) Steel shoes which may be specified must be properly attached.

Next, we will talk about concrete Piles. Let's review the storage and handling specifications for prestressed concrete piles: 455-7.3 Storage and Handling: Time of Driving Piles: Drive prestressed concrete piles at any time after the concrete has been cured in accordance with Section 450, and the concrete compressive strength is equal to or greater than the specified 28 day compressive strength.

Storage: Support prestressed concrete piles on adequate dunnage both in the prestress yard and at the job site in accordance with the locations shown in the Standard Indexes to minimize undue bending stresses or creating a sweep or camber in the pile.

This slide shows prestressed concrete piles being stored with timber block supports. These supports must be a spacing not exceeding those indicated in the standard indexes.

Handling of Prestressed concrete piles: In general, lift concrete piles by means of a suitable bridge or slings attached to the pile at the locations shown in the Standard Indexes. Construct slings used to handle piles of a fabric material or braided wire rope constructed of six or more wire ropes which will not mar the corners or the surface finish of the piles. Do not use chains to handle piles.

During transport, support concrete piles at the lifting locations shown in the Standard Indexes or fully support them throughout 80% or more of their length.

Now let's talk about damaged prestressed concrete piles. Cracked Piles: The Engineer will reject any pile that becomes cracked in handling to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. Inspectors must note the "damage", document with photographs, and report to PA. It is not the Inspector's responsibility to make final decisions on these piles.

The Inspector cannot reject a pile that is the PA's authority. Inspect concrete piles closely for damage. If any is evident, document and contact the Project Administrator for instructions.

Here is a short video that shows an improperly lifted concrete pile using two pick up points. Notice the bending of the pile.

This short video shows a concrete pile being lifted by 3 pickup points. Notice in this case there is not bending as in the previous case.

Pick up points and support details for prestressed concrete piles: Here is the Standard Index 20600 that specifies the requirements for pick up and support points. The Contractor is typically required to mark their lifting points based upon the plan details. The Inspector should double-check the Contractor's marks by measuring the length of pile, the diameter (size) and then refer to the plan details to verify the marks are correct.

Here is a detail of the required distances or spacings for pick up points and for storage and transport points. These distances will vary depending on the size of the pile. The smaller the size of the pile, the shorter the required distances between supports. The full size standard index is included in the Appendices. Use it for the next exercise.

Use the Standard Index included in the Appendices to work out this problem. Where should the pickup points be? When you are ready to see the answer, select the “check answer” button or press Shift+N on your keyboard.

Use the Standard Index included in the Appendices to work out this problem. Where should the support be for a 3-point support? When you are ready to see the answer, select the “check answer” button or press Shift+N on your keyboard.

The inspector needs to document the conditions of the piles as they arrive to the site. The Inspector needs to verify that the strands have been properly removed, the lifting eyes have been properly removed and patched and that the piles arrived to the site without damage.

The inspector also needs to verify that the piles are handled properly. Document if the Contractor did not use support points and pick-up points in accordance to the standards we just covered. Here is a picture of a concrete pile with bending cracks due to poor handling. Cases like this must be recorded, documented, photographed and brought to the attention of the PA.

Preparation for Transportation for prestressed concrete piles: Cut any strands protruding beyond the ends of the pile flush with the surface of the concrete using an abrasive cutting blade before transporting the piles from the casting yard. Cut and patch the metal lifting devices in accordance with 450-9.2.1.

Section 450 is the section that deals with prestressed concrete in general. Here is what section 450-9.2.1. has to say about cutting and patching the lifting devices in prestressed concrete piles**:** After lifting operations using flush or protruding metal lifting devices are complete, cut the lifting devices back to a minimum depth of 1 inch below the concrete surface and patch with a Type “F” epoxy compound meeting the requirements of Section

926. For all square prestressed piling, concrete sheet piling and concrete poles, cut and patch lifting devices before transporting from the casting yard.

The Inspector is to verify that the strands have been removed properly. They are to be cut with an abrasive cutting blade- not burnt off as shown here.

Shown in the photo are the lifting eyes cast in at the yard to facilitate lifting the pile from the form after casting. As reviewed earlier, our specifications require these be removed and patched with epoxy prior to leaving the casting yard and arriving at the jobsite.

Method of Driving for prestressed concrete piles: Unless otherwise directed, drive piles by a hammer or by means of a combination of water jets and hammer when jetting is allowed..

The Inspector must verify that the Contractor is adhering to their Pile Installation Plan sequencing, use of jets, templates, leads, etc., part of which is to check the template construction against the approved plan template. Discrepancies to the approved plan should be pointed out and documented and the PA contacted.

If a template is being used, it provides a great reference (elevation). When templates are used they are used as reference elevations as well. When fixed leads are used and no templates are used, then another suitable reference (batter board, string line, etc.) will need to be established. Have Contractor provide you the elevation.

At all possible, avoid using a reference that moves or will need to be moved before completing driving of the pile. The Fixed Template shown in this photo is the one that is typically used. For a Fixed Lead system, you will need to set a string line or something similar.

Make sure to select a reference that will not need to be moved and will be stable. If the reference is moved, then the Inspector needs to recalculate the “Min. Tip Target” and “Stop for Set-Check Cut-off Target.” The Inspector will also need to note the change in the Pile Driving Record.

In this lesson we have covered the following topics:

- Verify and Document Equipment Matches Approved Pile Installation Plan
- Document Contractor Compliance with Protection of Existing Structures, Excavations, etc.
- Verify contractor compliance for transportation, handling, storage, labeling & marking of piles.
- Identify Contractor provided elevations

This concludes Lesson 6, please continue to lesson 7 by selecting the next lesson button on this page.