Lesson 7 – Begin Pile Driving Transcript

Welcome to the Pile Driving Inspector Course. This is Lesson 7 – Begin Pile Driving. To begin, select the start button or press Shift+N on your keyboard.

The learning outcomes you will achieve during this lesson:

- Monitor and verify proper marking of the piles per contract documents and standards
- Verify & document contractor compliance with applicable tolerances
- Monitor, verify and document pile driving operations
- Identify applicable 455 specifications

As discussed earlier, the Inspector has numerous responsibilities throughout the pile driving operations. During pile driving, the Inspector needs to verify compliance with the project Plans and Specifications for pile plan location, axial alignment, monitor and maintain record of the driving and the most important to determine when to stop driving and accept the pile. During the driving of the pile, there are specific duties, such as hammer and pile cushion inspection, together with the recording of the operation, blows, stroke height/pressure, etc.

Here is a checklist that might be helpful during the Production Piling Phase. A full size version of the checklist is included in the Appendices which are located on the resources page.

Let's review the tolerances allowed by the specifications. General: Meet the tolerances described in this Sub-article to the piles that are free standing without lateral restraint (after the template is removed). After the piles are driven, do not move the piles laterally to force them to be within the specified tolerances.

Position: Ensure that the final position of the pile head at cut-off elevation is no more than 3 inches laterally in the X or Y coordinate from the plan position indicated in the plans. Axial Alignment: Ensure that the axial alignment of the driven piles does not deviate by more than 1/4 in/ft. from the vertical or batter line indicated in the plans.

Elevation: Ensure that the final elevation of the pile head is no more than 1 1/2 inches above, or more than 4 inches below, the elevation shown in the plans, however in no case shall the pile be embedded less than 8 inches into the cap or footing.

This illustrates the horizontal position tolerance which is a maximum of 3 inches in any direction. If out of tolerance, notify the contractor, document and notify the PA.

This illustrates the axial alignment tolerance. The maximum deviation allowed from the plan alignment is ¼ inch per foot. If out of tolerance, notify the contractor, document and notify the PA.

This illustrates one method for checking the axial alignment which is using a 4ft builders square.

This is an illustration of the vertical elevation tolerance described before. The final pile top of the pile cannot be higher than 1-1/2" above the cutoff elevation of the plans or more than 4 inches below the cutoff elevation shown in the plans.

Let's review the predrilling of pile holes specification. Predrilled pile holes are either starter holes to the depth described in this section or holes drilled through embankment/fill material down to the natural ground surface. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. The Contractor is not paid for Predrilled Holes. These are up to 10 ft. or 20 % of the pile length (whichever is greater) starter holes.

This illustrates what natural ground means in the predrilling specification. Natural Ground is defined as "The ground surface prior to any roadway construction." For concrete piles or other displacement piles, predrilling holes should be taken to at least the natural ground level

This indicates the required drill diameters for predrilled holes for concrete piles. It is important that the Inspector recognize that whatever the depth of predrilled hole is used in the Test Pile program, that is the depth to be used in production piles. Therefore, if 6 foot predrilled holes were used in the Test pile program and the Contractor wants to do 20 foot predrilled holes during production, this is not permitted. The Inspector should inform the Contractor it is not permitted, contact the PA and document the depth of hole predrilled.

For other pile sizes, use the diameter of the drills shown in the plans or approved by the Engineer.

For predrilled holes required through rock or other hard materials (such as: debris, obstructions, etc.) that may damage the pile during installation, predrill hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section.

In the setting of permanent and test piling, the Contractor may initially predrill holes to a depth up to 10 feet or 20% of the pile length, whichever is greater, except that, where installing piles in compacted fill, predrill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may predrill holes to greater depths to minimize the effects of vibrations on existing structures adjacent to the work and/or for other reasons the Contractor proposes. Note: the bottom of a Pre-drilled hole is NOT the bottom of an “Excavation”. The bottom of the excavation is the bottom of the footing or pile cap excavation.

Perform such work the Engineer allows but does not require at no expense to the Department. When the Engineer requires such work, the Department will pay for such work as Preformed Pile Holes as described in 455-5.9

Let’s review what the specs say about Preformed Holes: Preformed Pile Holes serve as a penetration aid when all other pile installation methods fail to produce the desired penetration and when authorized by the Engineer to minimize the effects of vibrations on adjacent structures.

