

**KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2007 EDITION**

SECTION 704

PILING

Page 100-52, delete subsection 157.2, and move content to SECTION 704, new subsection 704.25.

704.25 PILE DRIVING EQUIPMENT

a. General. Pile driving hammers other than drop hammers shall be of the size needed to develop the energy required to drive piles at a penetration rate of not less than 0.10 in. per blow at the minimum driving resistance according to the appropriate pile driving formula in **TABLE 704-1**.

In addition to all other requirements, single and double acting diesel hammers and air/steam hammers require the following.

(1) Open-End (Single Acting) Diesel Hammer. Equip open-end (single acting) diesel hammers with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder, to permit the Engineer to visually determine hammer stroke at all times during pile driving operation. Also, provide the Engineer a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used.

(2) Closed-End (Double Acting) Diesel Hammer. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge, mounted near ground level so as to be easily read by the Engineer. Also, provide the Engineer a chart, calibrated to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

(3) The weight of the striking part of air/steam hammers used shall be a minimum of $\frac{1}{3}$ the weight of the pile and drive cap, and in no case shall the striking part have a weight less than 2,750 pounds.

b. Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Concrete Piles. If a gravity hammer is used for driving steel piles, steel sheet and shells for cast-in-place concrete piles, use one with a minimum weight of 3,500 pounds. In no case may the weight of the gravity hammer be less than the pile being driven plus the weight of the driving cap. In lieu of weighing the hammer, a certification may be provided by the Contractor. Equip all gravity hammers with hammer guides to maintain concentric impact on the drive head or pile cushion. Regulate the fall to avoid injury to the piles. The fall shall be a maximum of 12 feet. If diesel or air/steam hammers are used, the maximum fall shall be 90% of the maximum fall recommended by the hammer manufacturer. If steam or diesel hammers are used, its rated gross energy in foot-pounds shall be a minimum of 2 $\frac{1}{2}$ times the weight of the pile in pounds. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

c. Hammers for Pre-stressed Concrete Piles. Unless otherwise provided, drive pre-stressed concrete piles with a diesel or air/steam hammer that can develop an energy per blow at each full stroke of the piston of a minimum of 1 foot-pound for each pound of weight driven. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

d. Vibratory Hammers. Vibratory hammers may only be used when specifically allowed by the Contract Documents or in writing by the Engineer. If approved, vibratory hammers shall be used in combination with pile load testing and re-tapping with an impact hammer. In addition, 1 of every 10 piles driven with a vibratory hammer shall be re-tapped with an impact hammer of suitable energy to verify that acceptable load capacity was achieved.

e. Additional Equipment. The plant and equipment provided for air/steam hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. In case the required penetration or bearing is not obtained by the use of a hammer complying with the above minimum requirements, provide a hammer of greater energy or when permitted, resort to jetting or pre-drilling at Contractor expense. Use of the pile driving analyzer may be required when minimum requirements are not obtained or results are doubtful.

f. Leads. Construct pile-driving leads to afford freedom of movement for the hammer. Hold them in position with guys or stiff braces to support the pile during driving. Except where piles are driven through water, use leads of sufficient length that the use of a follower shall not be necessary. Leads shall be of sufficient length to allow them to be spiked into the ground at the onset of driving.

g. Hammer Cushion. Equip all impact pile driving equipment except gravity hammers with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to maintain uniform driving behavior. Use hammer cushions made of durable, manufactured material that shall retain uniform properties during driving. All wood, wire rope and asbestos hammer cushions are prohibited. Place a striking plate on the hammer cushion to maintain uniform compression of the cushion material. Inspect the hammer cushion in the presence of the Engineer when beginning pile driving at each structure or after each 100 hours of pile driving, whichever is more frequent. Replace the hammer cushion whenever there is a reduction of hammer cushion thickness exceeding 25% of the original thickness, or when the cushion begins deteriorating, tearing, etc., before continuing driving.

h. Pile Driving Head. Fit piles driven with impact hammers with an adequate driving head to distribute the hammer blow to the pile head. Axially align the driving head with the hammer and the pile. The driving head is guided by the leads and shall not be free swinging. The driving head shall fit around the pile head in a manner that prevents transfer of torsional force during driving while maintaining proper alignment of hammer and pile.

i. Water Jets. When jets are permitted, the number of jets and the volume and pressure of water at the jet nozzle shall be sufficient to freely erode the material adjacent to the pile. Use a plant with sufficient capacity to deliver a minimum of 100 pounds per square inch pressure at $\frac{3}{4}$ inch jet nozzles at all times. At a minimum of 5 feet before the desired penetration is reached, withdraw the jets and drive the piles to secure the final penetration with an approved hammer.

