Kansas State University | Salina

Pile Driving Inspection Workbook

Certified Inspector Training Program

Ad Astra Per Aspera

Kansas Department of Transportation

Pile Driving Inspection Certification Workbook

Table of Contents

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Overview of Pile Foundation Design and Construction

1

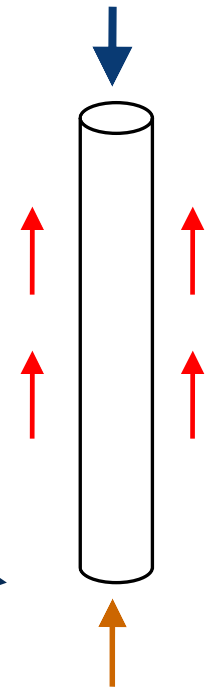
This class is concerned with the installation of driven pile.

Driven pile are hammered into the ground, where they develop resistance from the soil or rock.

2

The bridge load is transferred to the soil or rock by resistance along the length of the pile…

…and resistance from the tip.



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Piles which get most of their resistance from friction along the side are commonly called friction piles.

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Piles which get most of their resistance from the tip are referred to as **end-bearing piles**.

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Pile foundations are used for bridges in two general ways:

1) Abutments of most KDOT bridges

Current KDOT design practice prefers piling for abutments. Pile abutments tend to flex better with changes in temperature, putting less strain on the spans.

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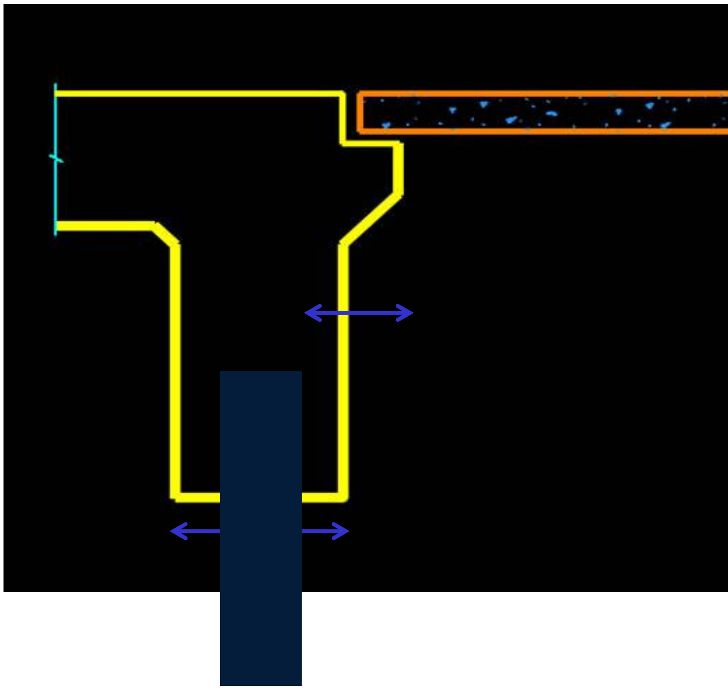

Thermal expansion & contraction

Pile foundations are used for bridges in two general ways:

2) Both Abutments and Piers of bridges in many parts of the state.

In central and western Kansas, bedrock is often too deep to use spread footings or drilled shafts.

This means you will be driving piles:

to a required resistance
(usually)

or to a predetermined depth
(occasionally, to get below a certain elevation in case some of the soils get scoured away during a storm)

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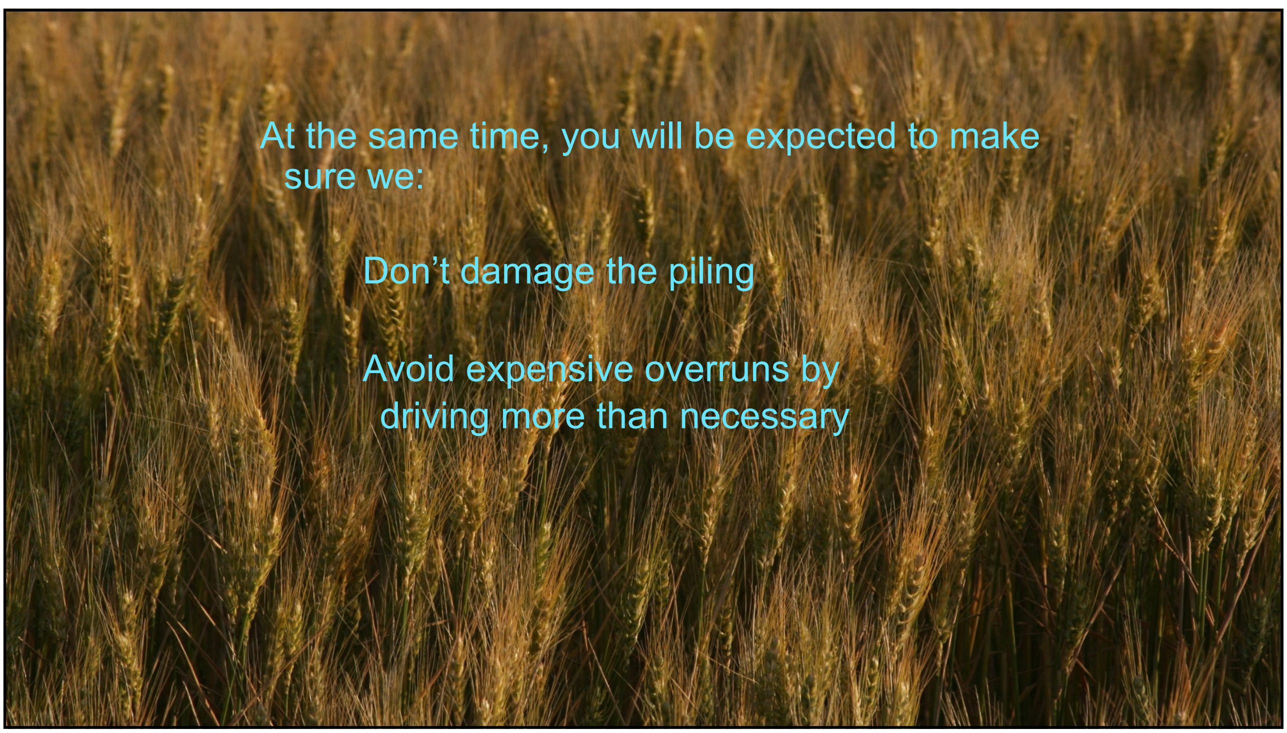

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Unfortunately…

There is a complex interaction between the pile and the surrounding soil. And so things can get complicated in the field.

Dolla Dolla
Billz,
y'all !!

But if it was easy, anyone could do it. Then they wouldn't have to give us so much money.

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Knowledgeable and diligent construction *supervision* and *inspection* are vital to proper installation of piling.

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So what are we trying to learn here?

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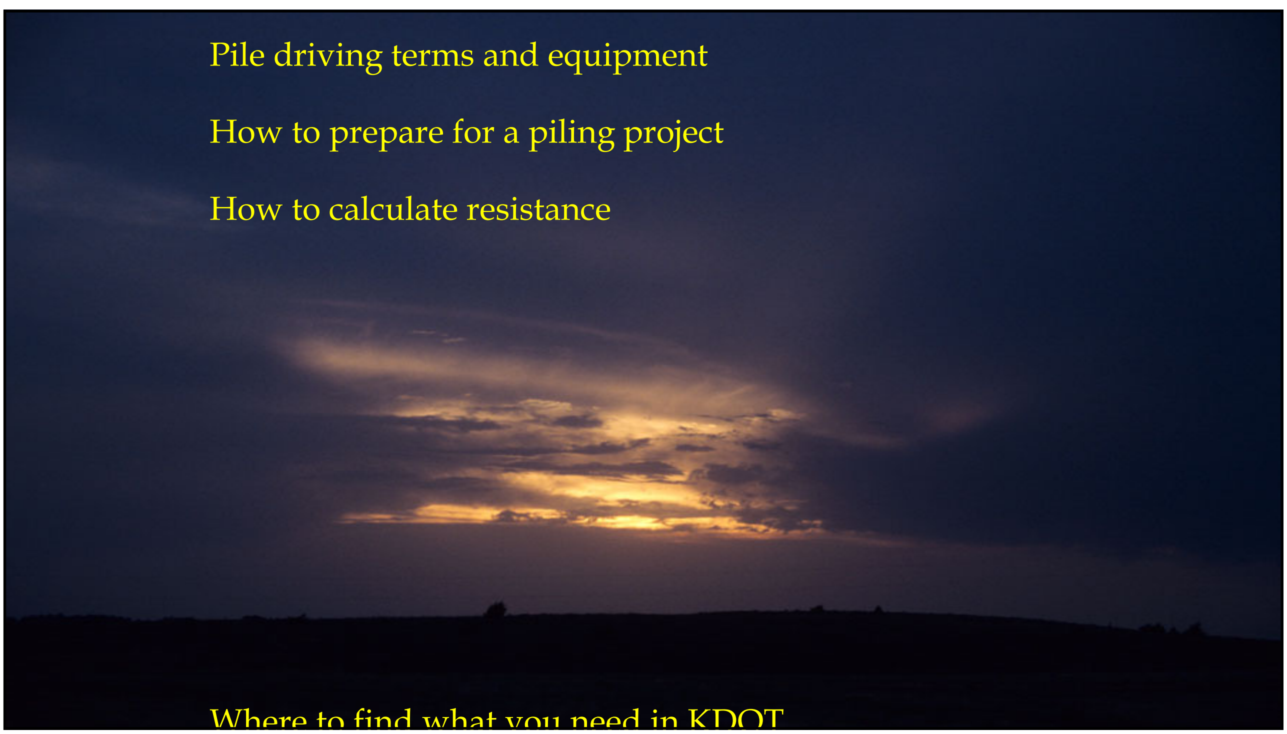

Pile driving terms and equipment

How to prepare for a piling project

How to calculate resistance

Where to find what you need in KDOT

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A few words about "bearing"....

1. **Bearing**
2. **Load**
3. **Resistance**

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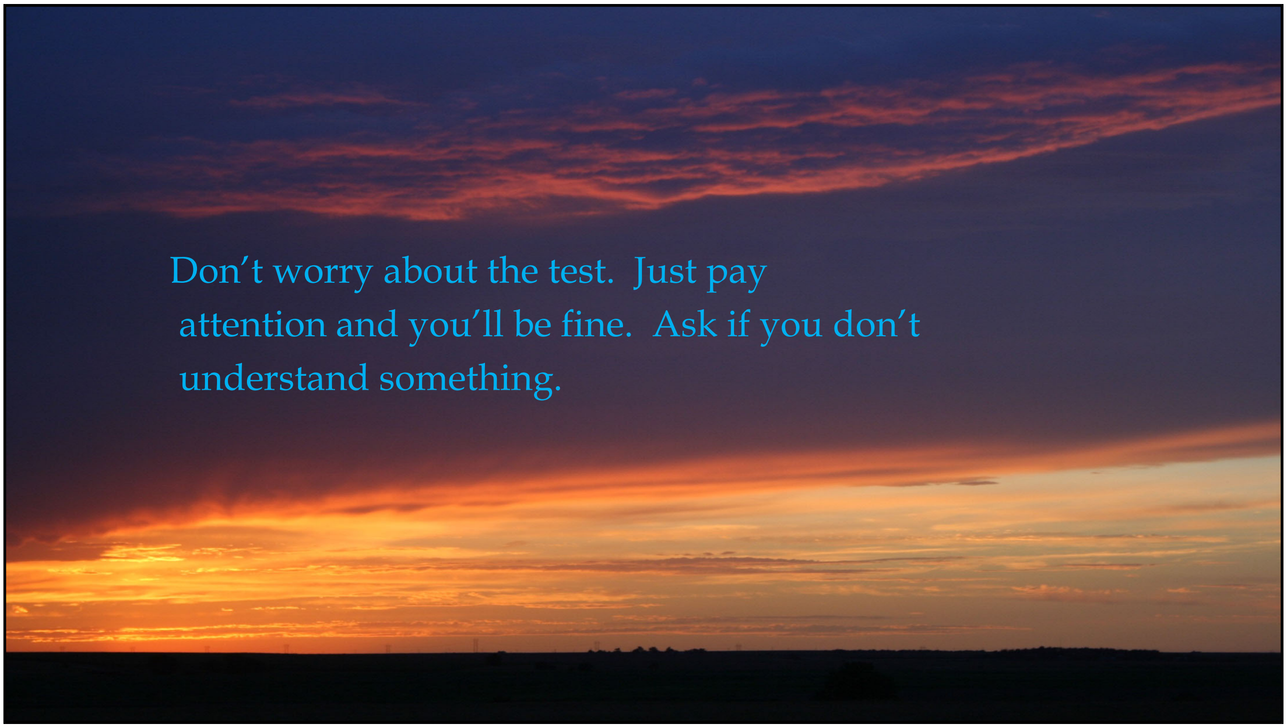

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We have made the things we cover as practical and as interesting as possible.

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Let’s get started.

Driven Pile Types

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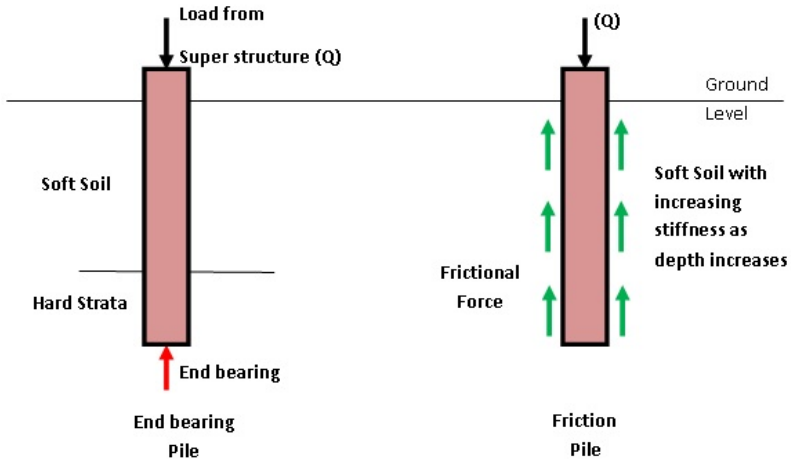
General Pile Types

- **Foundation piles**
  - Structural Support
- **Sheet pile**
  - Retention

2

Pile Design Designation



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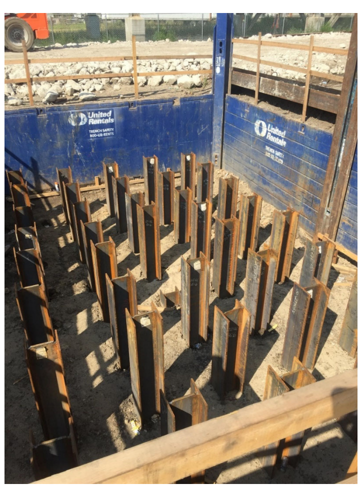
Pile Arrangement

➢ Pile Bents

➢Pile Groups



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Pile Arrangement

- Pile Bents
  - Pile extends into the substructure
  - Usually a single row of piles
  - Encased in concrete wall

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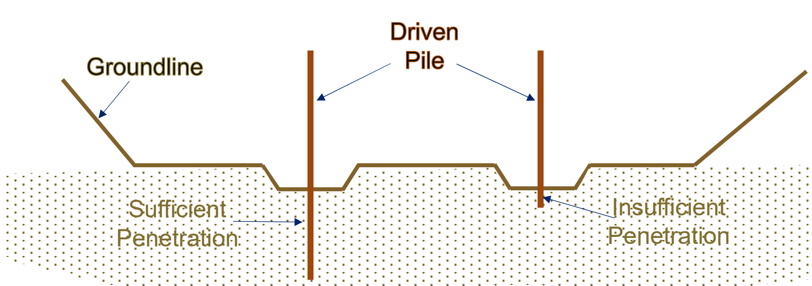
Pile Arrangement

- Pile Bents cont.
  - Pile within the bents shall penetrate not less than 1/3 the unsupported length or not less than 10 feet into hard cohesive or dense granular material



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Pile Arrangement

- Pile groups
  - Piles are driven to bearing in groups
    - Usually 6 or more per group, 9 common
  - Cutoff elevation is below ground
    - And usually below scour line

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Pile Arrangement

- Pile groups cont.
  - Pile cap is constructed on top of the group
  - Pier column built on top of pile cap to support the superstructure

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Pile Arrangement

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Pile Arrangement

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Pile Arrangement

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Pile Arrangement

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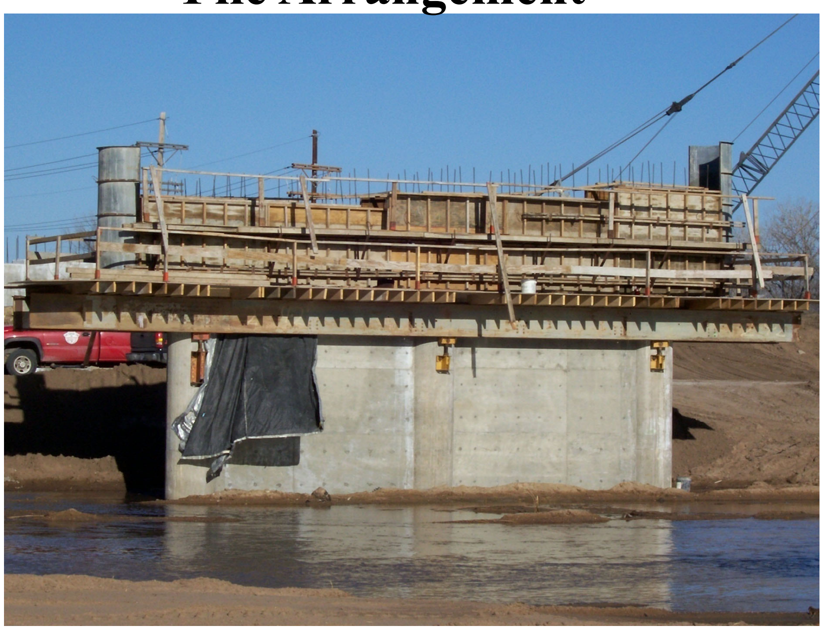
Pile Arrangement



Pile Arrangement

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Pile Group or Pile Bent?

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Pile Types

- Driven Piles
  - Concrete
  - Steel
    - H-Pile
    - Pipe
      - Open End
      - Closed End
  - Timber
  - Composite

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Timber Piles

Only used for False Work, which is not inspected by KDOT

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H-Pile

- Most common pile type used by KDOT
- Typical lengths range from 15 to 130 feet
- Typical design loads 45 to 225 tons
- Material Specs: F_y = 50 ksi
- Suited for either end or friction bearing

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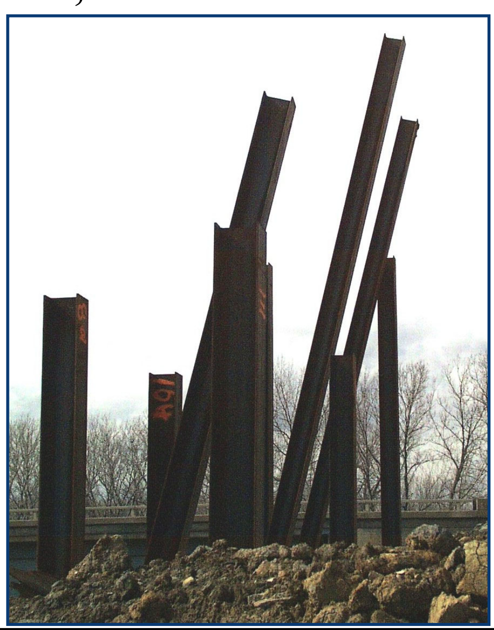
Battered Pile K-4 over Delaware River
Valley Falls, Kansas



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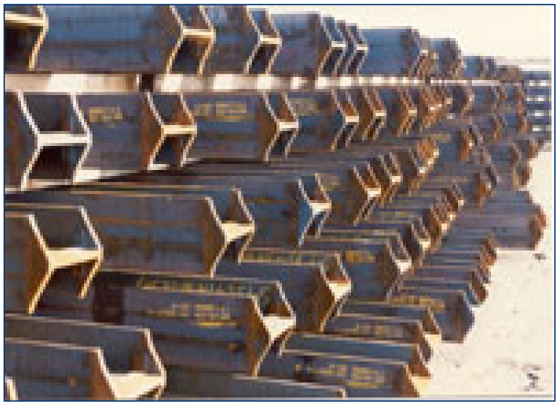
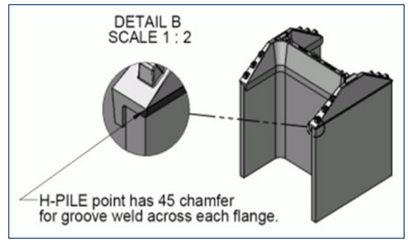
H-Pile With Tips

- ➢Embedding into hard bedrock
- ➢Encountering obstructions
  - ➢Help protect end of pile





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Splicing H-Pile

- ➢Used to add pile length
- ➢Certified Welder
- ➢Butt weld with no plate
- ➢Grind both ends of pile to form a bevel recess
- ➢Square and level two pile ends
- ➢Weld all the way around the pile with a full penetration welds

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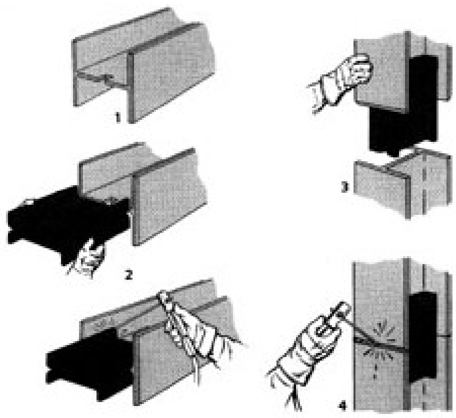
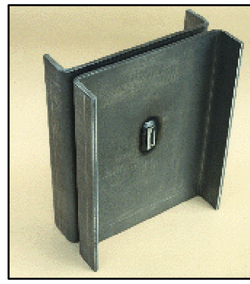
H-Pile Splice





KDOT does NOT approve of this method

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H-Pile Advantages

- Available in Various Lengths and Sizes
- Easy to Splice and to Cutoff
- High Capacity
- Close Spacing
- Low Soil Displacement
- Deep Penetration

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H-Pile Disadvantages

- Vulnerable to Corrosion When Exposed
- Can Deflect Easily if Obstructions Are Encountered
- Not Recommended as Friction Pile in Granular (sandy) Soils

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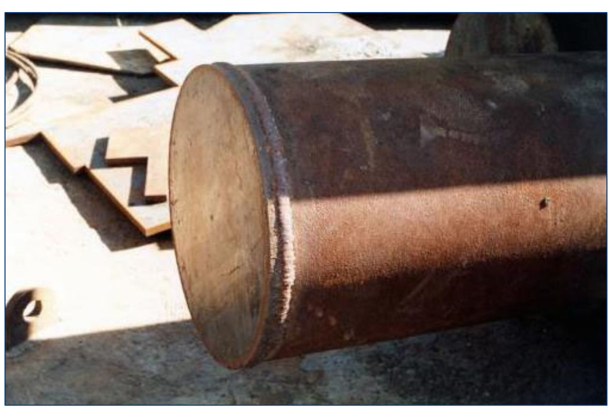
Closed End Pipe Pile

- Typical Lengths : 15 to 120 feet
- Material Specs: F_y = 45 ksi
- Typical Design Loads 40 to 300 tons



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Closed End Pipe Pile

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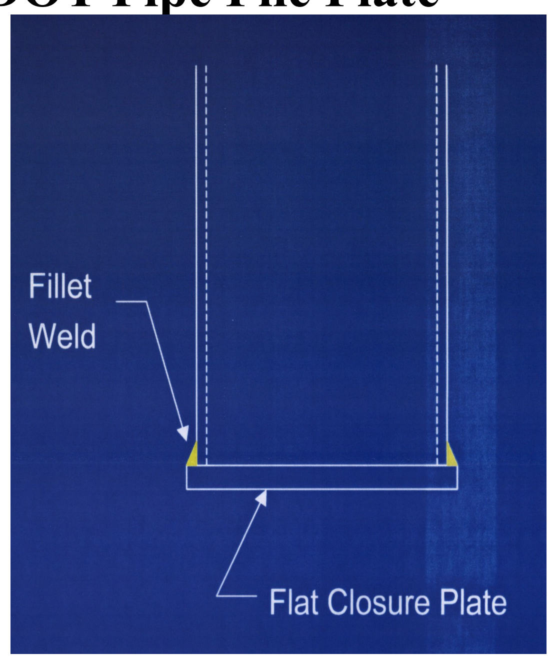
Typical KDOT Pipe Pile Plate



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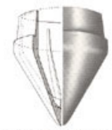
Closed End Pipe Pile
Using Conical Points

Drive fit point for pipe piles. Taper swages pipe to a friction joint so welding is not required.



Rib reinforced point for tough driving to deep penetration in difficult soils.

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Closed End Pipe Pile

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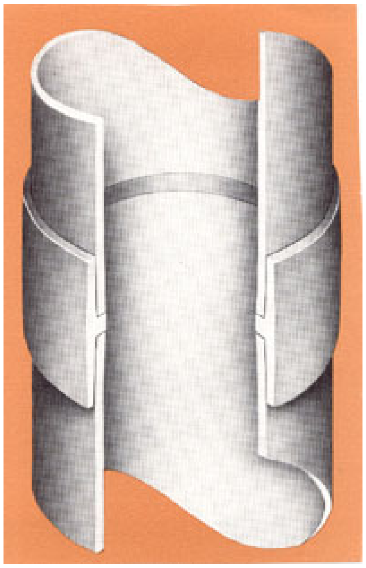
Pipe Pile Splice



Splicing Rings---KDOT Does NOT Use

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Usual KDOT Pipe Pile Splice

- Butt weld with no plate
- Grind both ends of pile to form a bevel recess
- Square and level two pile ends
- Weld all the way around the pile with a full penetration weld

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Pipe Pile Advantages

- Available in Various Lengths, Diameters & Wall Thickness
- Easy to Splice
- High-Capacity Potential
- High Bending Resistance Where Unsupported
- Length is Loaded Laterally

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Pipe Pile Disadvantages

- Vulnerable to Corrosion
- Could Hinder Required Penetration Depth
- Susceptible to Bending or Mushrooming at Head
- High Soil Displacement

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Concrete Piles Overview

- Typical Lengths: 30 to 130 feet
- Design Loads: 45 to 500 tons

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Concrete Piles

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Concrete Pile Bent

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Concrete Piles

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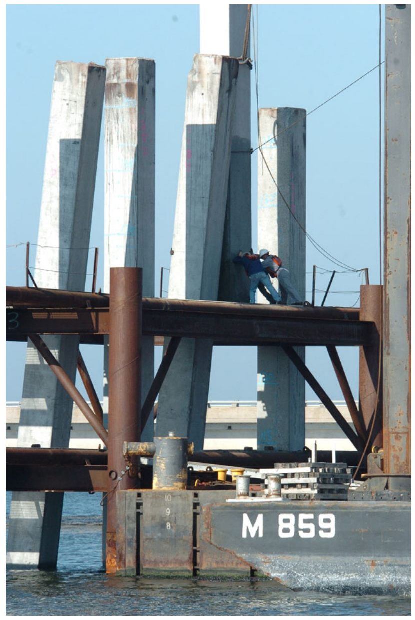
Concrete Piles



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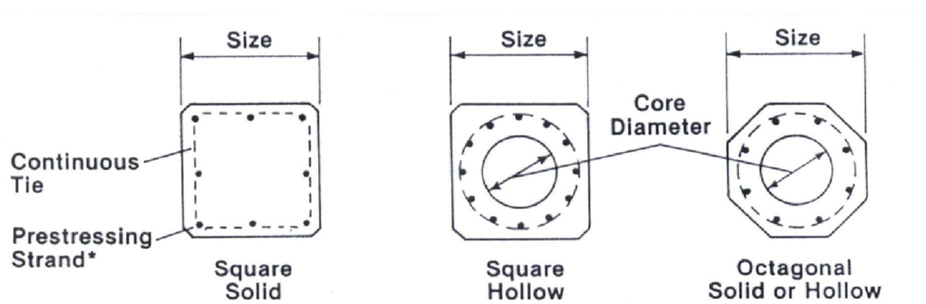
Concrete Pile Detail



Size: **10”and up**

20 to 36” could have 11 to 18” hollow center

10 to 24” could have 11 to 15” hollow center

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Concrete Pile Cushion

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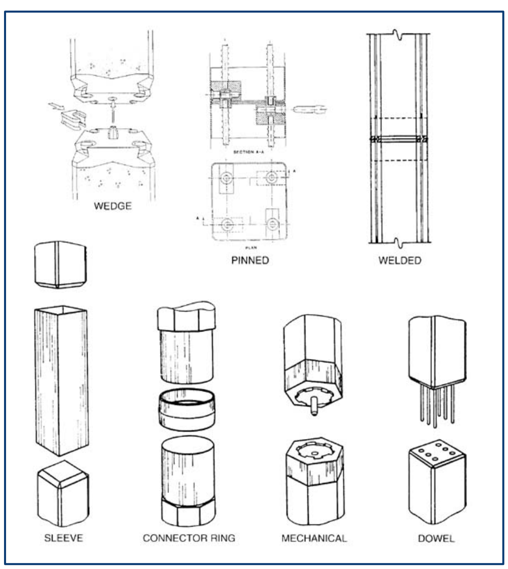
Concrete Pile Splice



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Concrete Pile Splice

24 inch octagon

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Concrete Pile Splice

30 inch square
Male/Female ends

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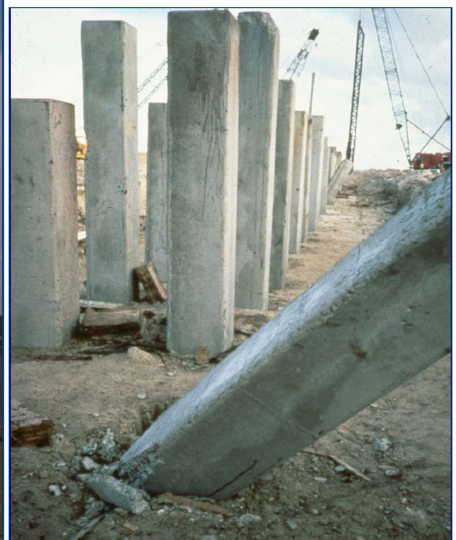
Concrete Pile Damage



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Concrete Pile Advantages

- ➢High load capacity
- ➢Can be made for corrosion resistance
- ➢Hard driving possible
- ➢Cylinder piles suited for bending resistance

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Concrete Pile Disadvantages

- Relatively high breakage
- Unless pre-stressed, vulnerable to handling damage
- Considerable soil displacement
- Difficult to splice
- High initial cost

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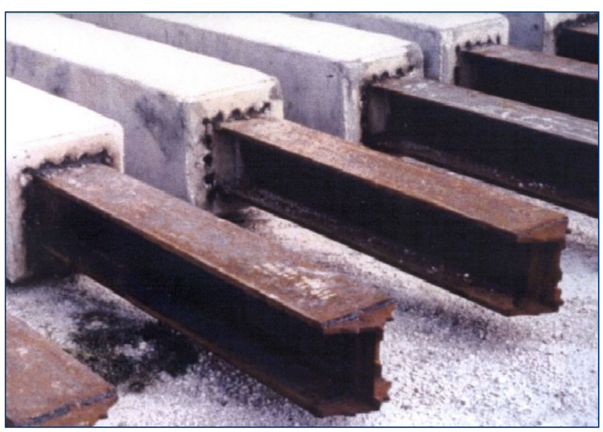
Composite Piles

- Two different materials
- Good qualities are taken advantage of
- Used in special circumstances
- Preferential Use
  - Geology
  - Structure
  - Durability
  - Cost



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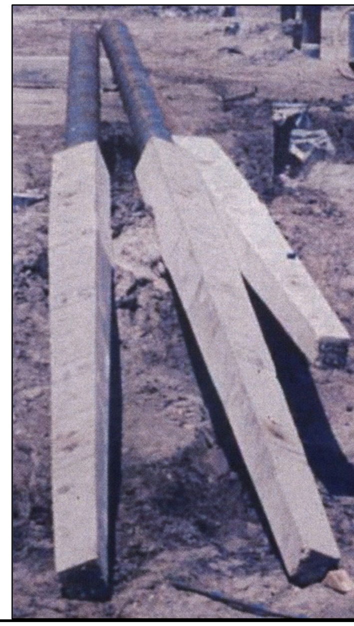
Composite Pile Variations

- ➢Concrete and H-pile
- ➢Steel pipe and H-pile
- ➢Steel pipe and concrete
- ➢Concrete filled pipe



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Composite Pile Variations Cont.

- ➢Fiberglass
- ➢Fiberglass shell filled with concrete
- ➢Corrugated shell and timber
- ➢Numerous others

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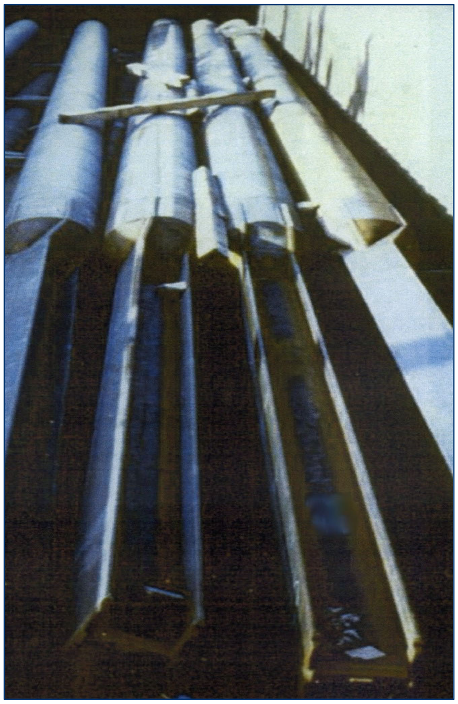

Pipe & H-pile Composite

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Composite Piles

- Typical Lengths 50 to 200 feet
- Maximum Design Stress: Dependent upon pile material
- Design Loads 30 to 200 tons
- Weakest material governs allowable stresses and capacity

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Composite Piles

- Advantages:
  - ➢May be applied in unusual design or installation situations
  - ➢High capacities possible but dependent on materials
  - ➢Could reduce foundation cost
  - ➢Some types offer corrosion protection

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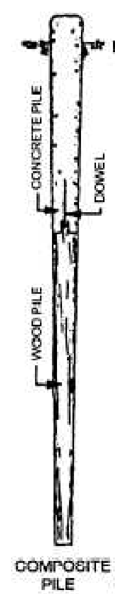
Composite Piles

- Disadvantages:
  - ➢May be difficult to splice
  - ➢May be difficult to attain good joint between materials
  - ➢Vulnerable to decay above water unless treated



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Other Types of Driven Pile

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Tapertube Piles

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Mono Tube Pile

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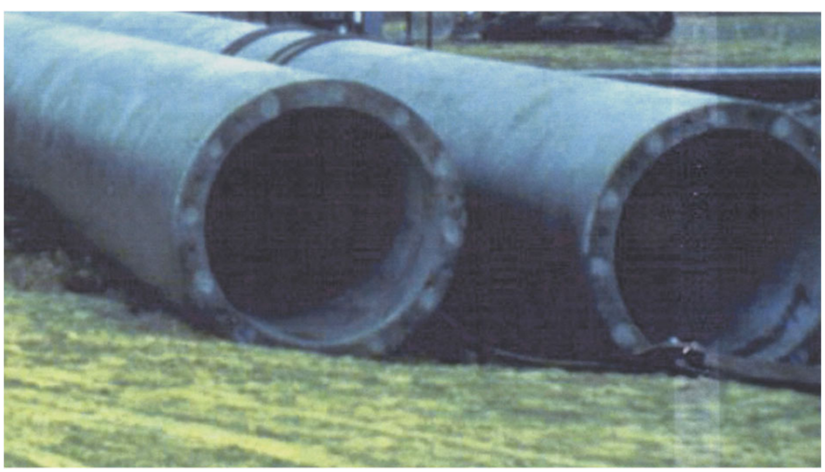
Cylinder Concrete Pile



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Spin Fin Pipe Pile

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Questions?

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1

The task of successfully installing piles involves selecting the most cost-effective equipment to drive each pile to its specified resistance or depth without damage in the least amount of time.

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2

The Leads

3

Hold and guide the hammer

Keep the hammer and pile aligned during driving

Brace long piles until they are driven enough to support themselves

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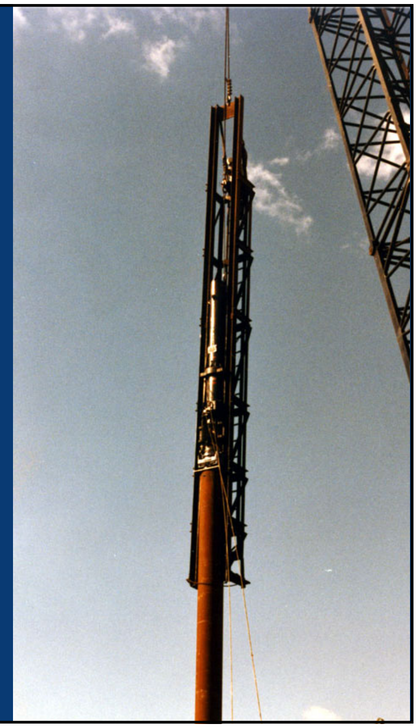
Swinging Leads

Swinging Leads are widely-used because they're:

- Simple
- Lightweight
- Low cost



Swinging Leads 1

Swinging leads can be moved easily to align the hammer and the pile head, without moving the crane

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Swinging Leads 2

Swinging leads are lightweight, which gives the crane a large operating radius. In other words, the contractor doesn't need to move the whole crane for every pile.

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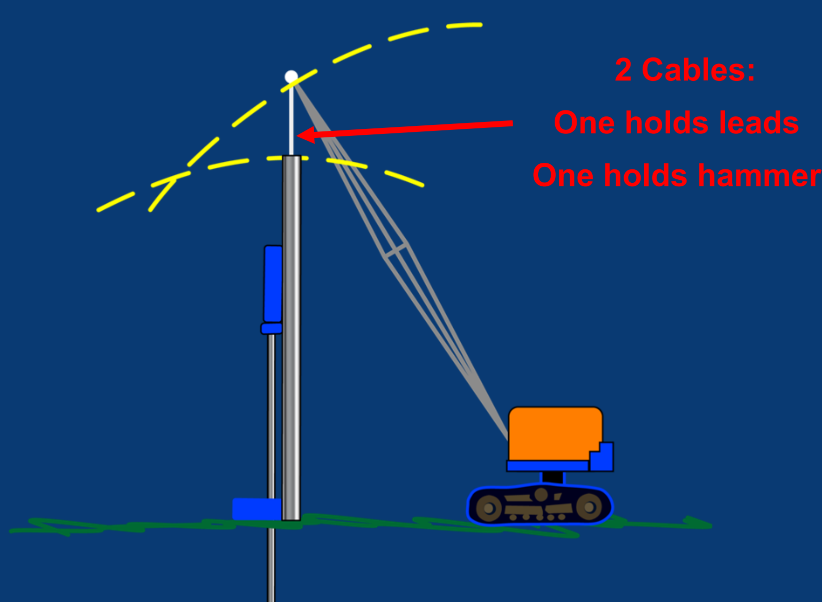
Most common setup for swinging leads



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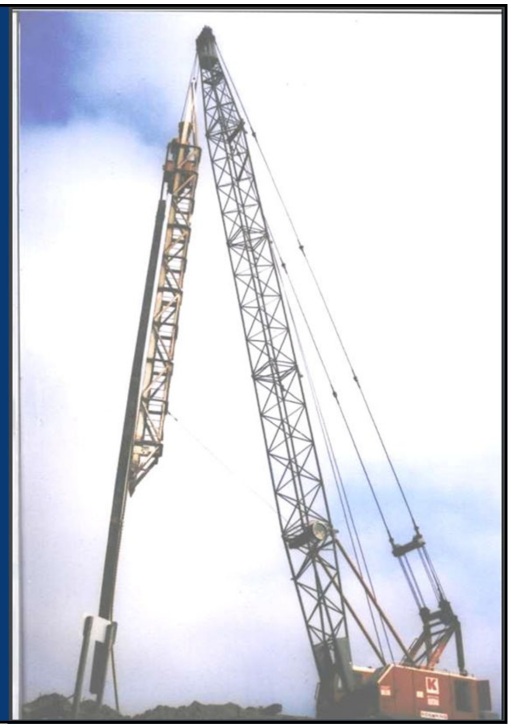
Crane With Swinging Leads



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Cable attached to a frame

Hammer slides along frame

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At top of frame are stops for moving entire hammer up and down the leads

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At the bottom is a catch for lifting the piston, to start hammer

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For years and years, KDOT contactors could leave swinging leads hanging in the air

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A specification (starting in the 2007 version) now says that piling leads must always be spiked into the ground

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It helps with hammer-pile alignment, and is also a safety matter

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This is an extreme example from summer 2013.

Long piles, short leads, Western winds…..

Lots of alignment trouble.

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This is from 2015

And this is from 2019

Fixed Leads

Fixed Leads are attached to the crane boom, and have a brace running from the bottom of the leads to the crane frame.

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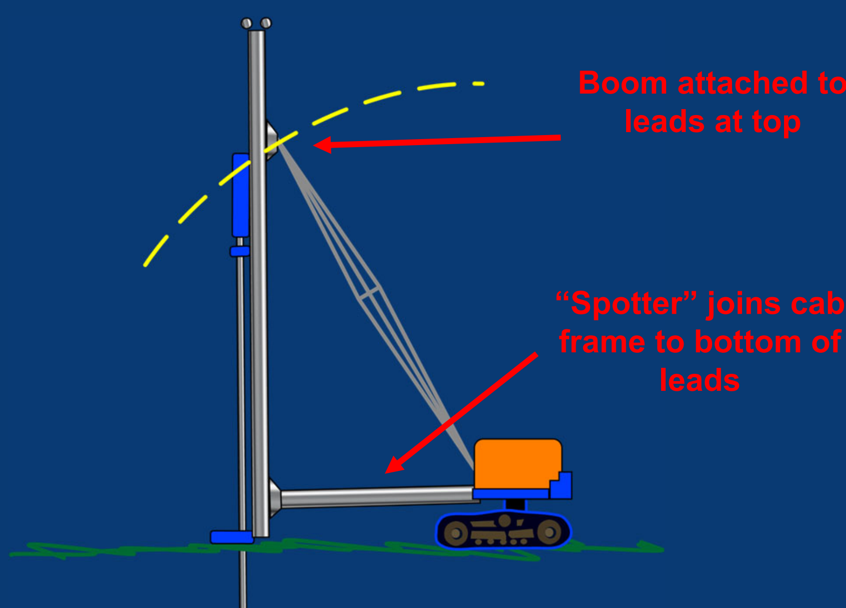
Fixed Leads 1



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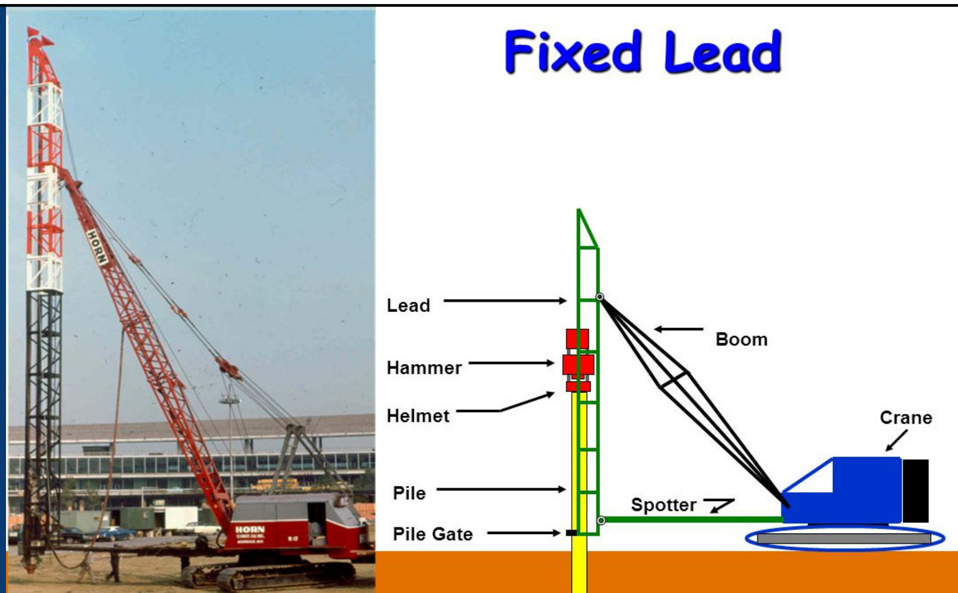

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Fixed Leads 2

Fixed leads hold the pile in a more true alignment during driving, but require much more time to set up.