The Preforming of Holes is generally called for in the Plans and the Contractor is paid for these holes. Remember that Preforming depths are typically shown in the Pile Data Table and are given as an Elevation. Preformed Hole Depth, for recording purposes, is the depth or length of Preformed Hole drilled by the Contractor. Therefore, the Inspector needs to verify that the preformed Hole was drilled to the elevation specified and then record that length for pay purposes.

Let's continue with the preformed hole specification. For preformed holes which are required through material that caves during driving to the extent that the preformed hole does not serve its intended purpose, case the hole from the surface through caving material. Note: Keep in mind that the bottom of a preformed hole is NOT the bottom of an "Excavation". The bottom of the excavation in the specs refers to the bottom of the excavation for the construction of the pile cap or footing.

Fill all voids between the pile and soil remaining after driving through preformed holes with clean A-3 sand or sand meeting the requirements of 902-3.3, after the pile has achieved the required minimum tip elevation, unless grouting of preformed pile holes is shown in the plans. If pile driving is interrupted during sand placement, drive the pile at least 20 additional blows after filling all of the voids between the pile and soil with sand at no additional compensation.

Provisions for Use of Preformed Pile Holes: The Department generally anticipates the necessity for Preformed Pile Holes and includes directions in the Contract Documents

Conditions under Which Payment for preformed holes Will Be Made:

a) Inability to drive piles to the required penetration with driving and jetting equipment.
b) To penetrate a hard layer or layers of rock or strong stratum that the Engineer considers not sufficiently thick to support the structure.

c) To obtain greater penetration into dense (strong) material and into dense material containing holes, cavities or unstable soft layers.

d) To obtain penetration into a stratum in which it is desired to found the structure.

e) To minimize the effects of vibrations or heave on adjacent existing structures.

f) To minimize the effects of ground heave on adjacent piles.

The specifications require the contractor to construct a hole that is equal to or slightly greater than the largest pile dimension for the entire length of the hole and of sufficient depth to obtain the required penetration.

When the plans call for grouting the Preformed Pile Holes, the contractor must provide a minimum dimension of the pile hole that is 2 inches larger than the largest pile dimension.

We will see now a short video of a pile being stuck in a preformed/predrilled hole. Note this one is just gliding in, very easy.

Grouting of preformed holes. Let us review the spec regarding preformed hole grouting: Grout Preformed Pile Holes for bearing piles, when the plans require grouting after driving. Clean the Preformed Pile Holes, and fill them with cement grout as shown in the plans. Use grout that has a minimum compressive strength of 3,000 psi at 28 days or as specified.

Which one, predrilling or Preforming, is the Contractor paid for accomplishing?

A. Predrilling

B. Preforming

Multiple Choice: The tolerance for plan position is _____.

A. 3 inches

B. 4 inches

C. 5 inches

D. 6 inches

For each of the following situations, answer which holes, **Predrilled holes or preformed holes,** are to have hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section?

When drilling through rock or other hard materials?

- **A. Predrilled**
- B. Preformed

which holes, **Predrilled holes or preformed holes,** are to have hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section,

When plans call for grouting the preformed holes?

- A. Predrilled
- **B. Preformed**

Multiple Choice: The tolerance for axial alignment for driven piles is _____.

- A. 2 inches/ft.
- B. 1 inch/ft.
- C. ½ inch/ft.
- **D. ¼ inch/ft.**

Generally, projects are designed in English units. These will require a blow count criteria in blows per foot, therefore the pile should be marked in 1 foot intervals. The Contractor is responsible for marking the piles. The Inspector needs to double check the Contractor's marks.

Inch marks come in handy as a reference; should real hard driving be encountered. When inspectors suspect it is possible to obtain 20 blows per inch or more, they typically stop to mark a particular increment in inches to

be able to stop within 1 or 2 inches in practical refusal. The idea is not to overdrive the piles. This short video shows a contractor employee marking a piles.

On the left is a marked pipe pile being driven, while on the right is an H pile, marked in feet and inches, being driven. It is important to understand that a pipe pile may rotate. Additional marks may be necessary in order to make them visible for inspection purposes. Remember to check the Contractor's marking of the pile.

This specification indicates that splices or build-ups are not allowed for timber piles. Piles with insufficient bearing need to be extracted and a longer pile must be driven.

Let's see what specs require regarding the pile lengths furnished of concrete piling. Provide piles full length without splices when transported by barge or the pile length is less than or equal to 120 feet. When piles are transported by truck and the pile length exceeds 120 feet but is less than the maximum length for a three point pick-up according to Index 20600, and splicing is desired, provide minimal splices. Include the cost of the splices in the cost of the pile.

