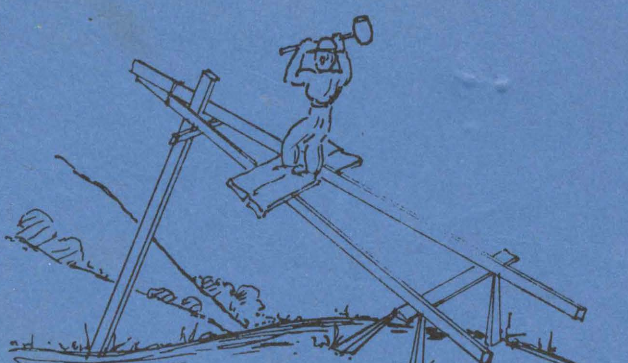
INSPECTOR'S HANDBOOK

PILE DRIVING



IOWA STATE HIGHWAY COMMISSION

AMES, IOWA

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PILE DRIVING

James Hart

INTRODUCTION

This handbook is intended as an aid to the inspector. With the exception of the list of gravity hammers and pile caps, the Instructions to Resident Engineers pertaining to pile driving have been included.

Although experience is still the best teacher, it is the author's hope that this manual will be a useful guide and reference for standards of good practice. The inspector must, of course, be governed by any special requirements of the plans and specifications for any project.

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PILE DRIVING

Plans, Special Provisions, etc.

Before commencing field inspection, the inspector should make sure that he has all of the necessary reference material.

Plans

Check for any revisions of the plans and void any sheets that have been revised. Check with the contractor to see that he is using revised plans in case of revisions.

Special Provisions and Supplemental Specifications

These will be listed with the Proposal Form. The inspector should make sure that he has a copy of the special provisions and supplemental specifications that pertain to the job.

Contract

The inspector should have a copy of the contract or at least the contract quantities and prices for the items involved in the operation being inspected.

Standard Specification Book

Check the supplemental specifications for any revisions of the standard specifications. Make a note on the articles that have been revised in the standard specification book. This will prevent mistakenly using an obsolete specification.

Field Record Book

A record must be kept on each contract item, approved materials, staking diagrams, cross-sections, daily happenings, etc. In short, a story and record of the project. Do not rely on your memory or scratch pad notes.

Construction Field Manual

This manual is intended only as a guide and an aid to field forces. It covers most phases of construction and discusses numerous typical problems that might arise. The plans and specifications will govern in case of conflict.

TYPES OF PILES

Piles are of wood, steel, and concrete. Wood piles driven entirely below the water table need no preservative treatment. If partially or entirely above the water table, they must be pressure treated with creosote preservative. Because of the gradual lowering of the water table, the trend is to require treated piles for all conditions. Although piles are inspected and approved at the source, they are subject to reinspection at the jobsite. The inspector should check the piles for tip and butt dimensions. Use the best piles in the more critical locations (outside rows on piers, battered piles on abutments). Treated piles must be either fir or pine.

Steel piles are of various types, such as H piles, shell piles, and sheet piles, all of which come in several sizes and in the case of sheet piles, several shapes also.

H piles are generally used for driving to shale or rock but may be used as friction piles as well. Shell piles are cylindrical and, after being driven, are filled with concrete. Steel sheet piles are interlocking. Their use is mostly as temporary cofferdams, but occasionally are used to permanently prevent scour at an abutment.

Concrete is used to build concrete trestle and sheet piles. Standard P10 shows the details of concrete bearing piles as well as steel shell and concrete encased H piles. Most concrete bearing piles are the prestressed type. Reinforced concrete piles are still permitted but are seldom used and may be phased out soon. Prestressed piles are less subject to damage from driving.

PILE DRIVING EQUIPMENT

Pile driving equipment consists of a hammer, cap, leads, and crane. The types of hammers most used are gravity and diesel. The steam hammer has generally been displaced by the diesel. For wood piles, gravity hammers must have an effective weight of at least 3000 pounds. The effective weight is the weight of the hammer less the drag force, or weight required to overcome friction and unwinding the cable drum. Depending on the amount of cable used and drum bearing conditions, this force could be from 50 to 100 pounds. For steel H and shell piles, the effective force must be at least 4500 pounds. For concrete bearing piles, the gravity hammer must have an effective weight of at least 50 percent of the total weight of the pile and driving cap. The height of drop of a gravity hammer and the energy output must not exceed the following:

Type of Pile	Drop in Feet	Energy in Ft./Lb.
Wood	*13 1/3	40,000
Steel H (10")	* 8 3/4	40,000
Steel H (12")	10	50,000
Steel H (14")	10	60,000
Steel shell	* 8 3/4	40,000
Precast concrete	8	60,000

Adjust height of drop to prevent exceeding maximum energy.

In addition to the minimum effective weights of gravity hammers listed above, the requirements of Article 2501.10 must be met.

Diesel hammers are of two types, single and double-acting. In the former, as the fuel explosion drives the pile down it also forces the ram upward, from where it falls by gravity to repeat the cycle. In the latter hammer, the upward movement of the ram compresses air in a cylinder. This compressed air assists the force of gravity in the fall of the ram for the next cycle, resulting in an increase in force and rate of blows. Delmag and M. Kiernan-Terry diesels are single acting. The Link-Belt hammer is double acting. Diesel hammer ratings have been determined from load tests. For a specific pile driving operation, the size of hammer required must be determined as outlined in Article 2501.10.

The energy ratings of the diesel hammers commonly used in Iowa are:

Hammer	Energy Rating (Foot Pounds)	Max. Ratings With Gage
Delmag D12	20,000	
McKiernan-Terry (DE30)	20,000	
Link-Belt 312	*12,500	15,000 ft/lbs
Delmag D22	35,400	
McKiernan-Terry (DE40)	36,000	
Link-Belt 520	*22,500	26,300 ft/lbs
Link-Belt 440	*15,000	18,200 ft/lbs

*Use these values when the hammer is operating vigorously at rated speeds (100 for 312, 80 for 520) unless pressure gage is used. If pressure gage is used, the rating shall be as shown on conversion chart supplied by manufacturer.

A moving part of the diesel hammer not encountered in gravity hammer is the anvil. The weight of the anvil must be included with the pile, ram and cap weights for use in the formula.

The weights of rams and anvils for the

various diesel hammers are listed below. Cap weights vary for the different hammers and types of piles. These should be weighed and stamped as provided in Instruction No. 2, Section XXI. Link-Belt cap weights may be found in their literature if the type or dimensions are known.

Hammer	Ram Weight (Pounds)	Anvil Weight (Pounds)
Delmag D12	2750	754
Delmag D22	4850	1147
McKiernan-Terry (DE30)	2800	775
McKiernan-Terry (DE40)	4000	1350
Link-Belt 312	3857	1188
Link-Belt 520	5070	1180
Link-Belt 440	4000	705

A cap is required for all pile driving operations. The cap fits on the head of the pile, protecting it from damage by the hammer. On wood piles with gravity hammers, the cap must have a recess in the shape of a truncated cone and the head of the pile must be shaped to fit. For other types of piles driven with gravity hammers and all piles driven with diesel hammers, the cap must fit the pile so as to bear evenly on the head and center the blow on the axis of the pile. A cushion, usually of wood, is used on top of the cap when driving with a gravity hammer.

The leads are used to direct the blow of a gravity hammer or guide a diesel hammer during the driving. Leads must be guyed or braced so the blow is delivered squarely along the axis of the pile and to prevent bending stress in the pile when driving on a batter or angle from the vertical. The runners of the leads should be greased to reduce friction.

The crane is used to hold the hammer, leads, and pile. It should be of suitable capacity for the work.

PILE WEIGHT DETERMINATION

The volume and weight of wood piles should be determined for each different length and each different kind of wood used on the job.

The volume of wood piles may be obtained from the following table of Standard Volumes of Round Forest Products. (See Page 8)

Wood Piling Example:

An abutment calls for 40-foot treated piling. The species is Southern Yellow Pine. Select enough piles of average size to represent the total number of piles. Measure the mid-point circumference and average the measurements.

