

ITEM 404

DRIVING STEEL PILING

404.1 Description. This specification shall govern for the driving of steel piling. The piling shall be of the site and weight shown on the plans and shall be in accordance with the lines, grades and dimensions shown therein.

The lengths of piling to be driven shall be as shown on the plans, or as necessary to obtain the required bearing resistance and required minimum penetration.

404.2 Material. The steel piling shall be manufactured in accordance with the Item, "Steel Sheet Piling", and/or the Item, "Steel H Piling".

404.3 Storing and Handling. The methods of handling shall be such as to prevent damage to the piling. When steel piling are to be stored, they shall be placed on skids which will raise them above the ground. The stored piling shall be kept clean and fully drained at all times. A sufficient number of skids shall be used to prevent deflection of the stored piling.

404.4 Driving Equipment. Steel piling shall be driven with gravity or power hammers, as described herein.

A. Gravity Hammers:

Hammer shall weigh between 2000 and 5000 pounds. Contractor shall furnish the certified scale weight of hammer. The minimum hammer energy, in foot-pounds, shall be 250 times the design load, in tons. The drop shall be regulated to avoid injury to the piling, but in no case, shall the drop be greater than 10 feet.

B. Power Hammers:

Power hammers used for driving piles shall develop energy per blow, in foot pounds of not less than $250 \times R$, where R is the required minimum bearing resistance of the pile in tons. Hammers developing an energy of more than 18,000 foot pounds per blow shall not be used except for the driving of unusually heavy piles and then only with the written permission of the Engineer. Hammers shall not be operated at less than 80 percent of the manufacturer's rated capacity.

1. Diesel. Diesel hammers shall be the enclosed ram type, equipped with gauges and charts to evaluate equivalent energy produced during driving. The minimum weight of the ram

shall be 2,000 pounds. The maximum ram stroke shall be 10 feet.

2. Steam, Hydraulic or Compressed Air. Use boiler or air compressor capacity at least equal to that specified by hammer manufacturer. Equip boiler or compressor with accurate pressure gauge to ensure proper operating conditions. The minimum weight of the ram shall be 3,000 pounds. The maximum ram stroke shall be 5-feet.

C. Leads:

Pile drivers shall be equipped with leads which will afford free vertical movement for the hammer. The leads shall be stiff enough to resist bending during the driving operation and shall be held rigidly in the driving position by stiff braces or guys.

The axis of the leads shall coincide with the axis of the piling as nearly as practicable. The leads shall be of sufficient length to permit driving to the required penetration without a follower, except where piling are driven through water.

404.5 Protection of Pile Heads. A cast or structural steel driving head, fitted with a wood cushion block shall be used when necessary to prevent damage to the pile head. The cushioning provided shall be sufficient to prevent material damage to pile head. Rope mat, belting or similar cushioning material may be used in addition to a wood cushion block, when necessary.

404.6 Penetration. The piling shall be driven to approximately the depth shown on the plans, or to a greater depth, if necessary to secure the bearing resistance required. The bearing resistance shall be determined by the equations given herein.

Piling shall be driven in pile alignment holes, when necessary to secure proper alignment. The required depth of alignment hole shall not exceed 5 feet. In general, the maximum diameter of the alignment hole will be 4 inches less than the diagonal of the piling.

Except as noted herein, piling lengths shown on the plans are the lengths estimated to give required bearing and are for estimating purposes only.

The elevations shown on the plan is the minimum depth necessary to satisfy design requirements for lateral stability. Piling shall be driven to this approximate elevation and to additional depths as required to obtain specified bearing resistance.

When plans indicate a required penetration into shale or other hard material, this penetration is required, although strata may be higher or lower, in elevation, than indicated.

404.7 Pilot Holes. In localities where water is not available for efficient jetting operations or where soil is of such material as will not permit jetting, the Contractor shall provide pilot holes as may be necessary to obtain the required pile penetration. Requirements for pilot holes shall be as follows. The size and depth of pilot hole required or permitted shall be determined by the Engineer from the results of trial operations made on the first few pilings driven. In general, the maximum diameter of hole permitted will be approximately 4 inches less than the diagonal of the piling. The size requirements may be varied by the Engineer as may be necessary to obtain penetration and/or bearing values.

In all cases, piling shall be driven with the hammer after being placed in the pilot holes. Such driving shall be at least sufficient to seat the pile and obtain the required bearing resistance. The load carrying capacity for the pile shall be determined from the results of this driving.

404.8 Jetting. Where material is suitable for jetting and water is available, the contractor shall provide jetting equipment as an auxiliary to the hammer as a means of placing the piling. The equipment shall be as follows. Sufficient power shall be provided, in addition to that used for operating the hammer to operate one or more pumps and one or two (depending upon requirements of the material), 2 1/2-inch inside diameter jet pipes provided with a 3/4-inch diameter nozzle. The plant shall be such that with two jets operating at the same time, it shall be capable of delivering a minimum of 150 psi, to the nozzle.

The jetting operations may be done with one or two jets as determined by the Engineer from the results of trial jetting operations. The required jetting may be done ahead of the actual driving operations or simultaneously with the driving operations as determined by the Engineer from the results of trials.

If the jets and hammer are used together for the driving, the jet shall be withdrawn and the final penetration of the pile obtained by driving with the hammer alone. This procedure shall be varied to suit the job conditions and to obtain the desired penetration and load carrying results for the piling.

404.9 Tolerance for Driving. Trestle piling shall be driven to the required vertical or batter alignment. Allowable variations from plan alignment shall not exceed the following:

Transverse to the centerline of bent, the top of piling shall be not more than 2 inches from the position shown on the plans.

Parallel to the centerline of the bent, the top of the piling shall be not more than 4 inches from the position shown on the plans.

Foundation piling shall be driven to the required vertical or batter alignment. The top of the pile shall be not more than 4-inches in any direction from the position shown on the plans.

Foundation piling shall be cut off reasonably square at the elevation shown on the plans. A tolerance of not more than 2-inches above or below established cut-off grade will be permitted.

The minimum edge distance for a piling in a footing shall be 5-inches. Additional concrete required to obtain the specified reinforcing steel cover shall be at the Contractor's expense.

404.10 Bearing Evaluation. Unless otherwise shown on the plans, the dynamic bearing resistance of piling shall be determined by one of the following formulas:

A. For Gravity Hammers

1.
$$P = \frac{2WH}{S+1.0}$$

2. When energy delivered (W x H) by gravity hammer is 24,000 foot-pounds or greater, and the penetration does not exceed 1/2-inch per blow for the last 40 blows delivered (Without increasing), determine bearing resistance by:

$$P = \frac{2WH}{3S}$$

B. For Single Acting Power Hammers

$$P = \frac{2WH}{S+0.1}$$

C. For Double Acting Power Hammers

$$P = \frac{2E}{S+0.1}$$

Where,

P = Dynamic resistance in pounds.

S = Average penetration in inches, per blow, for the last 20 blows.

W = Weight of ram, in pounds.

H = Height of fall of ram, in feet.

E = Manufacturer's rated energy in foot-pounds (for double acting power hammers).

E = Equivalent energy in foot-pounds determined by a calibrated gauge attached to the hammer and taken when the average penetration in inches, per blow, is determined (for enclosed ram diesel hammer).

Drive the piling to the penetration required by the plans and as defined herein. Use appropriate formula to evaluate the bearing resistance.

404.11 Measurement & Payment. No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but shall be considered subsidiary to the Item, for steel piling.

END OF ITEM 404