Let's talk about extensions and build-ups for concrete piles. General**:** Where splices and build-ups for concrete piles are necessary, construct such splices and build-ups in accordance with Standard Index 20601.

Let's make some explanatory comments here. While lengths extensions, splices and build ups are similar concepts in the specifications, the industry refers to the short extension, which are cast in place, as build-ups. This slide is a detail from Design Standard 20601 which illustrates what a normally known build-up looks like.

According to the current Design Standard, build-ups can be up to 5 ft. long. The term splice or extensions is reserved for the longer, precast extensions that are added to the original pile. The longer splices require prefabricated concrete sections that may be prestressed or not, depending whether they are drivable splices and also depending on the length.

Let's review what the specs say about pile extensions for concrete piles, when these are to be driven or are 21 feet or longer. They need to be prestressed concrete sections. These specifications apply to any section that needs be driven and for sections 21 feet or longer whether they need to be driven or not.

Extensions to be Driven or Those 21 feet or Longer: Construct extensions to be driven or extensions 21 feet or longer in length in accordance with the details shown in the plans and in a manner including the requirements, sequences, and procedures outlined below:

The following images will show the sequence in the making of a splice for a concrete pile. This is a pre-fabricated splice that just arrived to the site. The dowels of this splice will be used to fabricate a template to drill the holes in the pile head.

This picture shows holes being drilled in the template after the hole location has been marked.

In this picture the template is being checked with the splice rebar to make sure the template was accurately drilled.

This picture illustrates the template and forms being placed at top of the pile.

Here is what the specs say:

a) Cast a splice section in accordance with Section 450 with the dowel steel in the correct position and alignment. Note: section 450 is the Department's section regarding precast prestressed concrete construction. These splices need to be prefabricated prestressed concrete sections.
b) Drill dowel holes using an approved steel template that will position and align the drill bit during drilling. Drill holes a minimum of 2 inches deeper than the length of the dowel to be inserted

c) Clean the drilled dowel holes by inserting a high pressure air hose to the bottom of the hole and blowing the hole clean from the bottom upward. Eliminate any oil, dust, water, and other deleterious materials from the holes and the concrete

d) Place forms around joints between the pile sections. This picture shows the top of the pile after being drilled and cleaned.

Continuing with the splice sequence in the specifications:

e) (e) Mix the adhesive components in accordance with the manufacturer's directions. Do not mix sand or any other filler material with the epoxy components unless it is prepackaged by the manufacturer for this specific purpose. Use adhesives meeting the requirements of Section 926 for Type B Epoxy Compounds.

f) (f) After ensuring that all concrete surfaces are dry, fill the dowel holes with the adhesive material. This picture shows the adhesive being poured into the dowel holes

g) (g) Insert the dowels of the spliced section into the adhesive filled holes of the bottom section and position the spliced section so that the axes of the two sections are in concentric alignment and the ends of the abutting sections are spaced 1/2 inch apart. The Contractor may use small steel spacers of the required thickness provided they have 3 inches or more of cover after completing the splice. Fill the space between the abutting sections completely with the adhesive.

h) This picture shows the spliced after being inserted into the original pile. Note the adhesive that has been applied.

Continuing with the splicing sequence.

i) (h) Secure the spliced sections in alignment until the adhesive is cured in accordance with the manufacturer's directions for the time appropriate with the prevailing ambient temperatures. Do not

utilize the crane to secure the pile extension during the adhesive cure time. Utilize alignment braces to maintain the proper pile alignment during the epoxy cure time.

j) (i) After curing is completed, remove alignment braces and forms and clean and dress the spliced area to match the pile dimensions. This image shows how the alignment of the spliced sections is verified.

This picture shows a splice just being completed.

Regarding non drivable splices shorter than 21 ft., the following specification applies: Precast Reinforced Build-ups: Construct Precast Reinforced Buildups in accordance with the requirements of this Sub-article, Section 346, and Section 400.

Provide the same material for the form surfaces for precast build-ups as was used to form the prestressed piles. Use concrete of the same mix as used in the prestressed pile and dimension the cross-section the same as piling being built up. Install build-ups as specified in 455-7.7.2(b) through 455-7.7.2(i). The process is similar to building the prestressed concrete splice that we covered earlier, except that since a prestressed section is not required then the item (a) from the previous process is not required.