Let's say that the average mid-point circumference was 34½ inches. Looking at the copy of Standard Volumes, you find that the volume of

STANDARD VOLUMES OF WOOD PILES

MID-POINT CIRCUMFERENCE	LENGTH 20	25	30	35	40	45	50	55	60
28	8.6	10.8	13.0	15.1	17.3	19.4	21.6	23.8	
28½	9.0	11.3	13.5	15.8	18.1	20.3	22.6	24.8	
29	9.2	11.5	13.8	16.2	18.5	20.8	23.1	25.4	
29½	9.6	12.0	14.5	16.9	19.3	21.7	24.1	26.5	
30	9.8	12.3	14.8	17.2	19.7	22.1	24.6	27.1	29.5
30½	10.3	12.8	15.4	18.0	20.5	23.1	25.7	28.2	30.8
31	10.7	13.4	16.0	18.7	21.4	24.1	26.7	29.4	32.1
31½	10.9	13.6	16.4	19.1	21.8	24.5	27.3	30.0	32.7
32	11.3	14.2	17.0	19.9	22.7	25.5	28.4	31.2	34.0
32½	11.6	14.5	17.4	20.3	23.1	26.0	28.9	31.8	34.7
33	12.0	15.0	18.0	21.0	24.1	27.1	30.1	33.1	36.1
33½	12.5	15.6	18.7	21.9	25.0	28.1	31.2	34.3	37.5
34		15.9	19.1	22.3	25.4	28.6	31.8	35.0	38.2
34½		16.5	19.8	23.1	26.4	29.7	33.0	36.3	39.6
35		16.8	20.2	23.5	26.9	30.2	33.6	37.0	40.3
35½		17.4	20.9	24.4	27.9	31.3	34.8	38.3	41.8
36		18.0	21.6	25.2	28.9	32.5	36.1	39.7	43.3
36½		18.3	22.0	25.7	29.4	33.0	36.7	40.4	44.0
37		19.0	22.8	26.6	30.4	34.2	38.0	41.8	45.6
37½		19.3	23.2	27.0	30.9	34.8	38.6	42.5	46.3
38			24.0	27.9	31.9	35.9	39.9	43.9	47.9
38½			24.8	28.9	33.0	37.1	41.3	45.4	49.5
39			25.2	29.4	33.5	37.7	41.9	46.1	50.3
39½			26.0	30.3	34.6	39.0	43.3	47.6	52.0
40			26.4	30.8	35.2	39.6	44.0	48.4	52.8
40½			27.2	31.8	36.3	40.8	45.4	49.9	54.5
41					37.4	42.1	46.8	51.5	56.2
41½					38.0	42.8	47.5	52.3	57.0
42					39.2	44.1	49.0	53.9	58.8
42½					39.8	44.7	49.7	54.7	59.6
43					41.0	46.1	51.2	56.3	61.4
43½					41.5	46.7	51.9	57.1	62.3
44					42.8	48.1	53.5	58.8	64.1

a 40-foot pile with a mid-point circumference of 34½" equals 26.4 cubic feet.

The air dry weight of Southern Yellow Pine is 41 pounds per cubic foot plus 12 pounds per cubic foot for treatment. This equals 53 pounds per cubic foot.

Weight of pile = 53x26.4=1399 lbs.

Steel H Piles Example:

10BP42 steel H piling weighs 42 pounds per foot. The last numbers represent the weight per foot.

Weight of 40 foot pile = 40 x 42
= 1680 pounds.

14" P10A Concrete Piling Type IV Example:

Refer to P10A Standard

45 foot pile contains (2.01 + 5(.050))
= 2.26 cy. concrete

45 foot pile contains (237 + 5(3.87))
= 256 lbs. reinforced steel

Weight of concrete = 150 lbs. per cu.ft.

2.26 c.y. = 61.02 cubic feet
61.02 x 150 = 9153 pounds
Reinforcing steel = 256 pounds
Weight of 45 foot 14" concrete piling
= 9409 pounds.

Steel Shell Piles Example:

Where L = Length in feet

Cylindrical Shells

14" diameter = 27.66 L + 33
16" diameter = 36.87 L + 43

Union Metal Monotubes

	Type	Taper	14" Dia. Piles Length	14" Dia. Piles Weight	16" Dia. Piles Length	16" Dia. Piles Weight
Bottom Section ..	Y	1" in 2½'	15'	330#	20'	628#
	J	1" in 4'	25'	541#	33'	1025#
	F	1" in 7'	40'	895#	60'	1872#
Top Section . . .	N	5/8" in 20'	29# per foot		33# per foot	

WEIGHT PER CUBIC FOOT OF DIFFERENT SPECIES OF WOOD

SPECIES	GREEN LBS.	AIR DRY LBS.
Ash	48	41
Cedar-Western Red	27	23
Cedar-Southern White	26	23
Cottonwood-Northern	46	24
Cypress-Southern	51	32
Fir-Douglas	38	34
Fir-White	46	27
Elm	54	35
Gum-Red	50	34
Hackberry	50	37
Hickory	63	51
Maple-Hard	56	44
Maple-Soft	47	34
Oak-Red	64	44
Oak-White	63	47
Pine-Northern White	36	25
Pine-Western White	35	27
Pine-Norway	42	34
Pine-Southern Yellow	55	41
Sycamore	52	34
Tamarack	47	37
Walnut-Black	58	38

NOTE: (1) Air dry wood has moisture content of 12%.
(2) For weight of treated piling add 12 lbs. to the air dry weight.

REFERENCE: Wood Handbook, U.S. Dept. of Agriculture
Forest Products Laboratory
Compiled by J.L. Holdefer, April 5, 1948.

DRIVING PILES

Before driving piles, the inspector should check the bridge staking to be sure that pier and abutment locations are correct and piles are properly spotted. Make sure vertical piles are plumb. Line up wood piles with a plumb bob from two locations 90 degrees apart, sighting on the string as much of the pile as possible. Other piles may be plumbed with a level. Use a batter board (described later) on battered piles.

Generally, with gravity hammers, a heavy hammer and short drop will cause less damage to a pile than a light hammer and high drop, though the energies in foot pounds are equal.

The bearings required are always specified on the plans. For wood piles, the plans usually limit the maximum bearing to forty tons. Higher bearings frequently result in broken piles, especially when using gravity hammers. If insufficient penetration cannot be obtained at maximum allowed bearing, the specifications permit the engineer to require pre-bored holes or water jets in order to secure such penetration. Piles for bridges over streams subject to scour should be driven well below the scour line. On grade separation structures scour is no problem, and penetration is not critical. For stability, though, piles shorter than ten feet are seldom acceptable.

Concrete, shell, and H trestle piles should be held in position by a timber frame to assure alignment.

Every effort should be made to guy the leads so the hammer falls directly on the axis of the pile. Rigid leads, firmly fixed to the crane, are highly desirable when driving battered piles, but are not a specification requirement.

When gravity hammers are used, the inspector should make sure the hammer is allowed to fall freely without the application of drag by the operator. Any slowing down of hammer velocity reduces the energy imparted to the pile, resulting in erroneously higher computed bearing value.

PILE BEARING FORMULAS

The bearing value of piles is computed from the appropriate one of the following formulas:

A. For gravity hammers with wood, steel H or shell piles -

$$P = \frac{3WH}{S+0.35} \times \frac{W}{W+M}$$

B. For gravity hammers with concrete bearing piles -

$$P = \frac{4.5\ WH}{S+0.2} \times \frac{W}{W+M}$$

C. Diesel hammers with wood, steel H, or steel shell piles and steam hammers for all piles -

$$P = \frac{3E}{S+0.1} \times \frac{W}{W+M}$$

D. Diesel hammers with concrete piles -

$$P = \frac{7E}{S+0.1} \times \frac{W}{W+M}$$

P = the bearing value in tons.
W = the weight of a gravity hammer, or the ram of a steam or diesel hammer in tons. (The gross weight of the gravity hammer minus an amount sufficient to compensate for all friction and drag = the effective weight.)
H = the height of free fall of the hammer.
M = the weight of the pile plus the weight of the driving cap plus the weight of the anvil in tons.
E = the energy per blow in foot tons.
S = the average penetration, in inches per blow, for the last 5 blows for gravity hammers and the last 10 blows for steam or diesel hammers.