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Fixed Leads 4

Fixed leads are used for large piling on large projects.

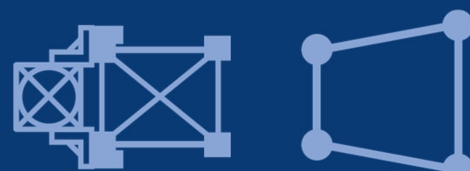
You will rarely see fixed leads on Kansas bridge projects.

Common Types of Leads

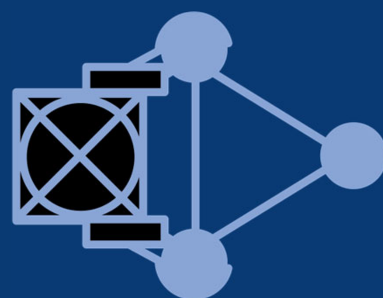
Truss
Triangular
Box
H-Beam
Pipe

Truss Lead

Square and Round Tube



Triangular Lead



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Truss Leads

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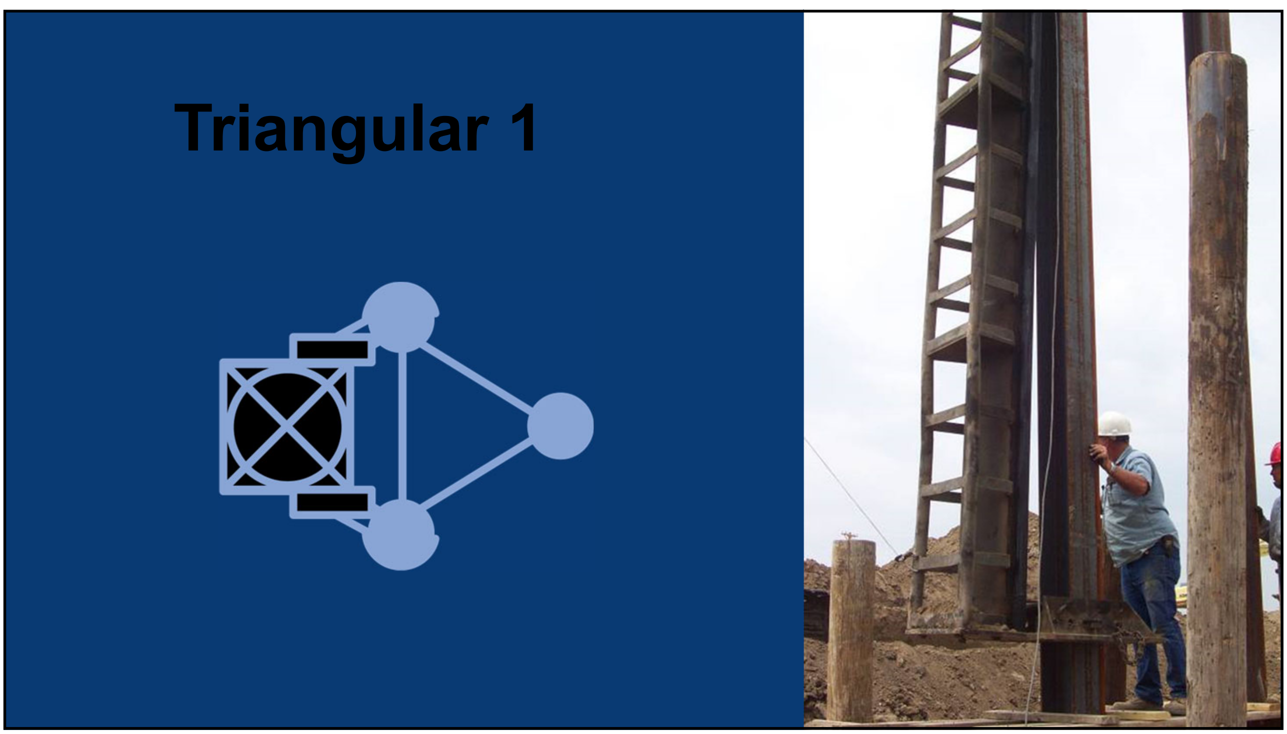

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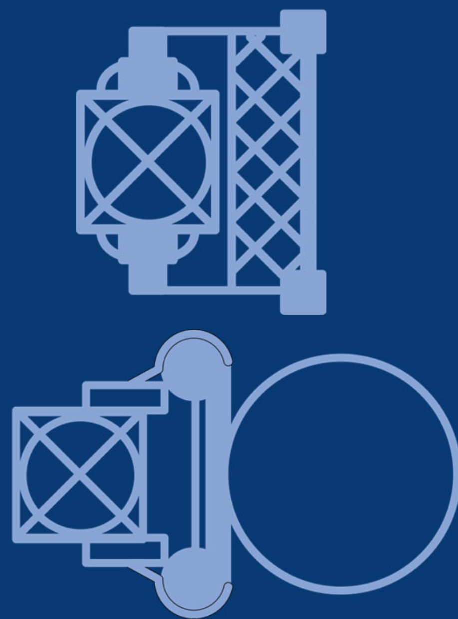
Box Lead

Pipe Lead



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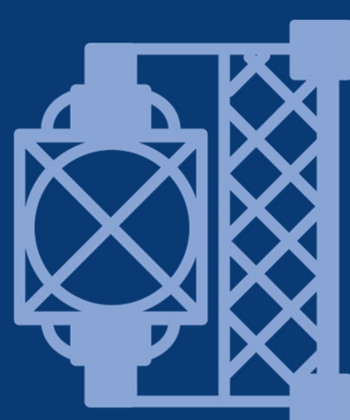
Box Lead 1



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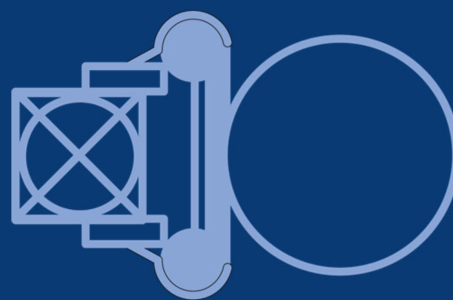
Pipe Leads With Ladder Frame



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H-Beam Lead

Square and Round Tube

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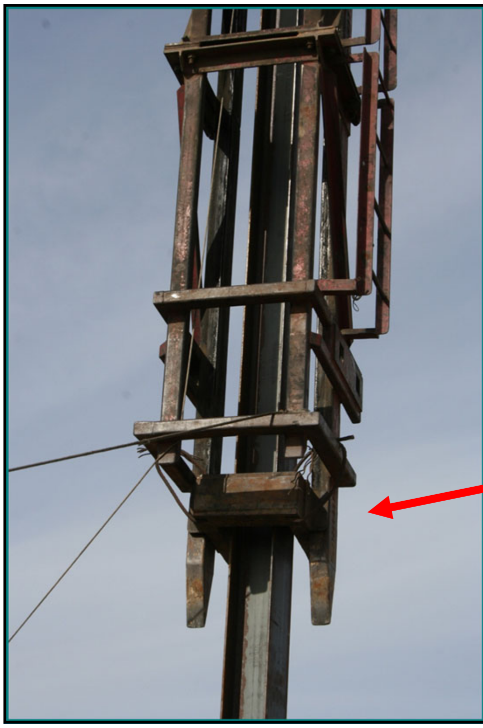

Pile Gate

At bottom of leads

Used to keep lower portion of the pile centered in the leads

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- **Pile Hammers**
  - Drop (Gravity)
  - Diesel
    - Single-Acting (Open-End)
    - Double-Acting (Closed-End)
  - Vibratory
  - Hydraulic
    - Single-Acting
    - Double-Acting
  - Air
    - Single-Acting
    - Double-Acting

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Drop (Gravity) Hammer

Concept has been used for thousands of years

Suitable for all types of piling except concrete

Very high dynamic forces can break concrete piling in easy driving if drop is not controlled

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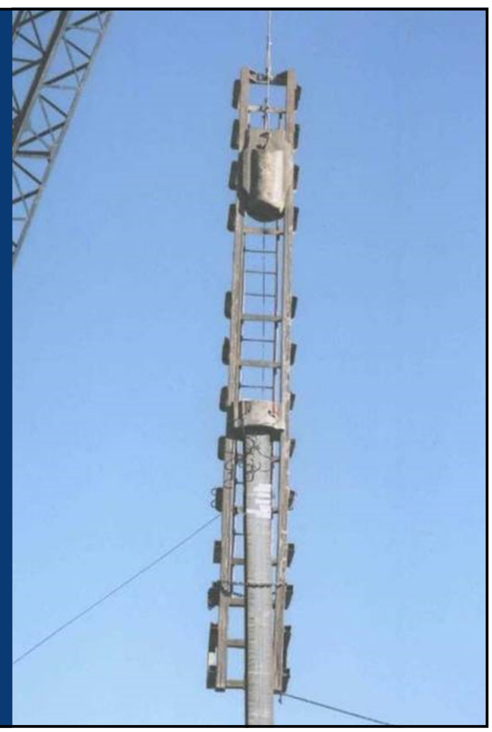

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Drop (Gravity) Hammer

Cheap to Buy

Cheap and easy to maintain

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Problems with using gravity hammers

If they're cheap, why don't we use them everywhere?

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They're slow

Low productivity

(Only 4 to 8 blows per minute on average)

Also…..

It can be hard to control the fall height of the weight

On KDOT projects, mainly used to start pile

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Drop (Gravity) Hammer

You will occasionally still see all piling on a bridge driven with a gravity hammer

Usually short pile stopping on a hard limestone or sandstone

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December 2019

near Woodbine

Vibratory Hammer

Vibratory Hammer

45

Vibratory Hammer

Don’t require leads

Fastest way to install a pile

- **12 to 30 pulses per second—eccentric weights**

High initial cost

High maintenance cost

Needs a separate power supply—runs on electricity or hydraulics (usually hydraulics)

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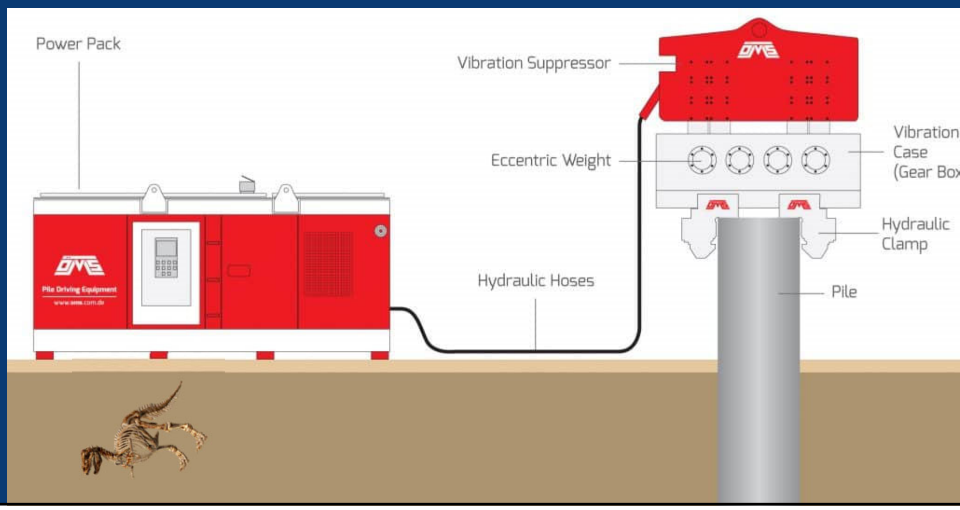
46

Vibratory Hammer 1



Vibratory Hammer

Suitable for steel H-pile, pipe pile, and sheet pile.

No good for concrete piles. Not at all.

A vibratory hammer would shake apart a concrete pile in about 3 seconds.

Kansas Department of Transportation

Vibratory Hammer

Suitable for end-bearing

Not recommended for friction piles

Very useful in granular soils

Not effective in stiff, clayey soils

Can be used for driving or pulling piles

Vibratory Hammer

How do you know when to stop it?

Must use another method to confirm pile capacity

Single-Acting (open-end) Diesel Hammer

- Suitable for all types of pile
- 40 to 60 blows per minute
- Carry their own fuel—they power themselves
- Stroke of the piston is directly related to pile resistance

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51

Single-Acting (open-end) Diesel Hammer

- Expensive to buy
- Fairly easy to maintain
- Pollutes the air and gets diesel fuel all over you
- Low blows per minute at high pile resistances
- Most popular hammer on KDOT projects

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52

Most diesel hammers on our projects carry between 5 and 20 gallons of fuel.

The capacity is such that a hammer can work all day on one tank.

They also carry lubricating oil. The two tanks are side-by-side.

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53

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54

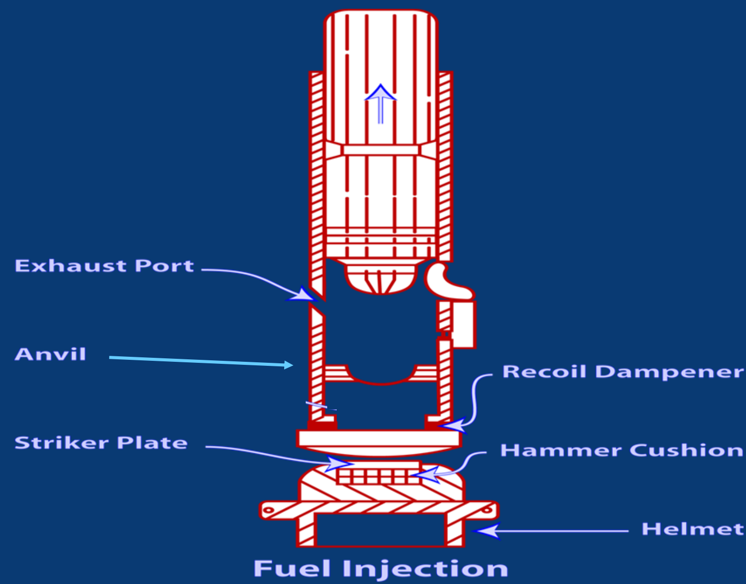
Kansas
Department of Transportation

55

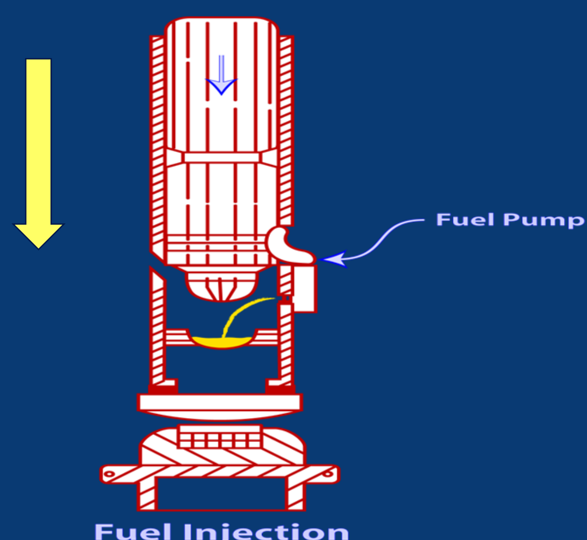
Kansas
Department of Transportation

56

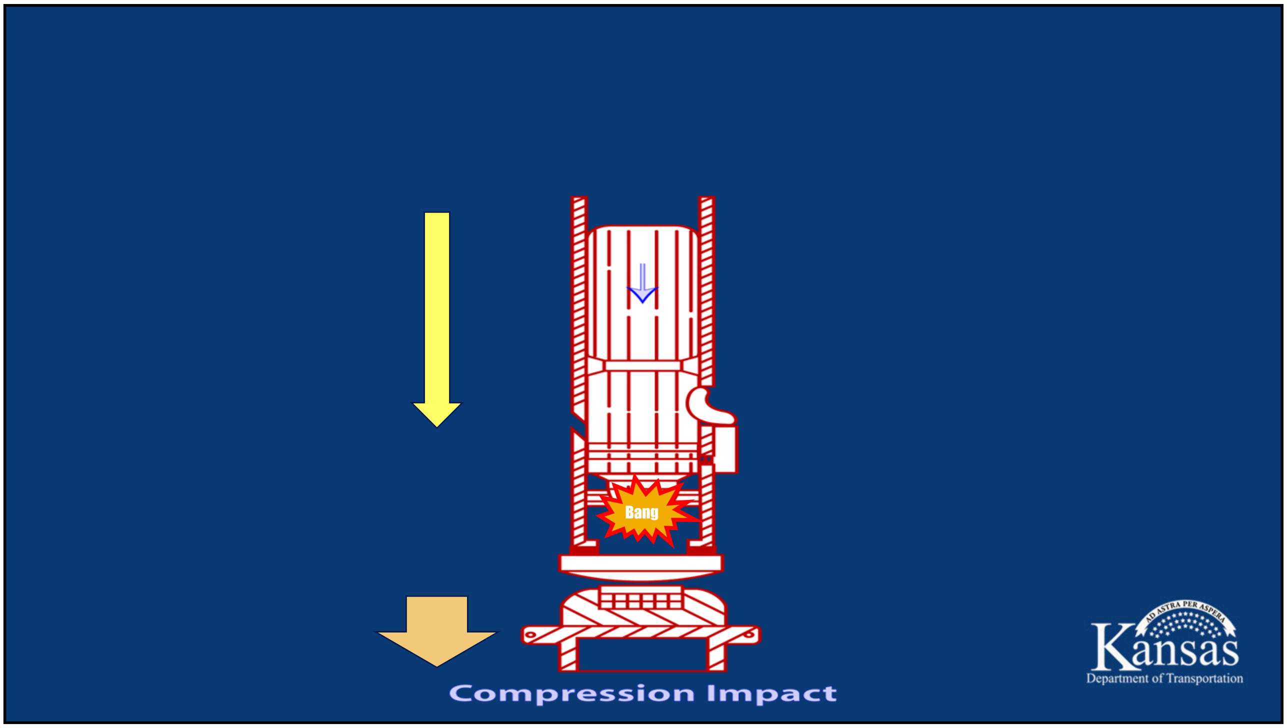
Single-Acting Diesel Hammer



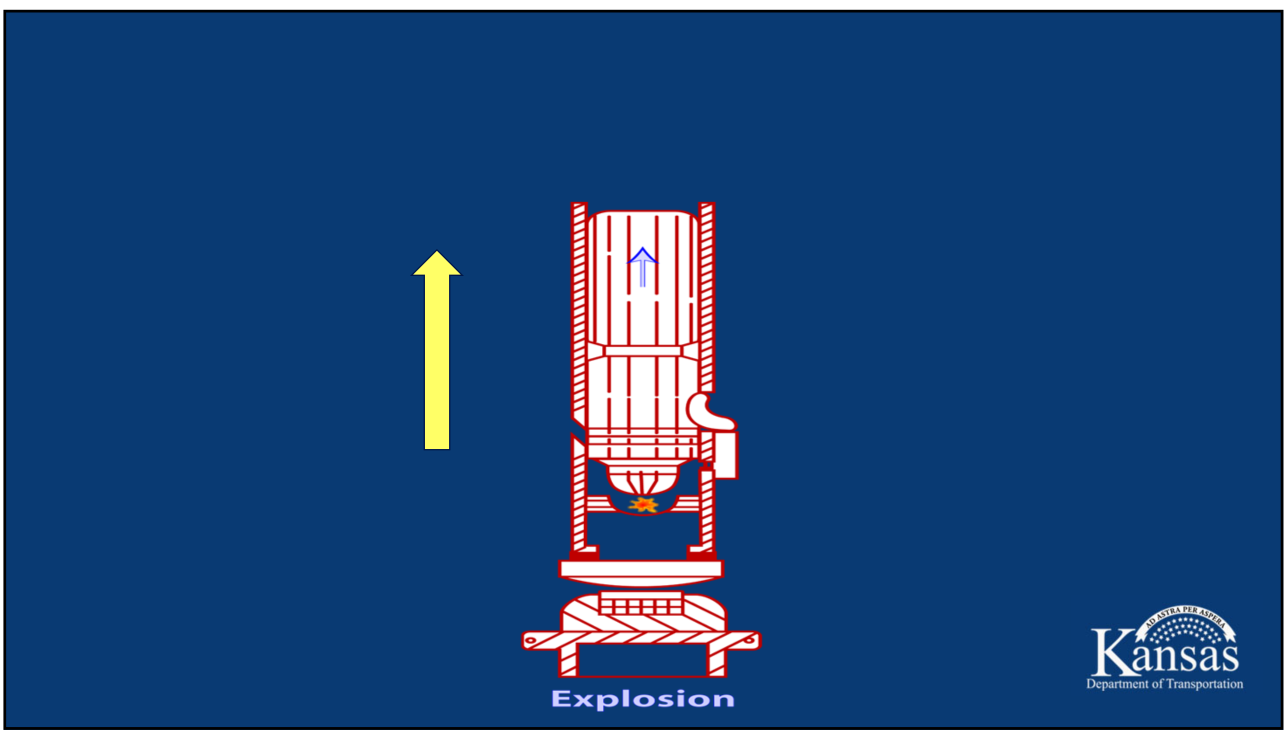
57



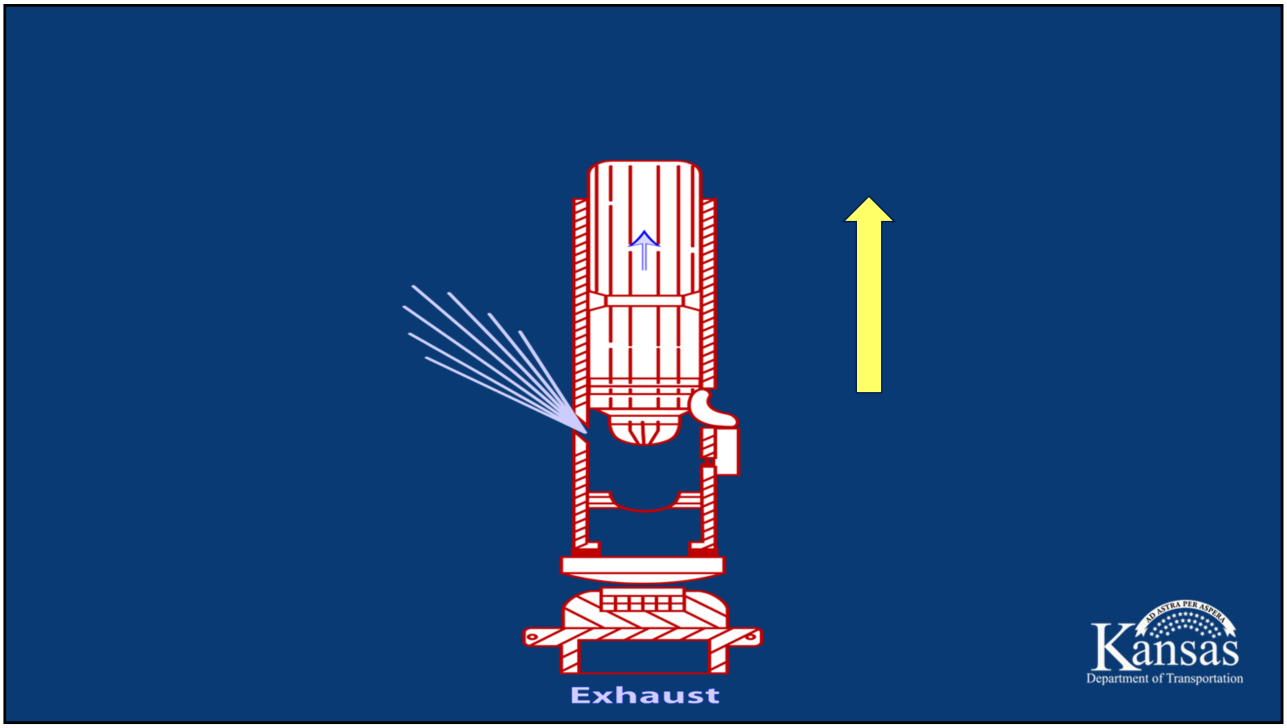
58


Bang
Compression Impact
AD ASTRA PER ASPERA
Kansas
Department of Transportation

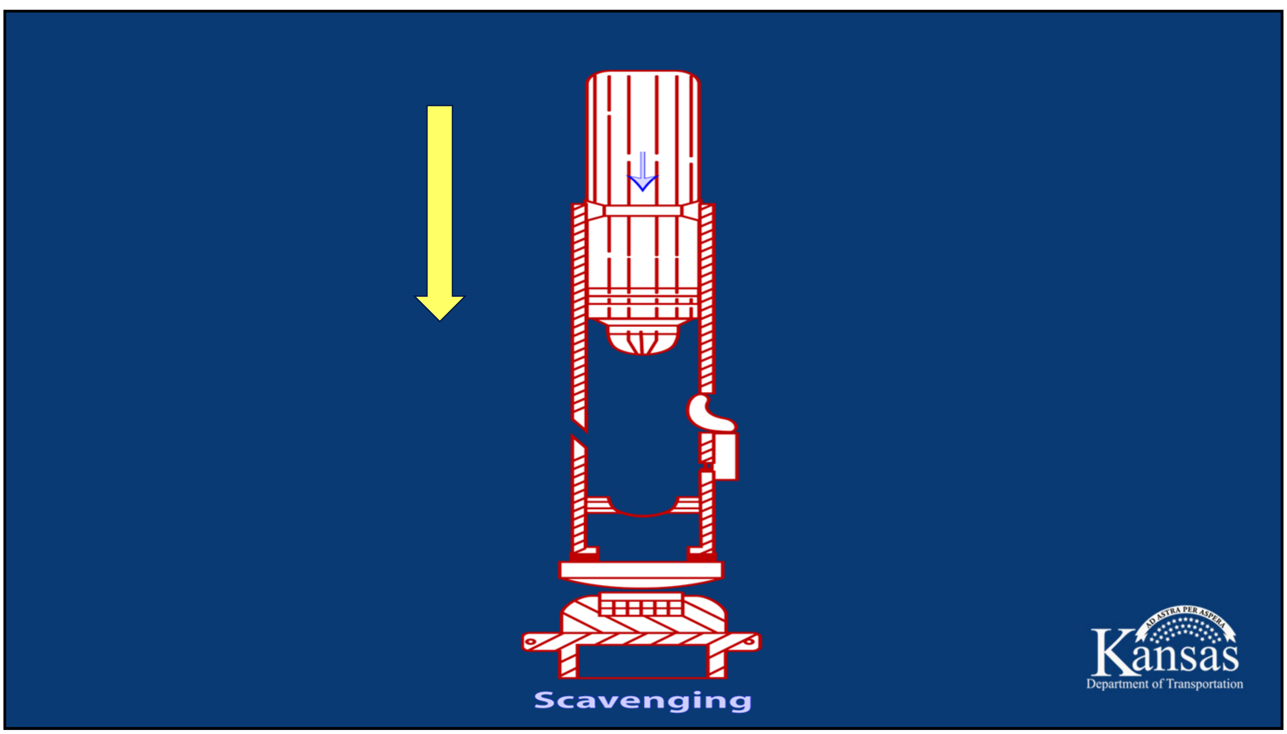
59


Explosion
AD ASTRA PER ASPERA
Kansas
Department of Transportation

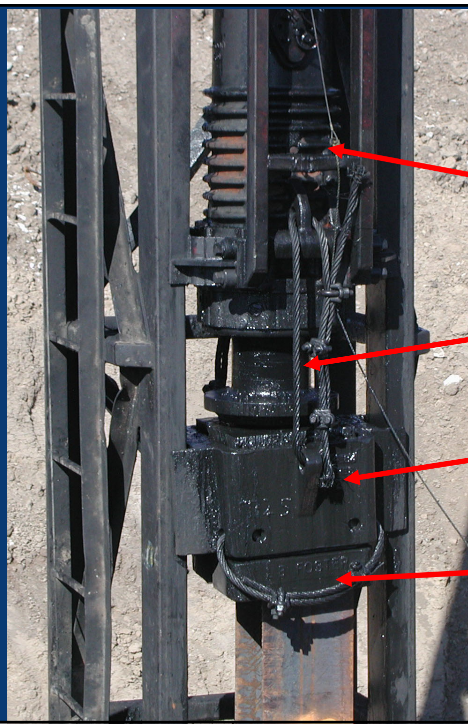
60


Exhaust
Kansas
Department of Transportation

61


Scavenging
Kansas
Department of Transportation

62



Hammer

Anvil

Helmet

Adapter

Kansas Department of Transportation

63

Rope connected to fuel pump

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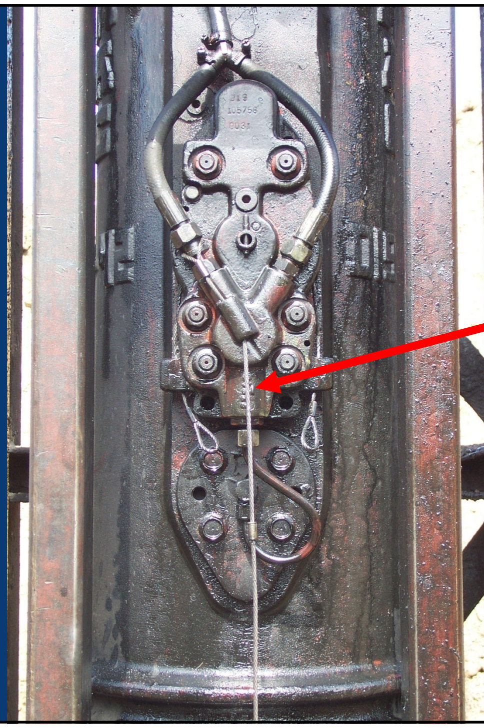
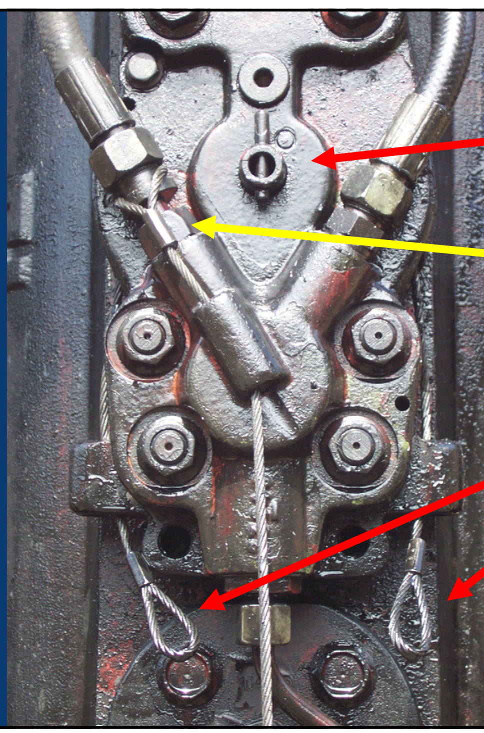
64



Rope connected to fuel pump

Kansas Department of Transportation

65



Fuel Setting Switch

Fuel Pump Cut-Off

Lines connected to setting switch

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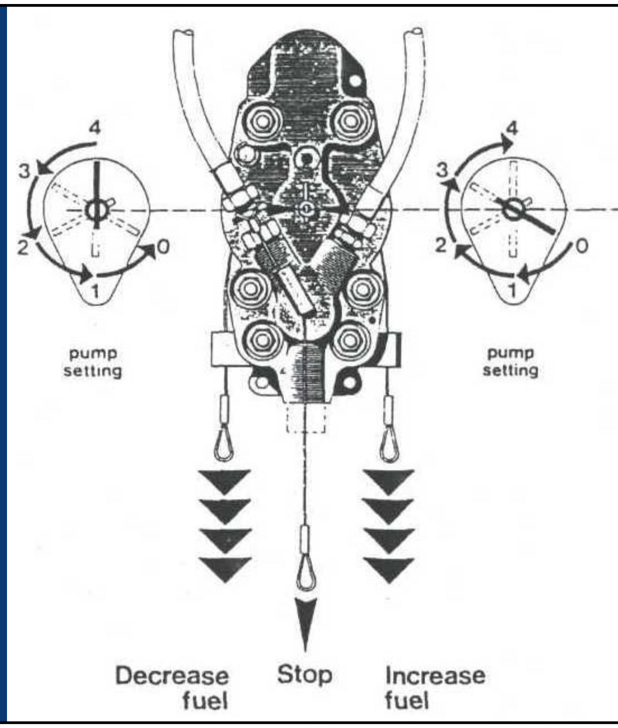
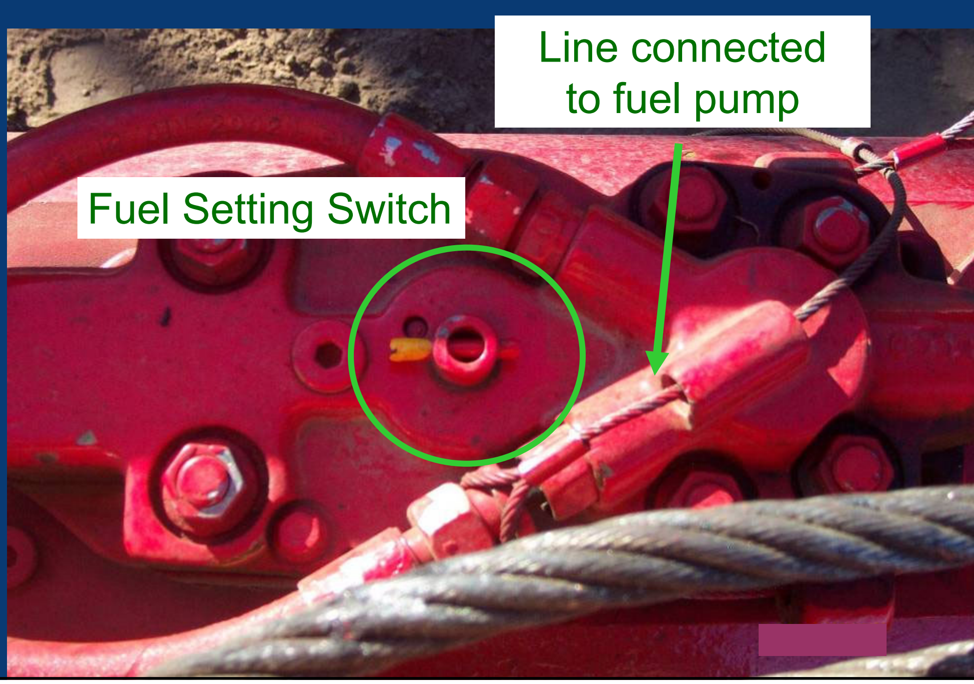
66

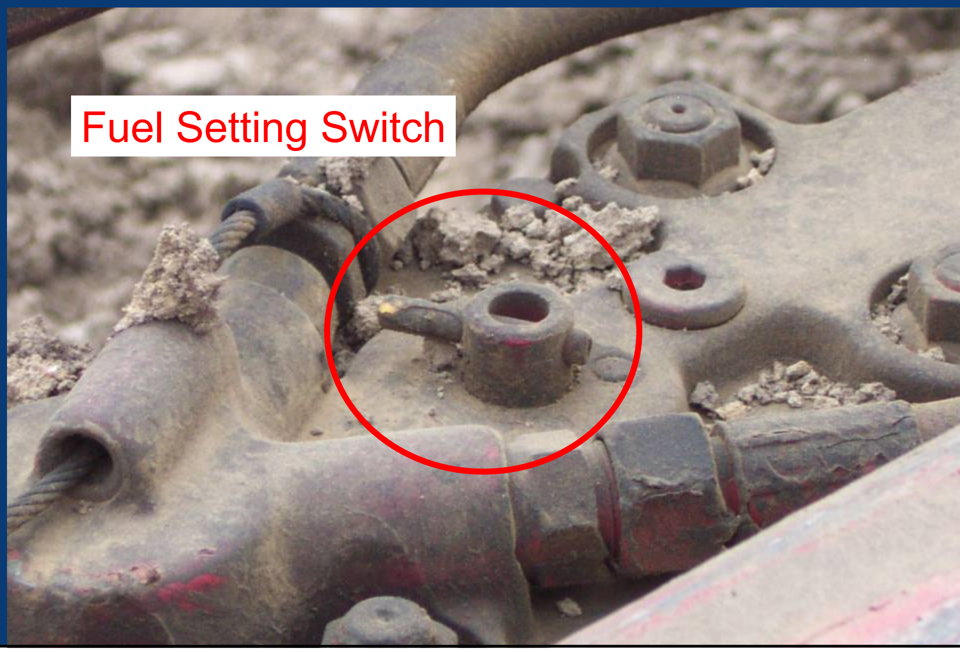


APE/Delmag Fuel Pump

67

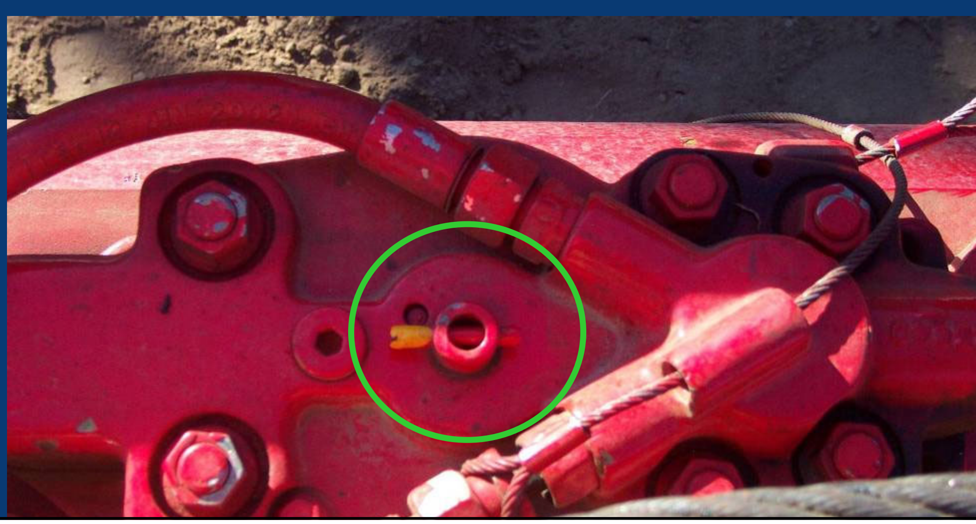


68



69

Use the highest setting in most cases



70

Range of Energy per Blow, by Pump Setting:

Example: Delmag D19-42

Position 4:	100 % =	42,800 ft-lbs
Position 3:	88 % =	37,660 ft-lbs
Position 2:	67 % =	28,680 ft-lbs
Position 1:	48 % =	20,540 ft-lbs

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71

Sometimes a contractor will drive different size pile or drive to different resistances with one large hammer. He will adjust the fuel setting accordingly.