Let us see what the specs say about preplanned splices. These may have been indicated in the plans or preapproved by the Engineer to meet a specific project restriction.

Pre-Planned Splices: Splices shall be made by the doweled splice method contained in the Standard Indexes or may be made using proprietary splices which are listed on the Department's Approved Product List (APL).

Splice test piles in the same manner as the production piles. Include in the pile installation plan, the chosen method of splicing and the approximate locations of the splice.

Generally, place the splice at approximately the midpoint between the estimated pile tip and the ground surface, considering scour if applicable. Stagger the splice location between adjacent piles by a minimum of 10 feet. Obtain the Engineer's approval prior to constructing any pile sections. Construct piles which are to be spliced using the doweled splice with preformed dowel holes in the bottom section and embedded dowels in the upper section.

Now, let's review the specifications for splices for steel piles: 455-8.3 Pile Splices: Order and use the full authorized pile length where practicable. Do not splice to obtain authorized lengths less than 40 feet except when shown in the plans. Locate all splices in the authorized pile length in portions of the pile expected to be at least 15 feet below the final ground surface after driving.

When it is not practicable to provide authorized pile lengths longer than 40 feet in a single length, use no more than one field splice per additional 40 feet of authorized pile length. Shop splices may be used to join single lengths of pile which are at least 20 feet in length. One shorter segment of pile may be used to achieve the authorized pile length when needed

This picture illustrates a splice on a steel pile.

Here is what the specifications say regarding pipe piles that need to be filled: Filling Pipe Piles: When required by the plans, fill pipe piles with the specified materials. Use clean concrete sands and concrete meeting the requirements of Section 346. Place concrete in pipes containing water using methods in accordance with 455-15.9 with modified tremie and pump line sizes. Concrete may be placed directly into pipes which are dry.

Let’s take a look at the specification for Pile Penetration Requirements: Measure the penetration of piles from the elevation of natural ground, scour elevation shown in the plans, or the bottom of excavation, whichever is lower. When the Contract Documents show a minimum pile tip elevation or a minimum depth of penetration, drive the tip of the pile to this minimum elevation or this minimum penetration depth. In all such cases, the Engineer will accept the bearing of a pile only if the Contractor achieves the required bearing when the tip of the pile is at or below the specified minimum tip elevation or depth of penetration and below the bottom of the preformed or predrilled pile hole

Penetration is measured as the difference between the lowest of these three elevations and the tip of the pile.
NOTE: The bottom of predrilled or preformed holes is not considered the bottom of an excavation.
Let’s continue with the Penetration Requirements: When the plans do not show a minimum depth of penetration, scour elevation, or minimum tip elevation, ensure that the required penetration is at least 10 feet into firm bearing material or at least 20 feet into soft material unless otherwise permitted by the Engineer. If a scour elevation is shown in the plans, achieve these penetrations below the scour elevation. The Engineer may accept a penetration between 15 and 20 feet when there is an accumulation of five consecutive feet or more of firm bearing material

Here is the definition of firm material in the specs. Firm bearing material is any material offering a driving resistance greater than or equal to 30 tons/ft2 of gross pile area as determined by the Wave Equation (455-5.11.2). Soft material is any material offering less than these resistances.

Piles shall not be driven beyond practical refusal in order to get the minimum tip elevation or the penetration requirements. Please remember that practical refusal is not 240 blows per foot, but 20 blows per inch.

Here is where the specs starts talking about how the piles will be accepted. The Engineer may accept a driven pile when the pile has achieved minimum penetration, the blow count is generally increasing and the minimum required bearing capacity obtained for 24 inches of consecutive driving. At his discretion, the Engineer may also accept a driven pile when the minimum penetration is achieved and driving has reached practical refusal in firm material.

Increasing blow count should not be a result of a change in fuel settings. Blow counts may drop with an increase in stroke height (OED hammers).

A hard copy Pile Driving Record is maintained by the Inspector. The Pile Driving Record includes information such as hammer blows for each interval, stroke height or bounce chamber pressure for each interval and notes of all the events that happen during the pile driving.

This video illustrates the use of a saximeter during the driving of a pile with an open End Diesel Hammer. You will notice on this video how the stroke changes from blow to blow. This is very typical of Diesel hammers. Note also how average values of stroke are shown once you hit the average key. In the top row labeled as LAST the saximeter displays the average values of stroke, blows per minute and number of blows observed in the previous increment. In the second row labeled NOW you will see the strokes, blows per minute and the blow number of the increment you are currently in.