For computing the bearing value of battered piles <u>driven with gravity hammers</u>, the value obtained from the formulas must be multiplied by the following factor:
(Cosine a) - (f sine a)
a = angle which the leads make with the

vertical. f = assumed to be 0.1 (friction between hammer and leads).

When the penetration is measured to determine the bearing value, the head of the pile must be free from broomed or crushed fibers, penetration of pile is reasonably quick and uniform, and no excessive bounce to the hammer after the blow.

When driving has been interrupted for more than 2 hours, the pile must be given at least 10 blows or 2 inches of penetration before measuring for the "S" value.

Example: 40-foot treated piling - Southern Yellow pine

Mid-point circumference = 34½"
Gravity hammer weight - 3643
Cap Weight = 840 - Height of drop = 10'

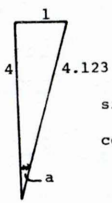
$$P = \frac{3WH}{S+0.35} \times \frac{W}{W+M}$$

W = 3600 effective wt. = 1.8 tons
H = 10 foot
M = 1399 lbs. pile wt.
840 lbs. cap wt.
2239 lbs. = 1.12 tons

$$P = \frac{3(1.8)(10)}{S+0.35} \times \frac{1.8}{1.8 + 1.12}$$

$$P = \frac{54}{S+0.35} \times .616$$

$$P = \frac{33.26}{S+0.35}$$



Same pile only battered 1:4
(cos a) - (f sin a)
.97017 - (0.1 x .24254) = .946

$$\sin a = \frac{1}{4.123} = .24254$$

$$\cos a = \frac{4}{4.123} = .97017$$

$$P = \frac{33.26}{S+0.35} \times .946$$

$$P = \frac{31.46}{S+0.35}$$

Factor for a pile battered 1:5 = .961
Factor for a pile battered 1:6 = .970
Factor for a pile battered 1:12= .988
Bearing must be computed to the nearest 0.1 ton.

These factors for batter do not apply when using diesel hammers since the energy expended is due to the fuel explosion, rather than the fall of the hammer.

CORRELATION FACTOR

The pile bearing formulas used are based on a compromise between science and practicality. Many scientific studies to determine pile bearing values by formulas have been made. These formulas generally are based on the energies obtained by falling masses and the penetration per blow of the pile, taking into account friction, the relative masses of the moving parts (including cap and pile), elastic compression losses in the pile and soil, rapidity of blows, hammer efficiency, pile rebound, etc. Such formulas become so cumbersome as to be unusable. In the interests of practicality, many of these formula elements have been approximated or empericized, resulting in formulas considered not only workable but reasonably accurate. These formulas have then been adapted for use with steam and diesel as well as gravity hammers. Modifications based on relative ram and pile weights also have been made, resulting in the formulas currently specified.

All formulas include a factor of safety, providing an indicated bearing having a desired ratio to the ultimate bearing value of the pile. Our formulas have a factor of safety of 2 for piles driven in granular material. The disturbance of water in clayey material due to the effects of driving lowers the bearing value of the soil at the time of driving. The stabilization of this water condition after driving ceases results in an increase in soil strength and consequent higher bearing value as time progresses. This increase in actual bearing value over the calculated or formula bearing obtained at the time of driving is considerably higher in clay than in granular soils.

The ratio of ultimate bearing value (determined by loading to the point of failure) to that obtained by formula is called the correlation factor, and is closely related to the factor of safety.

Correlation factors vary from 2 in sand to from 3 to 5 in clay. This means that in sand a pile with 20 tons bearing by formula will fail under load at approximately 40 tons. The same pile in clay, after standing undisturbed for some time, will yield at 60 tons or more.

In general, the plan bearing by formula should be obtained, but if a correlation factor is required on the plans or below plan bearings are encountered, the determination of the correlation factor should be referred to the central office.

MEASUREMENT OF PENETRATION

The inspector should use great care in measuring the penetration of a pile. In marking the pile for measuring penetration, use a method that will give a reading that indicates penetration measured along the axis of the pile. Drive an anchor stake into the ground to set the marking stick on or level from a previously driven pile, etc.

The penetration is measured for the last 5 blows of a gravity hammer and for the last 10 blows of a steam or diesel hammer. The measurement is then averaged for each blow. The average measurement per blow is then put into the appropriate formula, and the equation is solved to find the safe bearing value of the pile.

For all piles, except precast concrete, the weight of the gravity hammer used must be such that, when this weight is substituted for "W" in the formula, and the known values are substituted for "P", "H", and "M", the computed value of "S" will not be less than 1/4 inch.

For steam and diesel hammers, when the weight of the ram and energy per blow are substituted for "W" and "E" in the formula and the known values are substituted for "P", "H", and "M", the computed value of "S" must not be less than 1/8 inch.

PILE LAYOUT

The plans for structures will give a pile layout for each foundation. The dimensions of the pile spacing are usually at the bottom of footing or bottom of cap. These elevations should be kept in mind and allowances made when checking the pile spacing.

Run the centerlines or bearing lines into the bottom of the excavation. Use stringlines to check to see that pile spacings are measured from the correct line. Centerline of footing is not always centerline of bearing.

Care should be used in locating piles as shown on the plans. The deviation from designated locations must not exceed 3 inches at the time driving is begun, except as may be made necessary by the presence of unavoidable obstructions.

DRIVING SEQUENCE

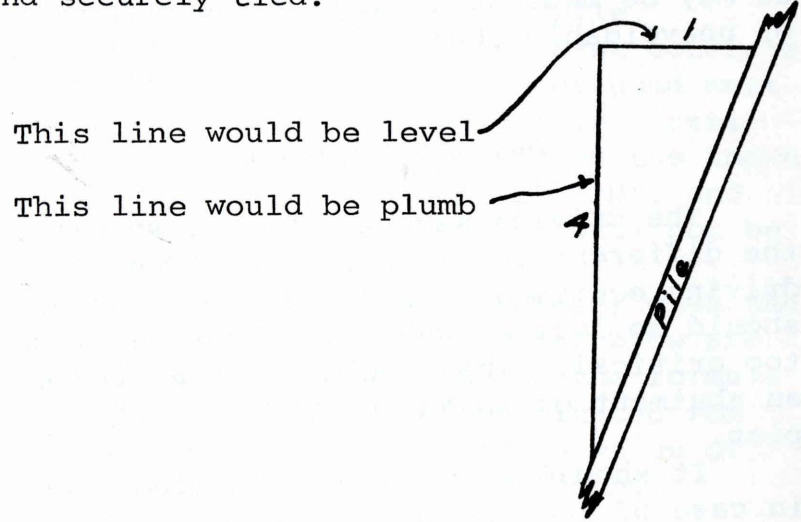
The driving sequence will vary with the different footings and the type of driving equipment. The first pile driven should be located where the bearing is not too critical. This could be in a wing of an abutment or in an interior row of a pier.

It should also be kept in mind that in case of low bearing the pile may be load tested. The first pile should be located so that two other piles can be driven, one on either side, so that the three will be in a straight line, spanning not over 18 feet and evenly spaced. The three piles should be vertical or driven with the same batter.

BATTERED PILES

The plans will show the piles that are to be battered and the rate of batter. A batter board should be made, with the proper batter dimensions or proportions. By using a carpenter's level and the batter board the pile can be placed in the proper batter line.

While being driven, the battered piles must be so held so as to deviate a minimum possible amount. The leads must be firmly and securely tied.



LOW BEARINGS

Occasionally, designed piling will not pick up the minimum required bearing. When trouble with low bearing first develops, driving should be stopped and the resident engineer should be notified. He in turn will notify the District Office. The District and Central Offices will have to decide whether to test load, splice and extend the pile, order new piling of greater length or accept the low bearing.