72

You also must be careful with concrete piles and may want to use a lower fuel setting to control the hammer energy

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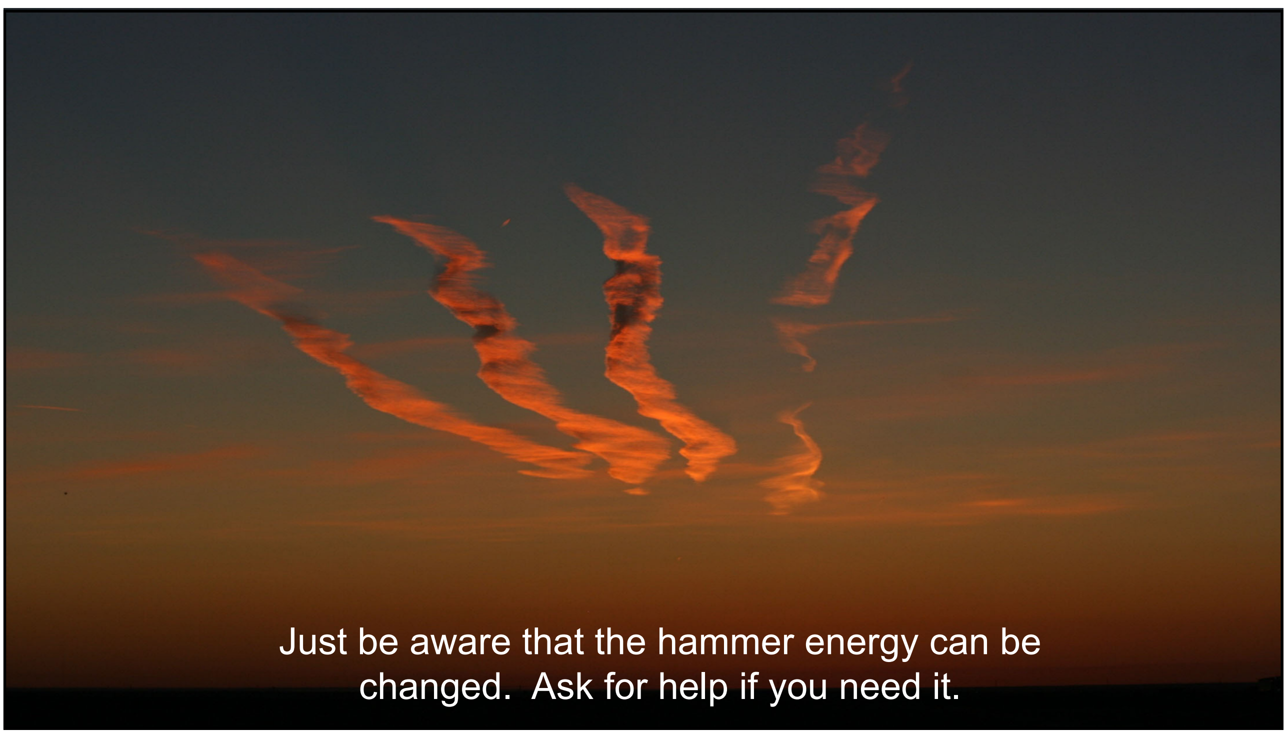
73



74

75

76

Ouija

Graduated Rod

Jump Stick

Yardstick

Make up your own name

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77

Piston at top of rebound

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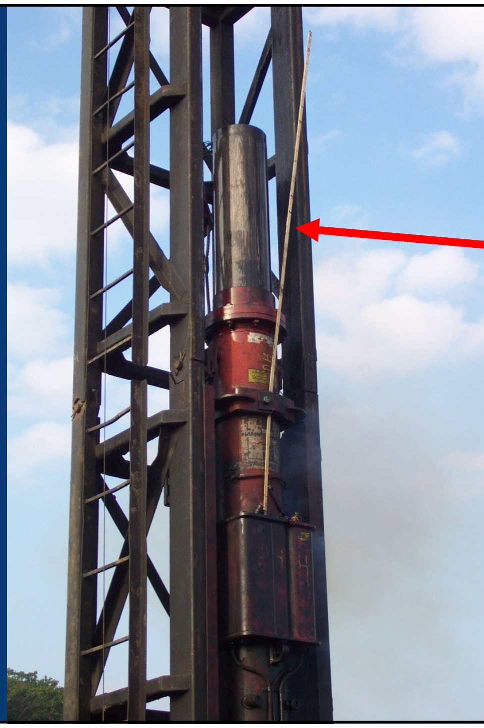
78



Piston at top of rebound 1

79

Hydraulic Hammer

Suitable for all types of pile

30 to 50 blows per minute (single-acting)

40 to 90 blows per minute (double-acting)

Energy is adjustable

80

Hydraulic
Hammer

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81

Hydraulic
Hammer 1

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Department of Transportation

82

Hydraulic Hammer 2

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83

Hydraulic Hammer

Double-acting can be used for underwater driving

Expensive to buy

More complex maintenance than other hammers

Must use another method to confirm pile capacity

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84

Hydraulic Hammer

Not allowed on KDOT projects

Can't stop it fast enough

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85

Air Hammer

Suitable for all types of pile

35 to 60 blows per minute (single-acting)

95 to 300 blows per minute (double-acting)

Double-acting can be used for underwater driving

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86

Air
Hammer

87

Air
Hammer 1

88

Air
Hammer 2

Kansas
Department of Transportation

89

Air
Hammer

Kansas
Department of Transportation

90

Air Hammer

Only moderately expensive to buy

Fairly easy to maintain

Need air compressor to run it

Heavy compared to most diesel hammers

Rarely seen on KDOT projects

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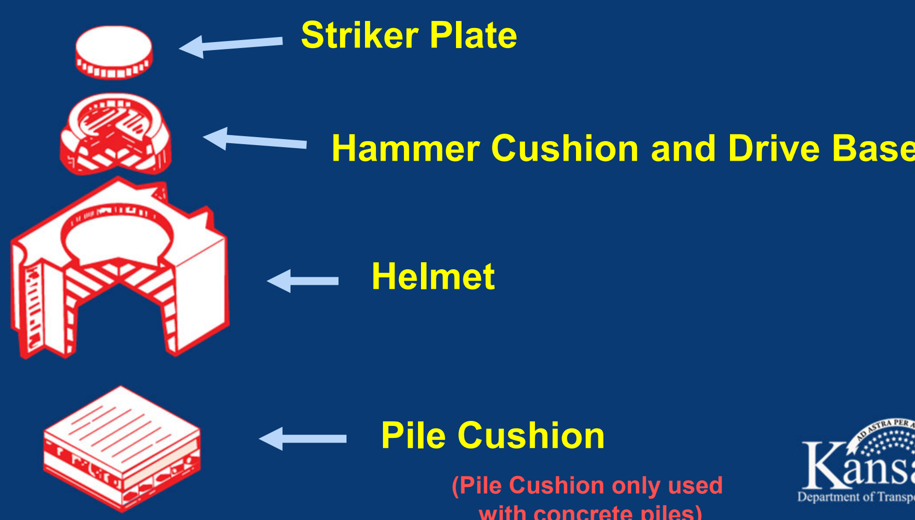
91

Pile Helmet



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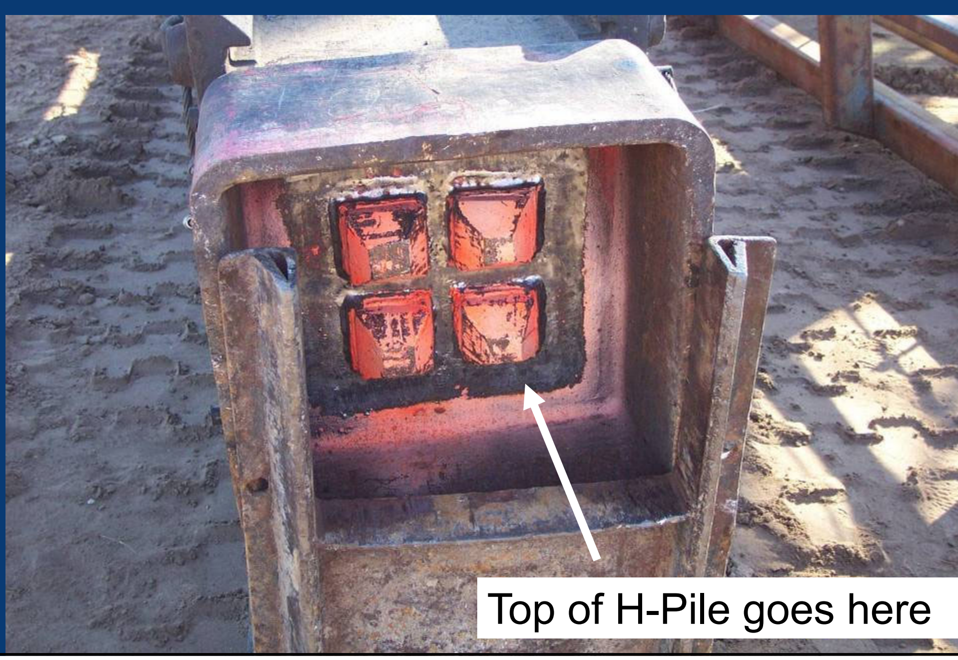
92

Pile Helmet 1

93

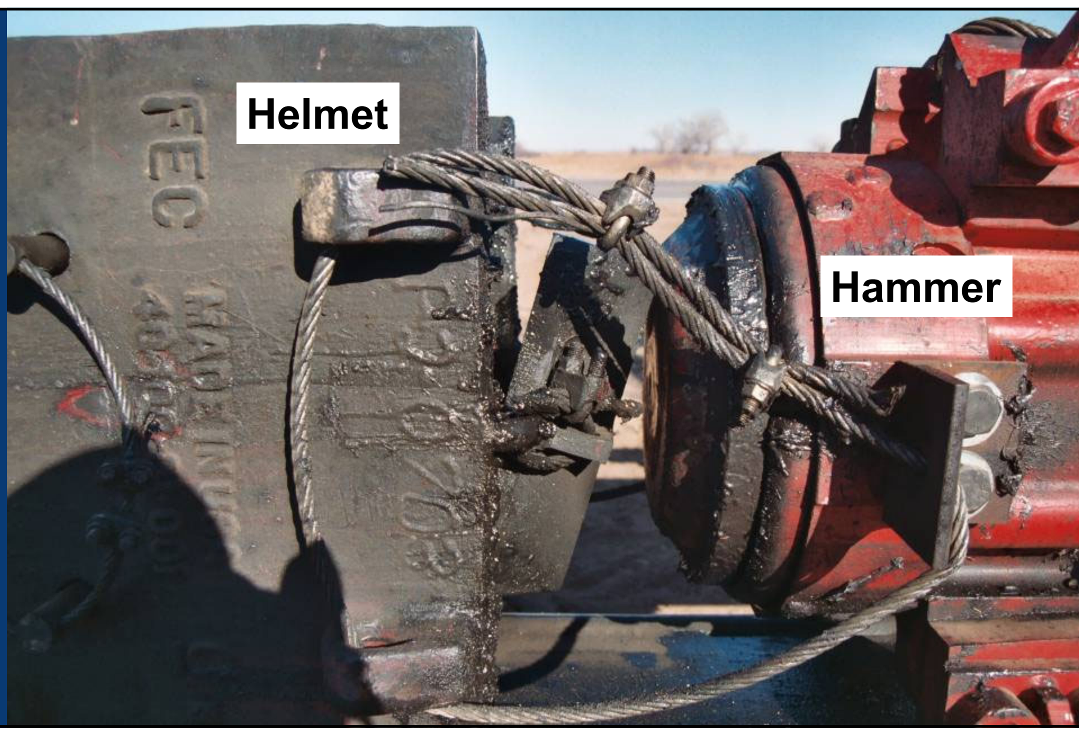
Bottom of Helmet



94

Bottom of Helmet 1

95



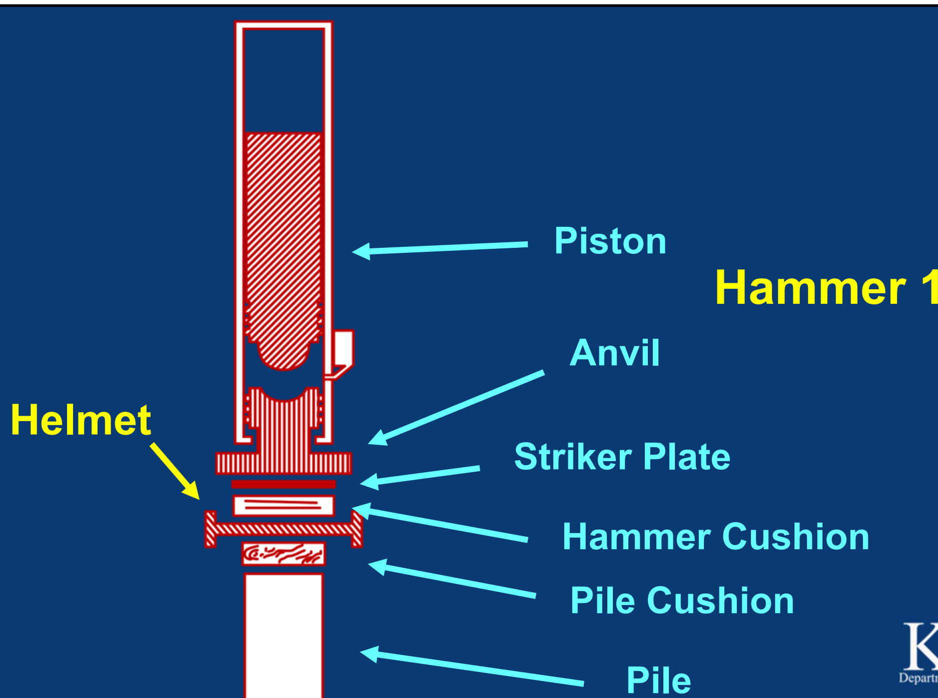
96

The bearing formula asks for the weight of the cap and anvil.

The "cap" is the pile helmet.

The "anvil" is the lowest piece of the hammer.

97



98

Normally, we call this piece the Helmet, because "pile cap" is also a structural term.

We don't need to confuse things any more than they already are.

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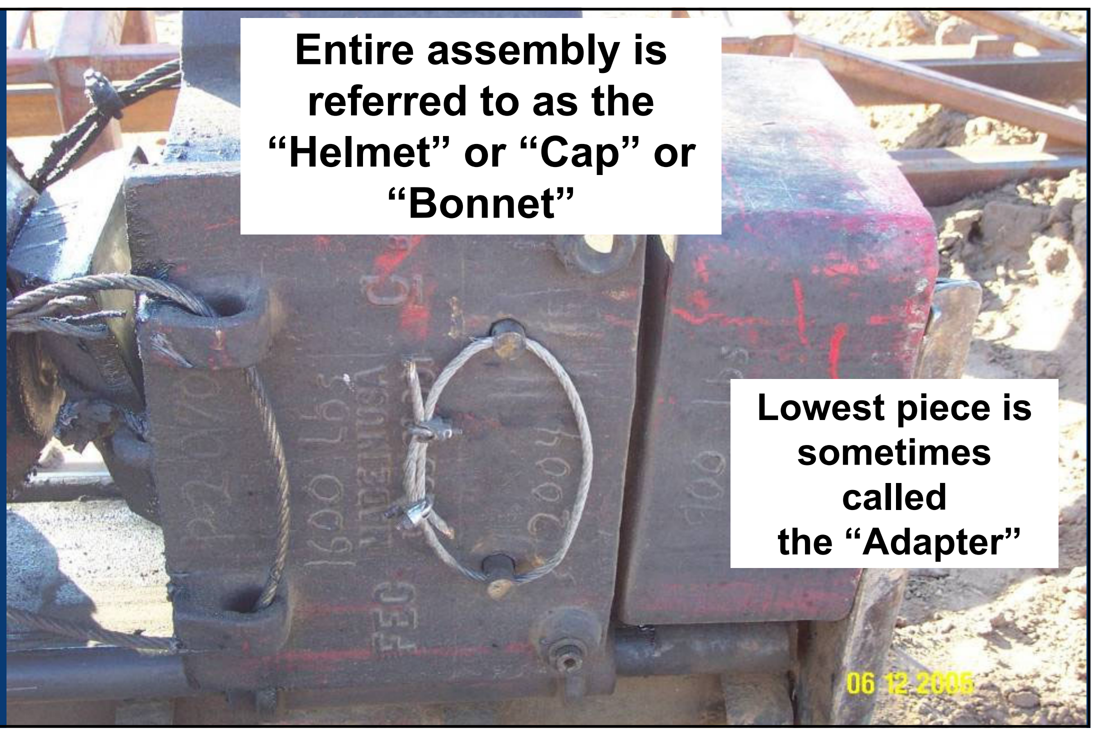
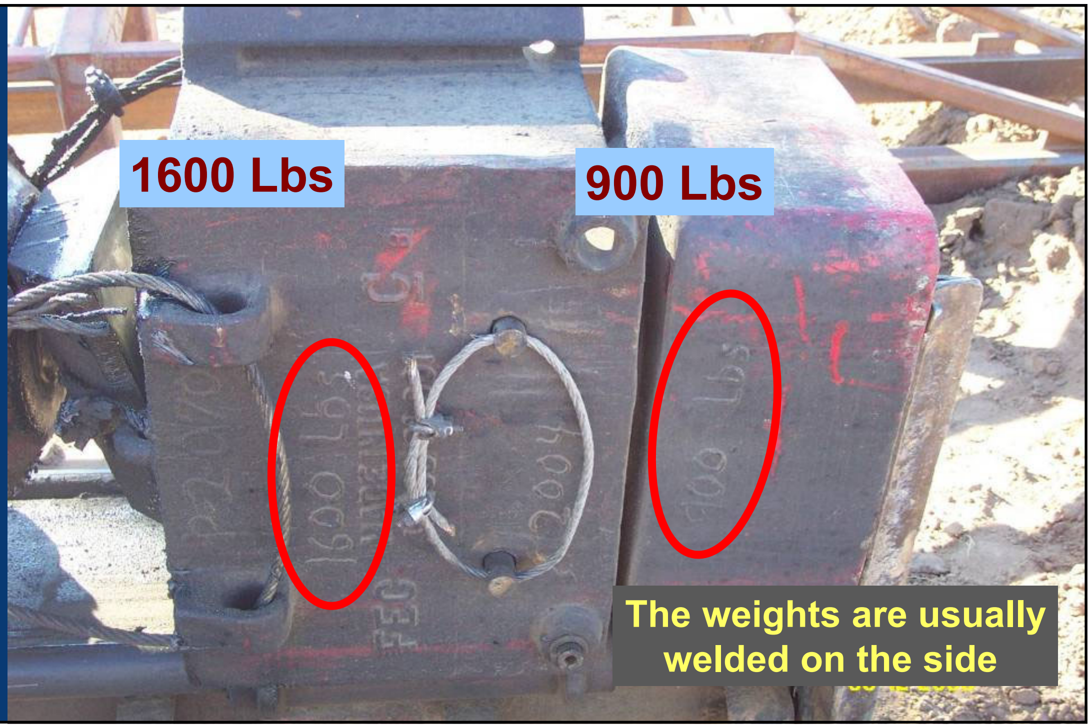
99



100



101

Hammer-helmet-pile alignment *must* be maintained, especially when driving concrete pile and thin-walled steel pipe piles.

102

Hammer Cushions

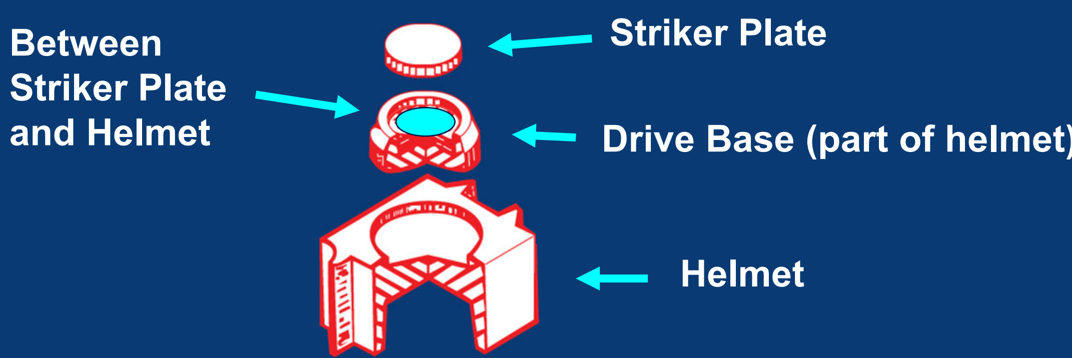
A hammer cushion is used between the hammer and the helmet to absorb some of the impact shock. This protects the hammer.

103

Sometimes also called a "cushion block"

104

Hammer Cushion



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105

Hammer Cushion 1

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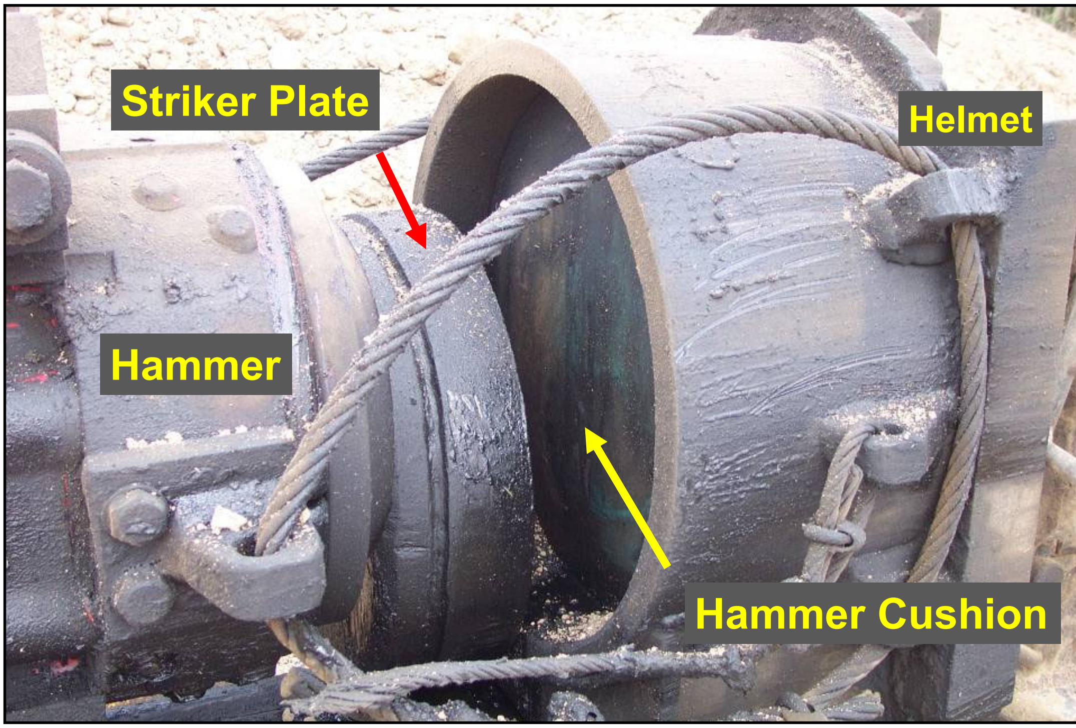
106



107

Worn-out hammer cushions cause bad things to happen…

Damage to the hammer, helmet or even the pile itself

Result in lower transferred energy to pile

Can result in increased bending stresses on pile

108

Acceptable Hammer Cushion Material

Micarta (phenolic fiber and aluminum)

Replace when it starts to powderize

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109

Acceptable Hammer Cushion Material

Micarta and Aluminum

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110

Acceptable Hammer Cushion Material

Reinforced Phenolic Resin

Acceptable Hammer Cushion Material

Nylon (usually blue)

Replace when you see horizontal cracks (vertical cracks are OK)

Acceptable Hammer Cushion Material

Nylon

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113

Also called a "cushion pad"

114

Why is everyone looking at me?….

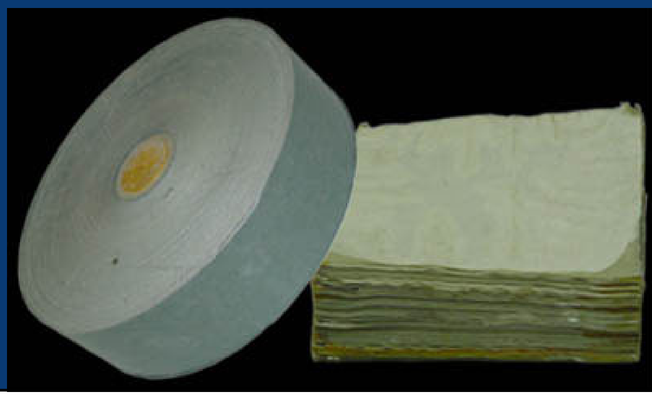
Acceptable Hammer Cushion Material

Hammortex (a reel of fiber or Kevlar sheeting backed with aluminum)

Replace when it begins disintegrating

Acceptable Hammer Cushion Material

Hammortex



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117

Acceptable Hammer Cushion Material

Urethane materials

Polymer materials

118

Aluminum may be present in laminations in hammer cushions, but only acts to transfer heat out of the cushion. This prolongs its life.

Wood, wire rope, and asbestos are *not* acceptable as a hammer cushion on KDOT projects.

(Wood can be used on gravity hammers)

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No matter what the material, KDOT requires the contractor to replace a hammer cushion when it looks like it's deteriorating, or when it's lost 25% of the original thickness.

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Most hammers on KDOT projects need cushions that are 2” to 3” thick.

It is OK to use 2 thinner cushions to make up the needed thickness.

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It’s not uncommon to have 2 thinner cushions of different materials, such as nylon and Micarta or aluminum and Micarta.

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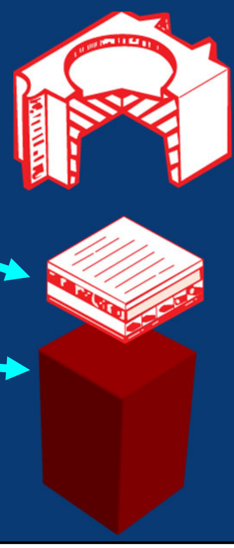
Pile Cushion—used to protect top of concrete pile



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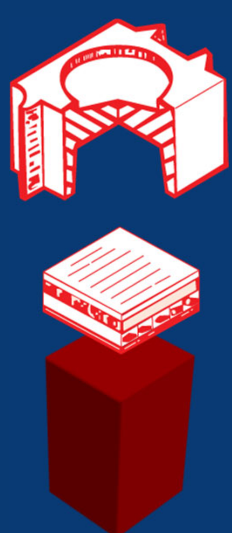
123

Pile Cushion



Concrete Pile

A **pile cushion** is required for concrete piles only

This protects the concrete from driving stresses

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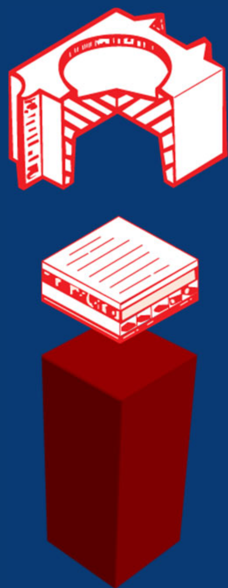
124

Pile Cushion 1

Concrete Pile



←

It will almost always consist of a stack of plywood sheets cut to fit inside the helmet.

It will try to catch fire after the hammer heats up during driving. Keep an eye on it.

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Follower

Used as an extension of the pile between the hammer and the pile head

Follower

127

Problems with followers

The follower will have a different weight per unit length from the pile

Hard to keep aligned

Allows for additional energy loss due to the compression of the follower and energy losses at the connections

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Department of Transportation

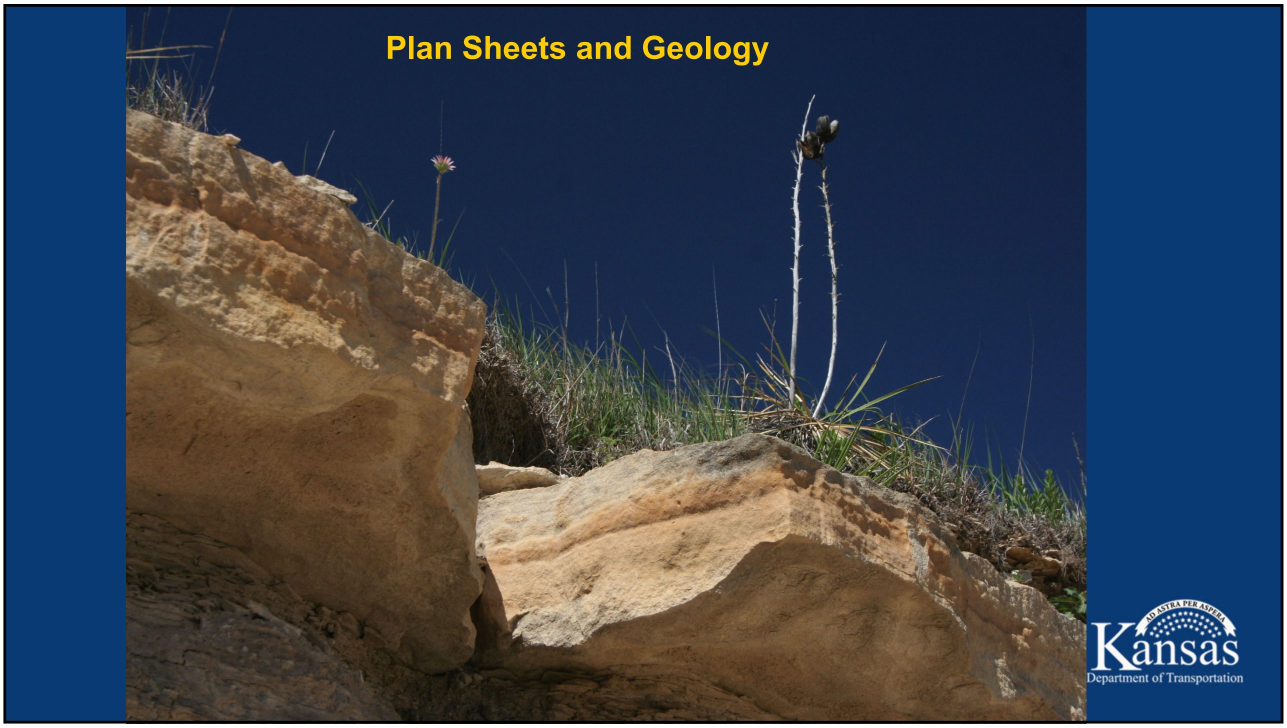
128

For these reasons, followers are not allowed on KDOT projects, except with the written permission of the Engineer

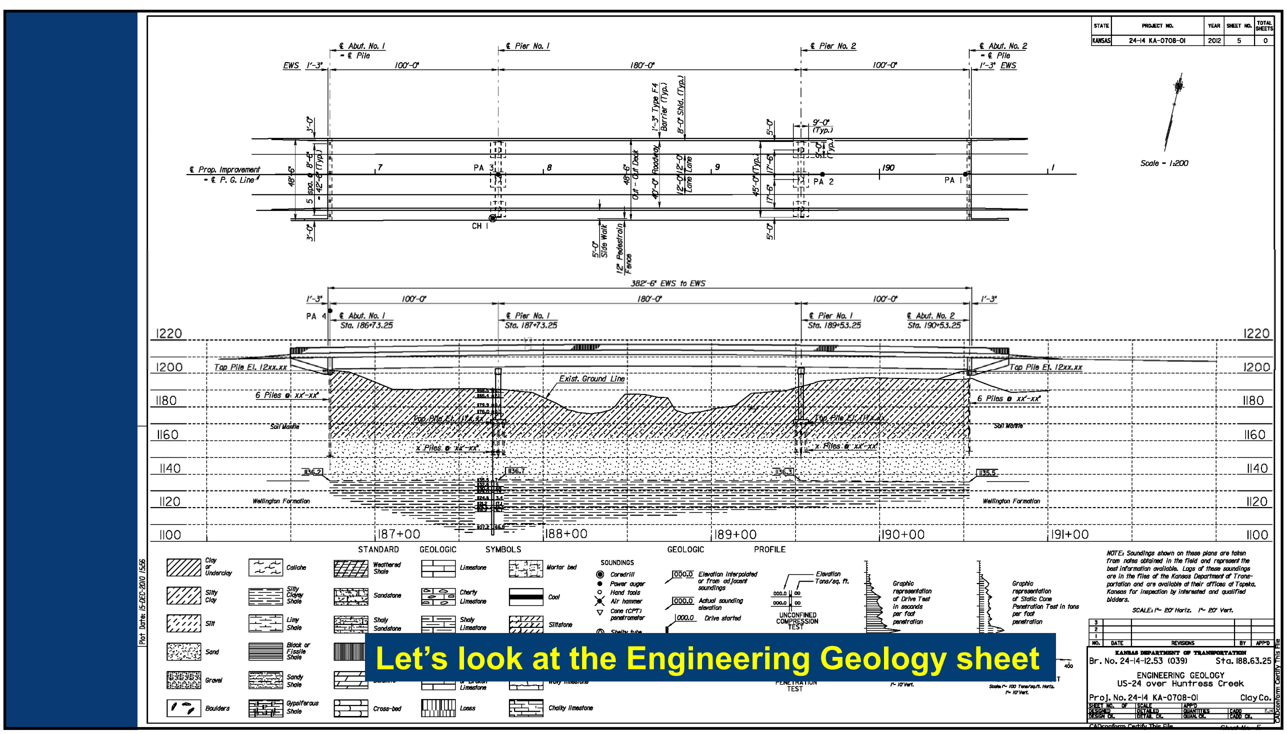
129

All Done!

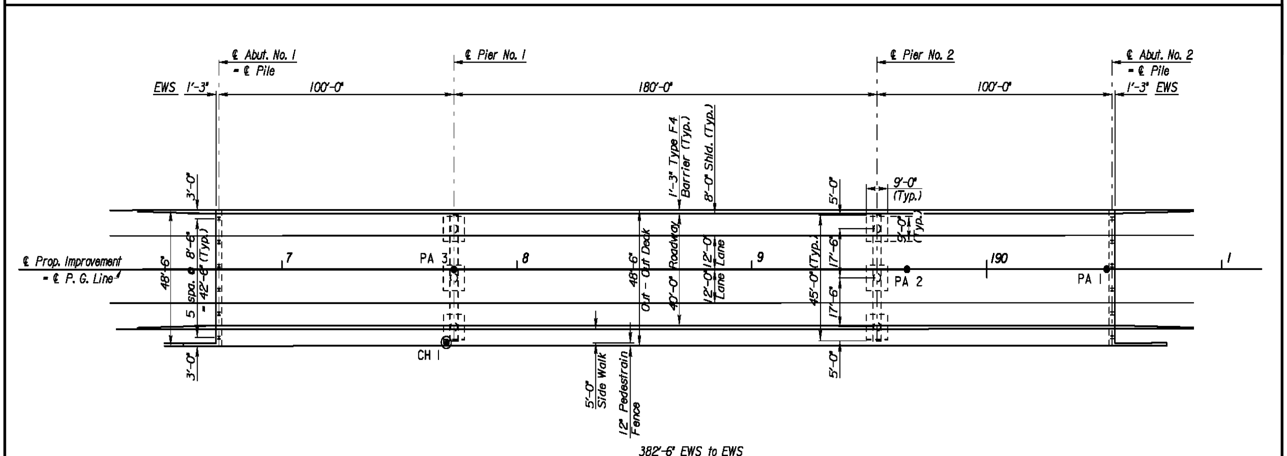
130


Plan Sheets and Geology
AD ASTRA PER ASPERA
Kansas
Department of Transportation

1


Let's look at the Engineering Geology sheet
KANSAS DEPARTMENT OF TRANSPORTATION
Br. No. 24-14-12.53 (039)
Sta. 188.63.25
ENGINEERING GEOLOGY
US-24 over Huntress Creek
Proj. No. 24-14 KA-0708-01
Clay Co.
STANDARD GEOLOGIC SYMBOLS
GEOLOGIC PROFILE
Exist. Ground Line
Wellington Formation
382'-6" EWS to EWS
187+00
188+00
189+00
190+00
191+00

2



Top half of page shows plan view of bridge with our drill locations

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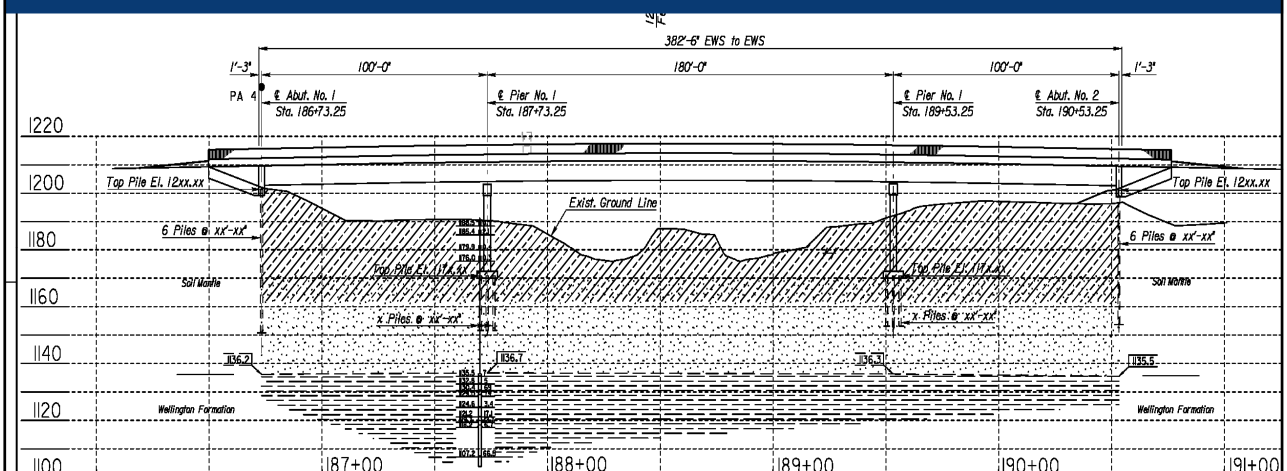

Bottom half of page shows a cross-section of the subsurface, with geology drawn in

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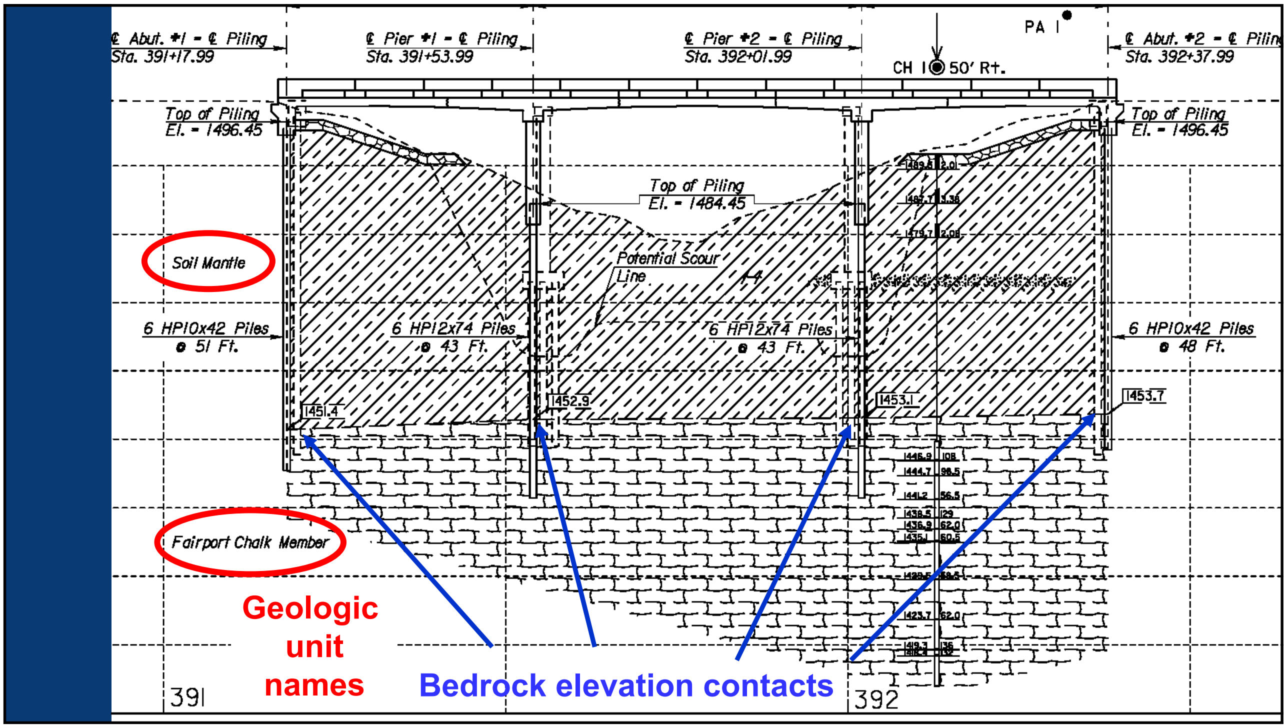
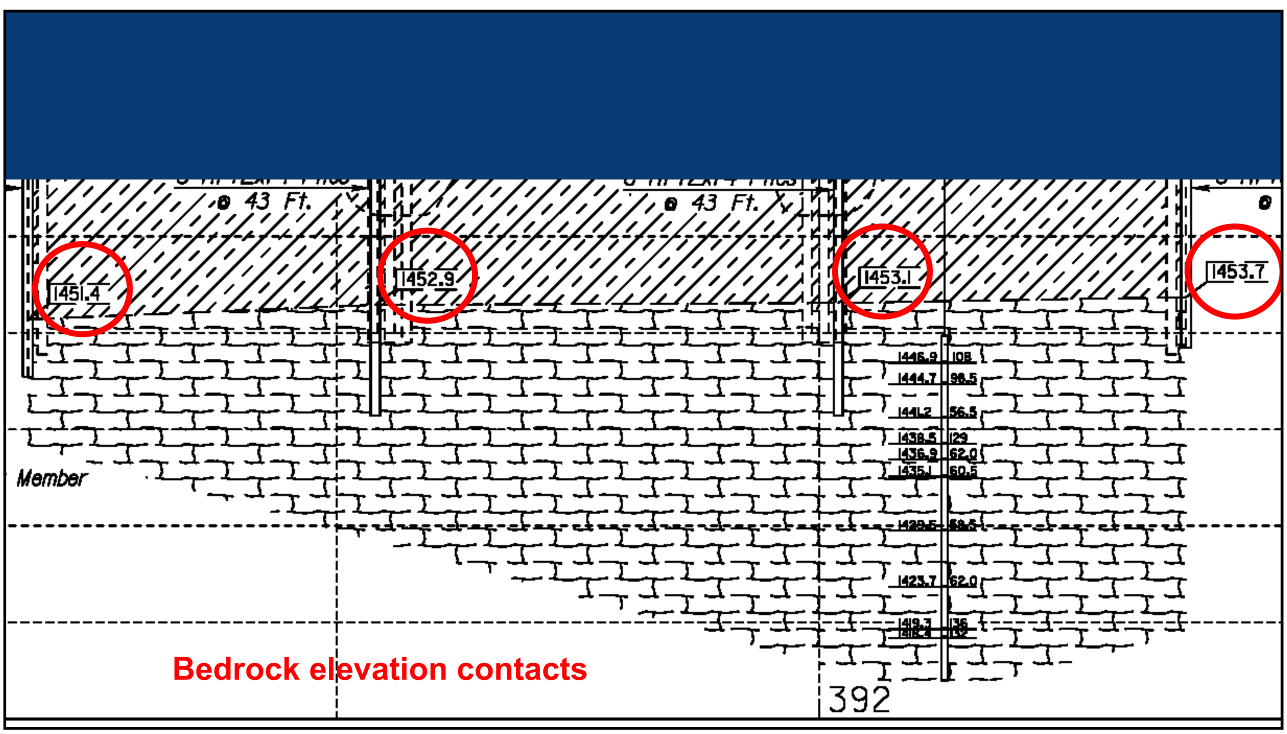


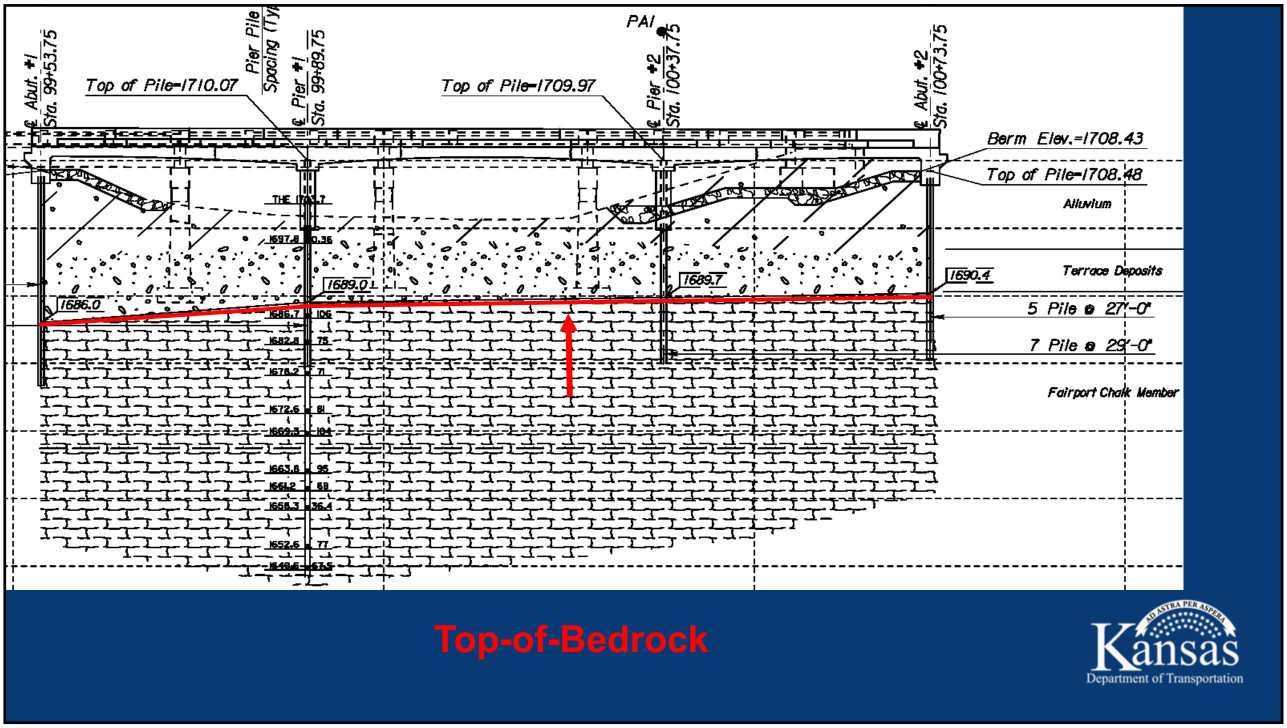
℄ Abut. #1 = ℄ Piling
Sta. 391+17.99
℄ Pier #1 = ℄ Piling
Sta. 391+53.99
℄ Pier #2 = ℄ Piling
Sta. 392+01.99
PA 1
CH 1 50′ Rt.
℄ Abut. #2 = ℄ Piling
Sta. 392+37.99
Top of Piling
El. = 1496.45
Top of Piling
El. = 1484.45
Top of Piling
El. = 1496.45
Soil Mantle
Potential Scour
Line
6 HP10x42 Piles
@ 51 Ft.
6 HP12x74 Piles
@ 43 Ft.
6 HP12x74 Piles
@ 43 Ft.
6 HP10x42 Piles
@ 48 Ft.
1451.4
1452.9
1453.1
1453.7
Fairport Chalk Member
Geologic
unit
names
Bedrock elevation contacts
391
392

5

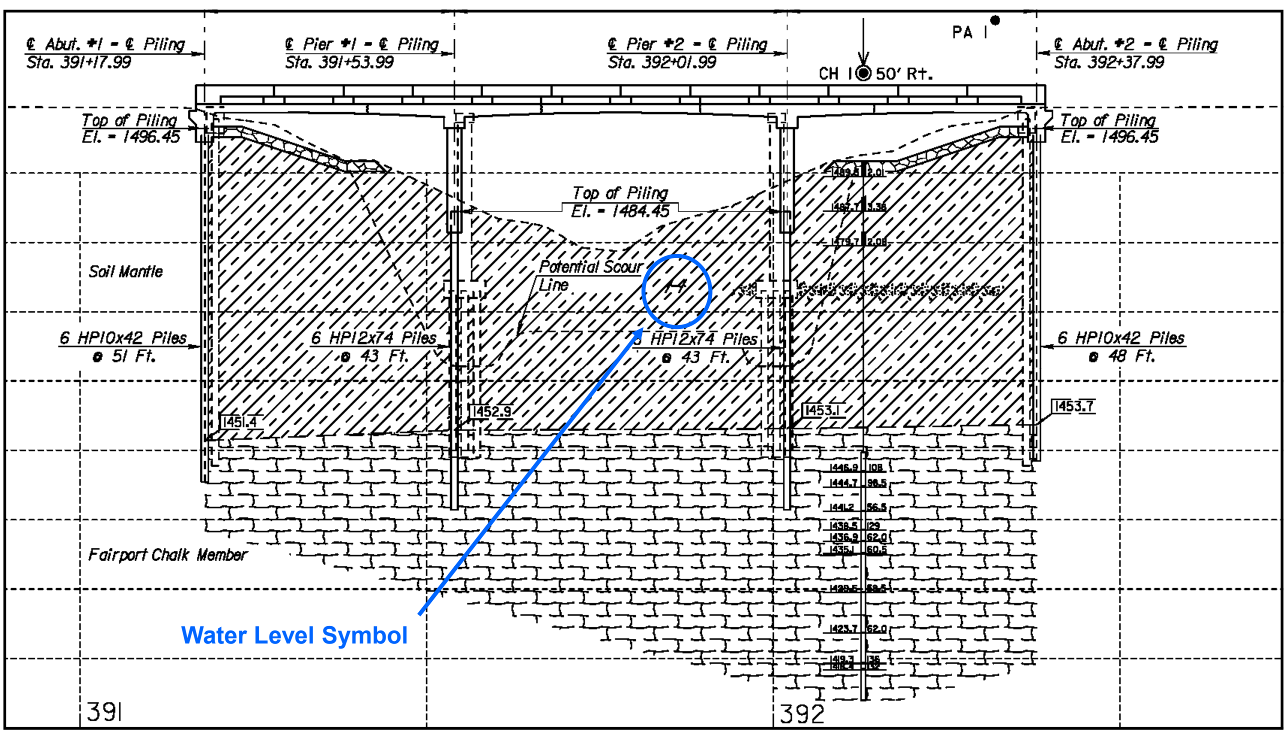


@ 43 Ft.
@ 43 Ft.
1451.4
1452.9
1453.1
1453.7
1446.9 108
1444.7 96.5
1441.2 56.5
1438.5 129
1436.9 62.0
1435.1 60.5
1423.7 62.0
Member
Bedrock elevation contacts
392