The Driving criteria Letter may provide a start of driving stroke height, fuel setting or pressure. This is quite common when dealing with concrete piles, especially if easy or soft driving is anticipated. Soft or little resistance at the tip and a big stroke height can result in excess tension in a concrete pile and damage the tip. In these cases, a reduced setting will be specified in the Driving Criteria Letter, to minimize the potential for pile damage, especially with concrete piles.

As shown in this letter sample there is a provision in case the blow count drops. In other words, in case the soil capacity drops. The driving criteria letter may require that the stroke be reduced to control stresses as it is the case in the sample letter shown here. Remember to document all fuel settings and changes that happens during the actual driving of the pile.

Shown here is a fixed four step fuel pump on a Delmag hammer. Generally open end diesel hammers are equipped with 4 fuel settings that enable the operator to control the stroke height.

Fuel setting #1 is the lowest, and thereby produces the least combustion, hence the lowest stroke height. Typically, the higher the fuel setting the higher the stroke. A lanyard is connected to the pump and adjustments made by someone on the ground pulling the lanyard. With these hammers, the fuel setting directly affects the stroke height: the higher the fuel setting the bigger the combustion, hence a higher stroke height.

Shown here is an adjustable pressure pump for fuel setting on an ICE hammer. Closed end diesel, air/steam and hydraulic hammers are pressure operated and allow for a more precise setting of the hammer energy delivered than the open end diesel or drop hammer.

This video will show a technician setting the fuel setting with a pump.

The various types of hammers have various ways to control the stroke. With drop hammers the stroke height is controlled by the operator lifting the weight. Open end diesel stroke height is a function of the fuel setting and resistance to driving, so in a sense is not really “set”.

In the case of air hammers, the stroke height can be set for providing a constant stroke through the means of a slide bar. The slide bar generally has two cogs for setting either a full stroke (typically 4 ft. or greater) and a short stroke (typically ½ the full stroke but generally no more than 2 ft.).

This image shows the control unit for a double acting BSP hydraulic hammer. It also includes a device that measures the impact energy of the hammer, by measuring the impact velocity of the hammer at the point of impact of the ram. The equivalent stroke is also determined and displayed based on the velocity and energy measurement.

For closed end diesel hammers, the pressure is displayed on the Bounce Chamber pressure gauge. With these systems, the Inspector depresses the panel button, typically with their foot, for approximately 10 seconds, during each increment, and records the average pressure being displayed during that time. Don't forget to measure the hose since the equivalent energy depends on the length of the hose.

Here is a typical bounce chamber pressure versus equivalent energy for a closed end diesel hammer. Note how there are different curves depending on the length of the hose.

This chart shows typical problems and indicators on Open End Diesel hammers. When you have read over this chart, select the continue button or press Shift+N on your keyboard to move to the next slide.

This chart shows typical problems and indicators on Closed End Diesel hammers. When you have read over this chart, select the continue button or press Shift+N on your keyboard to move to the next slide.

This chart shows typical problems and indicators on Air/Steam hammers. When you have read over this chart, select the continue button or press Shift+N on your keyboard to move to the next slide.

This chart shows typical problems and indicators on Hydraulic hammers. When you have read over this chart, select the continue button or press Shift+N on your keyboard to move to the next slide.

Let's review the specification regarding capblocks or hammer cushions. Maintain capblocks in good condition, and change them when charred, melted, or otherwise significantly deteriorated. The Engineer will inspect the

capblock before driving begins and weekly or at appropriate intervals determined by the Engineer based on field trial. Replace or repair any hammer cushion which loses more than 25% of its original thickness.

The Inspector should check the Driving Criteria Letter as it may specify a different inspection schedule than the standard specifications.

This image shows a damaged hammer cushion that must be replaced. Here is another hammer cushion that must be replaced. And another hammer cushion that must be replaced.

Here is what the specs say about pile cushions: Maintain pile cushions in good condition and change when charred, splintered, excessively compressed, or otherwise deteriorated to the point it will not protect the pile against overstressing in tension and/or compression. Protect cushions from the weather, and keep them dry. Do not soak the cushions in any liquid. Replace the pile cushion if, during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn.

Provide a new cushion for each pile unless approved otherwise by the Engineer after satisfactory field trial. Reuse pile cushions in good condition to perform all set-checks and redrives. Use the same cushion to perform the set-check or redrive as was used during the initial driving, unless this cushion is unacceptable due to deterioration, in which case use a similar cushion.