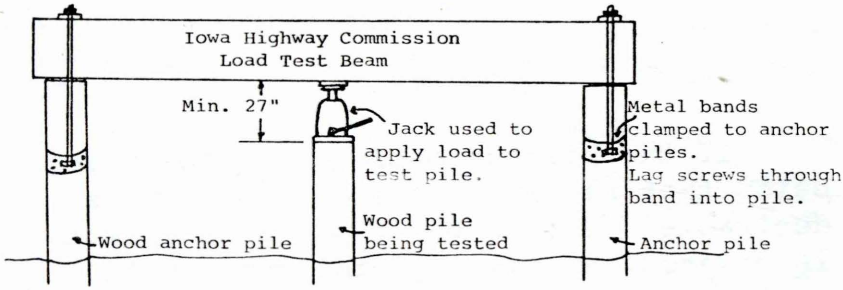
LOAD TESTS

If the bearing obtained by formula is below that required, a load test may be desirable. Before the testing equipment is ordered, approval of the construction engineer must be secured.

The pile to be tested should be driven to maximum penetration and cut off at grade at right angles to the axis of the pile. The pile to be tested must have a pile driven on either side for anchor piles, so that the three will be in a straight line, spanning not over 18 feet and evenly spaced. They should all 3 be vertical or with the same batter. The anchor piles should be left 27 inches above the test pile.

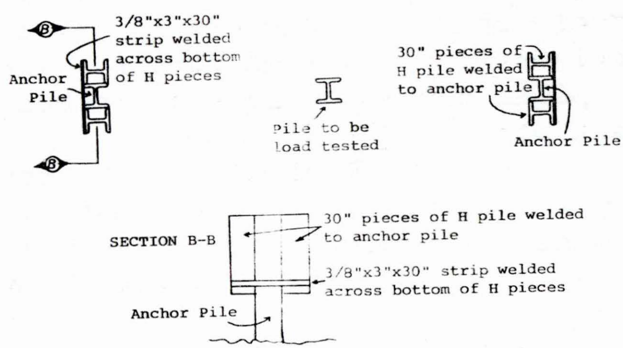
The actual work of making the test is done by representatives of the materials department. A report of the test will be issued as soon as possible after the test is completed.

The contractor's part of the work of setting the beam on and off the test pile and the help needed to make the necessary fastenings to the anchor piles are extras and will be paid for by an extra work order. The inspector will keep a record of labor and equipment furnished by the contractor. Prices should be agreed on by the resident engineer and the contractor. No extra payment will be made for loss of time occasioned by pile load tests.



STEEL H PILE LOAD TEST

PLAN VIEW



TEST PILES

Test piles are sometimes required to aid in the determination of pile lengths. After the required test piles are driven, the lengths of piling are determined by the engineer.

A pit should be excavated to the full depth of the intended footing excavation before driving the test pile.

Test piles should be driven with the same type of equipment and methods that will be used on piles of the permanent structure.

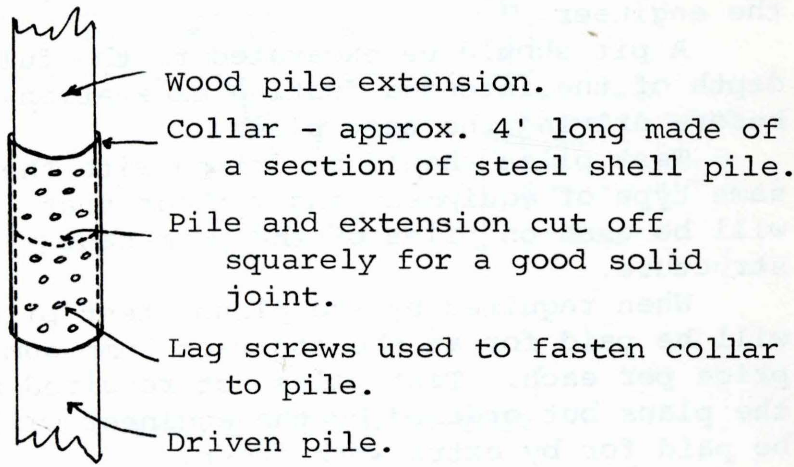
When required by the plans, test piles will be paid for at the contract lump sum price per each. Test piles not required by the plans but ordered by the engineer will be paid for by extra work order.

Bearings of test piles should be logged at various depth intervals, beginning when bearings of approximately 75 percent of required bearing is obtained. Test piles should be driven to full penetration if practicable, but not to such high bearings as to invite damage or breakage.

SPLICING OF PILES

Wood Piles

When wood piles are not long enough, it will usually be necessary to order new piling. Wood piles are difficult to splice; however, it can be done. Splicing should be done as directed by the engineer. One of the best methods consists of enclosing the adjacent ends of the pieces to be connected in a four-foot long collar, made of a section of steel shell pile. Splicing of wood piles shall be paid for as extra work.



Concrete Pile Extensions

When a precast pile is to be extended, the concrete at the end of the pile must be cut away to expose 20 diameters but not less than 24 inches of the longitudinal reinforcing bars, and reinforcing steel of the same size must be securely wired to the projecting steel.

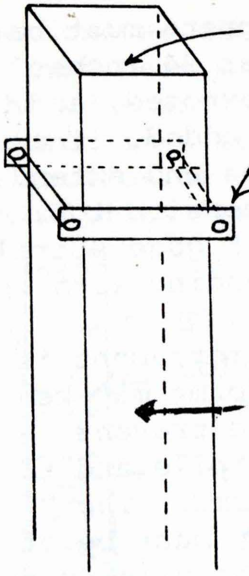
If the pile is prestressed, the concrete at the end is to be cut away to expose 24 inches of the existing extension bars, cast in the upper end of the pile, as well as 24 inches of the prestressing tendons. Reinforcing of equal size must be securely wired to the exposed steel. If, for any reason, extension bars do not exist at the splice, the concrete must be cut off squarely with at least 24 inches of the prestressing tendons exposed, and eight No. 7 reinforcing bars added. The bars must full lap the tendons and extend to within 3 inches of the extension top.

The extension must have 5 gage spiral reinforcing at 3 inch pitch ending with 6 close turns at the top.

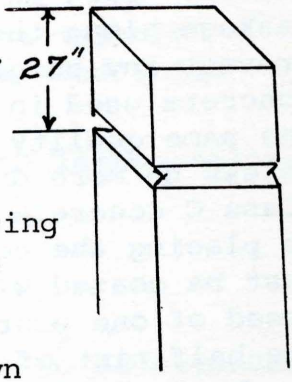
After the extension reinforcement is wired securely in place the forms may be placed. Care must be taken to prevent leakage along the face of the pile and to prevent any bulging of the forms. The concrete used in the extension must be of the same quality as that in the pile proper unless no more driving is required when Class C concrete may be used. Just prior to placing the concrete, the top of pile must be coated with a creamy mixture composed of one pint of water and one and one-half pint of dry cement. The forms may be removed after 24 hours and the extension cured by wrapping with two thicknesses of burlap kept wet for six days, or the extension may be cured by leaving the forms in place for seven days.

If at all possible the pile should be driven to the required bearing and then extended to the proper cutoff elevation.

The length paid for is measured from the top end of the extension to a point two feet below the end of the original pile.



1. Portion to be removed in preparing to extend the pile.
2. Use a heavy clamp of some sort to prevent pieces from breaking out below desired removal line.
3. Use an air chipping hammer along top of clamp to get a neat break line.
4. Concrete pile.



Minimum of 24" of reinforcing steel must be exposed plus 3" steel clearance.

Chip into the pile as shown before removing any of the top portion.

<u>Steel H and Shell</u>

Steel piling may be spliced and extended by welding on another piece. It is important that the splice is just as strong as any other point on the pile. The welders must be certified by the materials department each year. The inspector must check the certificate for date issued and particular types of welds the welder is qualified to do. Refer to the following instruction on welding different piling in different positions. The welds are paid for at 6 times the unit furnish price.