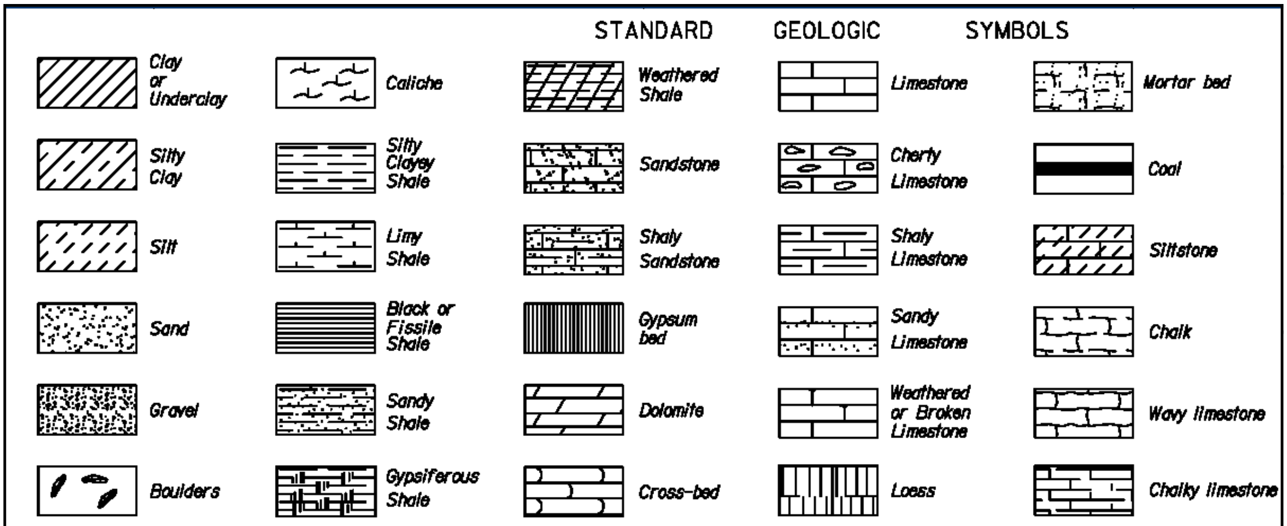
6


℄ Abut. #1
Sta. 99+53.75
Top of Pile-1710.07
Pier Pile Spacing (Typ
℄ Pier #1
Sta. 99+89.75
Top of Pile-1709.97
PAI
℄ Pier #2
Sta. 100+37.75
℄ Abut. #2
Sta. 100+73.75
Berm Elev.=1708.43
Top of Pile-1708.48
Alluvium
Terrace Deposits
1690.4
1689.0
1689.7
1686.0
5 Pile @ 27'-0"
7 Pile @ 29'-0"
Fairport Chalk Member
Top-of-Bedrock
Kansas
Department of Transportation

7


℄ Abut. #1 - ℄ Piling
Sta. 391+17.99
℄ Pier #1 - ℄ Piling
Sta. 391+53.99
℄ Pier #2 - ℄ Piling
Sta. 392+01.99
PA 1
CH 1 50' Rt.
℄ Abut. #2 - ℄ Piling
Sta. 392+37.99
Top of Piling
El. = 1496.45
Top of Piling
El. = 1496.45
Top of Piling
El. = 1484.45
Soil Mantle
Potential Scour
Line
6 HP10x42 Piles
@ 51 Ft.
6 HP12x74 Piles
@ 43 Ft.
6 HP12x74 Piles
@ 43 Ft.
6 HP10x42 Piles
@ 48 Ft.
1451.4
1452.9
1453.1
1453.7
Fairport Chalk Member
Water Level Symbol
391
392

8



Standard Geology Symbols

Lower left corner of Engineering Geology sheet

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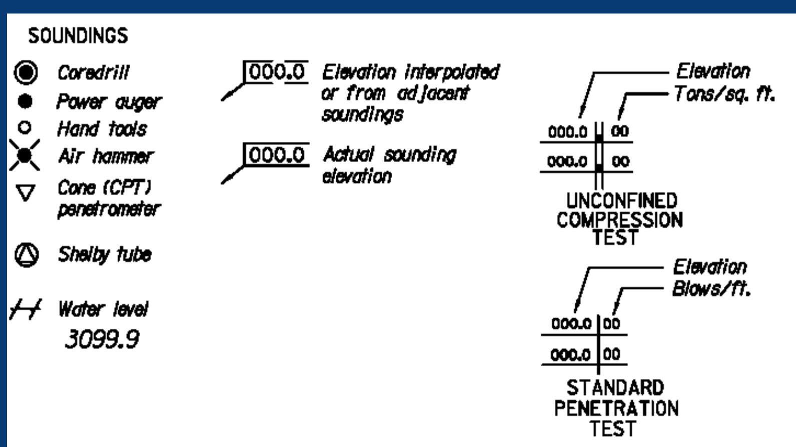

Legend

Bottom of Engineering Geology sheet

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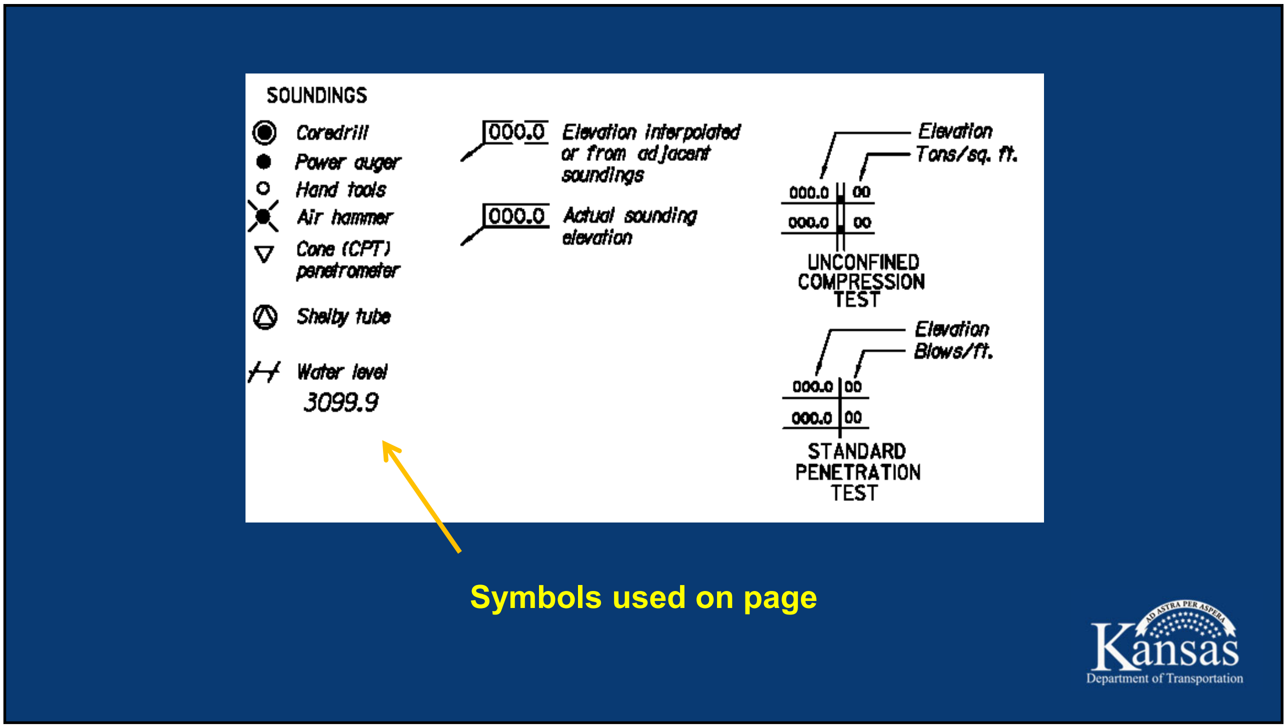
SOUNDINGS
Coredrill
Power auger
Hand tools
Air hammer
Cone (CPT) penetrometer
Shelby tube
Water level
3099.9
000.0 Elevation interpolated or from adjacent soundings
000.0 Actual sounding elevation
Elevation
Tons/sq. ft.
000.0 00
000.0 00
UNCONFINED COMPRESSION TEST
Elevation
Blows/ft.
000.0 00
000.0 00
STANDARD PENETRATION TEST
Symbols used on page
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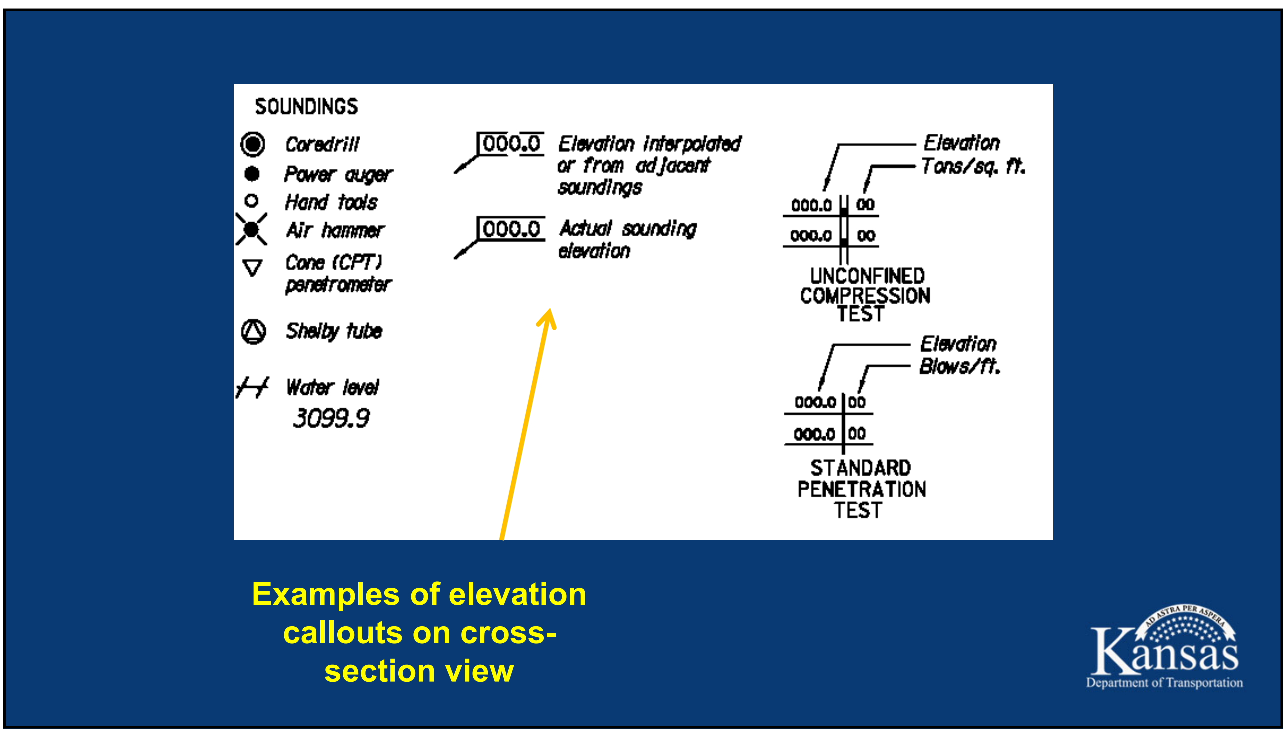
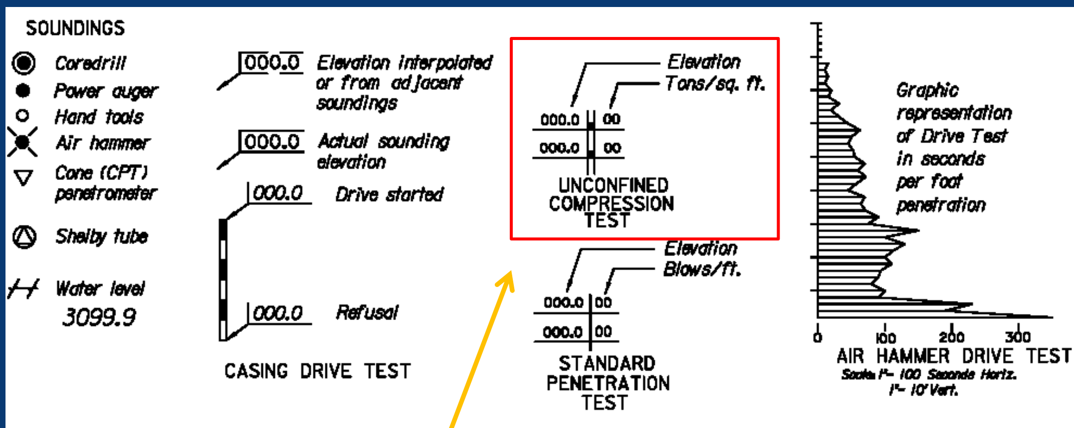
11


SOUNDINGS
Coredrill
Power auger
Hand tools
Air hammer
Cone (CPT) penetrometer
Shelby tube
Water level
3099.9
000.0 Elevation interpolated or from adjacent soundings
000.0 Actual sounding elevation
Elevation
Tons/sq. ft.
000.0 00
000.0 00
UNCONFINED COMPRESSION TEST
Elevation
Blows/ft.
000.0 00
000.0 00
STANDARD PENETRATION TEST
Examples of elevation callouts on cross-section view
Kansas
Department of Transportation

12



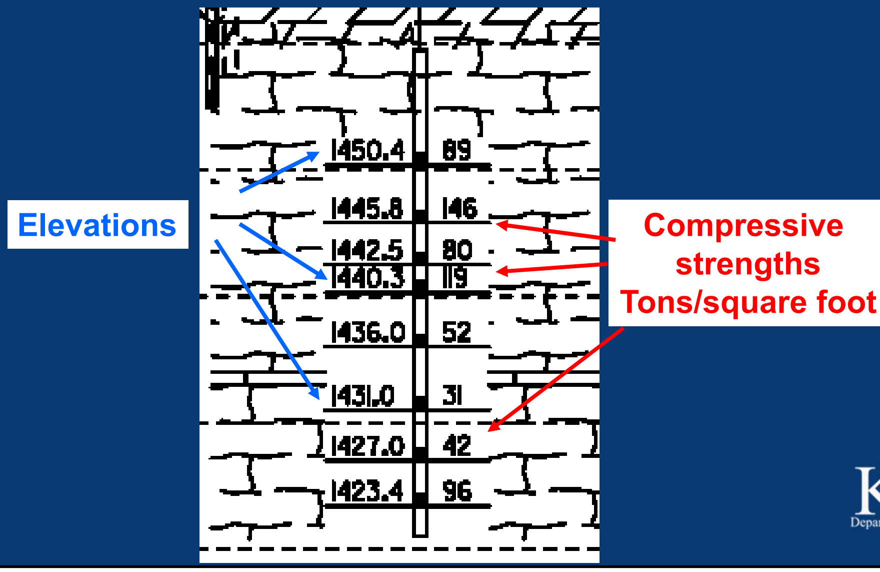
Format of results of lab strength tests on core samples

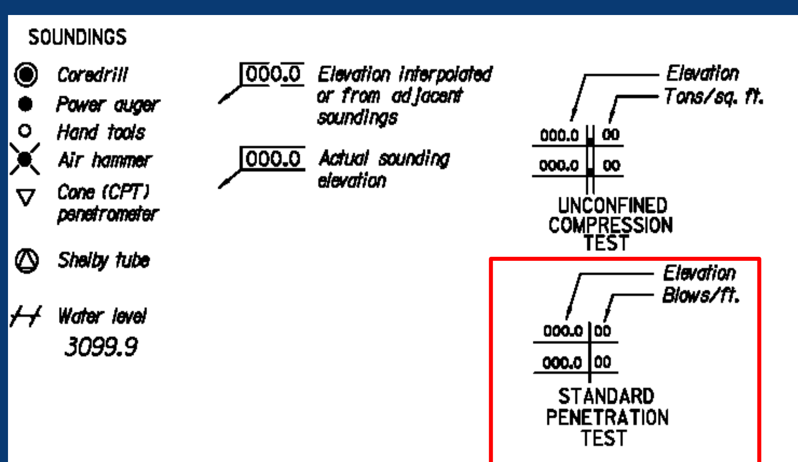
13

Cores

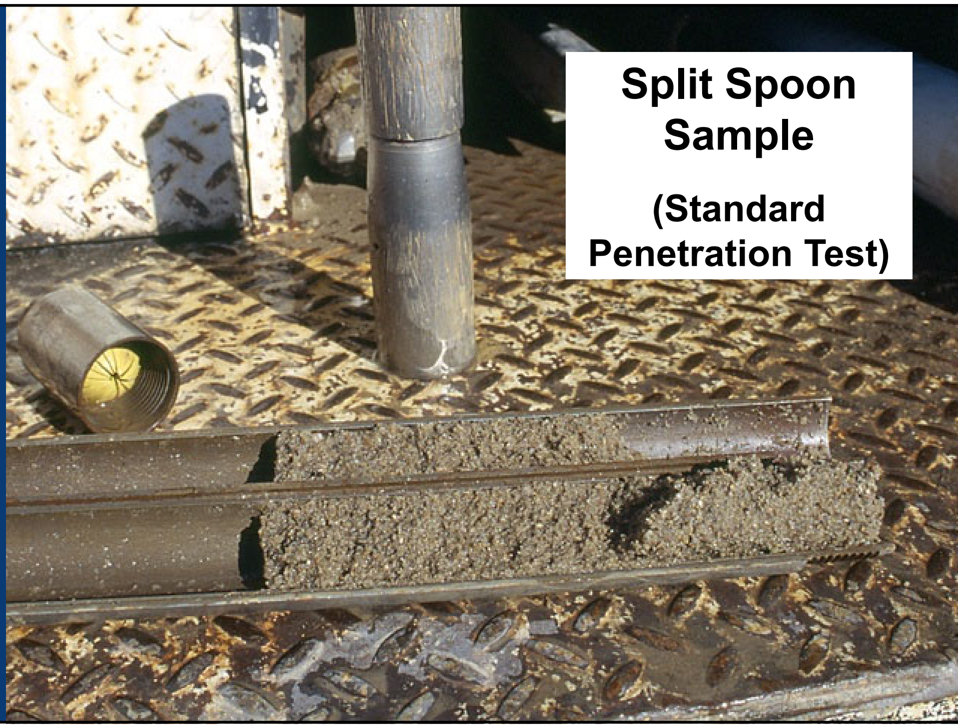
14

“Core Tree” on Engineering Geology Sheet
Results of lab tests on soil and rock samples





Format of standard penetration test results



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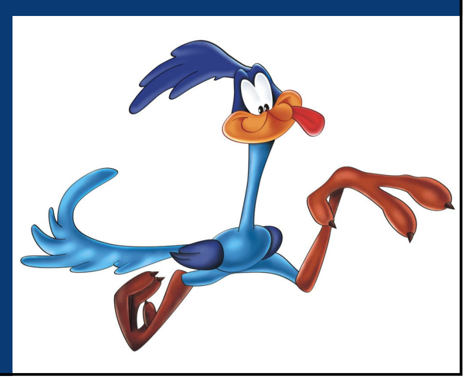
Standard Penetration Test

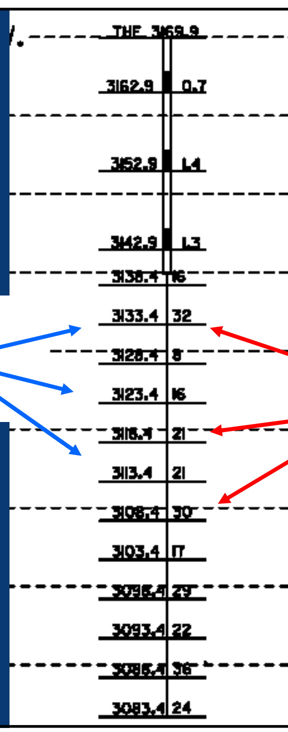
Gives both a relative resistance of the soil and a sample of it

Been around since the 1920’s

Used all over the world



18



Elevations

Standard Penetration Test Blow Counts

Core Drill with Water Truck

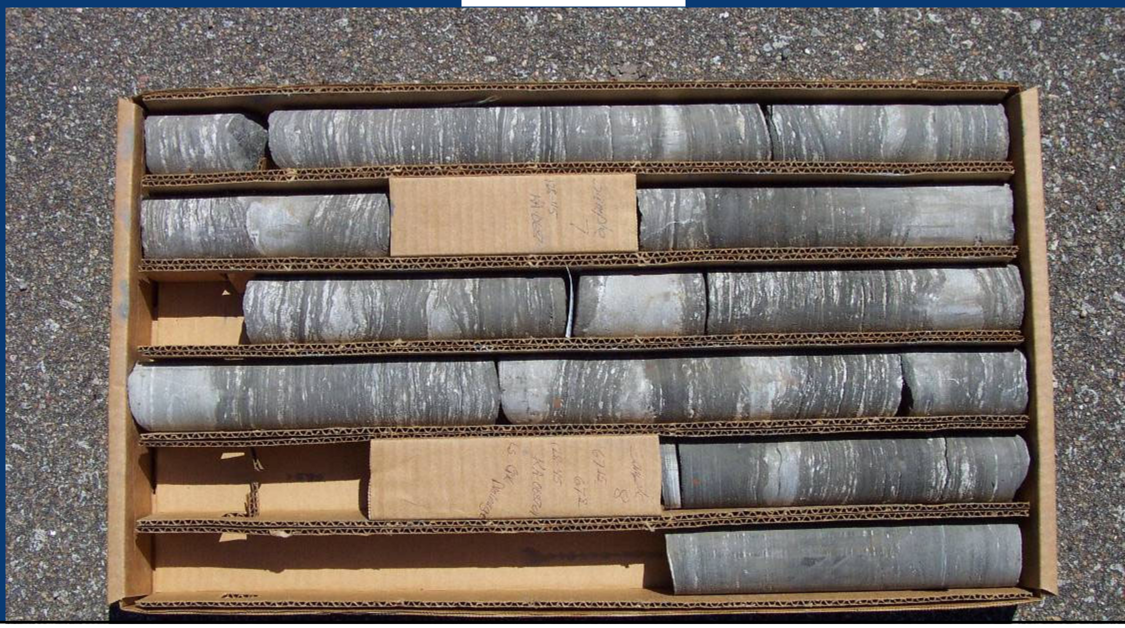
21

22

23

24

Cores

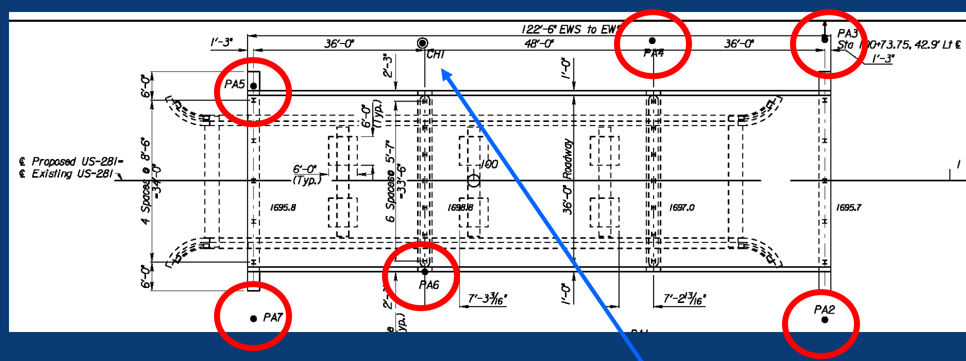


25

Cores

1.87” diameter

26



Power Auger Soundings

Core Hole

Power Auger

29

30

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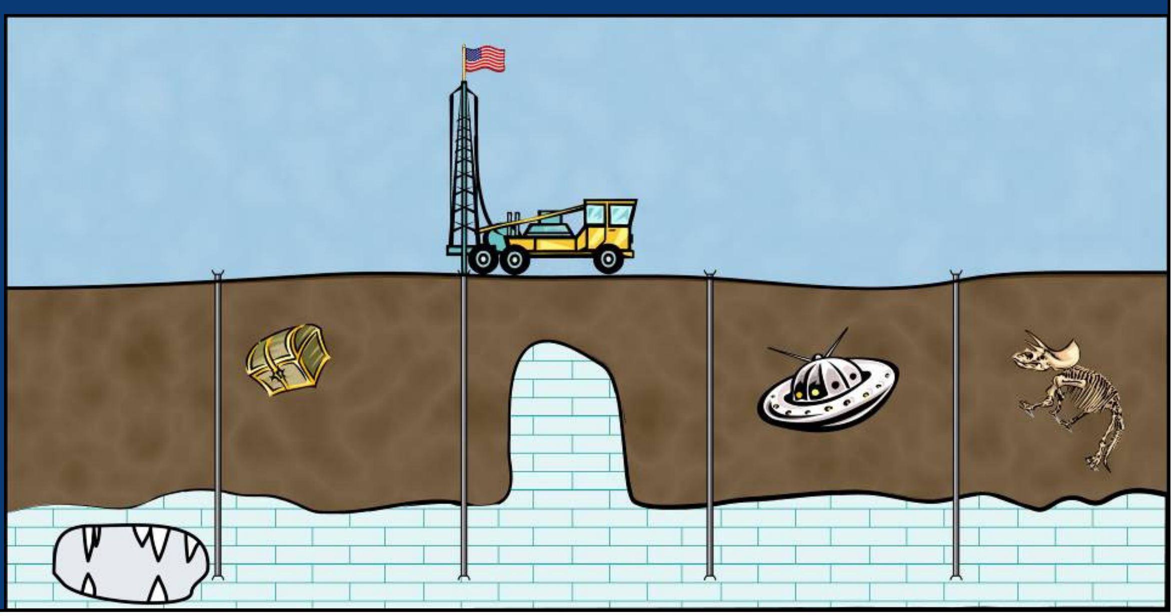
This is what we *hope* doesn't happen



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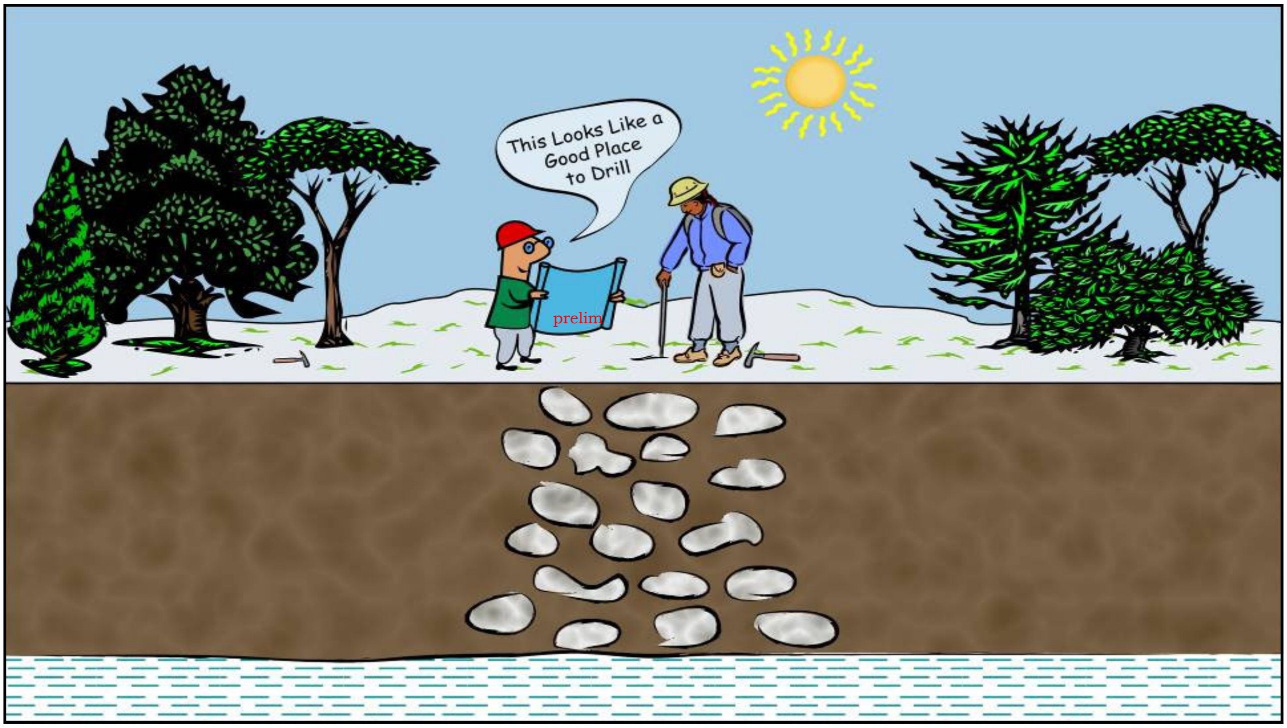
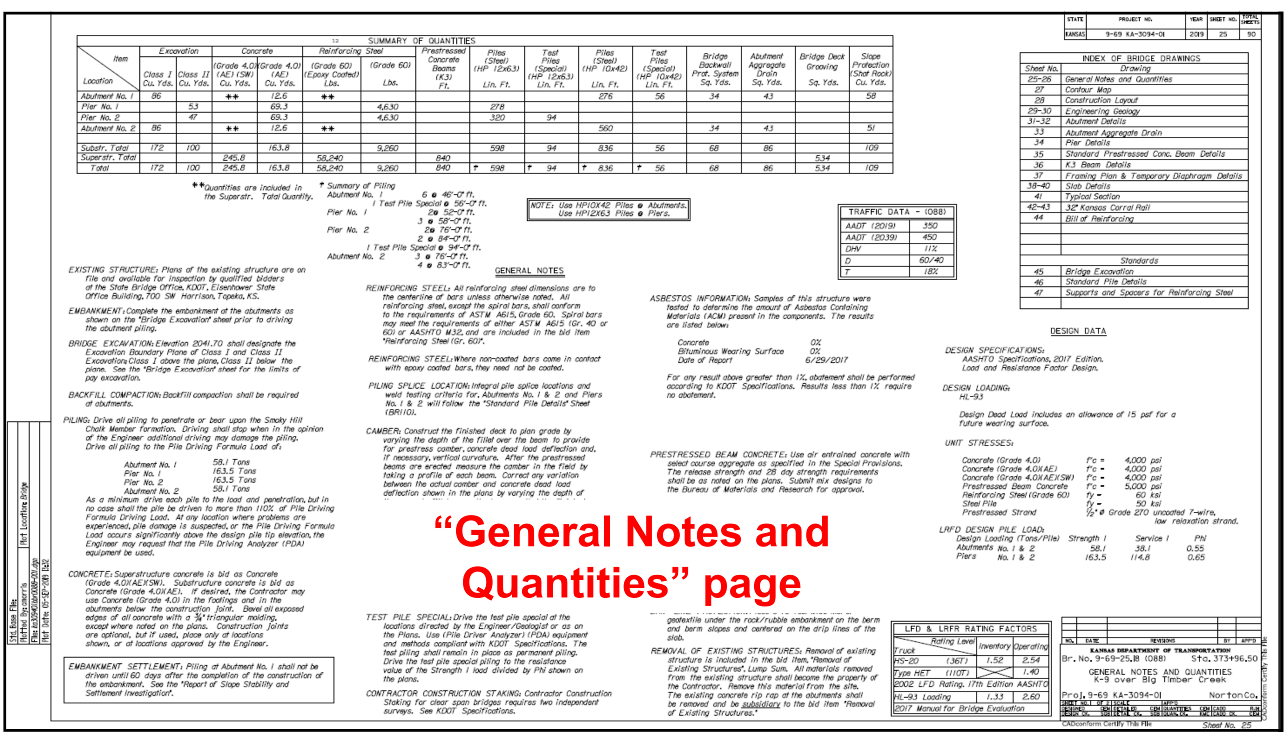

This Looks Like a Good Place to Drill
prelim

33


SUMMARY OF QUANTITIES
INDEX OF BRIDGE DRAWINGS
GENERAL NOTES
DESIGN DATA
TRAFFIC DATA - (088)
LFD & LRFR RATING FACTORS
“General Notes and Quantities” page

34

Excavation Boundary Plane of Class I and Class II Excavation; Class I above the plane, Class II below the plane. See the "Bridge Excavation" sheet for the limits of pay excavation.

BACKFILL COMPACTION: Backfill compaction shall be required at abutments.

PILING: Drive all piling to penetrate or bear upon the Smoky Hill Chalk Member formation. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment No. 1	58.1 Tons
Pier No. 1	163.5 Tons
Pier No. 2	163.5 Tons
Abutment No. 2	58.1 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving

Plot Location: Bridge

Look for the " PILING: " note on this page.
It will have the numbers you need for driving.

35

PILING: Drive all piling to penetrate or bear upon the Smoky Hill Chalk Member formation. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the $\boxed{\text{Pile Driving Formula Load}}$ of:

Abutment No. 1	58.1 Tons
Pier No. 1	163.5 Tons
Pier No. 2	163.5 Tons
Abutment No. 2	58.1 Tons

This is what you're interested in.

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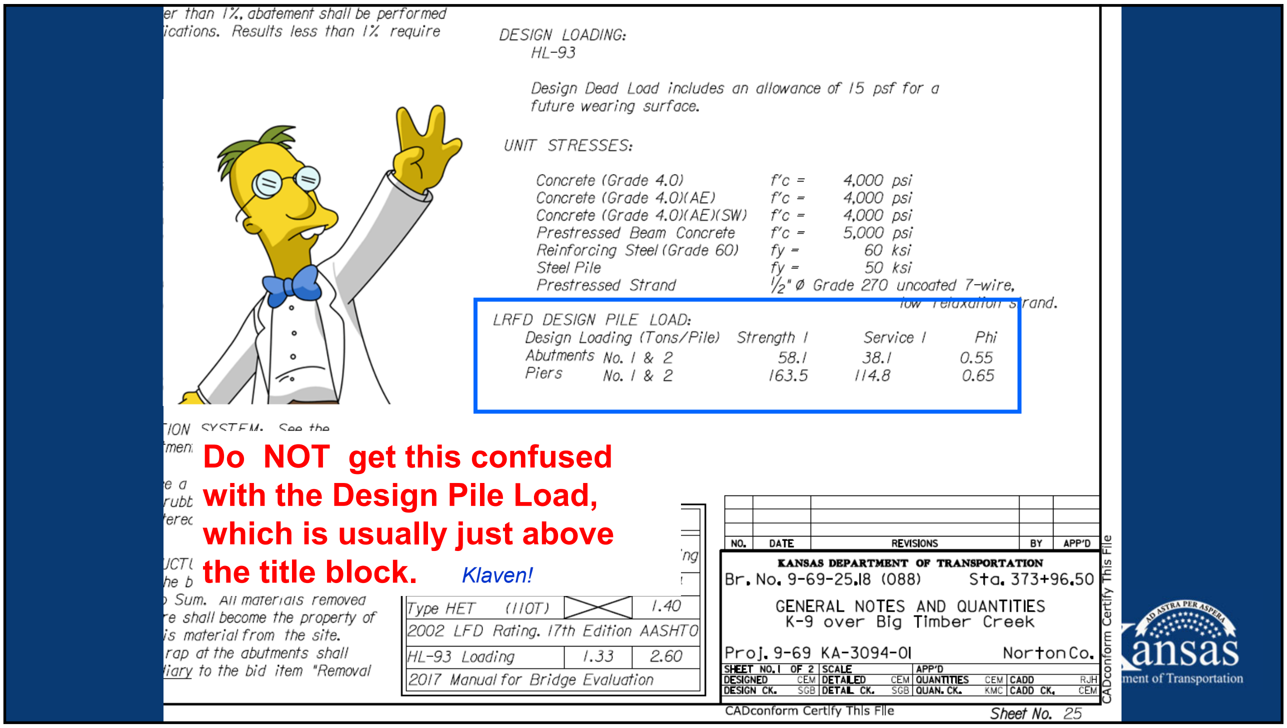
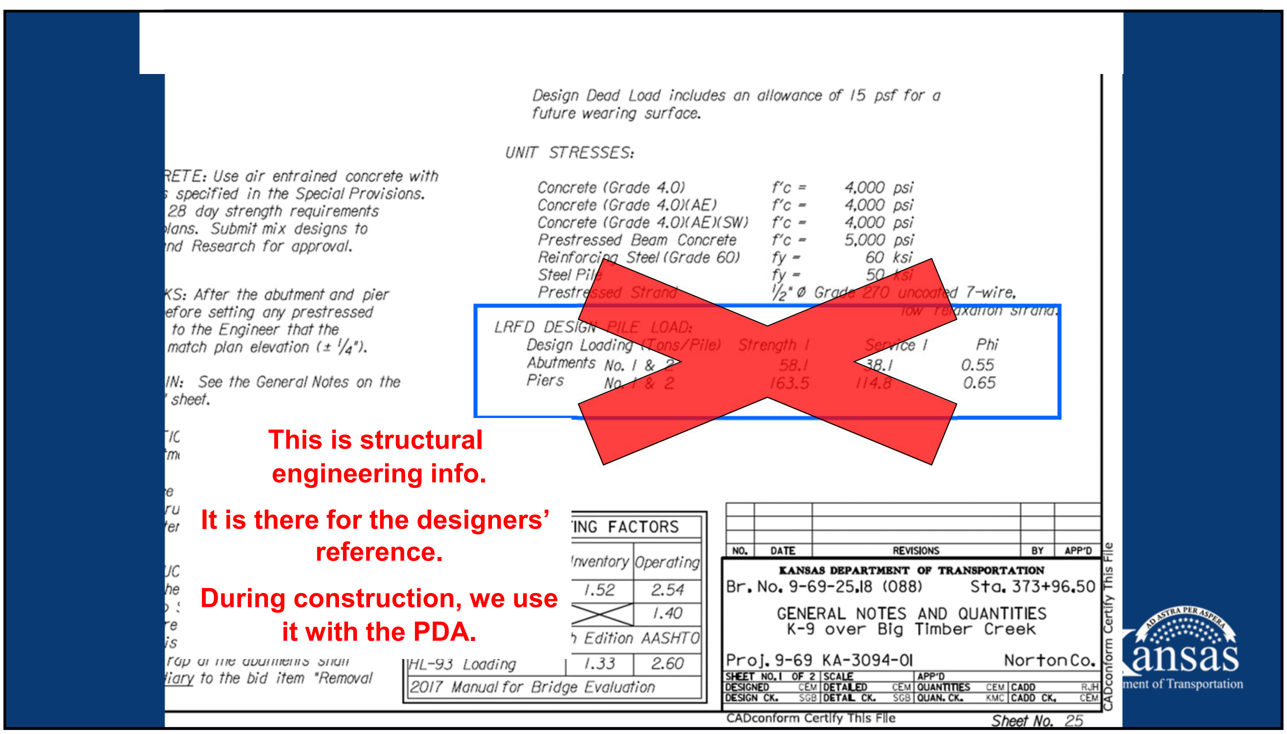

DESIGN LOADING:
HL-93
Design Dead Load includes an allowance of 15 psf for a future wearing surface.
UNIT STRESSES:
Concrete (Grade 4.0) f'c = 4,000 psi
Concrete (Grade 4.0)(AE) f'c = 4,000 psi
Concrete (Grade 4.0)(AE)(SW) f'c = 4,000 psi
Prestressed Beam Concrete f'c = 5,000 psi
Reinforcing Steel (Grade 60) fy = 60 ksi
Steel Pile fy = 50 ksi
Prestressed Strand ½" Ø Grade 270 uncoated 7-wire, low relaxation strand.
LRFD DESIGN PILE LOAD:
Design Loading (Tons/Pile) Strength I Service I Phi
Abutments No. 1 & 2 58.1 38.1 0.55
Piers No. 1 & 2 163.5 114.8 0.65
Do NOT get this confused with the Design Pile Load, which is usually just above the title block.
Klaven!
Type HET (110T) 1.40
2002 LFD Rating. 17th Edition AASHTO
HL-93 Loading 1.33 2.60
2017 Manual for Bridge Evaluation
NO. DATE REVISIONS BY APP'D
KANSAS DEPARTMENT OF TRANSPORTATION
Br. No. 9-69-25.18 (088) Sta. 373+96.50
GENERAL NOTES AND QUANTITIES
K-9 over Big Timber Creek
Proj. 9-69 KA-3094-01 Norton Co.
CADconform Certify This File
Sheet No. 25

37


Design Dead Load includes an allowance of 15 psf for a future wearing surface.
UNIT STRESSES:
Concrete (Grade 4.0) f'c = 4,000 psi
Concrete (Grade 4.0)(AE) f'c = 4,000 psi
Concrete (Grade 4.0)(AE)(SW) f'c = 4,000 psi
Prestressed Beam Concrete f'c = 5,000 psi
Reinforcing Steel (Grade 60) fy = 60 ksi
LRFD DESIGN PILE LOAD:
Design Loading (Tons/Pile) Strength I Service I Phi
Abutments No. 1 & 2 58.1 38.1 0.55
Piers No. 1 & 2 163.5 114.8 0.65
This is structural engineering info.
It is there for the designers' reference.
During construction, we use it with the PDA.
Inventory Operating
1.52 2.54
1.40
HL-93 Loading 1.33 2.60
2017 Manual for Bridge Evaluation
KANSAS DEPARTMENT OF TRANSPORTATION
Br. No. 9-69-25.18 (088) Sta. 373+96.50
GENERAL NOTES AND QUANTITIES
K-9 over Big Timber Creek
Proj. 9-69 KA-3094-01 Norton Co.
Sheet No. 25

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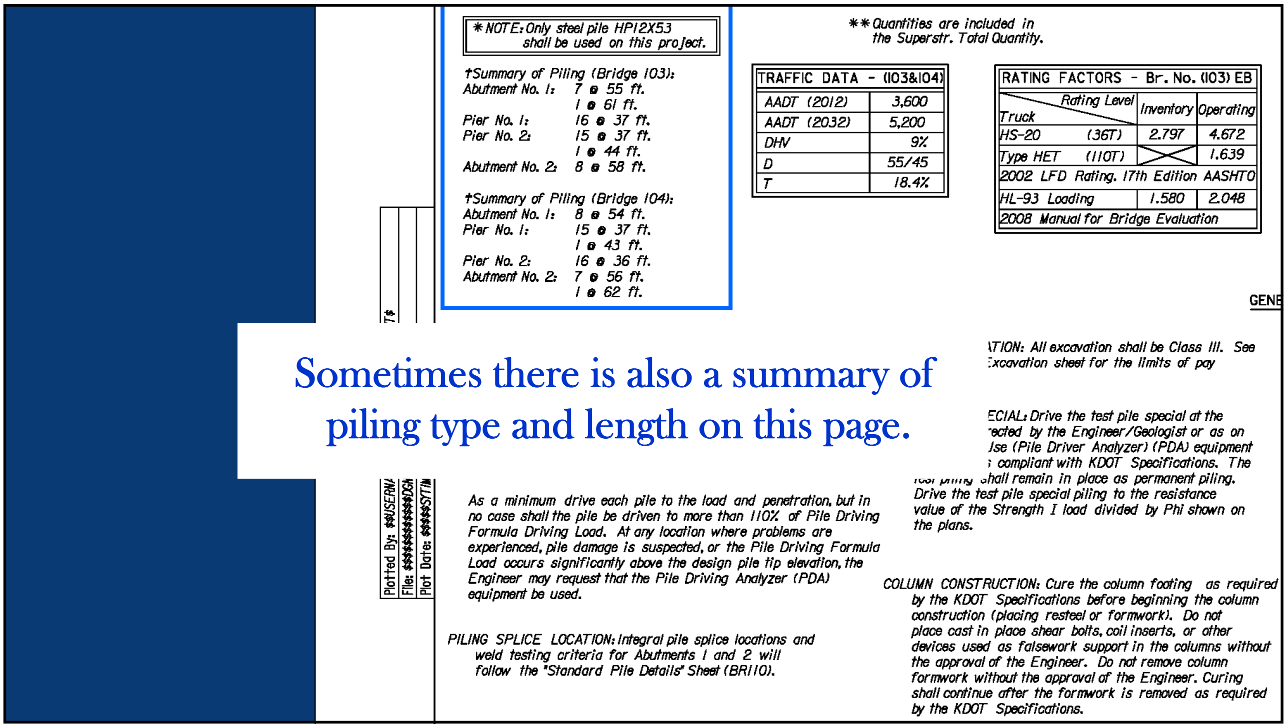

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For years at KDOT, we drove piling to the ***Allowable Load***.