The Inspector should check the Driving Criteria Letter as it may specify a different inspection schedule than the standard specifications. Try to answer the following questions: 1: Why might you want a new pile cushion at the start of each pile? And 2: Would you want to use a new cushion for set-checks/re-strikes? (add a continue button)

Let’s answer those questions: Why might you want a new pile cushion at the start of each pile? This replicates the Test Pile Program and provides for consistency. Would you want to use a new cushion for set-checks/re-

strikes? NO - New cushions compress, so you don't want a new one here. It will throw the blow count out of whack. Generally, unless it is needed to be replaced, the pile cushion being used when driving was stopped, is the one to use.

This picture compares a new cushion with a compressed cushion. The 455 specifications require a new pile cushion be used for each pile. A Note should be made in the Pile Driving Record, when changing pile cushions, generally the blow count will increase as the new cushion compresses giving a false sense of increased bearing capacity.

If the pile is getting close to "taking up" (achieving bearing) and the pile cushion has to be changed, the Engineer may want the have a certain number of hammer blows put on the new cushion prior to getting back on the pile and commencing driving. This picture illustrates a burned cushion.

The following video shows Contractor personnel changing a pile cushion. Note, that they are not far from running out of pile.

This picture shows a pile driving where the pile cushion is already burning. A pile cushion change should be made.

The video shows a pile driving where the pile cushion is burning.

Here is another video that shows a pile cushion burning.

This video shows a pile cushion burning in the trash. Be observant for where burning cushions are disposed of. They can be a fire hazard. To prevent fires, some contractors placed burning cushions in water before discarding them.

Steel piles are more susceptible to damage from compressive stresses than from tension. Here is a picture of a pipe pile that has suffered extensive damage due to compression stresses. The original length of this pipe pile was the same as the piles shown in the back. Notice also the point protector in the tip. Regardless the pile was damaged and compressed so much that the length was reduced dramatically. Remember refusal is 20 blows per inch, not 240 blows per foot. This picture shows H piles after being damage in compression during driving.

Listed on this table are the causes of damage on steel piles and possible indicators during driving. When piles move out of position during driving it may indicate excessive bending and buckling. Abrupt blow count change may be caused by splitting, buckling or accordion damages.

This image shows the damage to a concrete pile during driving. The Contractor kept saying the pile was good and getting penetration, but the PDA said the pile was damaged. The Pile was pulled and the PDA was right.

Here are the typical damages and common causes for concrete piles. Spalling and slaying may be caused by excessive compression stresses, which could happened when the cushions are getting used up or burning. Low concrete strength may play a part on this type of damage too.

Tip damage and longitudinal cracks may be created near the tip at high eccentric compression stresses. Longitudinal cracks at the top may be created by excessive compression stresses in voided piles at the top. Excessive driving, particularly going beyond refusal may create tip damage.

Transverse cracks may occur due to poor handling and lifting of the piles which creates excessive bending stresses. Also, transverse tension cracks may happen on easy driving. Unfortunately these cracks are usually located below ground. Puffs of concrete dust coming out of the side of the pile indicates the presence of

transverse cracks. A Pile walking out of position may indicate a pile already broken and abrupt blow change may indicate a pile damage.

Pile heave is the upward movement of a pile from its originally driven elevation. When heave happens the Contractor is required to redrive all piles that have heaved 1/4 inch or more unless the Engineer determines that the heave is not detrimental to pile capacity.

Unless otherwise approved by the Engineer, used pile cushions may be utilized to drive up to how many additional piles?

A. None

B. 1

C. 2

D. No limit

Pile “Heave” refers to _____.

A. The unloading of piles from the transport vehicle.

B. The downward movement of a previously driven pile.

C. **The upward movement of a previously driven pile**. (This is the correct answer)

D. The act of loading the pile into fixed leads.

Hammer cushions should be inspected before driving begins and at approx. _____ intervals during driving.

A. daily

B. hourly

C. weekly

D. monthly

True or False: Pile cushions are to be replaced when they are compressed more than 25% of their original thickness?

A. True

B. False

In this lesson we have covered the following topics:

- Monitor and verify proper marking of the piles per contract documents and standards.
- Verify & document contractor compliance with applicable tolerances.
- Monitor, verify and document pile driving operations.
- Identify applicable 455 specifications.

This concludes Lesson 7, please continue to lesson 8 by selecting the next lesson button on this page.