WELDING STEEL PILES

Our specifications provide that all welds comply with the Standard Specifications for Welded Highway and Railway Bridges. This booklet covers the method of qualifying welders and the requirements for all kinds of welds. The specifications pertaining to the field welding of steel piles are contained in this instruction.

All welding must be done by a certified welder. When a welder is qualified by the materials department, he is issued a certificate showing the types of welds for which he is qualified. The inspector should ask to see the welder's certificate, noting in his records the certificate number, date issued, and positions for which qualified. These certificates are good for one year and must be renewed annually.

Type I shell pile (Union Metal) splices require a fillet weld. The fillet weld should be equal in size to the thickness of the shell wall. If bearing has been obtained, the scallops shown on the P-10A standard need not be cut. If more driving is necessary after welding, the scallops must be cut in the top 5½ inches of the pile to be extended and the weld made continuous at the contact of the extension and the pile being extended.

Type II shell piles (such as Armco) require a butt weld. A backing ring at least one inch wide must be used on the inside of the connection. The space (root opening) between the extension and the pile to be extended must be at least 1/8 inch but not more than 3/16 inch. The lower end of the extension must be beveled. If the welds are made before driving (flat weld), the root opening must be at least the thickness of the shell but not more than 1/16 inch greater, and the ends of the section being spliced need not be beveled.

Type IV or regular H piles are also butt welded. The top of the pile being extended must be cut square with flat ends. The lower end of the extension must be beveled to a 45 degree angle (flanges and web). The root opening (space between sections) must be at least 1/8 inch but not more than 3/16 inch. After the first side is filled with weld metal, the back side must be gouged out before filling that side. If a backing plate is used, the gouging is not required. The backing plate may be of 1/4 inch material. If the welds are made flat (before driving), both ends must be beveled to a 60 degree angle and the gouging is required unless a backing plate is used. The gouging mentioned above consists of grinding or chipping the slag in the root of the weld to expose sound metal. When welding H piles, the web should be welded first.

Since our welders are qualified on 3/8" plates and groove welding can be done from both sides, the maximum thickness of plates that may be welded under our normal certificate is 3/4". Plates more than 3/8" must be beveled on both sides, with a root face not exceeding 1/16", as shown in Figure C. For butt welds of 42# 10" H piles, the weld may be made as shown in Figure E or F. Eight-inch 36# H piles must be welded as shown in Figure C or D. If material thicker than 3/4" is to be welded, qualification tests on one-inch plates will be required.

Typical welds are shown below:

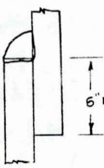


Figure A

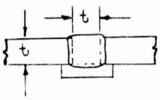


Figure B

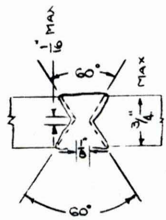


Figure C

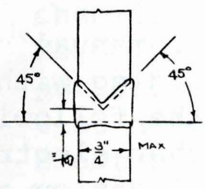


Figure D

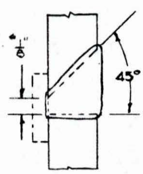


Figure E

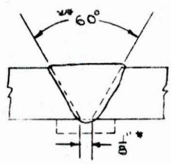


Figure F

With optional backing plate:

* Root Opening 1/4 inch
** Groove Angle 45 degrees

Figure A	Fillet Weld	Types I and VI Pile
Figure B	Flat Butt Weld	Types II and VII Pile
Figure C	Flat Butt Weld	H Pile
Figure D	Horizontal Butt Weld	H Pile
Figure E	Horizontal Butt Weld	10" 42# H Pile Only
Figure F	Flat Butt Weld	10" 42# H Pile Only

Supplement No. 1 to Instruction No.12, Section XXI, of the Construction Department's Instructions to Resident Construction Engineers. This replaces Supplement No. 1 dated December 7, 1964.

The purpose of this instruction is to outline the requirements regarding procedures, welding rods, and preheat temperatures for the various steels, including modifications dated February 1, 1965, from the Bureau of Public Roads.

1. Welding must be done with the same process and type of equipment used qualification.
2. If the operator has qualified with any of the steels permited (ASTM A7, A36, A373, and A441), he is qualified to weld any of the other three.
3. A welder qualified for manual shielded metal-arc welding with an electrode listed in the following table may weld any other electrode in the same group designation and with any electrode listed in a numerically lower group.

Group Designation	Electrode
F4 . . . E7015	E7016 E(60-70)18
F3 . . . E6010	E6011
F1 . . . E6030	EXX27* EXX28*

*For any use XX may be either 60 or 70 only.

The electrodes generally used for manual shielded metal-arc welding are: E7015, E7016, E(60-70)18, E6010, E6011, E6030, EXX27 and EXX28. For welding steel piles, the first three rods above are preferred for reasons shown later.

The meanings of the identifying numbers of the electrodes are as follows:

> The first two digits indicate the tensile strength in thousands of pounds per square inch.
>
> The next digit indicates the position permitted. If the digit is 1, the rod may be used for welding in any position. If 2 or 3, only the downhand position may be used.
>
> The fourth digit indicates the chemical make-up of the rod coating. Zero indicates a high cellulose potassium; 5 is low hydrogen sodium; 6 is a low hydrogen iron powder rod. Electrodes 6010 and 6011 are not low hydrogen rods. Their use is restricted by preheating requirements.

Preheating of the base metal means that the surfaces of the parts being welded, within 3 inches laterally and in advance of the welding, must be at or above the prescribed temperature. For A36 steel, the preheat temperature when other than low hydrogen rods are used is 200 degrees Fahrenheit. Welding of A7 steel with such rods is not permitted.

For all steels and rods, if the temperature of the base metal is below 32 degrees Fahrenheit, preheating to at least 70 degrees Fahrenheit is required. Welding when the ambient temperature is below 0 degrees Fahrenheit is not permitted. In inclement or windy weather, suitable shielding must be provided to permit welding in the normal manner.

All electrodes having low hydrogen coverings must be dried for at least two hours between 450 and 500 degrees Fahrenheit before being used. After drying, they may be kept in storage ovens at a minimum temperature of 250 degrees Fahrenheit. Electrodes not used within four hours after removal from the drying or storage oven must be redried before use. Electrodes are packaged in hermetically sealed containers at the factory. For the ordinary field pile welding job, they should be purchased in small packages, allowing for use within the prescribed time limit, unless provision for storage at 250 degrees Fahrenheit is made. The four-hour limit may be increased when humidity is very low, and decreased under humid conditions.

Preference of E7015, E7016, and E(60-70)18 for field welding may now be apparent. The digit 1 permits welding in all positions. These rod coatings are low in hydrogen, permitting use on all steels including A7 without preheating the base metal unless below 32 degrees Fahrenheit. These rods are also required for making the prequalification test.

The preceding restrictions and rules cover the welding of all of our steel piling since they apply to steel up to one inch thick. If welding is required on thicker plates, other special rules apply. In such case, the materials department should be contacted for assistance.

BEARING AND PENETRATION REQUIREMENTS FOR WOOD PILING

Unless so shown on the plans, required bearings for wood piles are usually 20 tons or less. Usually adequate penetration is attained by the time bearings of 20 to 30 tons are secured. Forty tons bearing should not be exceeded on wood piles, especially with gravity hammers. In case 40 tons bearing is reached before satisfactory penetration is attained, the remaining piles must be set in drilled holes to facilitate securing penetration without excessive overdriving.

The desired penetration is related to the possibility of scour (washing out). If hard driving is encountered to secure the required penetration, pile holes should be drilled before driving to avoid bearings in excess of 40 tons. Overdriving is encountered mostly in dry soils. Particular care must be taken when driving treated piling because the treatment tends to make them brittle by weakening the fibers.

PILES BROKEN DURING DRIVING

Occasionally a wood pile breaks while it is being driven. Sometimes a pile with no visual defects on the surface fails early in the driving.

If the contractor is operating in line with standard and approved practices, and through no fault or negligence on his part a wood pile does break during driving, it will be the policy of the Commission to compensate the contractor at least in part for this loss.