Now it is called the ***Pile Driving Formula Load*** .

40

If necessary, we can drive to 110 % of the Pile Driving Formula Load.

That's usually *not* necessary.

Most of the time, you should drive to the pile driving formula load and then stop.

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If you are driving to a certain depth, then the 110 % rule can be handy.

On most projects, going over the specified load is wasting money at best.

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At worst, you could damage the pile.

Make sure you have a good reason for driving much past the specified load.

Let's take another example….

PILING: Drive all piling to penetrate or bear upon the Wellington Formation. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment No. 1:	86 Tons
Pier No. 1:	88 Tons
Pier No. 2:	88 Tons
Abutment No. 2:	86 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

Abutment No. 1	86	Tons
Pier No. 1	88	Tons
Pier No. 2	88	Tons
Abutment No. 2	86	Tons

Let's do Abutment 2....

86 tons x 1.1 = 94.6 tons

So we'd drive to 86 tons. If necessary, we could go to 95 tons.

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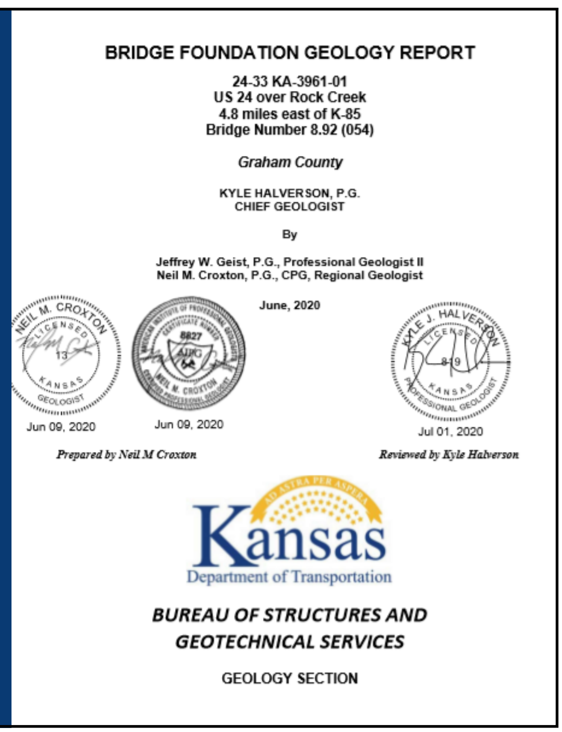
Bridge Foundation Geology Report



BRIDGE FOUNDATION GEOLOGY REPORT

24-33 KA-3961-01
US 24 over Rock Creek
4.8 miles east of K-85
Bridge Number 8.92 (054)

Graham County

KYLE HALVERSON, P.G.
CHIEF GEOLOGIST

By

Jeffrey W. Geist, P.G., Professional Geologist II
Neil M. Croxton, P.G., CPG, Regional Geologist

June, 2020

Jun 09, 2020 | Jun 09, 2020 | Jul 01, 2020

Prepared by Neil M Croxton | *Reviewed by Kyle Halverson*

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BUREAU OF STRUCTURES AND GEOTECHNICAL SERVICES

GEOLOGY SECTION

48

To find Geology Reports on Document Management from KDOT computer:

Open OnBase

Go to the Retrieval tab

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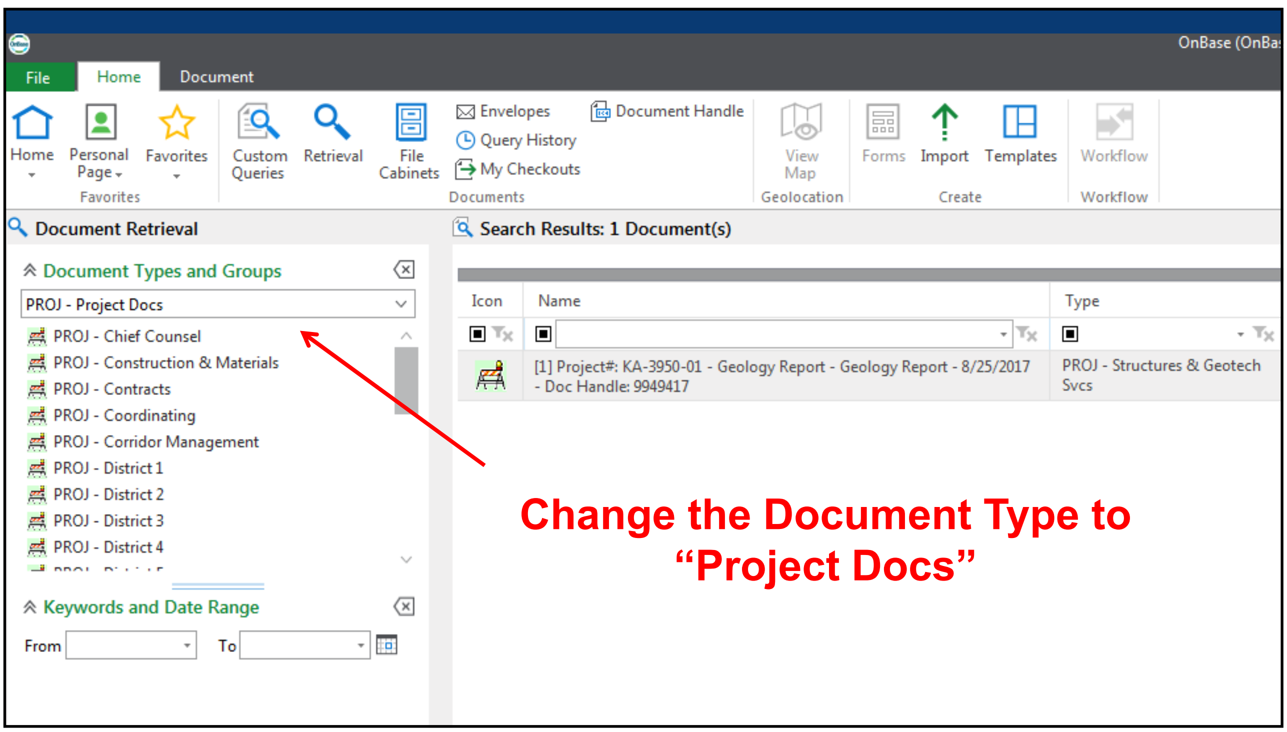

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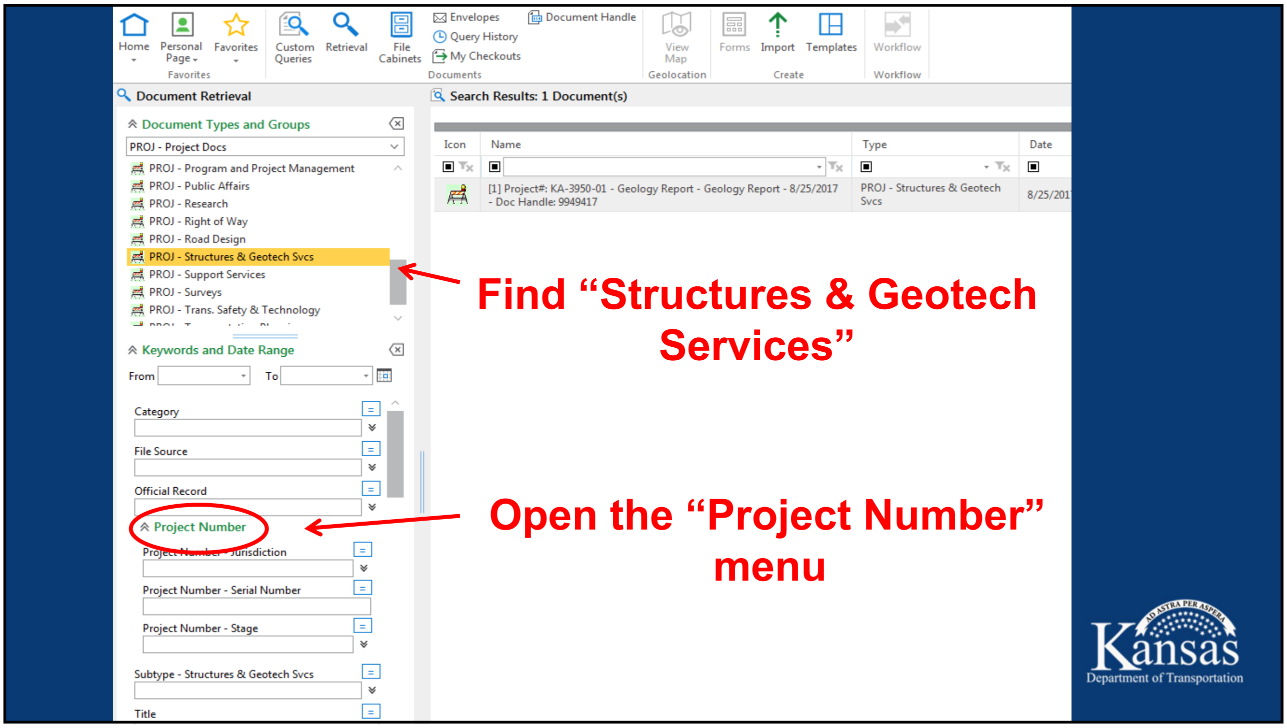
Document Retrieval
Document Types and Groups
PROJ - Project Docs
PROJ - Program and Project Management
PROJ - Public Affairs
PROJ - Research
PROJ - Right of Way
PROJ - Road Design
PROJ - Structures & Geotech Svcs
PROJ - Support Services
PROJ - Surveys
PROJ - Trans. Safety & Technology
Keywords and Date Range
Category
File Source
Official Record
Project Number
Project Number - Jurisdiction
Project Number - Serial Number
Project Number - Stage
Subtype - Structures & Geotech Svcs
Title
Search Results: 1 Document(s)
[1] Project#: KA-3950-01 - Geology Report - Geology Report - 8/25/2017 - Doc Handle: 9949417
PROJ - Structures & Geotech Svcs
Find "Structures & Geotech Services"
Open the "Project Number" menu
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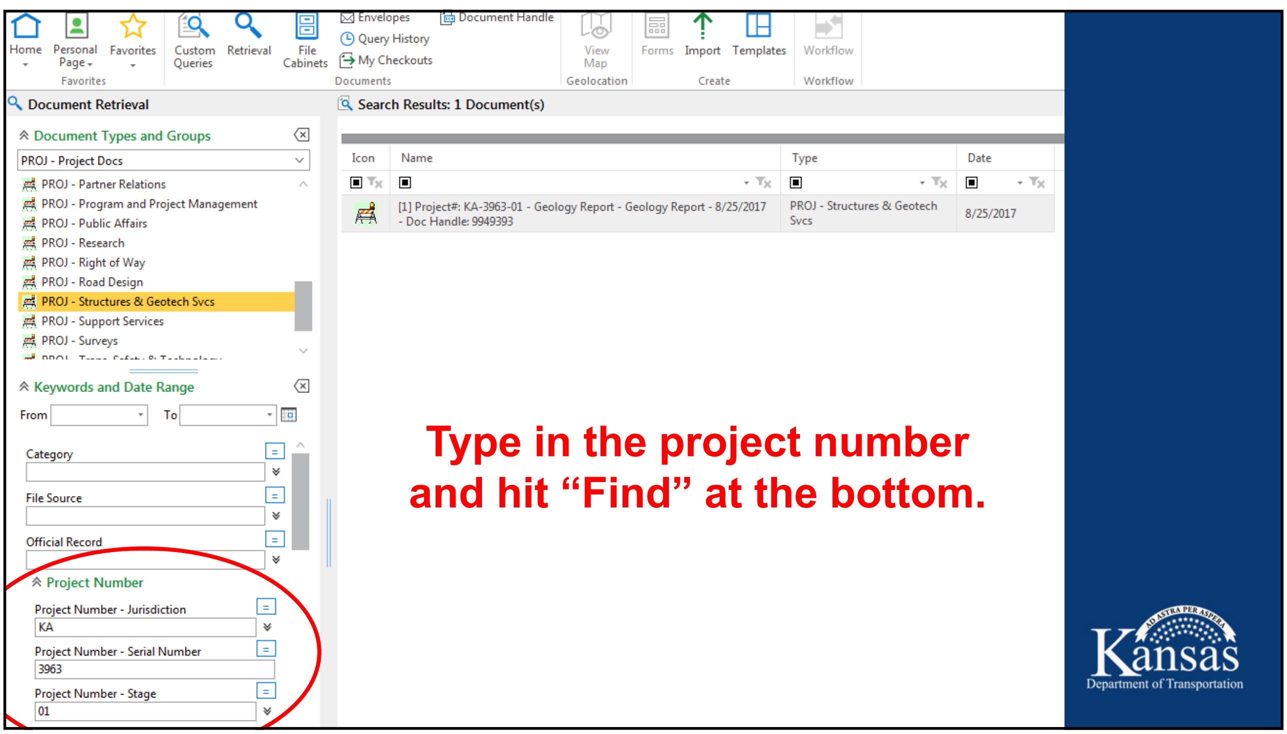
Document Retrieval
Document Types and Groups
PROJ - Project Docs
PROJ - Partner Relations
PROJ - Program and Project Management
PROJ - Public Affairs
PROJ - Research
PROJ - Right of Way
PROJ - Road Design
PROJ - Structures & Geotech Svcs
PROJ - Support Services
PROJ - Surveys
Keywords and Date Range
Category
File Source
Official Record
Project Number
Project Number - Jurisdiction
KA
Project Number - Serial Number
3963
Project Number - Stage
01
Search Results: 1 Document(s)
[1] Project#: KA-3963-01 - Geology Report - Geology Report - 8/25/2017 - Doc Handle: 9949393
PROJ - Structures & Geotech Svcs
8/25/2017
Type in the project number and hit "Find" at the bottom.
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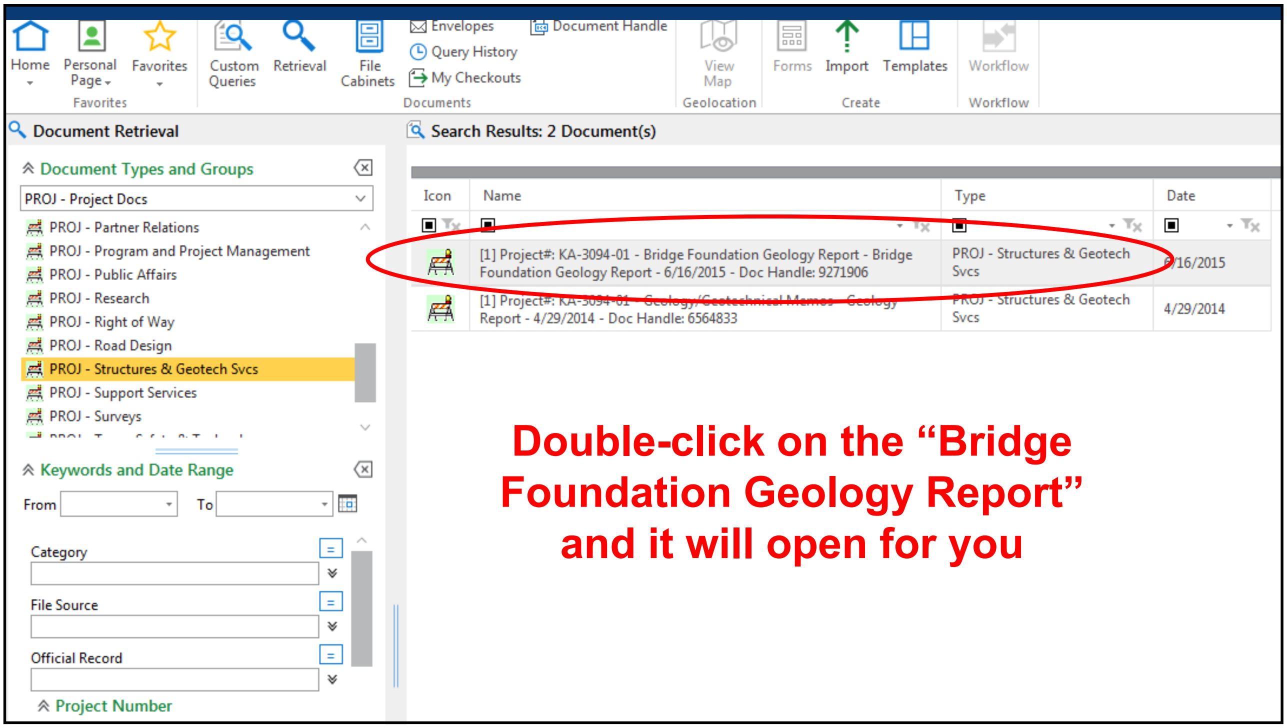

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To find Geology Reports from an outside computer:

https://www.ksdot.org

"Letting Information for Highway Contractors"

"Exploratory and Project Reports"

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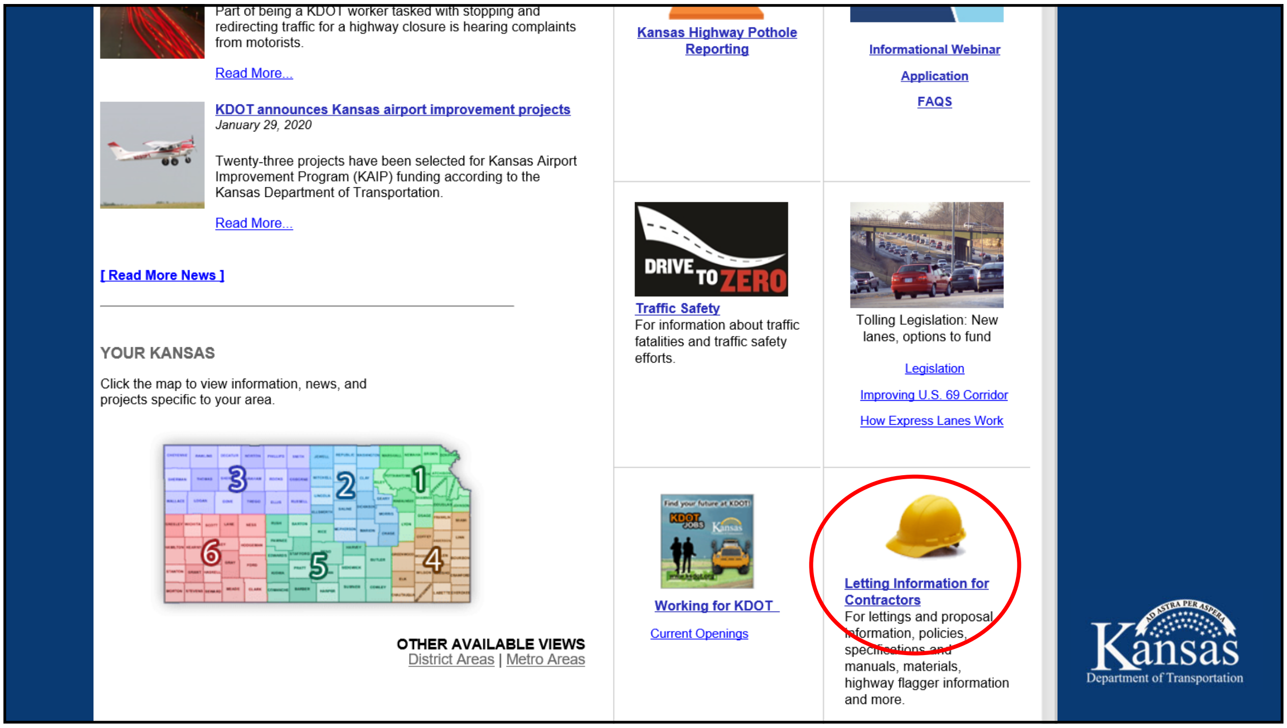
Part of being a KDOT worker tasked with stopping and redirecting traffic for a highway closure is hearing complaints from motorists.
Read More...
KDOT announces Kansas airport improvement projects
January 29, 2020
Twenty-three projects have been selected for Kansas Airport Improvement Program (KAIP) funding according to the Kansas Department of Transportation.
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[Read More News]
YOUR KANSAS
Click the map to view information, news, and projects specific to your area.
3
2
1
6
5
4
OTHER AVAILABLE VIEWS
District Areas | Metro Areas
Kansas Highway Pothole Reporting
Informational Webinar
Application
FAQS
DRIVE TO ZERO
Traffic Safety
For information about traffic fatalities and traffic safety efforts.
Tolling Legislation: New lanes, options to fund
Legislation
Improving U.S. 69 Corridor
How Express Lanes Work
Find your future at KDOT
KDOT JOBS
Kansas
Working for KDOT
Current Openings
Letting Information for Contractors
For lettings and proposal information, policies, specifications and manuals, materials, highway flagger information and more.
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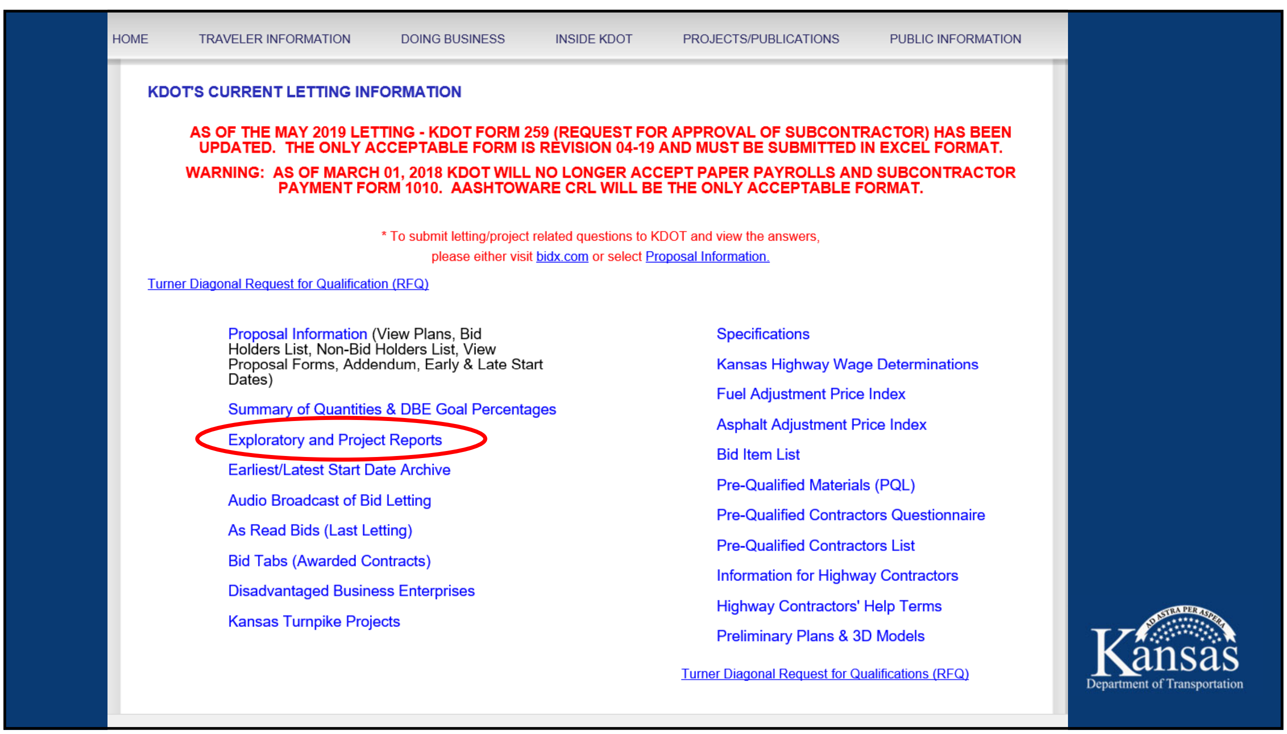
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PROJECTS/PUBLICATIONS
PUBLIC INFORMATION
KDOT'S CURRENT LETTING INFORMATION
AS OF THE MAY 2019 LETTING - KDOT FORM 259 (REQUEST FOR APPROVAL OF SUBCONTRACTOR) HAS BEEN UPDATED. THE ONLY ACCEPTABLE FORM IS REVISION 04-19 AND MUST BE SUBMITTED IN EXCEL FORMAT.
WARNING: AS OF MARCH 01, 2018 KDOT WILL NO LONGER ACCEPT PAPER PAYROLLS AND SUBCONTRACTOR PAYMENT FORM 1010. AASHTOWARE CRL WILL BE THE ONLY ACCEPTABLE FORMAT.
* To submit letting/project related questions to KDOT and view the answers, please either visit bidx.com or select Proposal Information.
Turner Diagonal Request for Qualification (RFQ)
Proposal Information (View Plans, Bid Holders List, Non-Bid Holders List, View Proposal Forms, Addendum, Early & Late Start Dates)
Summary of Quantities & DBE Goal Percentages
Exploratory and Project Reports
Earliest/Latest Start Date Archive
Audio Broadcast of Bid Letting
As Read Bids (Last Letting)
Bid Tabs (Awarded Contracts)
Disadvantaged Business Enterprises
Kansas Turnpike Projects
Specifications
Kansas Highway Wage Determinations
Fuel Adjustment Price Index
Asphalt Adjustment Price Index
Bid Item List
Pre-Qualified Materials (PQL)
Pre-Qualified Contractors Questionnaire
Pre-Qualified Contractors List
Information for Highway Contractors
Highway Contractors' Help Terms
Preliminary Plans & 3D Models
Turner Diagonal Request for Qualification (RFQ)
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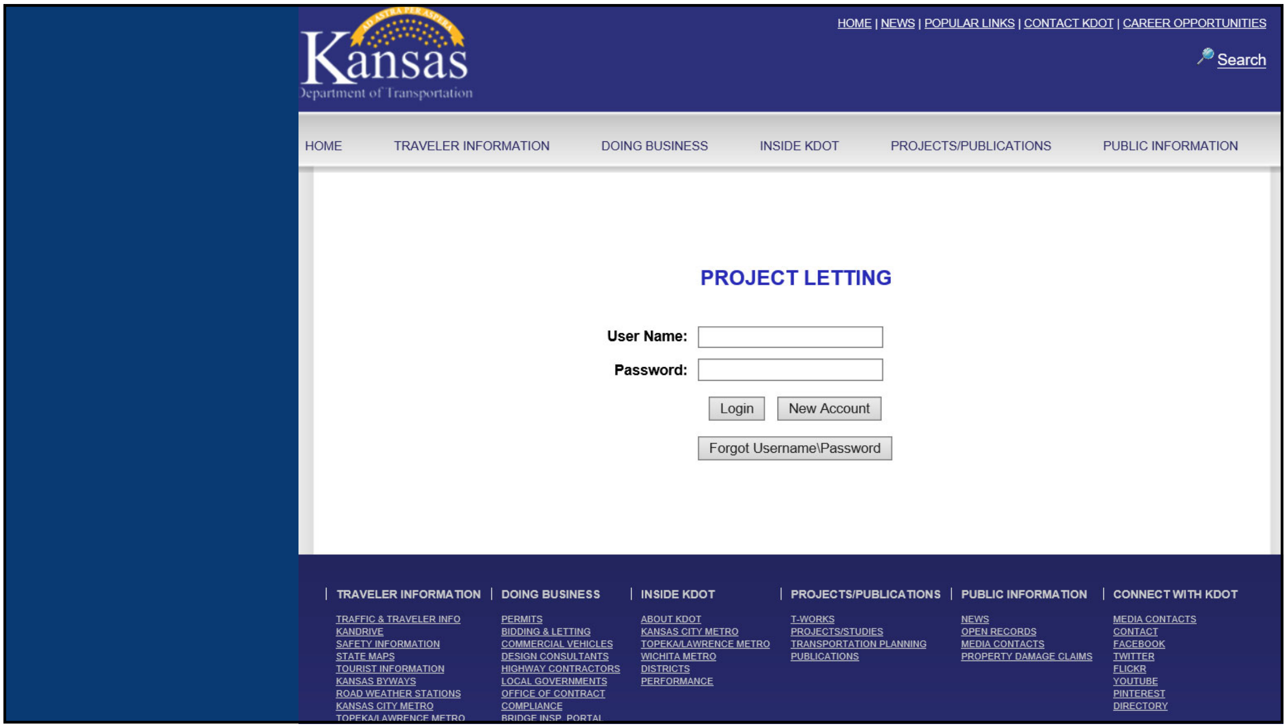

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OFFICE OF CONTRACT
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KANSAS CITY METRO
TOPEKA/LAWRENCE METRO
WICHITA METRO
DISTRICTS
PERFORMANCE
PROJECTS/PUBLICATIONS
T-WORKS
PROJECTS/STUDIES
TRANSPORTATION PLANNING
PUBLICATIONS
PUBLIC INFORMATION
NEWS
OPEN RECORDS
MEDIA CONTACTS
PROPERTY DAMAGE CLAIMS
CONNECT WITH KDOT
MEDIA CONTACTS
CONTACT
FACEBOOK
TWITTER
FLICKR
YOUTUBE
PINTEREST
DIRECTORY

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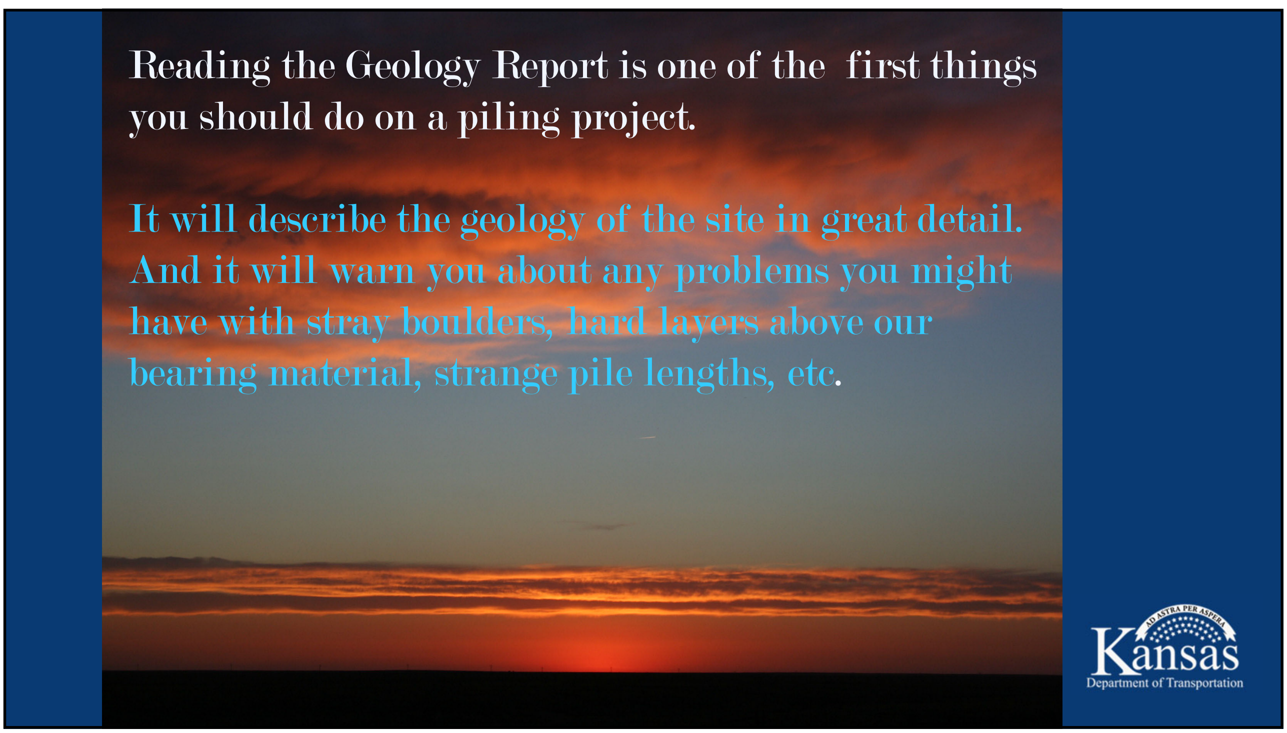

Reading the Geology Report is one of the first things you should do on a piling project.
It will describe the geology of the site in great detail. And it will warn you about any problems you might have with stray boulders, hard layers above our bearing material, strange pile lengths, etc.
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If you don't
believe me,
ask the
inspector on
this project…

60

Call your Regional Geologist with any questions about how the geology of your project will affect pile driving.

61

Never too busy to help inspectors….

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Kansas
Department of Transportation

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OK ?

The Pile Driving Formula & Problems with Dynamic Formulas

List of the Formulas

- Standard Specifications; version July 2015
  - Section 704
    - Subsection 704.4 Construction Requirements
      - Table 704-1 Pile Formulas

List of the Formulas

- Bridge Construction Manual
  - Version Oct 2009(updated 5-21-13)
  - Chapter 5.3 Driven Pile
  - Section 5.3.8.2 Pile Driving Formulas
  - Page 39

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List of the Formulas

TABLE 704-1: PILE FORMULAS

Hammer	Pile Type	Formula
Gravity	Steel Steel Shell Steel Sheet	$P=\frac{3\ W\ H}{S+0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P=\frac{2\ W\ H}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P=\frac{2\ E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P=\frac{1.6\ W\ H}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P=\frac{1.6\ E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers
** For diesel hammers, the quantity X/W shall not be less than 1.
P = safe bearing power in pounds
W = weight in pounds, of striking part of hammer
H = height of fall in feet
E = energy of ram in foot-pounds per blow
S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers
X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

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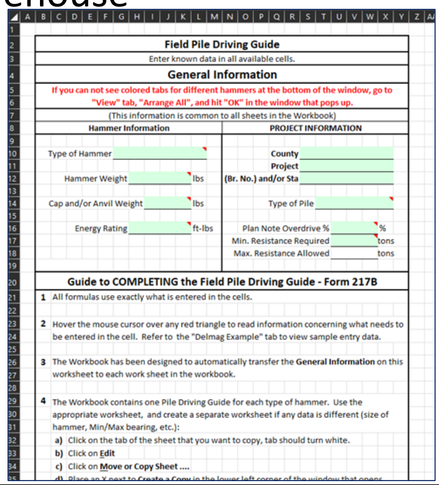
Computer Version of the Pile Driving Formulas

- Field Pile Driving Guide
  - Download from Forms Warehouse
  - Search Form 217b



Field Pile Driving Guide

Enter known data in all available cells.

General Information

If you can not see colored tabs for different hammers at the bottom of the window, go to "View" tab, "Arrange All", and hit "OK" in the window that pops up.

(This information is common to all sheets in the Workbook)

Hammer Information		**PROJECT INFORMATION**	
Type of Hammer		**County**	
		Project	
Hammer Weight	lbs	**(Br. No.) and/or Sta**	
Cap and/or Anvil Weight	lbs	Type of Pile	
Energy Rating	ft-lbs	Plan Note Overdrive %	%
		Min. Resistance Required	tons
		Max. Resistance Allowed	tons

Guide to COMPLETING the Field Pile Driving Guide - Form 217B

1 All formulas use exactly what is entered in the cells.

2 Hover the mouse cursor over any red triangle to read information concerning what needs to be entered in the cell. Refer to the "Delmag Example" tab to view sample entry data.

3 The Workbook has been designed to automatically transfer the **General Information** on this worksheet to each work sheet in the workbook.

4 The Workbook contains one Pile Driving Guide for each type of hammer. Use the appropriate worksheet, and create a separate worksheet if any data is different (size of hammer, Min/Max bearing, etc.):

a) Click on the tab of the sheet that you want to copy, tab should turn white.

b) Click on **Edit**

c) Click on **Move or Copy Sheet ....**

Using the Pile Driving Formula

- Piles should be driven to a minimum load of the <u>Pile Driving Formula Load</u> listed in the plans

- For LRFD projects 110% of the Pile Driving Formula Load will be the maximum allowed

Determining Max. Capacity

- Pile Driving Formula Load listed is 55 tons
  - Using the Pile Driving Formula, the **minimum** bearing capacity needed is **____tons**
  - The **maximum** capacity the pile can be driven to is 55 tons x 110% = **____tons**

7

Determining Max. Capacity

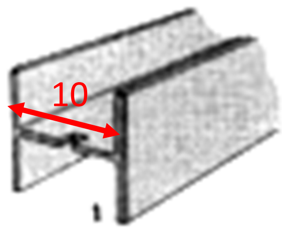
- Pile driving formula load listed is 55 tons
  - Using the pile driving formula, the minimum bearing capacity needed is 55 tons
  - The **maximum** capacity the pile can be driven to is 55 tons x 110% = 60.5 tons

8

Pile Call Out

What do the numbers on H-pile represent?

- **Size** and **Weight**
  - **For H-pile HP10x42**
    - The **10** represents the width of the web in inches
    - **42** represents the weight of the pile per linear foot (pounds/ft)
    - Calculate the weight of 35 ft. long pile



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Class Problem using the Pile Driving Formula For A Diesel Hammer

$$P = \frac{1.6\ W\ H}{S + [0.1(X / W)]}$$

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10

Determining Pile Bearing

- You are driving HP 10 x 42 using a Delmag D12 hammer.
- Hammer ram weight is 2820 pounds (from contractor)
- Cap + Anvil weight is 2710 pounds (from contractor)
- 24 feet of pile placed in the leads
- Pile Driving Formula Load is 55 tons (max is 55 x 110% = 60.5 tons)
- You have a stroke of 7.5 feet
- You record 3 inches of movement in 20 blows

$$P = \frac{1.6\ W\ H}{S + [0.1(X / W)]}$$

Determining Pile Bearing

- You are driving HP 10 x 42 using a Delmag D12 hammer.
- Hammer ram weight is 2820 pounds (from contractor)
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- You have a stroke of 7.5 feet
- You record 3 inches of movement in 20 blows

$$P = \frac{1.6\ W\ H}{S + [0.1(X / W)]}$$

W =	Weight of Hammer Ram =	2820 pounds
H =	Stroke of Hammer =	7.5 feet
S =	Set per blow (3 inches/20 blows) =	.15 inch
Cap + Anvil weight =		2710 pounds
Pile weight (24 feet x 42 pounds) =		1008 pounds
X = Cap + Anvil + Pile weight = 2710 + 1008 =		3718 pounds
X/W=	3718/2820 =	1.32

Determining Pile Bearing

- W= ram weight = **2820 lbs**
- H= stroke height = **7.5 feet**
- S= average set per blow = **.15 inch**
- X= Cap + Anvil + Pile weight = **3718 pounds**
- X/W = 3718/2820 = **1.32≥1.0**
- Pile Driving Formula load = **55 tons**

$$P = \frac{1.6\ W\ H}{S + [0.1(X / W)]}$$

- $P = \dfrac{1.6\ (2820\ \text{lbs})(7.5\ \text{ft.})}{0.15 + [0.1\ (3718\ \text{lbs}/2820\ \text{lbs})]}$
- $P = \dfrac{1.6\ (2820\ \text{lbs})(7.5\ \text{ft.})}{0.15 + [0.1 \times 1.32]} = \dfrac{33840}{0.15 + .132}$
- $P = \dfrac{33{,}840\ \text{lbs}}{0.28} = 120{,}857$ Pounds
- $P = \dfrac{120{,}857\ \text{lbs}}{2000\ \text{lbs}}$ (Convert to tons)
- P= 60 tons (Minimum Bearing Needed is 55 tons)

Class Problem

- You are inspecting a pile driving operation in which the contractor is using a Delmag D15 open end diesel hammer to drive 12 X 53 H-pile that is 50 feet long. The contractor has supplied you with the following hammer specification information:
- Ram (piston) weight 3300 pounds
- Cap weight 1323 pounds
- Anvil weight 311 pounds
- Total hammer weight 6603 pounds
- With a pile penetration depth of 42.5 feet you record a pile movement of 3.5 inches in 20 blows and observe a hammer stroke of 6.5 feet. Using the KDOT bearing formula for a Delmag hammer what is the bearing capacity of the pile at that time?
- $P = \dfrac{1.6\ W\ H}{S + [0.1(X / W)]}$
- P = bearing capacity in pounds W = weight of ram in pounds
- H = height of stroke in feet, S = set per blow in inches
- X = weight of pile, anvil, and cap in pounds

Determining Pile Bearing

- W= Mass of ram = 3300 pounds
- H= Stroke or fall height = 6.5 feet
- S= set per blow = 3.5 inches/20 blows = .175 inch
- X= weight of anvil + cap + pile = 311+1323+(50 X 53)

  X = 311+1323+2650 = 4284 pounds
- X/W = 4284/3300 = $1.298 \geq 1.0$
- $P = \dfrac{(1.6)(3300 \text{ lbs})(6.5 \text{ ft.})}{0.175 + [0.1(1.298)]} = \dfrac{34{,}320}{0.175 + .1298}$
- $P = \dfrac{34{,}320 \text{ lbs}}{0.3048} = 112{,}598.4252$ pounds
- $P = \dfrac{112{,}598.4252 \text{ lbs}}{2{,}000 \text{ lbs}} = 56$ tons

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Other uses of the Pile Driving Formula

- Checking the size of the hammer
- Calculating the required set in 20 blows

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Checking the size of the Hammer

- The inspector should check to see if the contractors hammer is big enough to drive the pile
- To do this you will need the hammer specifications
  (these are provided by the contractor)
- Assume a practical refusal of 10 blows/inch
- Use the maximum stroke the hammer can achieve
- Plug the number into the pile driving formula
- Your answer should be
  - Pile Driving Formula Load < P < 110% of PDFL

Where to find an example

- Bridge Construction Manual
- Version Oct 2009(updated 5-21-13)
- Chapter 5.3 Driven Pile
- Section 5.3.6.2 Preparing to Drive Pile
- Pages 19-20

Checking the size of the hammer

- Driving 40 feet of 10x42 H-pile using a Delmag D12
- Piston weight = **2750** pounds **(W)**
- Cap and anvil weight = 2690 pounds
- Pile weight = 40 feet x 42 lbs./ft = 1680 lbs.
- Weight of pile + weight of cap and anvil=
  2690 + 1680 = **4370** pounds **(X)**
- Maximum stroke = **8.17** feet **(H)**
- 1inch/10blows = **0.1** inch/blow **(S)**
- P= Pile Driving Formula Load = 112,000 pounds or 56 tons.
- 110% of design load is 123,200 pounds or 62 ton

$$P = \frac{1.6\,W\,H}{S + 0.1(X / W)}$$

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Determining Pile Bearing

- W= 2750 pounds   X= 4370 pounds
- H= 8.17 feet   S= 0.1 inch
- X/W= 1.6
- Pile Driving Formula Load=112,000 pounds or 56 tons
  110% = 123,200 pounds or 62 tons
- $$P = \frac{1.6\,W\,H}{S + 0.1(X / W)} = \frac{(1.6)(2750)(8.17)}{0.1 + [(0.1)(1.6)]}$$
- P=138,261 pounds = 69 tons
- 112,000 pounds<138,261123,200 pounds>1123,200 pounds
- 56 tons < 69 tons > 62 tons

However use caution as the Hammer is Capable of overdriving the pile

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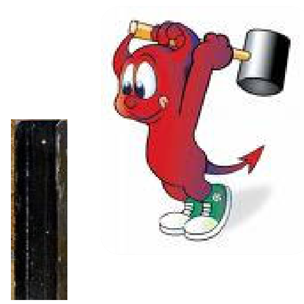
Calculating the required set in 20 blows

- Now that the hammer has been found to be okay you can calculate the actual average penetration required for the last 20 blows needed to achieve bearing



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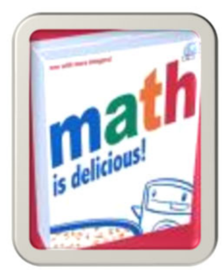
Calculating the required set in 20 blows

- $P = \dfrac{1.6\ W\ H}{S + 0.1(X / W)}$
- $S = \dfrac{1.6\ W\ H}{P} - 0.1(X/W)$
- $S = \dfrac{(1.6)(2750)(8.17)}{112{,}000} - 0.1(1.589)$
- $S = 0.321 - 0.159 = 0.16$ inch/blow



- This means that for the last 20 blows the pile should be driven down 3.2 inches (0.16 inch/blow x 20 blows) or less.
- If the pile is driven further than 3.2 inches for 20 blows, then the pile does **NOT** have the required bearing yet.