Page 700-10, delete subsections 704.3a. and b., and replace with the following:

a. Order Lists, Piles and Test Piles.

The order list is the same as the estimated quantity (number and length of piles) shown in the Contract Documents.

For piles and test piles, provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of driving piling. The Engineer will forward this information for Test Pile (Special) to the Topeka Geology Office.

When a restrike is required by the Engineer, follow **subsection 704.3e.** for restrike procedures. Provide piles for the structure according to the order list (number and length of piles) prepared by the Engineer.

Drive the specified test piles at the locations shown in the Contract Documents. The Engineer will use the test pile information to determine the pile tip elevation.

If multiple hammers are used on a project requiring test pile or test pile (special), drive a test pile or test pile (special), whichever is specified, with each hammer.

b. Test Pile (Special). Pile Driving Analyzer (PDA). The Engineer will use the PDA to monitor the driving of the test piles (special). Provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of driving piling. The Engineer will forward this information to the Topeka Geology Office.

In order to mobilize the PDA, notify the Engineer a minimum of 5 working days before driving the test piles (special). Prior to driving the test pile (special), the Engineer will require approximately 1½ hours to prepare the test piling (special) and install the dynamic measuring equipment. If with prior approval, the piles are to be welded prior to the Engineer attaching the testing equipment, provide the Engineer with safe and reasonable means of access to the pile for preparing the pile and attaching the instruments.

When a restrike is required by the Engineer, follow **subsection 704.3e.(3).** for restrike procedures.

To obtain the estimated ultimate loads, the Engineer will use the PDA to take dynamic measurements as the test pile (special) is driven to the required driving resistance. If non-axial driving is indicated by dynamic test equipment measurements, immediately realign the driving system. The Engineer will use the PDA results to provide the Contractor with a blow count for production driving.

Page 700-11, subsection 704.3c. Delete the last sentence in the first paragraph and replace with the following:
Use equipment that complies with **subsection 704.25 (above)**.

Page 700-11, Subsection 704.3c. Add the following at the end of the fifth paragraph ("Drive all pile heads..."):

On pipe pile, use a helmet with a minimum interior guide of 6 inches.

Page 700-11, subsection 704.3c. Delete the seventh paragraph ("Use full-length piles...") and replace with the following:

Use full-length piles where practicable. It is preferred that steel piling is not spliced. Splices may be made with the permission of the Engineer, or when shown in the Contract Documents. Make splices as shown in the Contract Documents. Use an approved welding process as provided in **DIVISION 700** to make the splices. Provide an experienced welder qualified under **SECTION 713** to make the welded splices for structural steel piling and shell piling. Correct or replace any failure in the splice at own expense.

Page 700-11, subsection 704.3c. Add the following bullet to the end of the tenth paragraph ("Do not force..."):

- Drive all piles in the orientation shown in the Plans. If the axial orientation of the pile rotates or twists by more than 10°, the Field Engineer will contact the State Bridge Office.

Page 700-12, delete subsection 704.3e.(1) and replace with the following:

(1) Use the following procedure when neither a Test Pile nor a Test Pile (Special) is called for in the Contract Documents, and the PDA is not available. The following procedure shall be used.

- Drive all of the piling in a group to within 2 feet of plan elevation;
- A group of piling is defined as all piles contained within a single footing.
- All of the piling in the pile group shall sit undisturbed for a minimum of 24 hours;
- Prior to starting the restrike procedure, warm the hammer up at a location as far away from the pile group as practical, preferably in another substructure member or pile group;
- Using the warmed up hammer, immediately restrike 20% of the piles in a group, with a minimum of 2 in a group restruck. Of these, restrike the piles in a single group with the furthest spacing away from each other. When possible, restrike those with the lowest resistance during driving.
- Restrike for 20blows or until the pile penetrates an additional 4 inches, whichever comes first. Record the penetration for every 5 blows. In the event the pile movement is less than ½ inch during the restrike, the restrike may be terminated after 10 blows.
- Restrike additional (the 20% or 2 minimum specified above) pile in the group as directed by the Engineer.

The driving resistance of the piling is computed based on the average penetration, if any, for the first 5 blows. The driving resistance of each piling is the driving resistance computed for the pile that was restruck. If the computed driving resistance is less than the design pile load, splice additional length onto each piling in the group and resume driving each piling until the required driving resistance is achieved.