The general procedure will be as follows:

That part of the pile in the ground, regardless of its length, can be paid for at the bid price. The part broken off can be paid for at one-half the bid price.

If possible, the broken portion should be pulled. However, if adequate bearing has been obtained before the break and the pile is near the surface, the pile may be usable by dishing the excavation around it and concreting around the pile. Otherwise, another pile should be driven alongside the broken one.

If a replacement pile is required, the contract price per foot may be increased by an amount sufficient to compensate the contractor for the additional cost per foot of pile f.o.b. the site of the work.

An extra work order will be required to cover payment for the replacement pile required.

If in the opinion of the engineer, pile breakage is due to the negligence of the contractor by not having his leads properly guyed or lined with the pile, failure to use a jet in material that will respond to jetting, excessive drop of the hammer or other causes within his control, no payment will be made for the broken pile and the replacement pile will be paid for at the contract price.

JETTING OF PILES

Jetting is a means of securing penetration when hard driving is encountered in granular material. Jetting washes away the material next to the pile and reduces the skin friction. The jet nozzle should operate near the pile tip.

When water jets are used, the number of jets and the volume and pressure of the water at the jet nozzles must be sufficient to freely erode the material adjacent to the pile. The plant must have sufficient capacity to deliver, at all times, at least 100 pounds per square inch pressure at two 3/4 inch jet nozzles. The jets are not attached to the pile, but must be operated independently.

Jetting should stop and the jet should be removed a few feet before the desired penetration is reached. The pile should then be seated with the hammer.

PILE LENGTH AND CUTOFF MEASUREMENT

All piles will be measured to the nearest foot before being driven.

All cutoffs will be measured to the nearest one-tenth foot and shown on the pile log.

Wood Piles

One-half of the total length of cut off should be deducted from the total length placed in the leads, except that cutoffs of 1.5 feet or less will not be included in the sum of cutoffs.

Example: Four 40 ft. piles driven, with cutoffs of 1.2, 3.4, 1.5, and 2.6 feet. The quantity paid for at the contract price per foot would be -

$$160-\frac{(3.4 + 2.6)}{2} = 157 \text{ ft.}$$

Precast Concrete Piles

The contractor will be paid the contract price per foot for the specified plan length with no deductions for the portion cut off.

Steel H and Shell Piles

For the length of piles incorporated in the structure, the contractor will be paid both the contract furnish and drive prices per foot. The cutoffs, and any unused piles ordered by the engineer or

specified in the contract and delivered to the site, will be paid for at 75% of the contract furnish price, and will become the property of the contractor. Cutoff used as extensions on work covered by the same contract are not to be paid for as cutoffs but as furnished and driven piles.

UNTREATED WOOD PILES

Untreated timber piles may be used for falsework or temporary construction, and for foundations below ground water level.

Timber piles to be used without preservative treatment may be white oak, burr oak, cypress, tamarack, douglas fir, southern pine, or other wood which will satisfactorily withstand driving.

Piles should be sound timbers, free from splits, unsound knots, clusters of knots, holes, excessive twist of grain and short crooks. Refer to Art. 4165.03.

TREATED WOOD PILES

Treated foundation piles must meet with requirements of untreated wood piles. They must be either southern pine or douglas fir. All piles must be peeled sound timbers, free from splits, unsound knots, clusters of knots, holes, excessive twist of grain and short crooks. The piles must be given a pressure preservative treatment with creosote oil. Refer to Art. 1165.03 and 1165.04.

Treated trestle piles must meet with the same requirements of treated foundation piles, except that they are required to be straighter. Refer to Art. 4165.04 and 4165.05.

P 10 PILES

A copy of P10A Standard follows which lists all of the concrete trestle and concrete foundation piles.

The tops of prestressed concrete piles will be marked. The top of the pile contains reinforcing steel that will be exposed and extended in case the pile has to be extended.

The pickup points should be used in handling the pile.

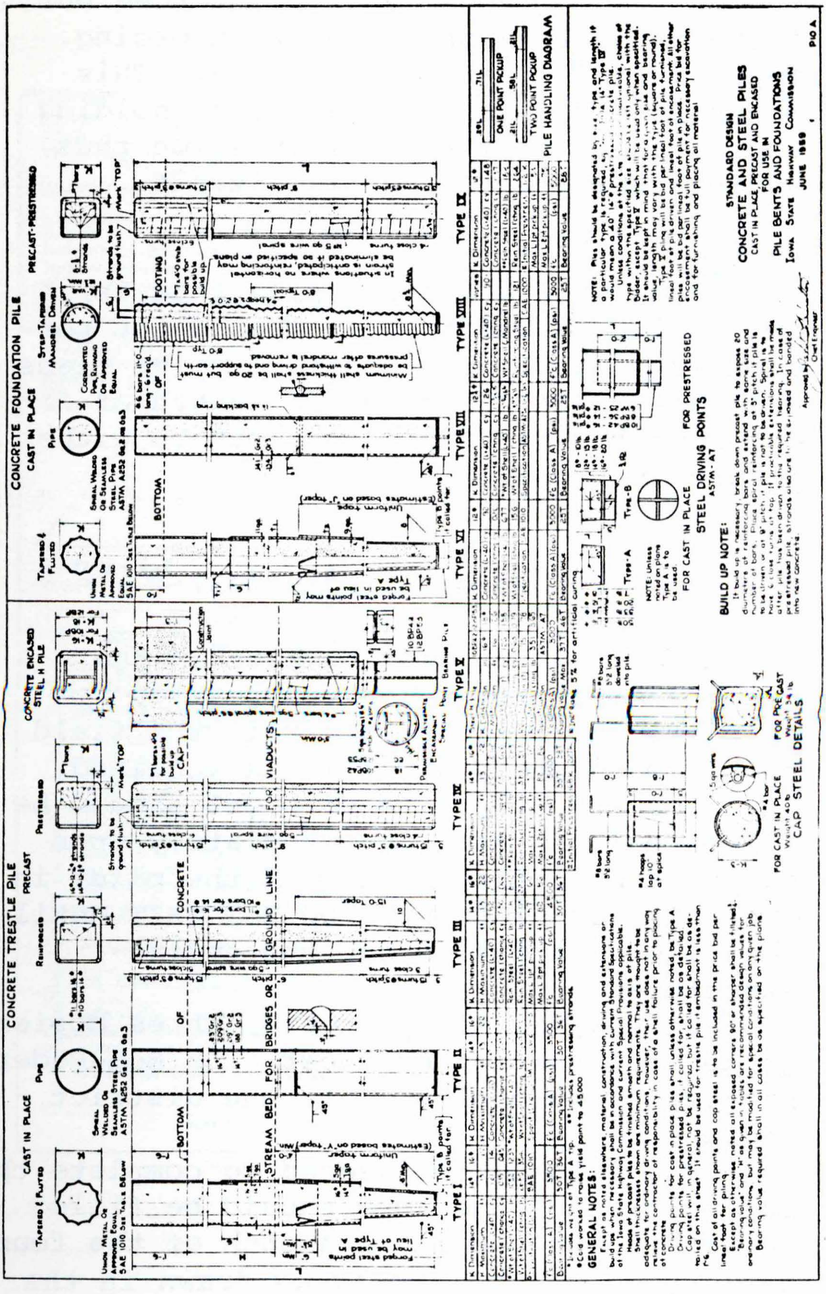
The piles must not be driven before the concrete has attained an age of 14 days.