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Problems with Dynamic Formulas

Problems with Dynamic Formula

- Dynamic formulas are based on physics and transfer of energy with built in assumptions about the
  - Driving System
  - Soil Resistance
  - Pile

The Driving System

- Dynamic formulas offer a poor representation of the driving system and the energy losses of the drive system components
  - Driving systems include many elements in addition to the ram such as the anvil, helmet, hammer cushion, and pile cushion

- These components affect the hammer energy at and after impact which influences the magnitude and duration of peak force

- Peak force and duration determines the ability of the driving system to advance the pile into the soil.

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The Soil Resistance

- Assumes soil resistance is a constant force
  - This assumption neglects obvious characteristics of real soil behavior

- Dynamic soil resistance is the resistance of the soil to rapid penetration produced by a hammer blow
  - This resistance is not equal to static soil resistance

  - Most dynamic formulas consider the resistance during driving to be equal to static resistance or pile capacity
    - In most cases capacity will increase or decrease with time due to soil set up or relaxation

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The Pile

- The dynamic formulas assume a rigid pile
  - Piles have flexure allowing them to penetrate the soil
  - Pile also have elastic properties
    - These compressive waves are responsible for advancing the pile into the ground

- Some formulas do not take the weight of the pile into account
  - KDOT's formula does

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Case Histories

- Let's take a look at a few cases where dynamic formulas gave false pile capacity results
  - 2 outside of KDOT
    - Various pile types
    - Delmag and McKierman-Terry Formula (aka the Engineering News Record Formula (ENR)
    - PDA and static load test

  - 2 KDOT projects
    - Engineering News Record Formula
    - PDA

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Case 1

- 24-inch square pre-stressed concrete pile
- 12-inch diameter void in center of pile
- Pile was driven to a final penetration of 34 blows per foot (end of drive)
- Re-strike test 13 days later penetration was 118 blows per foot
- Pile was then static load tested

Case 1 Results

- Using end of drive data (stroke and set)
  - The ENR formula predicted a pile driving formula load of **153** tons
- Dynamic testing with PDA on re-strike gave an ultimate pile capacity of **462** tons
- Static test had a failure load of **475** tons
- Hence:
  - The formulas significantly under predicted the pile driving formula load and ultimate pile capacity

Case 2

- 14 inch closed end pipe pile
- Pile Driving formula load 110 tons
- Pile was driven to a final penetration of 148 blows per foot (end of drive)
- Restrike was preformed
- Pile was static load tested

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Case 2

- End of drive data
  - ENR formula predicted a design load of **245** tons
  - PDA at end of drive ultimate capacity **229** tons
- PDA on re-strike showed decrease of ultimate capacity to **205** tons
- Static test had a failure load of **210** tons
  - PDA re-strike testing nearly matches static load testing
- Assuming a safety factor of 2, capacity would be 105 tons (210 tons/2)

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Case 2

- In this case:
  - ENR formula over predicted the design load by more than 230%
  - Over prediction partially due to soil relaxation

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Case 3 KDOT

- H-pile 14x73
- Pile pre-drilled to scour line
- Driven through silty sand and gravel into the Ogallala Formation
- Pile Driving formula load 91 tons; 100 tons (max)
- Re-strike test 24 hours later

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Case 3 Results

- End of Drive
  - ENR Formula **73** tons (need **91** tons)
  - PDA **185** tons (need **140** tons)
- 24 hour re-strike
  - ENR Formula **93** tons
  - PDA **207** tons
- In this case:
  - Pile Driving formula under predicted capacity by about 2.5 times
- Again, the ENR formula underpredicted the pile capacity

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Case 4 KDOT

- H-pile 10x42
- Driven through silty sand at south abutment of highway 400 over Arkansas River
- Pile driving formula load 70 tons; 77 tons (max)
- Re-strike test 24 hours later

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Case 4 Results

- End of Drive
  - Bearing Formula **51.6** tons (need **70** tons)
  - PDA **102** tons (need **107** tons)
- 24 hour re-strike
  - Bearing Formula **69** tons
  - PDA **170** tons

- Another case of pile driving formula underpredicting pile capacity

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LRFD

- Load and Resistance Factor Design (LRFD) does require more test pile and the use of the PDA:

  - 26 to 50 piles in the bridge structure
    - 1 to 3 piles (2-5% of total piles)
  - 51 to 100 piles in the bridge structure
    - 1 to 5 piles (2-5% of total piles)

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Pile Driving Formula

- The pile driving formula is still a good tool for KDOT inspectors to use to calculate bearing
- Will be conservative in most cases for Kansas Native Soil types
- Could over predict if relaxation occurs
- Should always consider options before splicing on more pile to drive deeper
  - Can the pile set for a period of time and see what the bearing is after a restrike
  - Are there other pile drive records in the area for review
  - Consult the Engineer in charge

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Questions?

Railroad Steam Pile Driver 1912

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Record Keeping

The Form 217

1

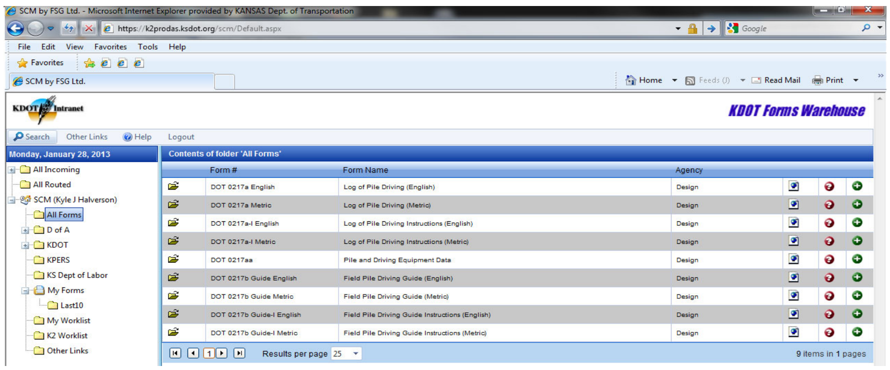
Explanation of Forms

- Bridge Construction Manual
  - Chapter 5.3 Driven Pile* Updated 5-21-13
  - Section 5.3.8 Log of Pile Driving
  - Page 26 through 36
- Forms Warehouse
  - Form 217a & 271b (English and Metric both available)

2

Where To Find Form 217

- KDOTweb-forms warehouse
  - Search for Form 217
- 217a is the form and 217a-1 is the instructions



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Form 217

- Consists of 4 Sections;
  - General Information
  - Record Keeping
  - Continuous Log
  - Summary

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General Information

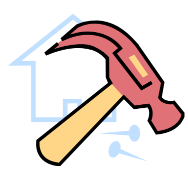
Guide to COMPLETING and CLEARING the Log of Pile - Form 217	
1	Piling and Elevations should be measured and reported to the nearest hundredth of a foot (0.01 ft). The formulas use exactly what is entered in the cell.
2	Hover the mouse cursor over any red triangle to read information concerning what needs to be entered in the cell. Refer to the "Delmag Example" tab to view sample entry data.
3	The Workbook has been designed to automatically transfer the **General Information** on this worksheet to each work sheet in the workbook. The Abutment and Pier No. have to be manually entered on each work sheet.
4	The Workbook contains one Log of Pile Driving sheet and one Continuous Log of Pile Driving Sheet for each type of hammer. Use the appropriate worksheet, and create a separate worksheet for each abutment and pier:
	a) Click on the tab of the sheet that you want to copy, tab should turn white.
	b) Click on **Edit**
	c) Click on **Move or Copy Sheet ....**
	d) Place an X next to **Create a Copy** in the lower left corner of the window that opens.
	e) Under the dialog box **Before Sheet:** click on the sheet you want your new sheet to appear.
	f) Click on **OK**.
5	Each worksheet is Protected. The Tab key will take you to all open (colored) cells for data input.
6	The Log of Continuous Pile Driving and/or Test Pile is the lower portion of the worksheet. This has been modified to allow for recording more than one Pile. To begin a new pile, simply replace X.XX with the starting depth under "From" and the next measured length under "To".
7	Print the form as any other document. In the "Print" box that opens, under "Print Range" enter a "1" in the "From" **AND** "To" boxes to print page one (or a "2" in order to print only page two).
8	To enter a picture into the "Footing Sketch" area: begin with some type of electronic picture format (.gif, .jpg, etc.) saved to your harddrive, select the "Footing Sketch" cell, go to the "Insert" menu tab, select "Picture", navigate to where the file is saved, resize as necessary to fit within the "Footing Sketch" cell.
9	If a mistake is made while entering data, simply enter the correct data over the incorrect data.

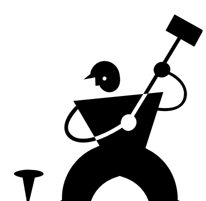
- Fill out the green boxes
- This information carries forward to all forms

1	Log of Pile - Form 217			
2	**General Information**			
3	(This information is common to all sheets in the Workbook)			
4	**Hammer Information**		**PROJECT INFORMATION**	
5	Go to "View" tab, "Arrange All", and hit "OK" in the window that pops up if you can not see colored tabs			
6	for different hammers at the bottom of the screen.			
7	Type of Hammer		**County**	
8			**Project**	
9	Hammer (Ram) Weight	lbs	**(Br. No.) and/or Sta**	
10			Type of Pile	
11	Cap and/or Anvil Weight	lbs		
12			Plan Note Overdrive %	%
13	Energy Rating	ft-lbs	Min. Bearing Required	tons
14			Max. Bearing Allowed	tons

General Information

- Type of hammer
  - Type, brand, model & size
    - Example: Diesel-Delmag D15





- Weight of the hammer (piston/ram)
  - Denoted on the hammer specification plate furnished by the contractor
  - Or look up in the reference chart in the Bridge Construction Manual
  - Online at: http://www.ksdot.org/Assets/wwwksdotorg/bureaus/burStructGeotech/ConstructionManual/pile.pdf

Hammer Info.

- Information from contractor
- Input this info. into form 217-aa
  - Form 217-aa can be found in the Forms Warehouse

PILE AND EQUIPMENT DATA

Contract No.: 516022585
Project : I235-087 KA 3109-01
County : Sedgwick
Structure Name and/or No.: 235-87-21.62 (838)
235-87-21.64 (839)
Pile Driving Contractor : Dondlinger & Sons Const.

HAMMER

Manufacturer : Pileco
Type : Single Action Diesel Hammer
Rated Energy : 42,480 @ ____ Ft. Length of Stroke
Model : D19-42
Serial No. 3196

Ram Weight : 4,015
Anvil Weight : 779

CAP BLOCK

Material : Steel Plate
Thickness :
Weight : In Pile Cap
Area : 289 Sq. In.

CUSHION

Cushion Material : MC904P Plasticized Blue Nylon

PILE CAP

Primary Helmet Weight : 1151
Drive-Head Weight : 890

PILE

Pile Type : Steel HP 12x53
Weight per Lineal Foot : 53
Design Pile Capacity : Varies 69 to 80 Ton
Length in Leads : Varies

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Form 217-aa Pile driving and Equipment data

Notice to Contractors
Pile and Driving Equipment Data
Test Pile/Test Pile (Special), Section 704, Division 700, 2007 Standard Specifications

Project No. | County
Contract No. | Structure Name/No
Pile Contractor or Subcontractor

HAMMER COMPONENTS: RAM, ANVIL
Manufacturer | Model
Type | Serial No
Rated Energy (ft-lb) @ (ft) Length of Stroke
Fuel Setting
Modifications

CAPBLOCK
Material
Thickness (inches) | Area (in²)
Modulus of Elasticity (E) (psi)
Coefficient of Restitution (e)

PILECAP
Helmet / Bonnet / Anvil Block / Drivehead | Weight (lb)

CUSHION
Material | Area (in²)
Modulus of Elasticity (E) (psi)

CUSHION
Material | Area (in²)
Modulus of Elasticity (E) (psi)
Coefficient of Restitution (e)

Pile and Driving Equipment Data
Test Pile/Test Pile (Special), Section 704, Division 700, 2007 Standard Specifications

PILE
Pile Type
Length (in leads) (ft)
Weight (per foot) (lb)
Wall Thickness (in) | Taper
Cross Sectional Area (in²)
Design Pile Capacity (ton)
Description of Splice
Tip Treatment Description

NOTE: If a mandrel, or follower, is used to drive the pile, attach the manufacturer's detail sheets including the weight and dimensions.

Submitted by | Date

One Copy Each Sent To:
Bureau of Construction and Maintenance
Bureau of Design, State Bridge Office
Bureau of Materials and Research, Geology Section
Project Engineer

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Now Back to Form 217!

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General Information

- Weight of the Cap and/or Anvil
  - Supplied by the contractor
  - May be welded on, or listed on a plate on the hammer
- Energy rating of the hammer
  - Denoted on the hammer specification plate
  - Can look it up in the Bridge Construction Manual
  - Online at: http://www.ksdot.org/Assets/wwwksdotorg/bureaus/burStructGeotech/ConstructionManual/pile.pdf

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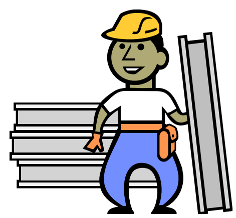
General Information

- County, Project Number, Bridge No. and Station for the structure
- Enter number the of the Abutment or Pier where the pile was driven
- Type and size of pile – enter entire description
  - Some Examples:
    - Pile (steel) HP10 x 42
    - Test Pile Special (steel) HP12 x 53
    - Pile (prestressed concrete) 12 inch



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General Information

- Minimum bearing required
  - This is the **Pile Driving Formula** load
    - Found on the **Summary of Quantities and General Notes Page**
    - Do not confuse this with the design load
- Maximum bearing allowed
  - **<u>110% of pile driving formula load</u>**

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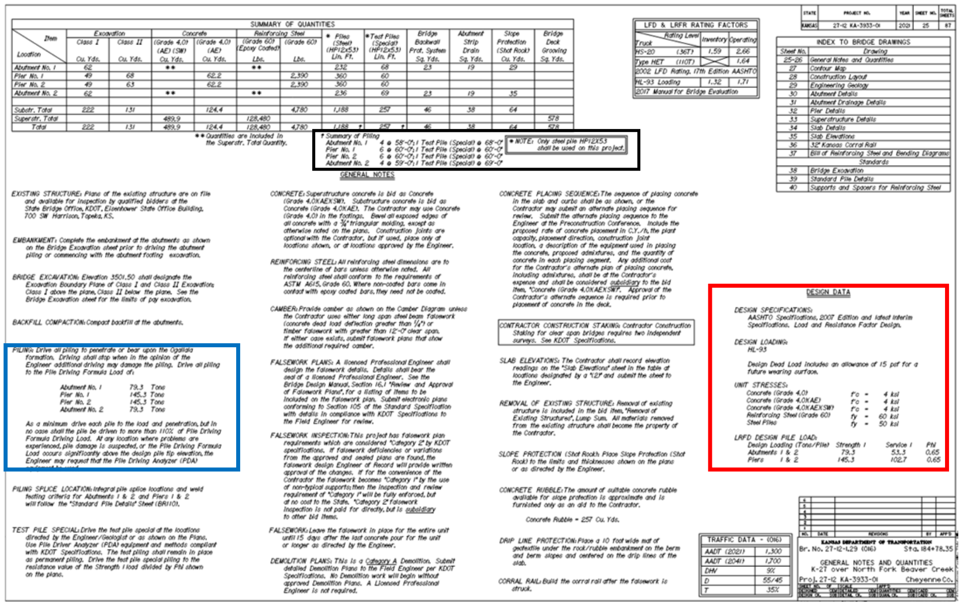
General Information



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General Information

PILING: Drive all piling to penetrate or bear upon the Ogallala formation. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment No. 1	79.3 Tons
Pier No. 1	145.3 Tons
Pier No. 2	145.3 Tons
Abutment No. 2	79.3 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

DESIGN DATA

DESIGN SPECIFICATIONS:
AASHTO Specifications, 2007 Edition and latest Interim Specifications. Load and Resistance Factor Design.

DESIGN LOADING:
HL-93

Design Dead Load includes an allowance of 15 psf for a future wearing surface.

UNIT STRESSES:

Concrete (Grade 4.0)	f'c =	4 ksi
Concrete (Grade 4.0)(AE)	f'c =	4 ksi
Concrete (Grade 4.0)(AE)(SW)	f'c =	4 ksi
Reinforcing Steel (Grade 60)	fy =	60 ksi
Steel Piles	fy =	50 ksi

LRFD DESIGN PILE LOAD:

Design Loading (Tons/Pile)	Strength I	Service I	Phi
Abutments 1 & 2	79.3	53.3	0.65
Piers 1 & 2	145.3	102.7	0.65

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General Information

Log of Pile - Form 217

General Information

(This information is common to all sheets in the Workbook)

Hammer Information		PROJECT INFORMATION	
Go to "View" tab, "Arrange All", and hit "OK" in the window that pops up if you can not see colored tabs for different hammers at the bottom of the screen.			
Type of Hammer	D19-42	County	Sedgwick
		Project	KA-3109-01
Hammer (Ram) Weight	4015 lbs	(Br. No.) and/or Sta	(838)/ 183+98.30
		Type of Pile	HP 12x53
Cap and/or Anvil Weight	1930 lbs		
		Plan Note Overdrive %	110 %
Energy Rating	42,480 ft-lbs	Min. Bearing Required	79.3 tons
		Max. Bearing Allowed	87.23 tons

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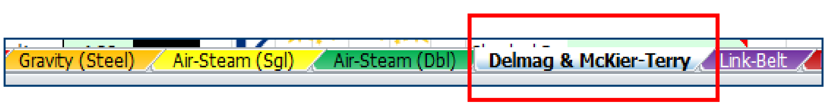
General Information

- After you fill out the “General Info” section you must determine the type of hammer you will be using to calculate pile bearing
  - Hammer type was provided from contractor
- This is important! There are specific bearing formulas for each hammer type.
  - Bearing formula is automatically entered based on type of hammer used.
  - This example is using a diesel hammer.
    - You should choose the “Delmag & McKier-Terry” option, for diesel hammers



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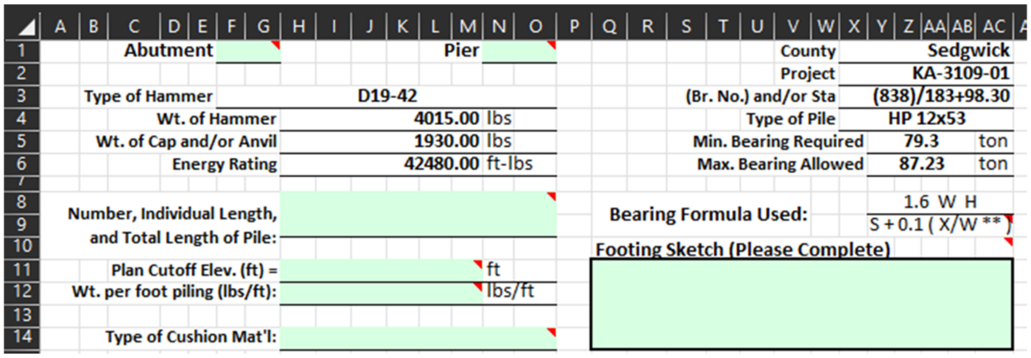
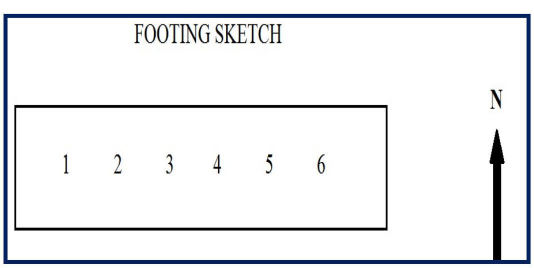
General Information



	A–G	H–O	P–W	X–AC
1	Abutment	Pier	County	Sedgwick
2			Project	KA-3109-01
3	Type of Hammer	D19-42	(Br. No.) and/or Sta	(838)/183+98.30
4	Wt. of Hammer	4015.00 lbs	Type of Pile	HP 12x53
5	Wt. of Cap and/or Anvil	1930.00 lbs	Min. Bearing Required	79.3 ton
6	Energy Rating	42480.00 ft-lbs	Max. Bearing Allowed	87.23 ton
7				
8–10	Number, Individual Length, and Total Length of Pile:		Bearing Formula Used:	1.6 W H / S + 0.1 (X/W **)
10			Footing Sketch (Please Complete)	
11	Plan Cutoff Elev. (ft) =	ft		
12	Wt. per foot piling (lbs/ft):	lbs/ft		
13				
14	Type of Cushion Mat'l:			

General Information

- Footing sketch
  - Draw a sketch of the footing with piles numbered to represent the numbers listed in the "Pile No." column on the form
  - A north arrow must be shown
- Represents the location of the pile no. listed in the data section.



General Information

- Number, Individual Length and Total Length of Pile
  - Enter the total length for the abutment or pier represented
  - Also give a breakdown of the number and the length of piles used
    - Example: 4 @ 58 ft. and 1 test pile @ 68 ft.
    - This will not change if driven length is different. Enter information from plans (example below)

† Summary of Piling

Abutment No. 1	4 @ 58′-0″; 1 Test Pile (Special) @ 68′-0″
Pier No. 1	6 @ 60′-0″; 1 Test Pile (Special) @ 60′-0″
Pier No. 2	6 @ 60′-0″; 1 Test Pile (Special) @ 60′-0″
Abutment No. 2	4 @ 59′-0″; 1 Test Pile (Special) @ 69′-0″

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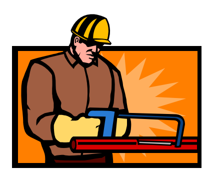
General Information

- Plan cutoff elevation as shown on plans
  - Enter top of pile elevation as shown on plans
- Type of cushioning material used for the hammer or pile
  - Example: Conbest, micarta
  - Maybe plywood for a pile cushion on concrete pile
  - Provided by contractor



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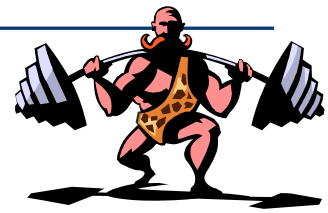
General Information



- Weight per unit length of pile
  - For H-pile HP10x42
    - The 10 represents the width of the web in inches
    - 42 represents the weight of the pile per foot (pounds/ft)
  - For steel pipe pile
    - weight per length can be found on the mill test/lading ticket from the supplier

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General Information

- Weight per unit length of pile
  - For pre-stressed concrete
    - Weight per length should be given in test report
    - Or one can use a density of 150 lbs/ft^3 to calculate a theoretical weight per unit length
      - 12” square = 150 lbs/ft.
      - 14” square = 204.22 lbs/ft.
      - 16” octagonal = 219.6 lbs/ft.

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General Information

Abutment	1	Pier	
		County	Sedgwick
		Project	KA-3109-01
Type of Hammer	D19-42	(Br. No.) and/or Sta	(838)/ 183+98.30
Wt. of Hammer	4015.00 lbs	Type of Pile	HP 12x53
Wt. of Cap and/or Anvil	1930.00 lbs	Min. Bearing Required	79.3 ton
Energy Rating	42480.00 ft-lbs	Max. Bearing Allowed	87.23 ton
Number, Individual Length, and Total Length of Pile:	4 @ 58'-0"; 1 TesPile (Special) @ 68'-0"	Bearing Formula Used:	$\frac{1.6\ W\ H}{S + 0.1\ (X/W^{**})}$
Plan Cutoff Elev. (ft) =	3516.210 ft	Footing Sketch (Please Complete)	1 2 3 4
Wt. per foot piling (lbs/ft):	53 lbs/ft		
Type of Cushion Mat'l:	Plasticized Blue Nylon		

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range

Record Keeping

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A!		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	132.0	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05	4.00	62.40		695.70					

- Elevations are calculated to the nearest one hundredth of a foot (0.01 ft)
  - Computer generated.
- Record pile length to the nearest one hundredth of a foot (0.01 ft)

Record Keeping

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A!		**3/20**	**1000.000**	**30.00**	**25.00**		**5.25**		24.75	975.25	9.00	0.2500	77.1	High
A2		**3/20**		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	**3/20**		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		**3/20**		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		**3/20**		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		**3/20**		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		**3/20**		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		**3/20**		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		**3/20**		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		**3/20**		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		**3/20**		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		**3/20**		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	132.0	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05	4.00	62.40		695.70					

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Record Keeping

- 1. “Actual Length Placed in Leads”
  - This is the length the Contractor opts to use
  - It is used to calculate weight of pile for use in the bearing formula
  - When driving first starts, the “Actual Length Placed in Leads” is equal to the length picked up in the leads
    - can change as driving progresses if splices are made

Kansas Department of Transportation

Record Keeping

- 2. “Actual Length Placed in Leads”
  - a. If bearing is not achieved and a splice is required, the **new** value for “Actual Length Placed in Leads” becomes:
    - The original length placed in the leads **plus** the length of pile spliced onto it.

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Example 1

- 45 feet picked up to start.
- 15 feet spliced on and driven to achieve bearing.
- 60 feet = “Actual Length Placed in Leads”

Kansas Department of Transportation

Record Keeping

- 3. "Actual Length Placed in Leads"
  - b. If bearing is achieved prior to splicing and the splice is made solely to achieve plan cutoff (no more driving to be done on the pile), the "Actual Length Placed in Leads" remains the original length in the leads
    - In this situation the "Ordered and Accepted Length" (original length + splice length) is greater than the "Length Placed in Leads"

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Situations in which the "Ordered and Accepted" length will differ from the plans

- 4. Ordered and Accepted

  2015 Specifications 704.4a
  - The order list is the same as the estimated quantity (number and length of piles) shown in the Contract Documents.

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Record Keeping

- 5. Ordered and Accepted
  - Typically, is the length the Engineer instructs the Contractor to use
    - i.e. the length of pile indicated on the plans
  - But in situations the "Ordered and Accepted" length will differ from the plans

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Example 2

- 25 feet picked up and driven to bearing
- 2 feet spliced on to bring the pile top up to cut off elevation, but no more driving occurred
- "Actual Length Placed in Leads" = 25 feet
- "Ordered and Accepted Length" = 27 feet
- "Length Left in Foundation" = 27 feet

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Ordered and Accepted

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		[illegible]	[illegible]		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		[illegible]	[illegible]		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		[illegible]	[illegible]		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		[illegible]	[illegible]		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	123.5	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05		62.40		695.70					

Situations in which the "Ordered and Accepted" length will differ from the plans

- 6. Ordered and Accepted
  - a. If the length listed on the plans is too short and additional pile length is needed, the contractor is authorized to add the additional length.
    - "Ordered and Accepted" length is now equal to the original length on the plans **plus** the additional length authorized to be spliced on

Example 3

- 45 feet listed on plans picked up and driven but bearing is not achieved
- 15 feet authorized to be spliced on

- 60 feet = “Ordered and Accepted Length”
- 60 feet = “Actual Length Placed in Leads”

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Situations in which the “Ordered and Accepted” length will differ from the plans

- 7. Ordered and Accepted
  - b. If the Contractor opts to use a longer pile than called for and the additional length, in whole or part, is needed to achieved bearing and “Plan Cutoff Elevation”, the “Ordered and Accepted” length is equal to the length of pile left in place.
    - Now “Ordered and Accepted” length and “Length Left in Foundation” are equal.

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Example 4

- 45 feet called for on the plans
- Contractor picks up a 50 footer to drive
- 48 feet was needed to achieve bearing

- “Ordered and Accepted Length” = “Length Left in Foundation” = 48 feet
- “Actual Length Placed in Leads” = 50 feet

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Record Keeping

- 8. Actual Measured Cutoff
  - The actual length of pile cutoff is the difference between the “Actual Length in Leads” length and what is left in footing.

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Actual Measured Cutoff

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced Afte Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	123.5	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05		62.40		695.70					

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Record Keeping

- 9. Actual Measured Cutoff
  - a. The “Actual Measured Cutoff” may not equal “Pay Cutoff”
    - If the Contractor elects to use a longer pile than was specified, the length in excess of the length specified is considered “Non Pay Cutoff”

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Record Keeping

- 10. Splicing Cutoff on another pile
  - The "Actual Measured Cutoff" from one pile may be spliced in part, or in whole, to another pile.
    - It may become part of the "Ordered and Accepted Length" on the pile that received the splice
      - This depends on the length of pile the Contractor was directed to use.
- Be sure to track where the cutoff came from and where it is going to. If the cutoff from one pile is used in a different bent, then you will need to address that in the remarks of both locations.

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Length Left in Foundation

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A!		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	132.0	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05	4.00	62.40		695.70					

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Record Keeping

- 11. Length left in foundation:
  - Is **The Pay Length:** The length of pile left after any cutoff is removed or the addition of a splice is made after driving to achieve the desired elevation. If splice is made after bearing is achieved, the new “Ordered and Accepted” length is equal to pay length provided the new length is equal to or greater than the plan length.

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Pile Tip Elevation

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	123.5	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05		62.40		695.70					

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Record Keeping

- 12. Pile tip elevation
  - Is typically the "plan cutoff elevation" minus the length left in foundation
  - If battered piles are used, the batter needs to be taken into account to determine the tip elevation

Stroke, Penetration, & Bearing

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	123.5	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05		62.40		695.70					

Record Keeping

- 13. Stroke or Drop of Hammer
  - Observed by the inspector and recorded
- 14. Average penetration
  - The penetration per 20 blows divided by 20
    - Example 5 inches per 20 blows = .25 inch per blow
    - Could be less than 20 blows i.e. 5 blows.
- 15. Computed Bearing capacity of pile
  - Computed by the inspector or computer
    - Note: All inspectors are required to know how to manually calculate bearing using the bearing formula

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Record Keeping

- 16. “Totals” -- Total each column
  - “Actual length placed in leads”
  - “Ordered and accepted”
  - “Actual measured cutoff”
  - “Length left in foundation”

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		3/20	1000.000	30.00	25.00		5.25		24.75	975.25	9.00	0.2500	77.1	High
A2		3/20		28.00	26.75		1.25	1	26.75	959.40	9.50	0.3000	71.3	OK
A3	y	3/20		29.00	28.00		3.25		25.75	960.40	10.00	0.2000	100.0	High
A4		3/20		25.30	25.30		0.00		25.30	960.85	10.00	0.3500	66.7	OK
A5		3/20		25.00	25.00		1.50		23.50	962.65	10.00	0.2500	85.7	High
A6		3/20		25.00	25.00		3.00		22.00	964.15	11.00	0.3000	82.5	High
A7		3/20		25.00	25.00		1.70		23.30	962.85	9.50	0.3000	71.3	OK
A8		3/20		25.00	25.00		1.70		23.30	962.85	10.00	0.3500	66.7	OK
A9		3/20		25.00	27.00	2.00	0.00	1	27.00	959.15	10.00	0.2500	85.7	High
A10		3/20		25.50	25.00		1.40		24.10	962.05	10.00	0.2500	85.7	High
B1		3/20		52.00	52.00		1.90		50.10	936.05	10.00	0.2500	85.7	High
B2		3/20		52.00	52.00		3.50		48.50	937.65	11.00	0.2500	94.3	High
B3		3/24		52.00	52.00		4.00		48.00	938.15	9.00	0.3000	67.5	OK
B4		3/24		52.00	52.00		5.00		47.00	939.15	10.00	0.3000	75.0	High
B5		3/24		52.00	54.00	2.00	0.00	1	54.00	932.15	10.00	0.3500	66.7	OK
B6		3/24		52.00	52.00		1.55		50.45	935.70	10.00	0.2500	85.7	High
B7		3/24		52.00	52.00		1.70		50.30	935.85	10.00	0.2500	85.7	High
B8	y	3/25		75.00	55.00		23.80		51.20	934.95	11.00	0.1500	123.5	High
B9		3/25		52.30	52.00		1.90		50.40	935.75	11.00	0.2500	94.3	High
				754.10	730.05		62.40		695.70					

Kansas Department of Transportation

Summary Section

Summary of driven pile from Record Keeping section

754.10	730.05	4.00	62.40		695.70

		********Contract Line Item Number*********	27
Total Accepted Length =	730.05 ft	Remarks:	
Production Pile Pay Length =	**618.75** ft	Pile A1 thru A10 are normal pile	
Test Pile Pay Length =	**79.20** ft	Pile B1 thru B9 are battered at 15 degrees	
Production Pile Pay Cutoff =	**24.30** ft	Pile A3 and B8 are test pile	
Non Pay Cutoff =	5.30 ft	Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9	
Test Pile Cutoff =	23.25 ft	Used 3.8 ft. test pile cutoff B8 on B9	
		3 unplanned splices made at to A2, A9, B5	
No. of Test Pile Pay Splices =	**0**	A9 used 2 ft. of pay cutoff from A6 to make elevation	
No. of Pay Splices =	**3**	B5 used 2 ft. brom B3 to make elevation	

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Inspected By:

Checked By:

Submitted By:

Kansas Department of Transportation

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Summary Section

- 17. “Accepted Length”
  - Equals the total from the “Ordered and Accepted” column

754.10	730.05	4.00	62.40		695.70

		********Contract Line Item Number*********	27
Total Accepted Length =	730.05 ft	Remarks:	
Production Pile Pay Length =	**618.75** ft	Pile A1 thru A10 are normal pile	
Test Pile Pay Length =	**79.20** ft	Pile B1 thru B9 are battered at 15 degrees	
Production Pile Pay Cutoff =	**24.30** ft	Pile A3 and B8 are test pile	
Non Pay Cutoff =	5.30 ft	Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9	
Test Pile Cutoff =	23.25 ft	Used 3.8 ft. test pile cutoff B8 on B9	
		3 unplanned splices made at to A2, A9, B5	
No. of Test Pile Pay Splices =	**0**	A9 used 2 ft. of pay cutoff from A6 to make elevation	
No. of Pay Splices =	**3**	B5 used 2 ft. brom B3 to make elevation	

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Inspected By:

Checked By:

Submitted By:

Kansas Department of Transportation

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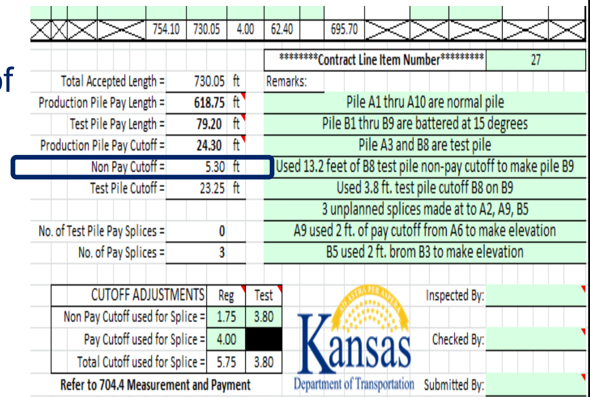
Summary Section

- 18. "Non-Pay Cutoff"
  - Represents the length of pile in excess of the length specified and was cutoff
  - Equals the "Actual Measured Cutoff" column minus any "Pay Cutoff"



754.10	730.05	4.00	62.40	695.70

			********Contract Line Item Number********* 27
Total Accepted Length =	730.05	ft	Remarks:
Production Pile Pay Length =	618.75	ft	Pile A1 thru A10 are normal pile
Test Pile Pay Length =	79.20	ft	Pile B1 thru B9 are battered at 15 degrees
Production Pile Pay Cutoff =	24.30	ft	Pile A3 and B8 are test pile
Non Pay Cutoff =	5.30	ft	Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9
Test Pile Cutoff =	23.25	ft	Used 3.8 ft. test pile cutoff B8 on B9
			3 unplanned splices made at to A2, A9, B5
No. of Test Pile Pay Splices =	0		A9 used 2 ft. of pay cutoff from A6 to make elevation
No. of Pay Splices =	3		B5 used 2 ft. brom B3 to make elevation

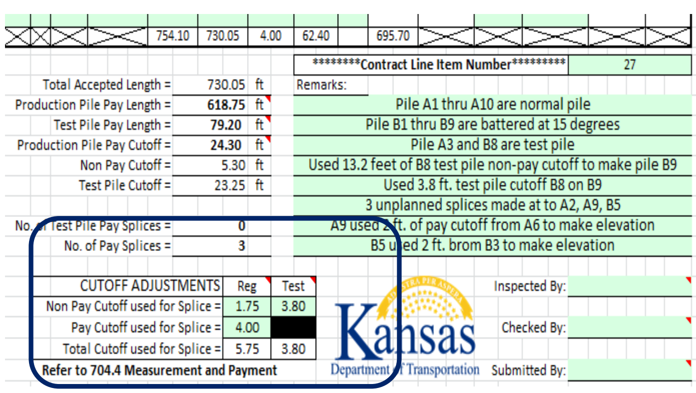
CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Inspected By:
Checked By:
Submitted By:

Kansas Department of Transportation

Non-Pay Cutoff used for Splice, Pay Cutoff used for Splice, & Cutoff used for Splice



754.10	730.05	4.00	62.40	695.70

			********Contract Line Item Number********* 27
Total Accepted Length =	730.05	ft	Remarks:
Production Pile Pay Length =	618.75	ft	Pile A1 thru A10 are normal pile
Test Pile Pay Length =	79.20	ft	Pile B1 thru B9 are battered at 15 degrees
Production Pile Pay Cutoff =	24.30	ft	Pile A3 and B8 are test pile
Non Pay Cutoff =	5.30	ft	Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9
Test Pile Cutoff =	23.25	ft	Used 3.8 ft. test pile cutoff B8 on B9
			3 unplanned splices made at to A2, A9, B5
No. of Test Pile Pay Splices =	0		A9 used 2 ft. of pay cutoff from A6 to make elevation
No. of Pay Splices =	3		B5 used 2 ft. brom B3 to make elevation

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Inspected By:
Checked By:
Submitted By:

Kansas Department of Transportation

Summary Section

- 19. “Non-Pay Cutoff Used for Splice”
  - Is the length of pile that was originally considered part of “Non-Pay Cutoff”, but was spliced to another pile to achieve “Plan Cutoff Elevation” and/or bearing

				754.10	730.05	4.00	62.40		695.70				

			********Contract Line Item Number*********	27
Total Accepted Length =	730.05	ft	Remarks:	
Production Pile Pay Length =	**618.75**	ft	Pile A1 thru A10 are normal pile	
Test Pile Pay Length =	**79.20**	ft	Pile B1 thru B9 are battered at 15 degrees	
Production Pile Pay Cutoff =	**24.30**	ft	Pile A3 and B8 are test pile	
Non Pay Cutoff =	5.30	ft	Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9	
Test Pile Cutoff =	23.25	ft	Used 3.8 ft. test pile cutoff B8 on B9	
			3 unplanned splices made at to A2, A9, B5	
No. of Test Pile Pay Splices =	**0**		A9 used 2 ft. of pay cutoff from A6 to make elevation	
No. of Pay Splices =	3		B5 used 2 ft. brom B3 to make elevation	

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Kansas Department of Transportation

Inspected By:

Checked By:

Submitted By:

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Example 9

- 45 feet called for on the plans
- Contractor picks up a 50 footer to drive
- 45 feet was needed to achieve bearing
  - Contractor cuts off the other 5 feet as “Non Pay Cut Off”
- This 5 feet is spliced to another pile and becomes “Non Pay Cut Off Used For Splice”

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Summary Section

- 17. Pay cutoff used for splice
  - Is the length that was originally considered part of the “Pay Cutoff” from one pile but was spliced to another pile to achieve “Plan Cutoff Elevation” and/or bearing.
  - Since this cutoff was previously considered “Pay Cutoff” deduct it from the “Pay Cutoff” total so it is not paid for as “Pay Length” and “Pay Cutoff”.
  - If came from different location, the first report will need to be amended to track pile cutoff to new location.

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Example 10

- 45 feet listed on plans picked up and driven but bearing is not achieved
- 15 feet authorized to be spliced on but only 10 feet can be driven
- 5 feet has to be cut off as “Pay Cut Off”
- This 5 feet is spliced on another pile and becomes “Pay Cut Off Used For Splice” and is now “Pay Length”

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Example 10 continued

Since this cutoff was previously considered “Pay Cutoff” deduct it from the “Pay Cutoff” total so it is not paid for as “Pay Length” and “Pay Cutoff”.

Summary Section

- 18. “Cutoff Used for Splice”
    - Equals the “Non-pay Cutoff Used for Splice” **plus** “Pay Cutoff Used for Splice”

Number of Pay Splices, Pay Length, & Pay Cutoff

				754.10	730.05	4.00	62.40		695.70		

********Contract Line Item Number********* 27

Total Accepted Length =	730.05	ft
Production Pile Pay Length =	**618.75**	ft
Test Pile Pay Length =	**79.20**	ft
Production Pile Pay Cutoff =	**24.30**	ft
Non Pay Cutoff =	5.30	ft
Test Pile Cutoff =	23.25	ft
No. of Test Pile Pay Splices =	**0**	
No. of Pay Splices =	**3**	

Remarks:

Pile A1 thru A10 are normal pile
Pile B1 thru B9 are battered at 15 degrees
Pile A3 and B8 are test pile
Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9
Used 3.8 ft. test pile cutoff B8 on B9
3 unplanned splices made at to A2, A9, B5
A9 used 2 ft. of pay cutoff from A6 to make elevation
B5 used 2 ft. brom B3 to make elevation

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Kansas Department of Transportation

Inspected By:

Checked By:

Submitted By:

Kansas Department of Transportation

Summary Section

- 19. "Number Pay Splices"
  - Total number of splices ordered by KDOT to extend the pile beyond the original "Ordered and Accepted Length"
  - Splices made for contractor's convenience are not considered pay splices

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Summary Section

- 20. “Pay Length”
  - Equals the total from the “Length Left in Foundation” column
- 21. “Pay Cutoff” equals the

“Actual Length in Leads”
minus “Length Left in Foundation”
minus “Test & Non Pay Cutoff”

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Remarks

754.10	730.05	4.00	62.40		695.70		

Total Accepted Length =	730.05	ft
Production Pile Pay Length =	**618.75**	ft
Test Pile Pay Length =	**79.20**	ft
Production Pile Pay Cutoff =	**24.30**	ft
Non Pay Cutoff =	5.30	ft
Test Pile Cutoff =	23.25	ft
No. of Test Pile Pay Splices =	**0**	
No. of Pay Splices =	**3**	

********Contract Line Item Number*********	27

Remarks:

- Pile A1 thru A10 are normal pile
- Pile B1 thru B9 are battered at 15 degrees
- Pile A3 and B8 are test pile
- Used 13.2 feet of B8 test pile non-pay cutoff to make pile B9
- Used 3.8 ft. test pile cutoff B8 on B9
- 3 unplanned splices made at to A2, A9, B5
- A9 used 2 ft. of pay cutoff from A6 to make elevation
- B5 used 2 ft. brom B3 to make elevation

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	1.75	3.80
Pay Cutoff used for Splice =	4.00	
Total Cutoff used for Splice =	5.75	3.80

Refer to 704.4 Measurement and Payment

Inspected By:

Checked By:

Submitted By:

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Summary Section

- 22. "Remarks"—provide a recap of **all** splicing information and unique information
  - a. Indicate if it was pay or non-pay splice (i.e. was it ordered by KDOT or was it the Contractors option)
  - b. Which pile the splice came from
  - c. Which pile the splice was spliced to
  - d. The length of the splice pile
  - e. Indicate if the splice was made after bearing was achieved
  - f. Other information as you see fit

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Continuous Log Section

- Just below the Summary Section.
- Used for Test piles when required.