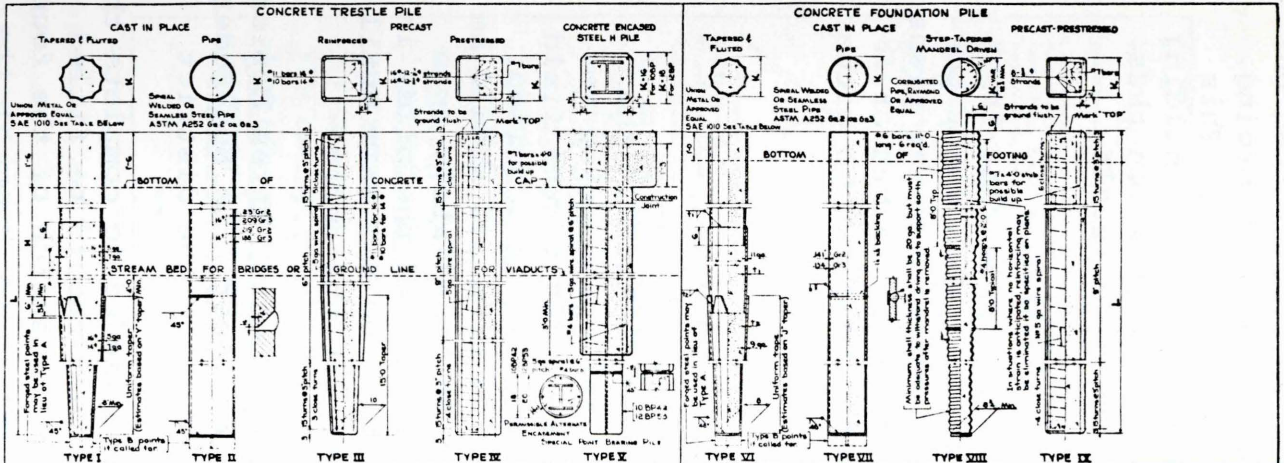
Cast in Place

These consist of Types I, II, VI, VIII and VIII. These are shell piling that are driven to bearing and then filled with concrete.

Precast

These consist of Types III, IV, and IX. Precast means that the pile is cast at the plant and delivered, fully formed and ready


CONCRETE TRESTLE PILE
CAST IN PLACE
PRECAST
CONCRETE ENCASED STEEL H PILE
CONCRETE FOUNDATION PILE
CAST IN PLACE
PRECAST-PRESTRESSED
TYPE I
TYPE II
TYPE III
TYPE IV
TYPE V
TYPE VI
TYPE VII
TYPE VIII
TYPE IX
STREAM BED FOR BRIDGES OR GROUND LINE FOR VIADUCTS
BOTTOM OF CONCRETE
BOTTOM
FOOTING
GENERAL NOTES:
CAP STEEL DETAILS
STEEL DRIVING POINTS
FOR CAST IN PLACE
FOR PRESTRESSED
BUILD UP NOTE:
PILE HANDLING DIAGRAM
ONE POINT PICKUP
TWO POINT PICKUP
STANDARD DESIGN
CONCRETE AND STEEL PILES
CAST IN PLACE, PRECAST AND ENCASED
FOR USE IN
PILE BENTS AND FOUNDATIONS
IOWA STATE HIGHWAY COMMISSION
JUNE 1959
P10A



K Dimension	14"	16"
H Maximum ft	15	[illegible]
Concrete (L+40) cy	[illegible]	14
Concrete 1' change cy	.015	.045
*Wt of Shell (L+40) lb	1052	1253
Wt of Shell 1' chng lb	[illegible]	35.4
Specification	SAE 1010	
f'c (Class A) (psi)	3500	
Bearing Value	30T	36T

K Dimension	14"	16"
H Maximum ft	15	22
Concrete (L+40) cy	[illegible]	[illegible]
Concrete 1' change cy	[illegible]	[illegible]
*Wt of Shell (L+40) lb	[illegible]	[illegible]
Wt of Shell 1' chng lb	[illegible]	[illegible]
Specification	ASTM A252 [illegible]	
f'c (Class A) (psi)	3500	
Bearing Value	30T	36T

K Dimension	14"	16"
H Maximum ft	15	22
Concrete (L+40) cy	1.52	2.30
Concrete 1' change cy	[illegible]	[illegible]
Rein Steel (L+40) lb	[illegible]	612
Rein Steel 1' chng lb	[illegible]	22.0
Max L 1pt pickup ft	57	60
Max L 2pt pickup ft	82	86
f'c (psi)	4500	
Bearing Value	30T	36T

K Dimension	14"	16"
H Maximum ft	15	22
Concrete (L+40) cy	[illegible]	[illegible]
Concrete 1' change cy	[illegible]	[illegible]
**Rein Steel (L+40) lb	[illegible]	[illegible]
Rein Steel 1' chng lb	3.81	[illegible]
Max L 1pt pickup ft	[illegible]	[illegible]
Max L 2pt pickup ft	82	[illegible]
f'c (psi)	5000	
Bearing Value	33T	38T
Initial Prestress	168K	227K

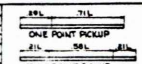
Steel H Pile	10BP42	12BP53
K Dimension in	16"	18"
H Maximum ft	16	26
Concrete (L+40) cy	1.25	1.58
Concrete 1' chng cy	0.063	0.079
Rein Steel (L+40) lb	75	78
Rein Steel 1' chng lb	3.51	3.65
Specification	ASTM - A7	
f'c (Class A) (psi)	3000	
Bearing value Max	37T	46T

K Dimension	12"
Concrete (L+40) cy	.92
Concrete 1' chng cy	.026
*Wt of Shell (L+40) lb	677
Wt of Shell 1' chng lb	15.6
Specification	SAE 1010
f'c (Class A) (psi)	3000
Bearing Value	25T

K Dimension	12¾"
Concrete (L+40) cy	1.26
Concrete 1' chng cy	[illegible]
*Wt of Shell (L+40) lb	[illegible]
Wt of Shell 1' chng lb	[illegible]
Specification	ASTM A252 [illegible]
f'c (Class A) (psi)	3000
Bearing Value	25T

K Dimension	Varies
Concrete (L+40) cy	.90
Concrete 1' chng cy	
Wt Shell & Mandrel lb	
Reinforcing Steel lb	121
Specification	SAE 1000
f'c (Class A) (psi)	3000
Bearing Value	25T

K Dimension	12"
Concrete (L+40) cy	1.48
Concrete 1' chng cy	[illegible]
**Rein Steel (L+40) lb	[illegible]
Rein Steel 1' chng lb	2.64
Initial Prestress	[illegible]
Max L 1pt pickup ft	[illegible]
Max L 2pt pickup ft	[illegible]
f'c (psi)	5000
Bearing Value	26T



PILE HANDLING DIAGRAM

* Includes weight of Type A tip. ** Includes prestressing strands.
• Cold worked to raise yield point to 45,000
ǂ Increase 5% for artificial curing

GENERAL NOTES:

Except as noted elsewhere, material, construction, driving and extensions or build ups when necessary shall be in accordance with current Standard Specifications of the Iowa State Highway Commission and current Special Provisions applicable.

Heads of precast piles to be finished smooth and normal to axis of pile.

Shell thicknesses shown are minimum requirements. They are thought to be adequate for ordinary driving conditions, however, their use does not in any way relieve the contractor of responsibility in case of a shell failure prior to placing of concrete.

Driving points for cast in place piles shall, unless otherwise noted, be Type A.

Driving points for prestressed piles, if called for, shall be as detailed.

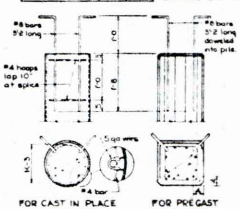
Cap steel will, in general, not be required, but if called for shall be as detailed on this sheet. It should be used for trestle pile if embedment is less than 1'-6.

Cost of all driving points and cap steel is to be included in the price bid per lineal foot for piling.

Except as otherwise noted all exposed corners 90° or sharper shall be filleted ¾.

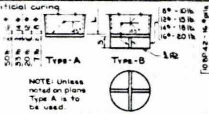
"Bearing value" and "H" as given in tables are recommended design values for ordinary conditions, but may be modified for special conditions on any given job.

Bearing value required shall in all cases be as specified on the plans.



FOR CAST IN PLACE Weight 40 lb.
FOR PRECAST Weight 34 lb.

CAP STEEL DETAILS



FOR CAST IN PLACE
FOR PRESTRESSED

STEEL DRIVING POINTS
ASTM - A7

BUILD UP NOTE:

If build up is necessary, break down precast pile to expose 20 diameters of reinforcing bars and extend with same size and number of bars. Place spiral reinforcing at 3" pitch if pile is to be driven or at 9" pitch if pile is not to be driven. Spiral is to have 6 close turns at top. If practicable extensions shall be made after pile has been driven to the required bearing. In case of prestressed pile, strands also are to be exposed and bonded into new concrete.