Pile No.	Total Pile Length	Length Driven		Number of Blows (Blow Count)	Drop of Hammer (Stroke) (ft.)	Average Penetration (in.)	Computed Resistance (tons)	Computed vs. Specified
		From	To					
		0.00						

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Log of Continuous Pile Driving and/or Test Pile Sheet

Refer to 704.4 Measurement and Payment

Submitted By:

County: Riley

Abutment: 1 Pier:

Project: K-XXXX-01 (103)

(Br. No.) and/or Sta: (103) 10+513.17

Pile No.	Total Pile Length	Length Driven From	Length Driven To	Number of Blows (Blow Count)	Drop of Hammer (Stroke) (ft.)	Average Penetration (in.)	Computed Resistance (tons)	Computed vs. Specified
A3	29	1.25	4.50	7	3.00	5.57	1.6	Low
A3	29	4.50	7.00	10	3.00	3.00	2.9	Low
A3	29	7.00	11.00	10	3.00	4.80	1.8	Low
A3	29	11.00	14.50	10	3.00	4.20	2.1	Low
A3	29	14.50	17.00	15	3.00	2.00	4.3	Low
A3	29	17.00	19.00	15	3.50	1.60	6.2	Low
A3	29	19.00	20.00	20	3.50	0.60	15.0	Low
A3	29	20.00	21.00	23	3.50	0.52	16.9	Low
A3	29	21.00	22.00	23	3.50	0.52	16.9	Low
A3	29	22.00	23.00	24	4.00	0.50	20.0	Low
A3	29	23.00	24.00	25	4.00	0.48	20.7	Low
A3	29	24.00	24.50	22	4.50	0.27	36.5	Low
A3	29	24.50	25.00	23	4.50	0.26	37.5	Low
A3	29	25.00	25.25	26	4.75	0.12	64.8	Low
A3	29	25.25	25.60	27	4.75	0.16	54.8	Low
A3	29	25.60	25.80	20	5.25	0.12	71.6	Ok
A3	29	25.80						

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Driving Information

- 23. Log of Continuous pile driving and/or test pile
  - Record a continuous pile driving record for a representative pile on each abutment and pier footing on the structure
  - The record should be inclusive from the beginning of drive to the final bearing

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When filling out the “Log of Continuous pile driving”

- For structures under 755 feet in length, a continuous pile driving record is required on 2 footings, one in the abutment and one in the pier (opposite ends)
- For structures over 755 feet in length a continuous pile driving record is required on 3 footings, one abutment and two pier footings
- If the piers have no piling then information will be recorded on one pile from each abutment

Kansas Department of Transportation

When filling out the “Log of Continuous pile driving”

- a. Record any “set” length
  - Pile set with a gravity hammer from 0 to 16 feet
- After pile is set, record 1 foot increments
- Record the fractional increment just prior to achieving final bearing
  - 47 to 47.3 feet

Kansas Department of Transportation

When filling out the "Log of Continuous pile driving"

- b. Record the number of blows per 1-foot increments
- c. Record the observed hammer stroke

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Department of Transportation

When filling out the "Log of Continuous pile driving"

- d. Record Average penetration per blow
  - The total 1 foot increment divided by the number of blows for that foot
  - Example: from 6.0 to 7.0 ft. you had 16 blows

    1.0 ft/16 blows = 12 inches/16 blows = .75 inch/blow
- e. Record Computed bearing capacity of pile

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Department of Transportation

When filling out the “Log of Continuous pile driving”

- f. Under the last entry (the fractional increment)

  Record: 1. movement in the last 20 blows (.55 ft)

  2. average penetration per blow (0.33 in)

  3. the associated bearing (69.8 tons)

Abutment 1 Pier

Project K-XXXX-01 (103)

(Br. No.) and/or Sta (103) 10+513.17

Row	Pile No.	Total Pile Length	Length Driven From	Length Driven To	Number of Blows (Blow Count)	Drop of Hammer (Stroke) (ft.)	Average Penetration (in.)	Computed Resistance (tons)	Computed vs. Specified
70	A4	25.3	1.50	4.50	10	6.00	3.60	4.9	Low
71	A4	25.3	4.50	7.00	15	6.00	2.00	8.6	Low
72	A4	25.3	7.00	11.00	20	6.50	2.40	7.8	Low
73	A4	25.3	11.00	14.50	20	7.00	2.10	9.5	Low
74	A4	25.3	14.50	17.00	20	7.50	1.50	14.1	Low
75	A4	25.3	17.00	19.00	20	8.00	1.20	18.5	Low
76	A4	25.3	19.00	20.00	20	8.50	0.60	36.4	Low
77	A4	25.3	20.00	21.50	20	8.50	0.90	25.5	Low
78	A4	25.3	21.50	22.50	20	9.00	0.60	38.6	Low
79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80	A4	25.3	23.15	23.70	20	10.00	0.33	69.8	Ok
81	A4	25.3	23.70						
82	A4	25.3							

Kansas Department of Transportation

Driving Information

- 24. Distribution list--Copies to appropriate personnel
- 25. Signatures--**<u>Always</u>**
  - The individual that inspected the pile drive operation
  - The individual that checked any computations

Kansas Department of Transportation

Completed Form 217

Abutment	1	Pier	
Type of Hammer	D-19	County	Riley
Wt. of Hammer	3750.00 lbs	Project	K-XXXX-01 (103)
Wt. of Cap and/or Anvil	420.00 lbs	(Br. No.) and/or Sta	(103) 10+513.17
Energy Rating	42480.00 ft-lbs	Type of Pile	12x53
		Min. Bearing Required	65 ton
		Max. Bearing Allowed	73.7 ton
Number, Individual Length, and Total Length of Pile:	9 @ 25 = 225; 8 @ 52 = 416 batt. Test 1 @ 28', 1 @ 55'	Bearing Formula Used:	$\frac{1.6\ W\ H}{S + 0.1\ (X/W^{**})}$
Plan Cutoff Elev. (ft) =	986.150 ft		
Wt. per foot piling (lbs/ft):	53 lbs/ft		
Type of Cushion Mat'l:			

Footing Sketch (Please Complete)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
B1	B2	B3	B4	B5	B6	B7	B8	B9	

Pile No.	Test Pile	Date	Varied Plan Cutoff Elev.	Actual Length in Leads	Ordered & Accepted	Spliced After Drive	Actual Cutoff	Pay Splices	Length Left in Footing	Pile Tip Elev.	Stroke (Drop of Hammer)	Average Penetration (inches)	Computed Bearing Power	Range
A1		6/22	987.500	30.00	25.00		5.25		24.75	962.75	6.00	0.1500	72.0	OK
A2		6/22		25.00	27.75	2.75	0.00	1	27.75	958.40	6.00	0.1500	72.0	OK
A3	y	6/22		29.00	28.00		3.20		25.80	960.35	5.25	0.1250	70.0	OK
A4		6/22		25.30	25.00		0.00		25.30	960.85	6.25	0.1500	75.0	High
A5		6/22		25.10	25.00		1.50		23.60	962.55	5.75	0.1500	69.0	OK
A6		6/22		25.20	25.00		3.00		22.20	963.95	6.50	0.2000	65.0	OK
A7		6/22		25.00	25.00		1.70		23.30	962.85	6.25	0.1750	68.2	OK
A8		6/22		25.00	25.00		1.70		23.30	962.85	6.50	0.2000	65.0	OK
A9		6/22		25.00	25.00		1.40		23.60	962.55	6.25	0.1750	68.2	OK
A10		6/22	987.500	25.00	27.00	2.00	0.00	1	27.00	960.50	6.50	0.2000	65.0	OK
B1		6/23		51.00	53.50	2.50	0.00		53.50	932.65	8.00	0.2500	68.6	OK
B2		6/23		52.00	52.00		3.50		48.50	937.65	8.25	0.2500	70.7	OK
B3		6/23		52.00	52.00		4.00		48.00	938.15	8.50	0.2500	72.9	OK
B4		6/23		52.00	52.00		5.00		47.00	939.15	8.25	0.2500	70.7	OK
B5		6/23		52.00	54.00	2.00	0.00	1	54.00	932.15	8.25	0.2750	66.0	OK
B6		6/23		52.00	52.00		1.55		50.45	935.70	8.50	0.2500	72.9	OK
B7		6/23		52.00	52.00		1.70		50.30	935.85	8.25	0.2750	66.0	OK
B8	y	6/23		65.00	55.00		13.80		51.20	934.95	8.25	0.2000	81.7	High
B9		6/23		52.30	52.00		1.90		50.40	935.75	8.25	0.2750	66.0	OK
				739.90	732.25		49.20		699.95					

Total Accepted Length =	732.25	ft
Production Pile Pay Length =	622.65	ft
Test Pile Pay Length =	77.00	ft
Production Pile Pay Cutoff =	19.85	ft
Non Pay Cutoff =	3.10	ft
Test Pile Cutoff =	3.20	ft
No. of Test Pile Pay Splices =	0	
No. of Pay Splices =	3	

********Contract Line Item Number*********

Remarks:
- A are normal, B are battered pile. A3 and B8 are Test Pile
- 3 pay splices made; tops of A2, A10, and B5
- 1 unpaid splice made to pile B1; 3 splices require special inspection
- A2 used 0.25' pay cutoff and 2.5' Non-pay cutoff from pile A1
- A10 used 2.0' of pay cutoff from A6 to make elevation
- B5 used 2.0' of pay cutoff from B4 to make elevation
- B1 used 2.5' of pay cutoff from B2 to make elevation
- 13.8' of test pile cutoff from B8 used to make pile B9

CUTOFF ADJUSTMENTS	Reg	Test
Non Pay Cutoff used for Splice =	2.50	13.80
Pay Cutoff used for Splice =	6.75	
Total Cutoff used for Splice =	9.25	13.80

Refer to 704.4 Measurement and Payment

Inspected By:

Checked By:

Submitted By:

County: Riley
Project: K-XXXX-01 (103)
(Br. No.) and/or Sta: (103) 10+513.17

Abutment 1 Pier

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Form 217 B-the chart-make before you begin to drive pile

Field Pile Driving Guide

Enter known data in all available cells.

General Information

If you can not see colored tabs for different hammers at the bottom of the window, go to "View" tab, "Arrange All", and hit "OK" in the window that pops up.

(This information is common to all sheets in the Workbook)

Hammer Information		PROJECT INFORMATION	
Type of Hammer		County	
		Project	
Hammer Weight	lbs	(Br. No.) and/or Sta	
Cap and/or Anvil Weight	lbs	Type of Pile	
Energy Rating	ft-lbs	Plan Note Overdrive %	%
		Min. Resistance Required	tons
		Max. Resistance Allowed	tons

Guide to COMPLETING the Field Pile Driving Guide - Form 217B

1. All formulas use exactly what is entered in the cells.
2. Hover the mouse cursor over any red triangle to read information concerning what needs to be entered in the cell. Refer to the "Delmag Example" tab to view sample entry data.

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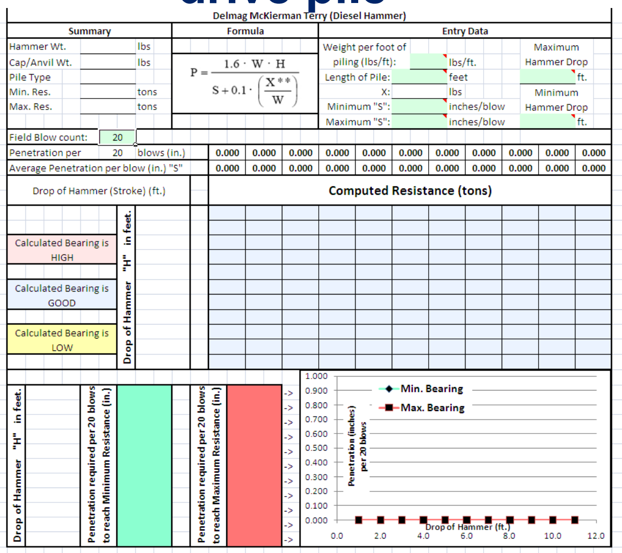
Form 217 B-the chart-make before you begin to drive pile



Delmag McKiernan Terry (Diesel Hammer)

Summary			Formula	Entry Data			
Hammer Wt.		lbs	$P = \dfrac{1.6 \cdot W \cdot H}{S + 0.1 \cdot \left(\dfrac{X^{**}}{W}\right)}$	Weight per foot of piling (lbs/ft):		lbs/ft.	Maximum Hammer Drop ft.
Cap/Anvil Wt.		lbs		Length of Pile:		feet	
Pile Type				X:		lbs	Minimum Hammer Drop ft.
Min. Res.		tons		Minimum "S":		inches/blow	
Max. Res.		tons		Maximum "S":		inches/blow	

Field Blow count: 20

Penetration per 20 blows (in.)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Average Penetration per blow (in.) "S"	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Drop of Hammer (Stroke) (ft.) — Computed Resistance (tons)

Calculated Bearing is HIGH

Calculated Bearing is GOOD

Calculated Bearing is LOW

Drop of Hammer "H" in feet.

Drop of Hammer "H" in feet. | Penetration required per 20 blows to reach Minimum Resistance (in.) | Penetration required per 20 blows to reach Maximum Resistance (in.)

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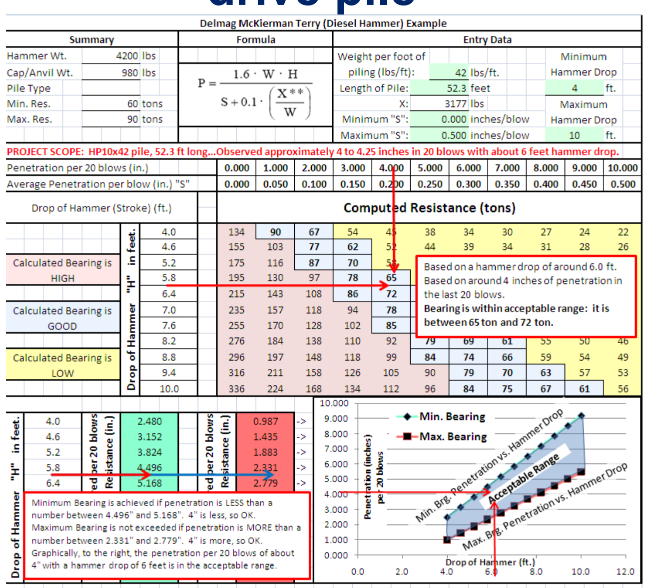
Form 217 B-the chart-make before you begin to drive pile



Delmag McKiernan Terry (Diesel Hammer) Example

Summary			Formula	Entry Data			
Hammer Wt.	4200	lbs	$P = \dfrac{1.6 \cdot W \cdot H}{S + 0.1 \cdot \left(\dfrac{X^{**}}{W}\right)}$	Weight per foot of piling (lbs/ft):	42	lbs/ft.	Minimum Hammer Drop 4 ft.
Cap/Anvil Wt.	980	lbs		Length of Pile:	52.3	feet	
Pile Type				X:	3177	lbs	Maximum Hammer Drop 10 ft.
Min. Res.	60	tons		Minimum "S":	0.000	inches/blow	
Max. Res.	90	tons		Maximum "S":	0.500	inches/blow	

PROJECT SCOPE: HP10x42 pile, 52.3 ft long...Observed approximately 4 to 4.25 inches in 20 blows with about 6 feet hammer drop.

Penetration per 20 blows (in.)	0.000	1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.000	9.000	10.000
Average Penetration per blow (in.) "S"	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500
Drop of Hammer (Stroke) (ft.) "H" in feet.	**Computed Resistance (tons)**										
4.0	134	90	67	54	45	38	34	30	27	24	22
4.6	155	103	77	62	52	44	39	34	31	28	26
5.2	175	116	87	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5.8	195	130	97	78	65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.4	215	143	108	86	72	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.0	235	157	118	94	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.6	255	170	128	102	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.2	276	184	138	110	92	79	69	61	55	50	46
8.8	296	197	148	118	99	84	74	66	59	54	49
9.4	316	211	158	126	105	90	79	70	63	57	53
10.0	336	224	168	134	112	96	84	75	67	61	56

Calculated Bearing is HIGH

Calculated Bearing is GOOD

Calculated Bearing is LOW

Based on a hammer drop of around 6.0 ft. Based on around 4 inches of penetration in the last 20 blows. **Bearing is within acceptable range: it is between 65 ton and 72 ton.**

Drop of Hammer "H" in feet.	Penetration required per 20 blows to reach Minimum Resistance (in.)	Penetration required per 20 blows to reach Maximum Resistance (in.)	
4.0	2.480	0.987	->
4.6	3.152	1.435	->
5.2	3.824	1.883	->
5.8	4.496	2.331	->
6.4	5.168	2.779	->

Minimum Bearing is achieved if penetration is LESS than a number between 4.496" and 5.168". 4" is less, so OK. Maximum Bearing is not exceeded if penetration is MORE than a number between 2.331" and 2.779". 4" is more, so OK. Graphically, to the right, the penetration per 20 blows of about 4" with a hammer drop of 6 feet is in the acceptable range.

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Questions
?
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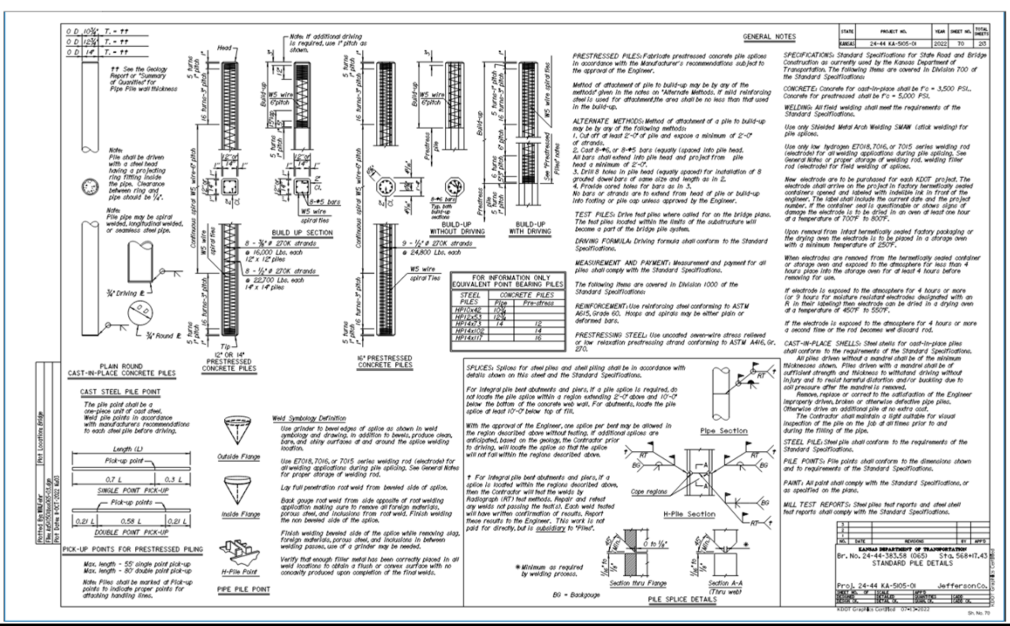
Welded Pile Splices

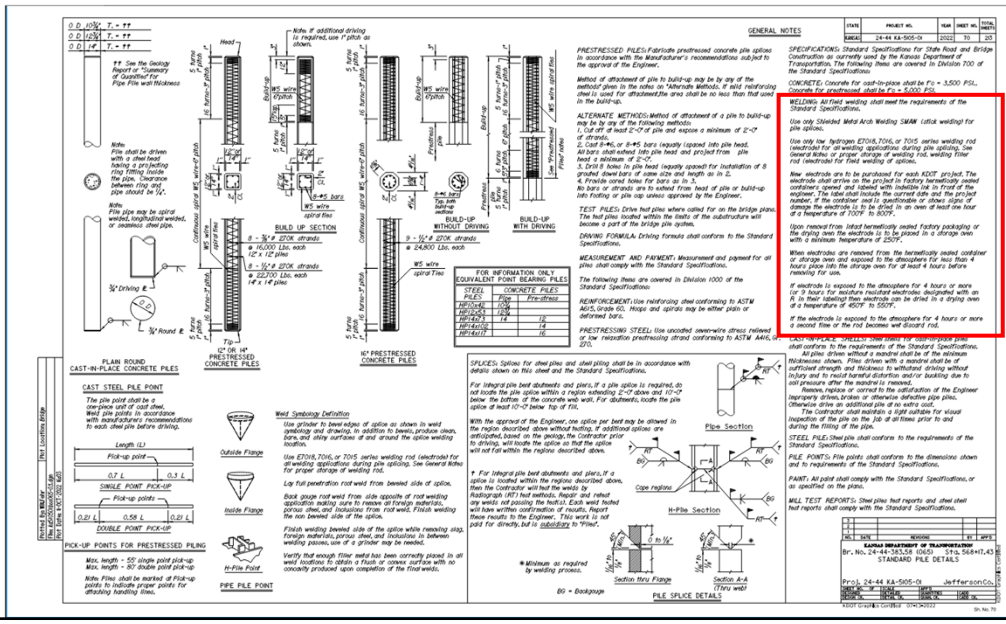
1

Standard Pile Details



2

Standard Pile Details



Standard Pile Details

...accordance with the Manufacturer's recommendations subject to
approval of the Engineer.

...thod of attachment of pile to build-up may be by any of the
...thods" given in the notes on "Alternate Methods. If mild reinforcing
...el is used for attachment,the area shall be no less than that used
the build-up.

...TERNATE METHODS: Method of attachment of a pile to build-up
...y be by any of the following methods:
Cut off at least 2'-0" of pile and expose a minimum of 2'-0"
strands.
Cast 8-#6, or 8-#5 bars (equally (spaced into pile head.
bars shall extend into pile head and project from pile
...d a minimum of 2'-0".
Drill 8 holes in pile head (equally spaced) for installation of 8
...uted dowel bars of same size and length as in 2.
Provide cored holes for bars as in 3.
bars or strands are to extend from head of pile or build-up
...o footing or pile cap unless approved by the Engineer.

...EST PILES: Drive test piles where called for on the bridge plans.
...he test piles located within the limits of the substructure will
...come a part of the bridge pile system.

...RIVING FORMULA: Driving formula shall conform to the Standard
...pecifications.

...EASUREMENT AND PAYMENT: Measurement and payment for all
...les shall comply with the Standard Specifications.

...he following items are covered in Division 1000 of the
...tandard Specifications:

...EINFORCEMENT: Use reinforcing steel conforming to ASTM
...615, Grade 60. Hoops and spirals may be either plain or
...formed bars.

...RESTRESSING STEEL: Use uncoated seven-wire stress relieved
... low relaxation prestressing strand conforming to ASTM A416, Gr.
...70.

Transportation. The following items are covered in Division 700 of
the Standard Specifications:

CONCRETE: Concrete for cast-in-place shall be f'c = 3,500 PSI..
Concrete for prestressed shall be f'c = 5,000 PSI.

WELDING: All field welding shall meet the requirements of the
Standard Specifications.

Use only Shielded Metal Arch Welding SMAW (stick welding) for
pile splices.

Use only low hydrogen E7018, 7016, or 7015 series welding rod
(electrode) for all welding applications during pile splicing. See
General Notes or proper storage of welding rod. welding filler
rod (electrode) for field welding of splices.

New electrode are to be purchased for each KDOT project. The
electrode shall arrive on the project in factory hermetically sealed
containers opened and labeled with indelible ink in front of the
engineer. The label shall include the current date and the project
number. If the container seal is questionable or shows signs of
damage the electrode is to be dried in an oven at least one hour
at a temperature of 700°F to 800°F.

Upon removal from intact hermetically sealed factory packaging or
the drying oven the electrode is to be placed in a storage oven
with a minimum temperature of 250°F.

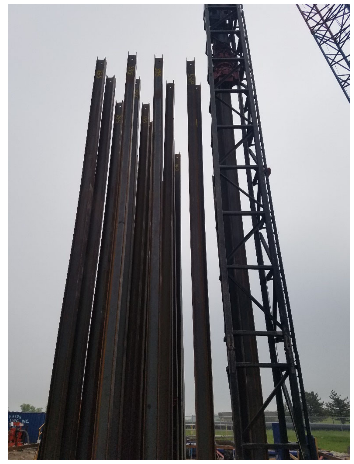
When electrodes are removed from the hermetically sealed container
or storage oven and exposed to the atmosphere for less than 4
hours place into the storage oven for at least 4 hours before
removing for use.

If electrode is exposed to the atmosphere for 4 hours or more
(or 9 hours for moisture resistant electrodes designated with an
R in their labeling) then electrode can be dried in a drying oven
at a temperature of 450°F to 550°F.

If the electrode is exposed to the atmosphere for 4 hours or more
a second time or the rod becomes wet discard rod.

CAST-IN-PLACE SHELLS: Steel shells for cast-in-place piles
shall conform to the requirements of the Standard Specifications.

KDOT H-Pile splices



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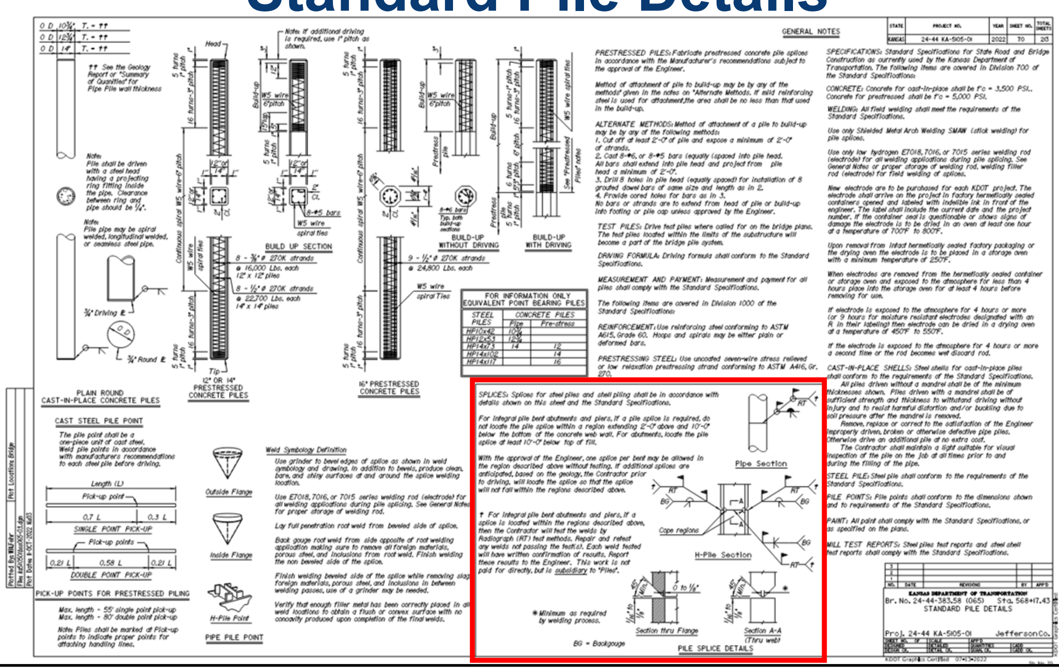
Standard Pile Details



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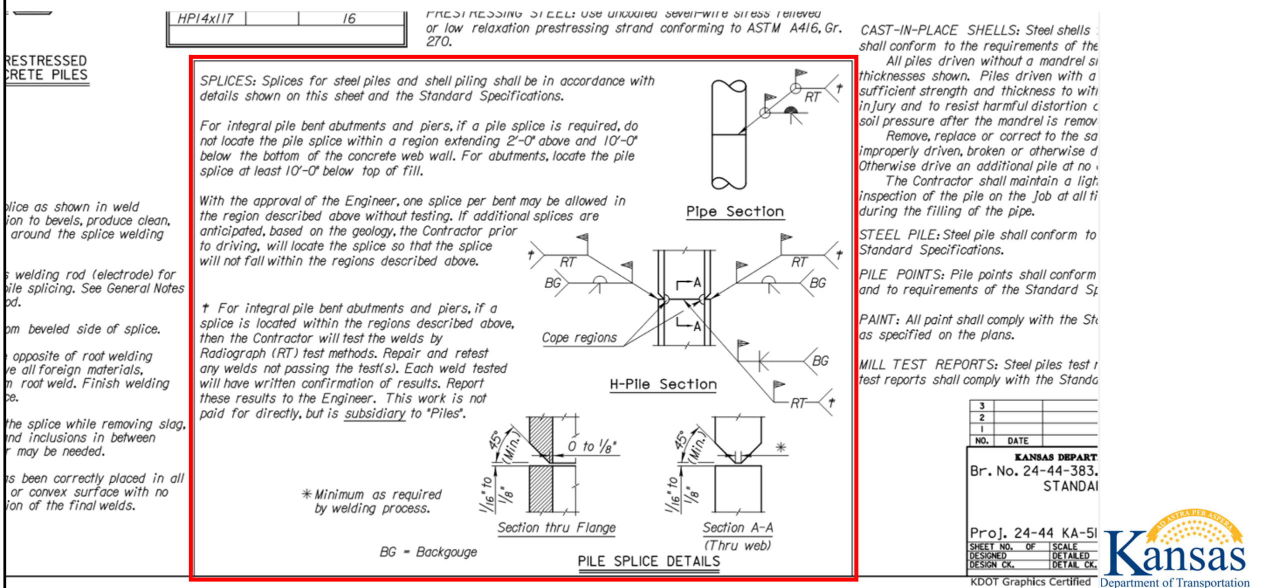
Pile Splice Details



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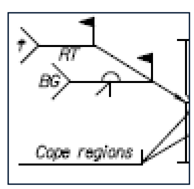
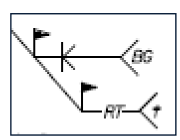
Weld Symbology Meaning

Solid Flag pointing away from work area

- Field Weld Symbol

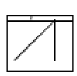




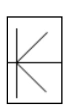
Half circle

- Filled is: Melt Through
- Unfilled is: Backing or Backgouge

•Single Bevel Grove:



•Double Bevel Groove:



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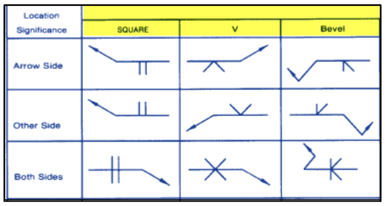
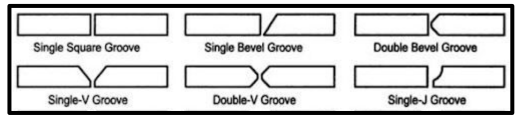
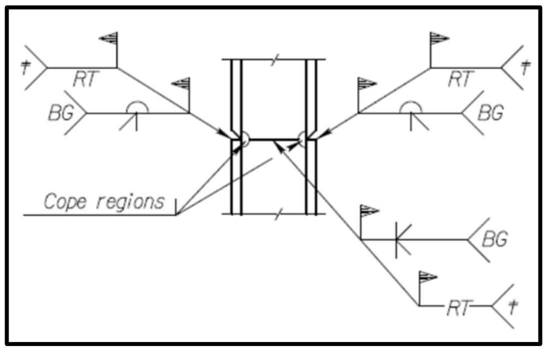
Weld Symbology Details







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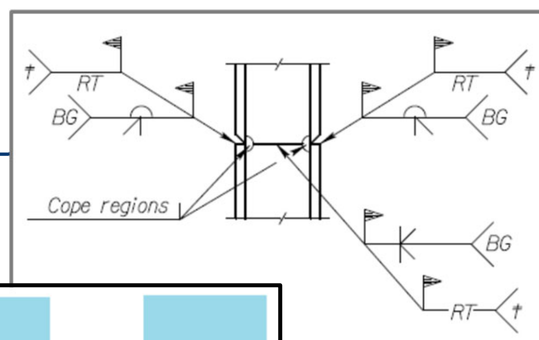
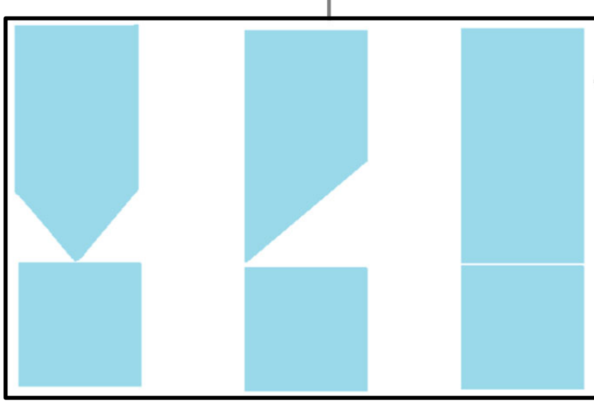
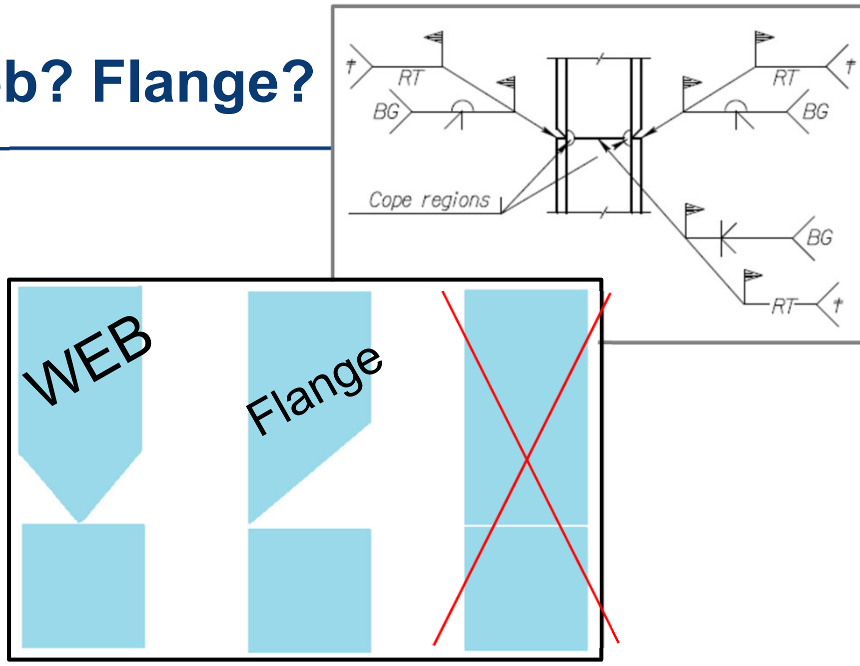
Web? Flange?





10

Web? Flange?



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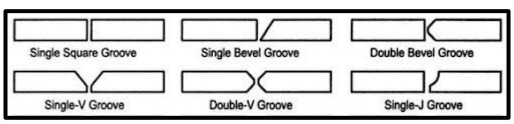
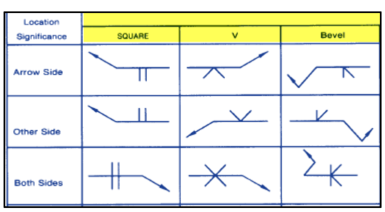
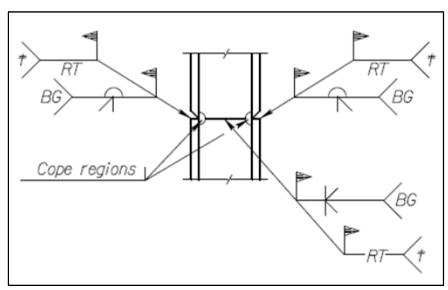
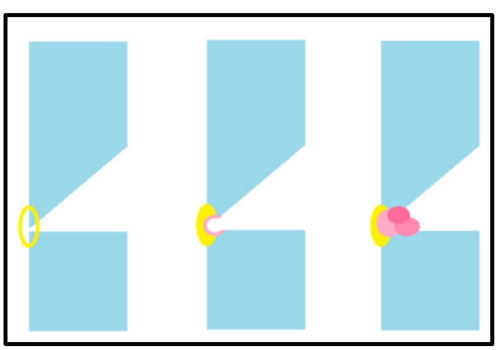
Welding Details









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Welding Details

13

Welding Details

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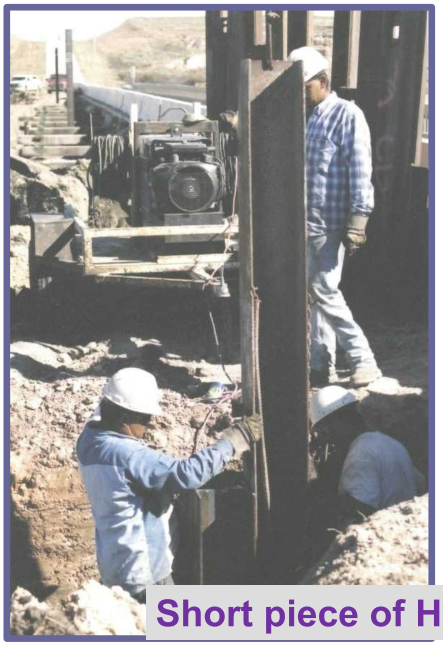
ALIGNMENT METHODS



Short piece of H-pile clamped on

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15

C-Clamps and Boards

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16

What <u>NOT</u> to do

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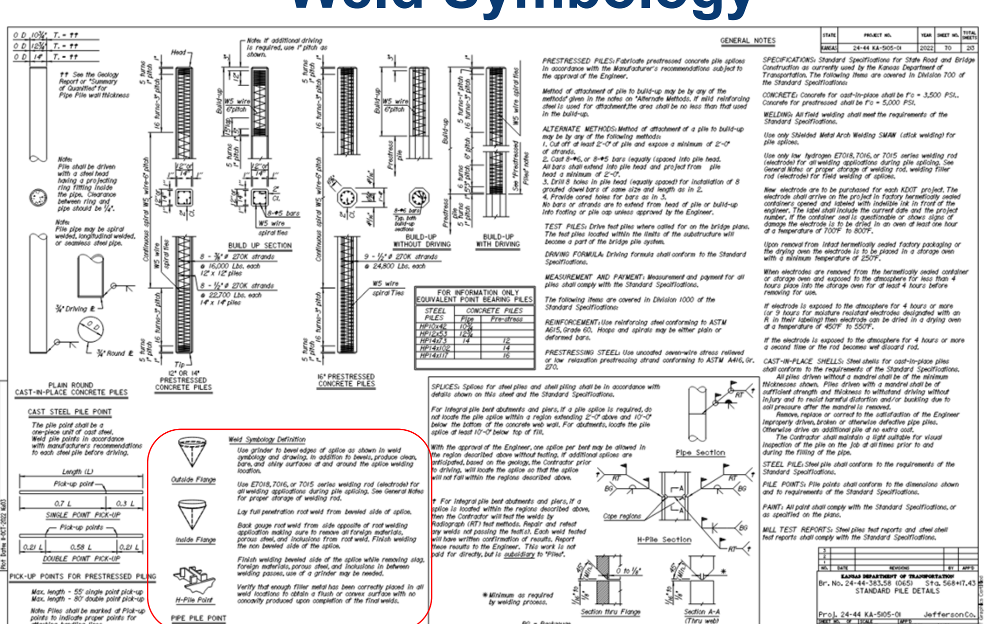
Weld Symbology



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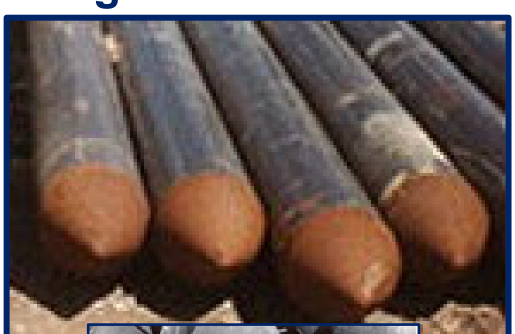
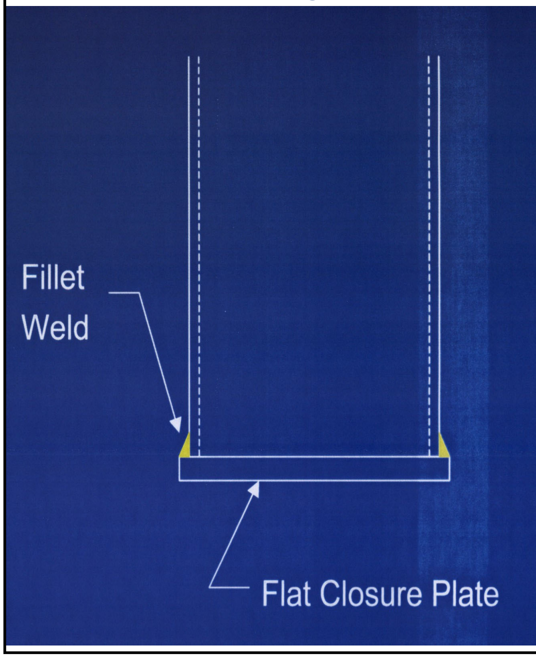
Closed End Pipe Pile

Closed End Pipe Pile

Using Conical Points



Typical KDOT Pipe Pile Plate



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Questions?

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22

1

Test Piles

Driven before main production piles to get an idea of how piles will behave.

2


We use the information to devise an efficient way of driving the production piles and to plan any splice locations.
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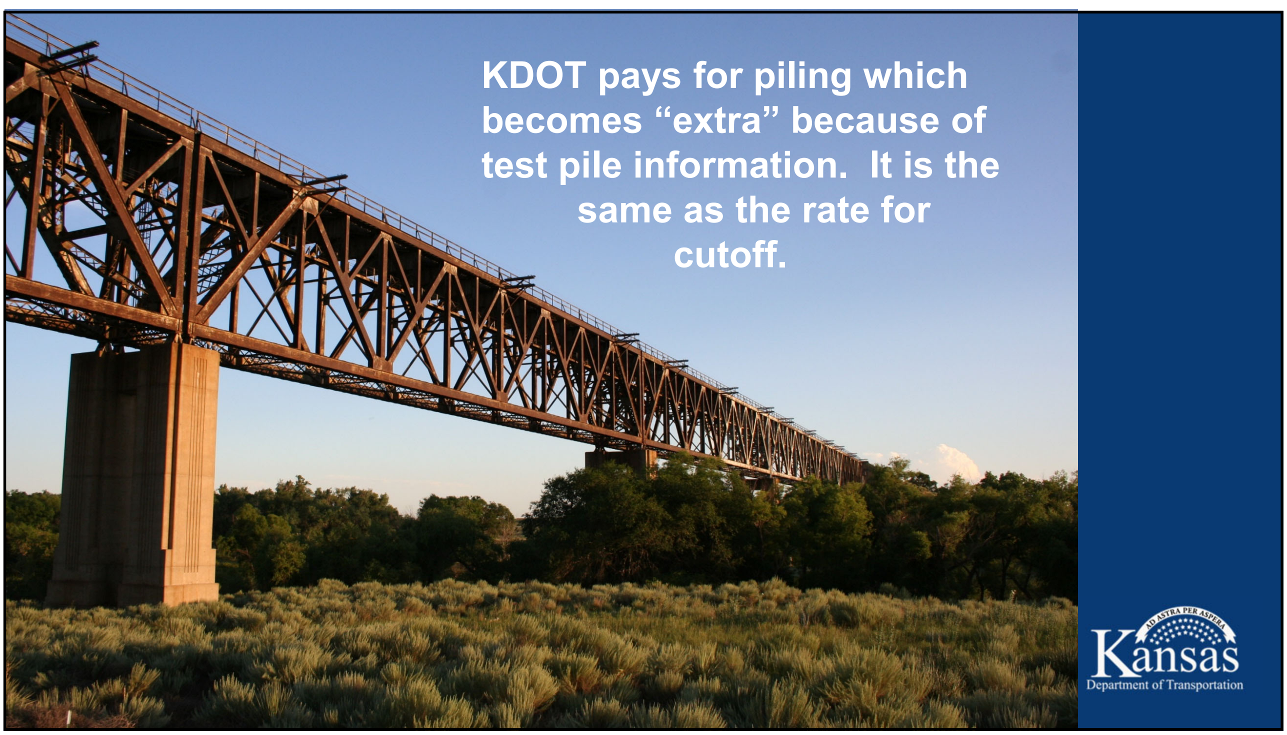
3


KDOT pays for piling which becomes "extra" because of test pile information. It is the same as the rate for cutoff.
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4

5

What You Have To Do For a Regular Test Pile 1

Avoid delays once driving has started

Finish driving the test pile in one day unless you need to do a restrike

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6

Uh-Oh….

If pile doesn't get resistance within roughly 2 feet of plan elevation, try a restrike

Call the Regional Geology Office for help

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7

Pile Restrike Procedure *from 704.4 (e)*

Wait overnight

Warm up hammer far from test pile

Immediately restrike test pile for 30 blows or until it moves 4 inches, whichever comes first

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8

Pile Restrike Procedure

Record penetration for every 5 blows

If pile moves less than ½ inch, stop restrike after 20 blows

Calculate resistance based on average penetration for first 5 blows

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9

Pile Restrike Procedure 1

If calculated resistance is still too low, splice and resume driving

Why, you little….!!

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10

Pile Restrike Procedure 2

If you get enough resistance with the restrike, then we will use that elevation (plan pile tip elevation) for the production piles

11

Tell your boss how the test pile went

12

Test Pile (Special)

A fancy name for a test pile that is monitored by the Pile Driving Analyzer

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Test Pile (Special)

Contact the Topeka Geology Office when the project gets going, just to warn John.

(785) 291-3861

Forward him the hammer data when you get it from the contractor.