NOTE: Piles should be designated by size, type and length if a particular type is required, eg. "40' Pile 14" Type IV" would mean a 40' 14" prestressed concrete pile.

Unless conditions at the site make it inadvisable, choice of type within the specified size should be left optional with the Bidder, except Type V which will be used only when specified. It should be kept in mind that for a given size and bearing value, length may vary with the type (square or round).

Type V piling will be bid per lineal foot of pile furnished, lineal foot of pile driven and lineal foot of encasement. All other piles will be bid per lineal foot of pile in place. Price bid for encasement shall be full payment for necessary excavation and for furnishing and placing all material.

STANDARD DESIGN
CONCRETE AND STEEL PILES
CAST IN PLACE, PRECAST AND ENCASED
FOR USE IN
PILE BENTS AND FOUNDATIONS
IOWA STATE HIGHWAY COMMISSION
JUNE 1959

Approved by [signature] Chief Engineer

P10 A

for driving. Type III is reinforced but there is no tension on the reinforcing. Types IV and IX are prestressed. This means that the steel strands are holding the concrete firmly in compression thus adding strength to the pile itself.

<u>Encased</u>

Type V is a steel H pile that is driven to bearing first. Then a top portion is encased with concrete. The plans will designate the size and length of encasement. The encasement may be either square or round.

PILING LOGS (FORM 343)

A piling log must be kept in the field record book. The information for this log should be recorded in the field book, immediately after it is acquired.

The log of piling Form 343 should be filled out and sent in immediately upon completion of the driving of the piles in each pier or abutment. DO NOT WAIT until the piles are driven for the entire structure.

On Federal Aid projects, three copies go to the district engineer. On Non-Federal projects, two copies go to the district engineer.

The information needed to complete the top portion of the form should be filled in with no problems. A sketch of the foundation and piling should be drawn in the

Form 343
5M 8-66
I.H.C.

LOG OF PILING DRIVEN

Iowa State Highway Commission

Kind of Piling *Treated Southern Pine*
Untreated, Treated, (Give Species) Steel, (Give Type), Concrete (Precast or Prestressed)

County *Harrison* Proj. No. *FN-75-2(1)2*

Type of Hammer *Gravity*
Single or Double Acting Steam, Gravity, Diesel

Contractor *Capital Const. Co.*

I. H. Comm. No. of Hammer *730*

Gross Weight of Hammer *3530* Effective Wt. *3500*

Hammer Energy *35,000* Ft. Tons *17.5*

Weight of Driving Cap *1123*

Weight of Pile *1749*

Formula Used *P=(3WH ÷ S+0.35)(W ÷ W+M)*

Plan Length *45'*

Required Bearing *See Remarks*

Was Bearing Determined Immediately Upon Completion of Driving? *yes*

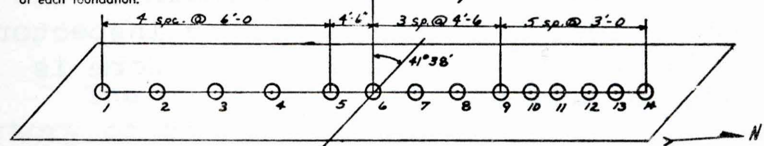
Design No. *168* Sta. of C. L. *572+11*

Foundation Number *East Abutment*

Length, Width and Type of Structure *130'-0 x 44'-0 Continuous Concrete Slab Bridge*

Remarks: *Plans required 20 tons minimum. After test loading pile #3, required bearing was reduced to 10 tons*

Sketch below foundation and location of each pile by circles with numbers therein. Note battered piles on sketch, and give amount of batter. Mail 3 copies on F. A. projects and 2 copies on state projects to Dist. Engr., upon completion of each foundation.



Looking west
All piles vertical

14 piles @ 45' required
Dimensions given at bottom footing

Pile No.	Date Driven	Length in Leads Nearest Foot	Length Cut Off Nearest Tenth Foot	Length in Structure*	Ave. Penetration Last 5 Blows (inches)	Drop in Feet	Bearing in Tons
1	10-9-68	45	1.7	43.3	1.13	10	19.5
2	10-4-68	45	0.9	44.1	1.50	10	15.6
3	10-4-68	45	0.0	45.0	1.50	10	15.6
4	10-4-68	45	0.0	45.0	1.75	10	13.7
5	10-9-68	45	1.1	43.9	1.63	10	14.6
6	10-9-68	45	1.9	43.1	1.38	10	16.7
7	10-9-68	45	1.5	43.5	1.13	10	19.5
8	10-9-68	45	0.8	44.2	1.38	10	16.7
9	10-10-68	45	1.2	43.8	1.50	10	15.6
10	10-10-68	45	1.6	43.4	1.25	10	18.0
11	10-10-68	45	1.0	44.0	1.25	10	18.0
12	10-10-68	45	0.5	44.5	1.13	10	19.5
13	10-10-68	45	2.2	42.8	1.50	10	15.6
14	10-10-68	45	0.6	44.4	1.25	10	18.0
15							
16	Totals	630	15.0	615			
17							
18	Total length to be paid for						
19							
20	$= 630 - \frac{7.4}{2} = 626.3$ feet						
21							
22	Note: for wood piles do not						
23	deduct for payment, cutoffs						
24	measuring 1.5' or less.						
25							

Pile No.	Date Driven	Length in Leads Nearest Foot	Length Cut Off Nearest Tenth Foot	Length in Structure*	Ave. Penetration Last — Blows (inches)	Drop in Feet	Bearing in Tons
26							
27	Pile formula:						
28							
29	W = 3500 or 1.75 tons						
30	H = 10						
31	M = cap wt.				1123		
32	Pile wt.				1749		
33					2872		
34							
35–36	$P = \frac{3WH}{S+0.35} \times \frac{W}{W+M}$						
37–38	$P = \frac{3(1.75)(10)}{S+0.35} \times \frac{3500}{3500+2872}$						
39							
40–41	$P = \frac{52.5}{S+0.35} \times .549$						
42							
43–44	$P = \frac{28.82}{S+0.35}$						
45							
46							
47							
48							
49							
50							

*On Pile Trestle Bridges give length in ground and also total length in structure.

Inspector

Resident Const. Engineer

middle of the form. Note the pile spacings, a north arrow, and centerlines or bearing lines. Note the direction of battered piles by dotted lines. Information for the bottom portion of the form will be taken from the record book. The bearings should be figured to the nearest tenth of a ton. The length to be paid for as furnished and the length to be paid for as driven should be noted on the bottom portion of the form. The calculations for figuring the pile bearings should be shown on the back of the original copy. The inspector should sign his name. A sample form is shown on page 41.

MATERIAL REPORTS

All of the materials used must meet with the specification requirements. Piling will normally be inspected at their source. Treated timber piles will be inspected at the place of treatment. Untreated piles will be inspected at their source. Concrete piles are inspected as they are being made. Steel piling are approved from actual weights and measurements and certified mill analysis reports.

Inspection test reports are forwarded to the Ames and District Materials offices from the sources and producers of the different piling. The Materials Department will then issue an approval report to the Resident Engineer's Office.

The inspector should check the piling to see that none have been omitted or damaged in shipment since the report was made. A record should be kept of the approved materials. If materials are delivered to the job site and are not approved, notify the contractor. It is his responsibility to see that approvals are furnished before material is incorporated in the structure.

DIARY

The daily diary should be a complete story of the job as it progresses. Record the weather conditions, temperature, time started and stopped, number of men working that day, etc. Note any delays, conversations pertaining to the project, visitors and their comments, and describe the work that was actually done that day.

Above all make your entries in the diary every day while the events are fresh in your mind. Do not rely on your memory or scratch pad notes; and if in doubt as to whether something should be recorded or not, record it anyway. Sign or initial each entry.