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You are **required** to contact the Topeka Geology Office (John) a minimum of 5 working days before the Test Pile Special.

(785) 291-3861

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15

What to Expect When You're Expecting John…

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16

Test Pile (Special)

We Will Need Beforehand:

- Hammer type and size
- Pile type, size, and grade
- Test pile locations
- Cut-off elevations
- Plan design pile tip elevations
- If pile bents, the bottom of web wall elevation

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Remind the contractor that a restrike is required with a Test Pile (Special).

This may be an overnight restrike.

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Test Piles (Special)

On the day of the test pile we'll need:

Ground elevation at each test pile location

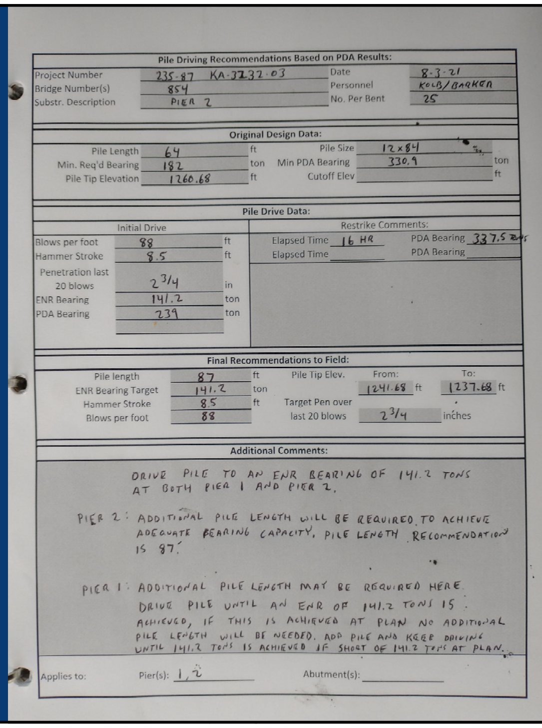
Maybe whiskey and beer, depending
on how it goes…

19

Keep a continuous log of driving

PDA crew will tell you what elevation to drive to, or what resistance you need using the Pile Drive Formula

20



Pile Driving Recommendations Based on PDA Results:

Project Number	235-87 KA-3232-03	Date	8-3-21
Bridge Number(s)	854	Personnel	KOLB/BARKER
Substr. Description	PIER 2	No. Per Bent	25

Original Design Data:

Pile Length	64 ft	Pile Size	12×84
Min. Req'd Bearing	182 ton	Min PDA Bearing	330.9 ton
Pile Tip Elevation	1260.68 ft	Cutoff Elev	ft

Pile Drive Data:

Initial Drive

Blows per foot	88 ft
Hammer Stroke	8.5 ft
Penetration last 20 blows	2 3/4 in
ENR Bearing	141.2 ton
PDA Bearing	239 ton

Restrike Comments:

Elapsed Time	16 HR	PDA Bearing	337.5 TONS
Elapsed Time		PDA Bearing	

Final Recommendations to Field:

Pile length	87 ft	Pile Tip Elev.	From: 1241.68 ft	To: 1237.68 ft
ENR Bearing Target	141.2 ton			
Hammer Stroke	8.5 ft	Target Pen over last 20 blows	2 3/4 inches	
Blows per foot	88			

Additional Comments:

DRIVE PILE TO AN ENR BEARING OF 141.2 TONS AT BOTH PIER 1 AND PIER 2.

PIER 2: ADDITIONAL PILE LENGTH WILL BE REQUIRED TO ACHIEVE ADEQUATE BEARING CAPACITY. PILE LENGTH RECOMMENDATION IS 87'.

PIER 1: ADDITIONAL PILE LENGTH MAY BE REQUIRED HERE. DRIVE PILE UNTIL AN ENR OF 141.2 TONS IS ACHIEVED, IF THIS IS ACHIEVED AT PLAN NO ADDITIONAL PILE LENGTH WILL BE NEEDED. ADD PILE AND KEEP DRIVING UNTIL 141.2 TONS IS ACHIEVED IF SHORT OF 141.2 TONS AT PLAN.

Applies to: Pier(s): 1, 2 Abutment(s):

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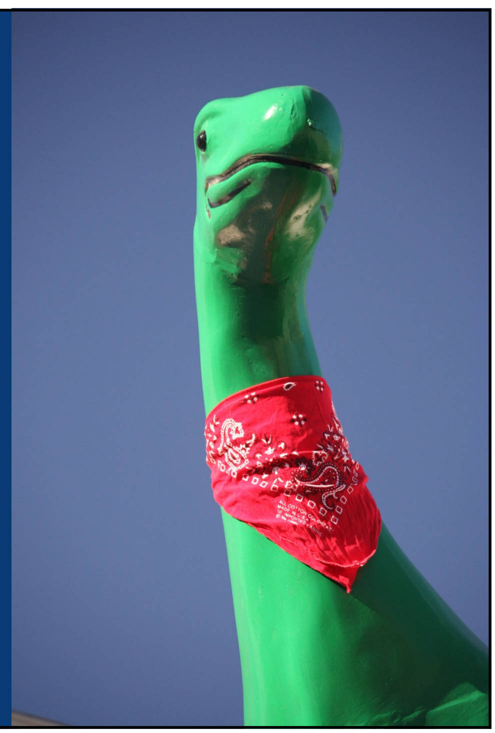
21

Because of the high loads we are putting on piles now, expect to see more test pile *specials* (the PDA). And you probably won't see any regular test piles for the foreseeable future.



22

That’s it for test piles

Test Pile (Special) and Restrike Testing

1

What is a Test Pile (Special)?

- Similar to a Test Pile except we monitor pile installation using the Pile Driving Analyzer
- Inspector still performs their roll
- Ususally one Test Pile (Special) for one Abutement and one Pier
  - Dependent geologic variability, pile loads, and number of piers

2

Dynamic Testing at a Glance

- A ram impacts the pile top
- The pile top is compressed at the instant of impact
- A stress wave travels through the pile
- The wave is partially reflected back up the pile due to
  - soil resistance---representing capacity
  - pile property change
  - or at the pile toe
- From the reflected waves PDA calculates capacity

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Measures

- Evaluation of the Drive System Performance
- Calculation of the Driving Stresses During Installation
- Assessment of Pile Integrity
  - Damage

Kansas Department of Transportation

Measurements Cont.

- Assessment of the Pile Capacity and Soil Conditions
- Allows You to Discount any Bearing Capacity in the Scour Zone
- Allows You to See Shaft Versus Toe Capacity on the Pile

Kansas Department of Transportation

5

Preparing for the PDA

- Your target pile load
- PDA target
- PDA target = Strength I load/ Phi factor
- PDA Measures in kips
  - Kip = ½ ton

PILING: Drive all piling to penetrate the soil mantle and achieve bearing within either the Odell Shale Formation or the Cresswell Limestone Member of the Winfield Limestone Formation. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment No. 1	84 Tons
Pier No. 1	150 Tons
Pier No. 2	150 Tons
Abutment No. 2	84 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

TEST PILE SPECIAL: Drive the test pile special at the location directed by the Engineer/Geologist or as shown on the Plans. Use Pile Driving Analyzer (PDA) equipment and methods compliant with KDOT Specifications. The test piling shall remain in place as permanent piling. Drive the test pile special piling to the resistance value of the Strength I load divided by Phi shown on the plans.

Std. Base File:
Plotted By: Delbert
File: ka3104 bbr0192-001.dgn
Plot Location: Bridge Design
Plot Date: 1 -FEB-2016 08:17

DESIGN DATA

DESIGN SPECIFICATIONS:
AASHTO Specifications, 2007 Edition and latest Interim Specifications. Load and Resistance Factor Design.

DESIGN LOADING:
HL-93

Design Dead Load includes an allowance of 25 psf for a future wearing surface.

UNIT STRESSES:

Concrete (Grade 4.0)(AE)	f'c	=	4 ksi
Concrete (Grade 4.0)(AE)(SW)	f'c	=	4 ksi
Reinforcing Steel (Grade 60)	fy	=	60 ksi
Steel Piles	fy	=	50 ksi

LRFD DESIGN PILE LOAD:

Design Loading (Tons/Pile)	Strength I	Service I	Phi
Abutments 1 & 2	84	56	0.65
Piers 1 & 2	150	106	0.65

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6

Before the PDA

- Determine depth to bedrock
- Determine plan tip depth
- Test pile has been clearly marked by the foot
- Communication between Geology, inspectors, and foreman
  - You (and a helper) keep track of the blows/foot and stroke of hammer
  - Foreman will be marking the pile every 5 or 10 blows
    - Marking depth will be determined by testing crew

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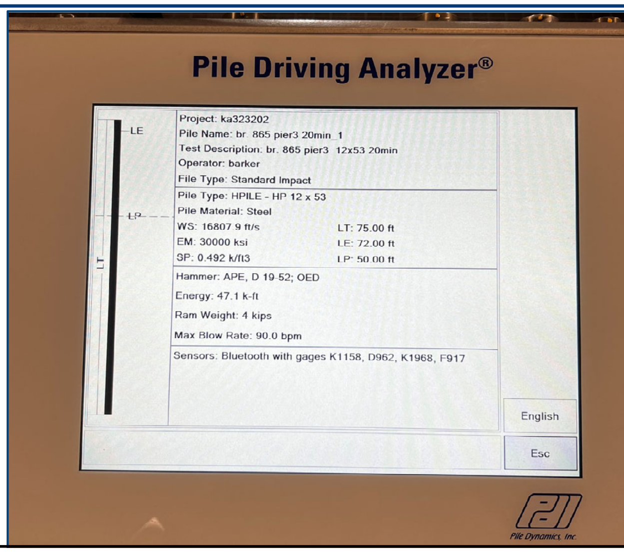
PDA Set-up



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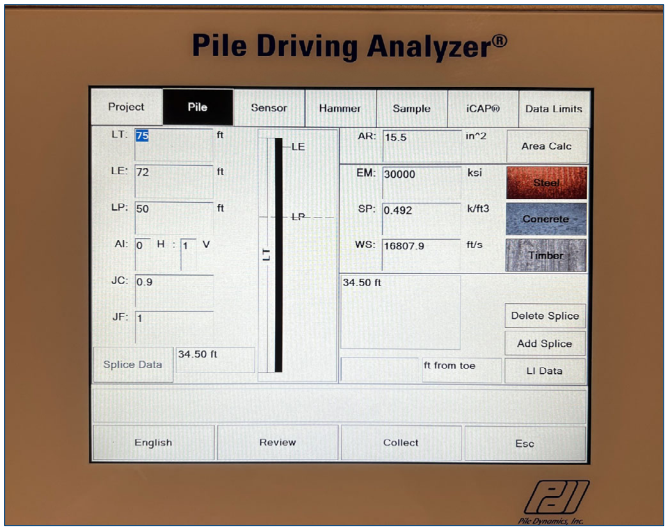
PDA Set-Up



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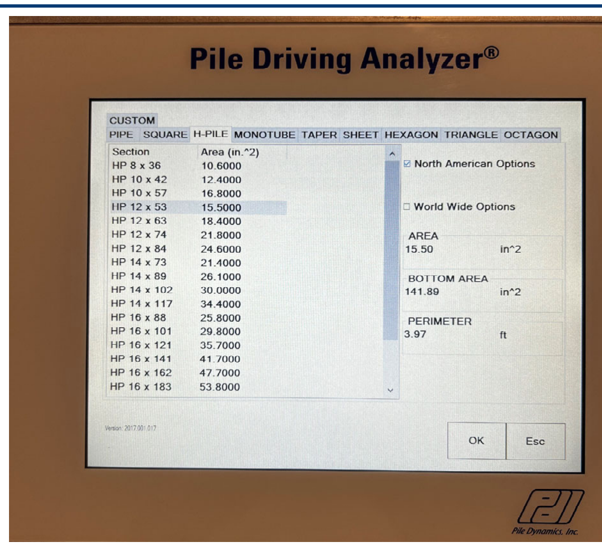
PDA Set-Up



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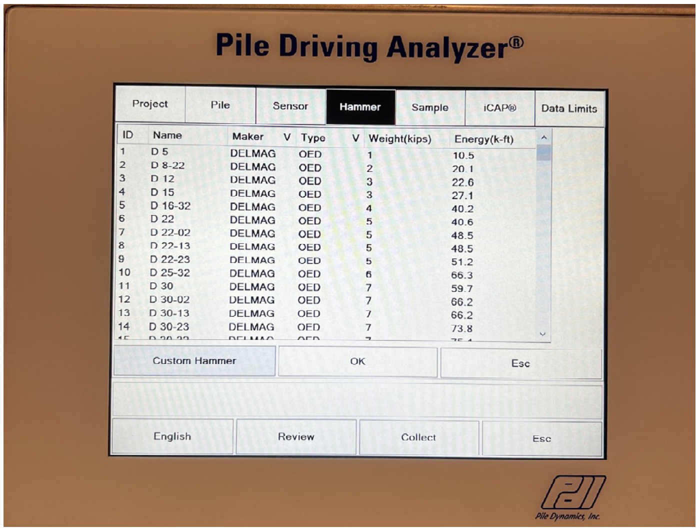
PDA Set-Up



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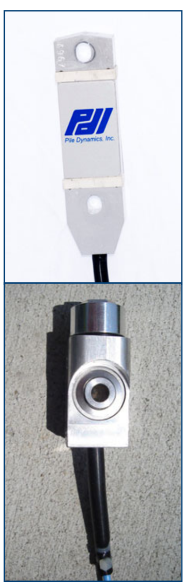
Strain & Acceleration Measurements



Strain Transducers measure force

Two Strain Transducers **Required** to Reduce Bending Effects.

Accelerometers measure velocity

Two Accelerometers Used for Redundancy

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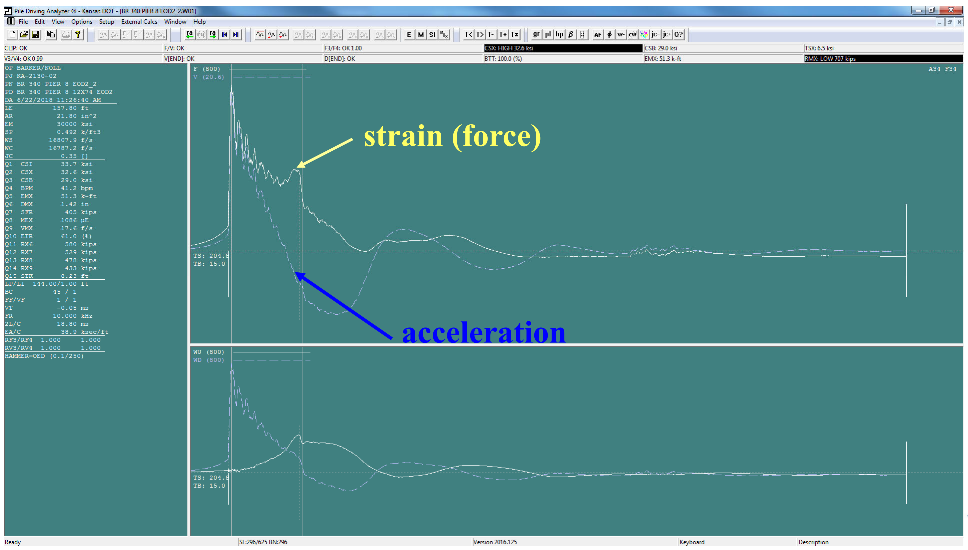
Raw PDA Data



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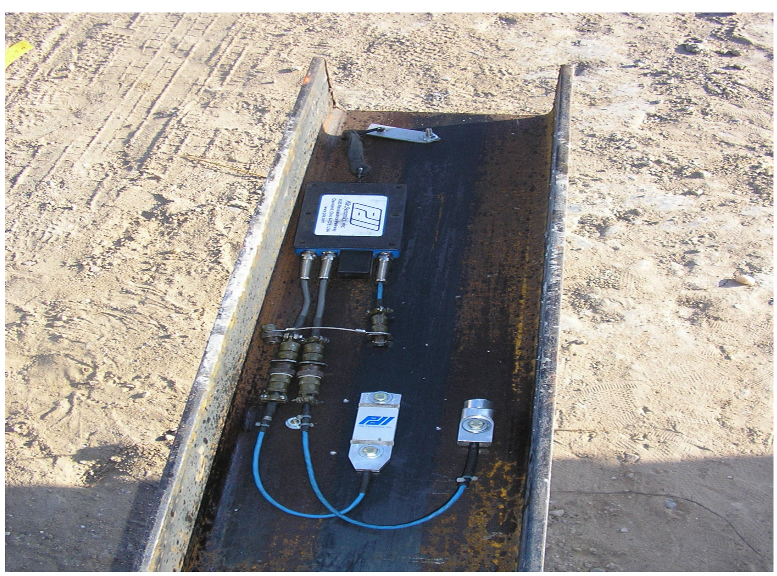
Typical Gage Attachment



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PDA Gage Attachment

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PDA Gage Attachment

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Hammer Placement

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17

Test Pile Special Length

- 10 ft longer than production
  - Allows room for PDA equipment
  - Able to drive deeper if necessary
  - Additional length has a mild effect the ENR calculation

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PDA Testing Process

- Foreman marks the pile every 5 or10 blows until end of drive
  - Usually beginning at a depth slightly above bedrock
- The last 20 blows from the initial drive is used for:
  - PDA Analysis
  - ENR Calculation

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PDA Restrikes

- Standard PDA series of restrikes (15 min, 1 hour, 4 hour, 24 hour)
- Foreman marks every 5 blows
- First 5 blows are the most important!

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Projects with PDA

- Lewis and Clark Viaduct - Pier 18
  - 1 Test Pile Special
  - Results will be applied to 2 pier (Pier 18 and Pier 17)
  - Pile Design Load = 110 tons
  - PDA Target Load (110/.65) = 169 tons (338 kips)
  - Plan length 82 ft
  - 12 x 74 H-Pile
  - Pileco D30-32

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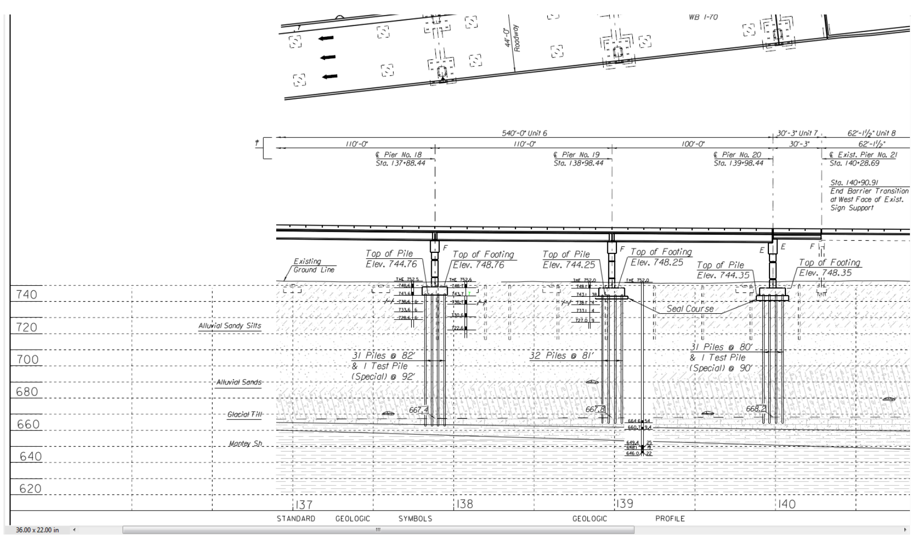
Lewis and Clark Viaduct, Pier 18



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Lewis and Clark, Pier 18

- **End of drive** – Stop 5 feet above plan tip
  - PDA recording **243.5** tons (we needed **169** tons)
  - Bearing Formula recording **80** tons (needed **110** tons)
    - **80** tons is the new target.
- Good example of typical PDA Test
  - The target load is recognized by the PDA first.
  - New target Bearing Formula Load is less than plan.
- Important to understand
  - We are **NOT** changing the design load of the pile.
  - 80 tons (from the bearing formula) = 243.5 tons (from the PDA)

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Lewis and Clark Viaduct

- Pier 11
  - 1 Test Pile Special
  - Results will be applied to Pier 11 only
  - Pile Design Load = 120 tons
  - PDA Target Load = 184.6 tons (369 kips)
  - Plan Length 128 ft
  - 12 x 74 H-Pile
  - Pileco D36-32

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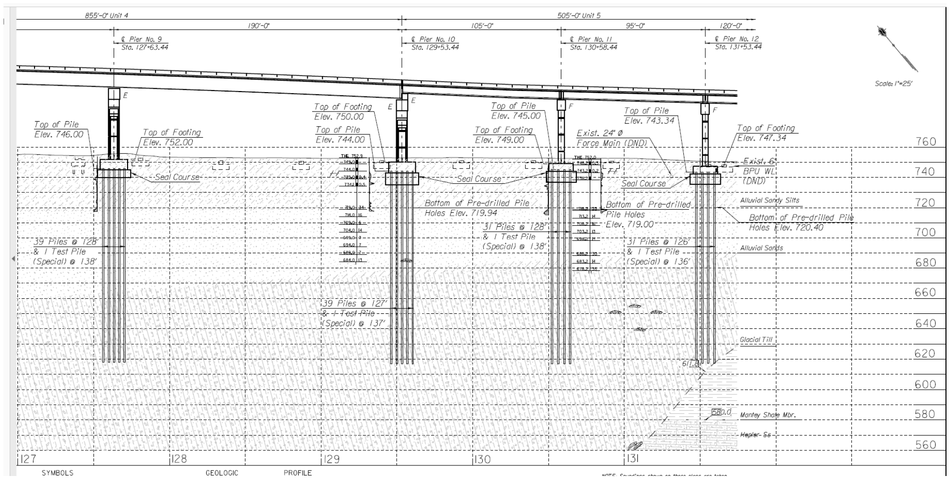
Lewis and ClarkViaduct, Pier 11



Lewis and Clark, Pier 11

- End of drive – Stopped at plan tip
  - PDA recording **131** tons (we needed **185** tons)
  - Bearing Formula recording **45.2** tons (needed **120** tons)
- 15 minute restrike
  - PDA recording **170** tons
  - Bearing Formula recording **65.9** tons
- 1 hour restrike
  - PDA recording **193** tons
  - Bearing Formula recording **79.6** tons

Lewis and Clark, Pier 11

- Results
  - Sufficient capacity achieved after 1 hour.
  - Strictly using the ENR Bearing Formula, driving would have continued well past plan tip elevation.
  - New target Bearing Formula Load is less than plan.

- Important to understand following a PDA with restrikes
  - Follow the initial driving criteria (movement and stroke)
    - **45** tons will be the new target.
  - If capacity is questionable after initial, conduct a 24 hour restrike.
    - Use the ENR values from the PDA restrikes to guide you.

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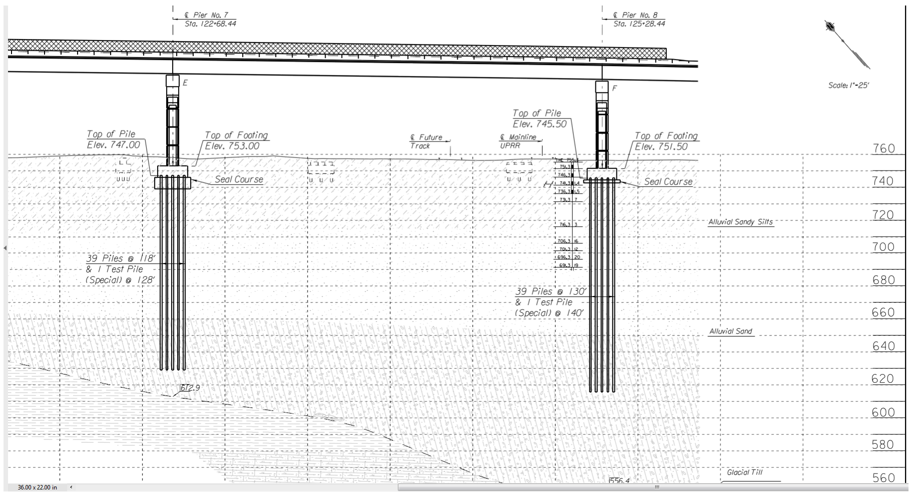
Lewis and Clark Viaduct

- Pier 8
  - 1 Test Pile Special
  - Results will be applied to Pier 8 only
  - Pile Design Load = 164 tons
  - PDA Target Load 164/.65 = 252 tons (504 kips)
  - Plan Length 130 ft.
  - 12 x 74 H-Pile
  - Pileco D36-32

Kansas Department of Transportation

Lewis and Clark Viaduct, Pier 8

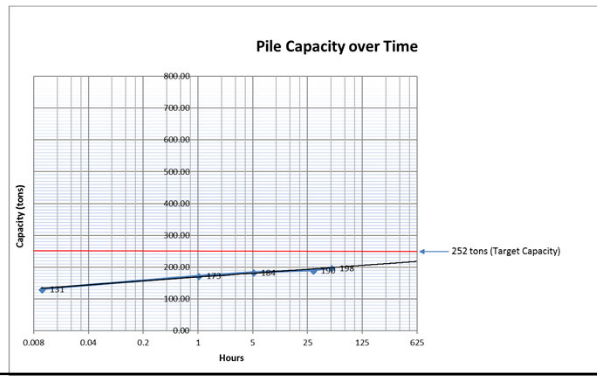


Lewis and Clark, Pier 8

- End of drive – Stopped at plan tip
  - PDA recording **131** tons (we needed **252** tons)
  - Bearing Formula recording **43** tons (needed **165** tons)
- 1 hour restrike
  - PDA recording **173** tons
  - Bearing Formula recording **55.1** tons
- 5 hour restrike
  - PDA recording **184** tons
  - Bearing Formula recording **71** tons
- 29 hour restrike
  - PDA recording **190** tons
  - Bearing Formula recording **85** tons

Lewis and Clark, Pier 8

- 50 hour restrike
  - PDA recording **198** tons (we needed **252** tons)
  - Bearing Formula recording **113** tons (needed **164** tons)
- Summary up to this point
  - 26 days, and still not achieving sufficient capacity near plan tip
  - Within a 2 days
  - Keep driving



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Lewis and Clark, Pier 8

- End of drive # 2
  - Spliced on an additional 25 ft.
  - Drove pile until the PDA started showing capacity was being gained
    - Ended up drove an additional 21.5 ft.
  - Decided to let it set over the weekend, would restrike on Monday
  - PDA recording **207** tons (needed **252** tons)
  - Bearing Formula recording **100** tons (needed **165** tons)
- 66 hour restrike
  - PDA recording **306** tons
  - Bearing Formula recording **167.6** tons

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Why use the PDA?

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Why Use the PDA

- PDA and Restrike Testing Better Quantifies Bearing Capacity
- PDA Monitors (Bearing Formula cannot do these)
  - Driving Stresses
  - Checks Hammer Performance
  - Evaluates Soil Performance
  - Checks Pile Integrity (will see damage)
  - Can discount capacity in potential scour areas
- In Most Cases by Utilizing the PDA and/or Restrike Testing a Savings Resulting From Fewer Splices or Shorter Pile Lengths

34

Why Use the PDA

- Elimination of overdriving the pile
- PDA monitors driving stresses
  - May allow piles to be driven harder to reach a minimum pile tip elevation
    - Using bearing formula, driving must stop once 110% of pile driving load is achieved because stresses are not known using the formula
    - Hopefully well before as to not damage the pile, especially in end bearing situations

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Restrike Testing

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RestrikeTesting

- Long term pile capacity
- Estimating static pile capacity using dynamic method calculations
- Accounts for possible changes in soil conditions
- Restrike testing can record these capacity changes over time
- Only true way to evaluate the pile performance over time

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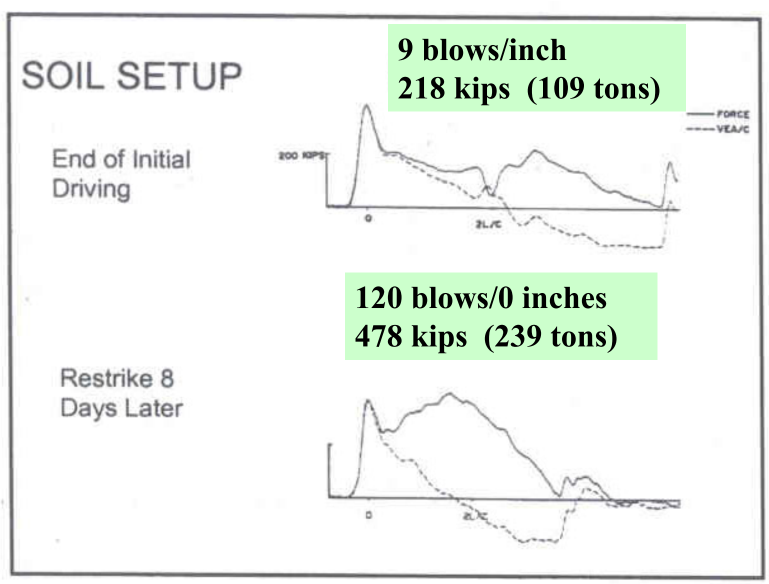
RestrikeTesting



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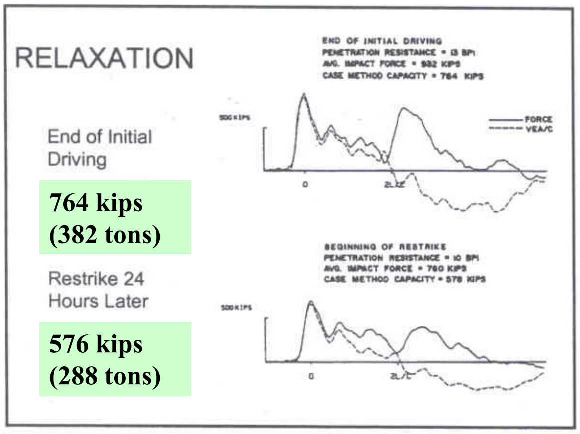
Soil Relaxation



- Piles driven into weathered shale
- Displacement piles driven into dense saturated silts or fine sands due to a negative pore pressure effect at the pile toe

Note:
Bearing capacity loss at toe
Some capacity gain on shaft

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PDA Restrike Testing Procedure

- No driving activity near test site for at least 24 hours prior to testing
- Conduct the restrike a minimum of 24 hours later, unless otherwise specified
- Warm-up hammer—operating correctly
- Hammer should be warmed up at a location as far from the test pile as possible
- Restrike pile for 20 blows or a movement of 4 inches whichever comes first

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PDA Restrike Testing Procedure

- Record the first blows
- Mark every 5 blows
  - Can compare the first blows of the restrike to the last blows of the restrike.
  - In most cases by doing a restrike you will see an increase in bearing capacity due to soil setup.
  - If pile is mobilized, you should see a difference between beginning and end of restrike in bearing capacity and in set per blow

PDA Restrike Testing Procedure

PDA Restrike Testing

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Questions?

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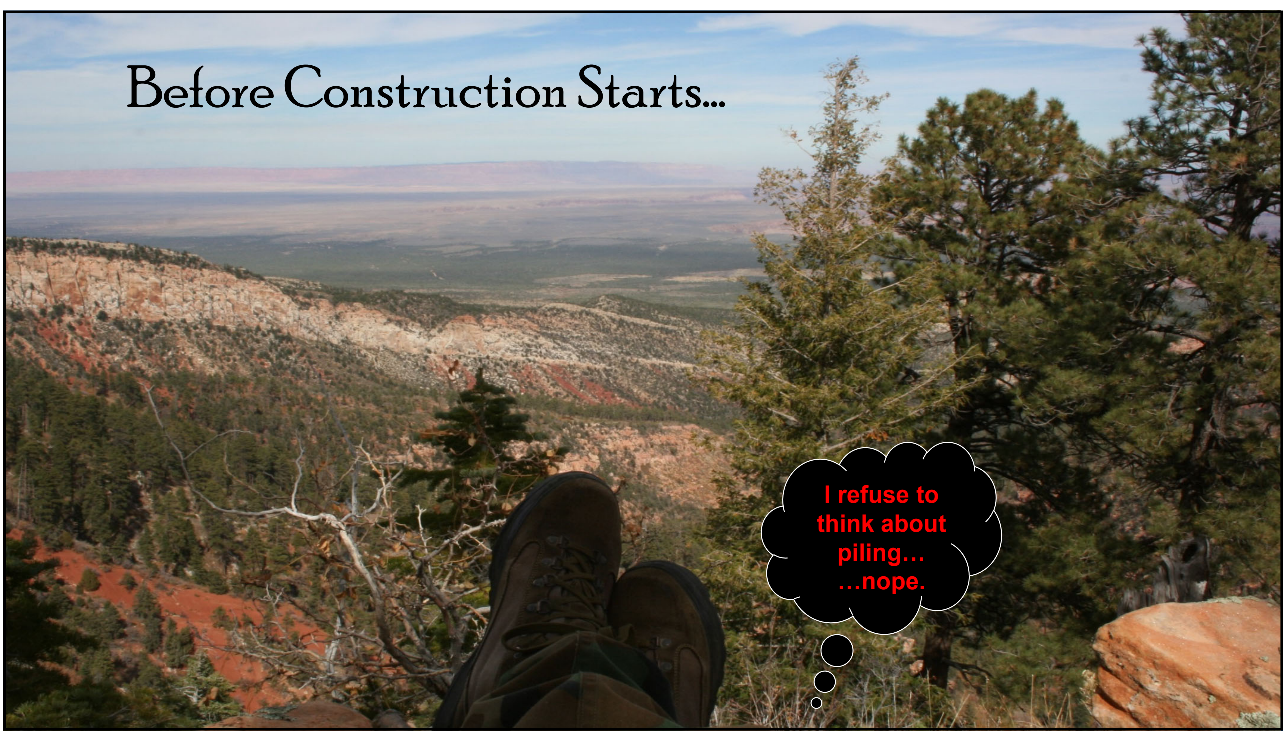
THE INSPECTOR'S ROLE

1


Before Construction Starts...
I refuse to think about piling…
…nope.

2

1 Study the Plans

Kansas Department of Transportation

3

Study the Plans

For piling, see the “General Notes and Quantities” page

and the “Engineering Geology” page

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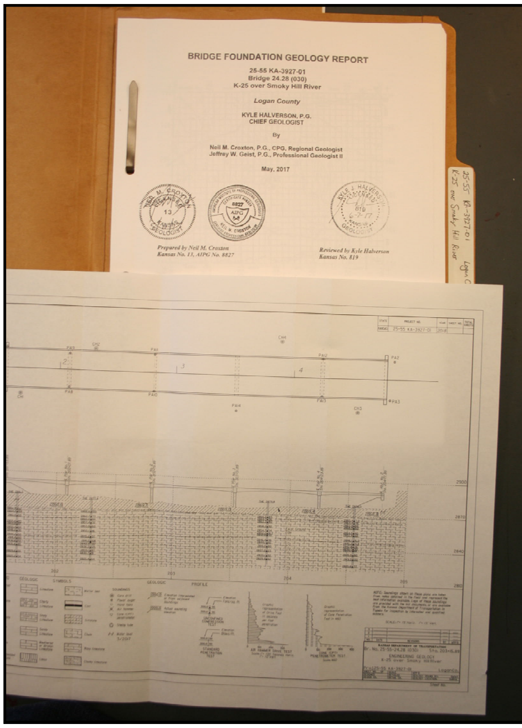
4



2 Read the Bridge Foundation Geology Report

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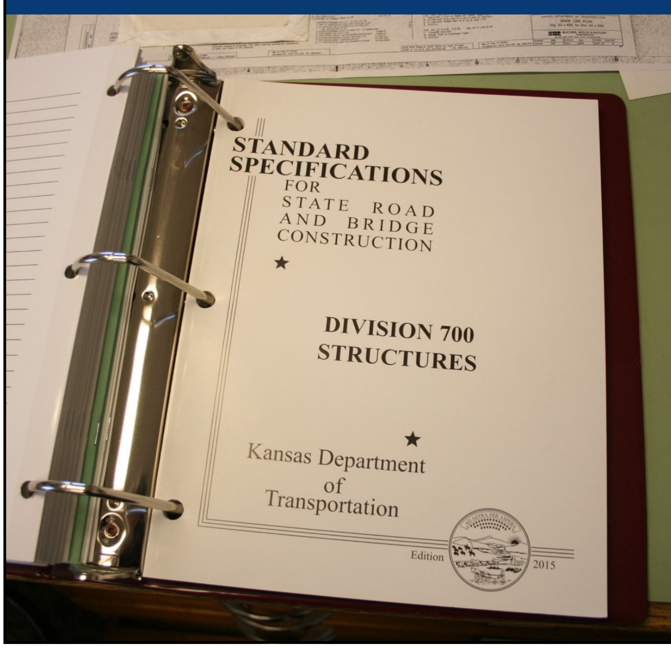
5



3

Read Section 704 of the Standard Specifications and check for new Special Provisions

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6

4 Get all the hammer info from the Contractor

To use the driving equation, you need:

Weight of the hammer piston (ram)

Weight of the pile cap (helmet) and the anvil

7

To check the hammer size, you also need:

Maximum stroke of piston

8

This is Form 217 AA, in the Forms Warehouse

NOTICE TO CONTRACTORS

PILE AND DRIVING EQUIPMENT DATA
[Test Pile (Special), Section 704, Standard Specifications]

Project No. ____________ County ____________

Contract No. ________ Structure Name/No. ____________

Pile Driven By (Contr. or Subcontr.) ____________

HAMMER: Manufacturer ____________ Model ______

HAMMER COMPONENTS — RAM, ANVIL

Type ____________ Serial No. ______

Rated Energy ______ (ft-lb\J) @ ______ (ft\m) Length of Stroke

Modifications ____________

CAPBLOCK: Material ____________

Thickness ______ (in\mm) Area ______ (in²\mm²)

Modulus of Elasticity - E ______ (psi\MPa)

Coefficient of Restitution - e ______

PILE CAP: Helmet / Bonnet / Anvil Block / Drivehead — Weight ____________ (lb\kg)

CUSHION: Material ____________ Area ______ (in²\mm²)

Modulus of Elasticity - E ______ (psi\MPa)

Coefficient of Restitution - e ______

9

Here is the hammer's maximum stroke and weight of the pile cap.

NOTICE TO CONTRACTORS

PILE AND DRIVING EQUIPMENT DATA
[Test Pile (Special), Section 704, Standard Specifications]

Project No. ____________ County ____________

Contract No. ________ Structure Name/No. ____________

Pile Driven By (Contr. or Subcontr.) ____________

HAMMER: Manufacturer ____________ Model ______

HAMMER COMPONENTS — RAM, ANVIL

Type ____________ Serial No. ______

Rated Energy ______ (ft-lb\J) @ ______ (ft\m) Length of Stroke

Modifications ____________

CAPBLOCK: Material ____________

Thickness ______ (in\mm) Area ______ (in²\mm²)

Modulus of Elasticity - E ______ (psi\MPa)

Coefficient of Restitution - e ______

PILE CAP: Helmet / Bonnet / Anvil Block / Drivehead — Weight ____________ (lb\kg)

CUSHION: Material ____________ Area ______ (in²\mm²)

Modulus of Elasticity - E ______ (psi\MPa)

Coefficient of Restitution - e ______

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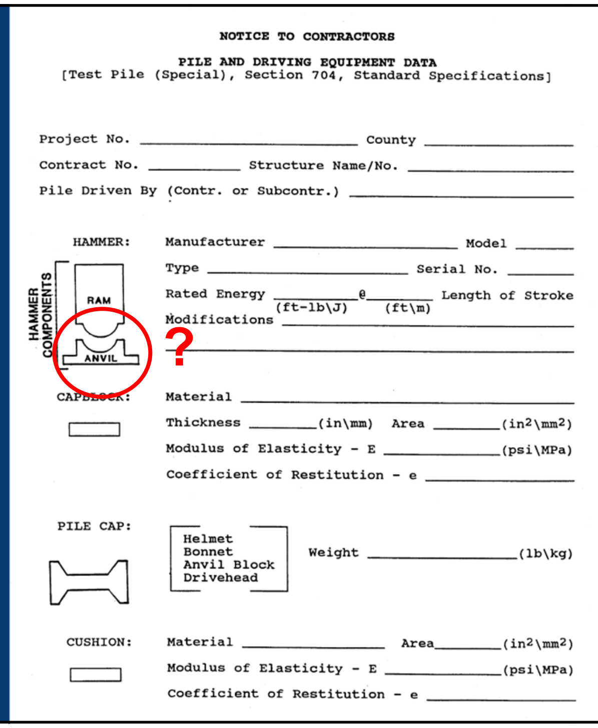
10

Notice that the anvil weight is not here.



NOTICE TO CONTRACTORS

PILE AND DRIVING EQUIPMENT DATA
[Test Pile (Special), Section 704, Standard Specifications]

Project No. ______________________ County ________________

Contract No. _________ Structure Name/No. ________________

Pile Driven By (Contr. or Subcontr.) _______________________

HAMMER: Manufacturer __________________ Model ______

Type ____________________ Serial No. ______

Rated Energy _________@________ Length of Stroke
(ft-lb\J) (ft\m)

Modifications ______________________________

HAMMER COMPONENTS

RAM

ANVIL

?

CAPBLOCK: Material ________________________________

Thickness _______(in\mm) Area _______(in2\mm2)

Modulus of Elasticity - E ___________(psi\MPa)

Coefficient of Restitution - e ______________

PILE CAP: Helmet / Bonnet / Anvil Block / Drivehead — Weight _______________(lb\kg)

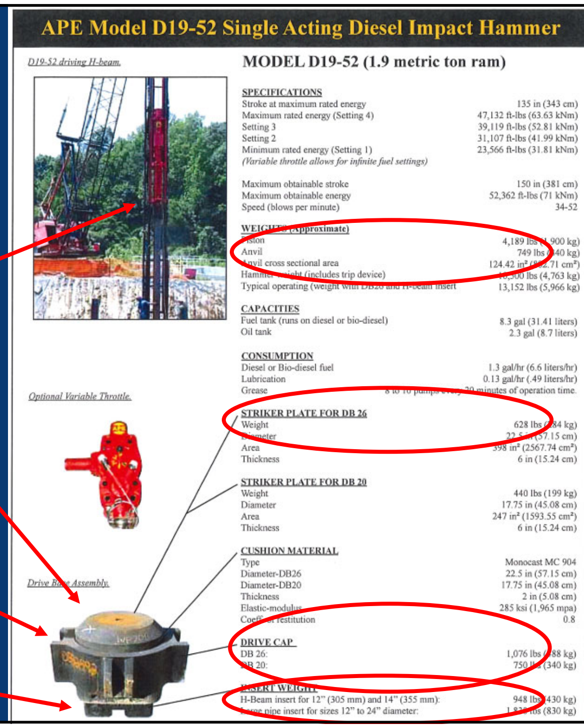
CUSHION: Material ______________ Area_______(in2\mm2)

Modulus of Elasticity - E ___________(psi\MPa)

Coefficient of Restitution - e ______________

Most of the time, a contractor will send you their company’s form and not KDOT’s

This is off the internet—
American Pile Equipment



APE Model D19-52 Single Acting Diesel Impact Hammer

D19-52 driving H-beam.

MODEL D19-52 (1.9 metric ton ram)

SPECIFICATIONS	
Stroke at maximum rated energy	135 in (343 cm)
Maximum rated energy (Setting 4)	47,132 ft-lbs (63.63 kNm)
Setting 3	39,119 ft-lbs (52.81 kNm)
Setting 2	31,107 ft-lbs (41.99 kNm)
Minimum rated energy (Setting 1)	23,566 ft-lbs (31.81 kNm)
(Variable throttle allows for infinite fuel settings)	
Maximum obtainable stroke	150 in (381 cm)
Maximum obtainable energy	52,362 ft-lbs (71 kNm)
Speed (blows per minute)	34-52
WEIGHTS (Approximate)	
Piston	4,189 lbs (1,900 kg)
Anvil	749 lbs (340 kg)
Anvil cross sectional area	124.42 in² ([illegible] cm²)
Hammer weight (includes trip device)	[illegible] lbs (4,763 kg)
Typical operating (weight with DB20 and H-beam insert	13,152 lbs (5,966 kg)
CAPACITIES	
Fuel tank (runs on diesel or bio-diesel)	8.3 gal (31.41 liters)
Oil tank	2.3 gal (8.7 liters)
CONSUMPTION	
Diesel or Bio-diesel fuel	1.3 gal/hr (6.6 liters/hr)
Lubrication	0.13 gal/hr (.49 liters/hr)
Grease	8 to 10 pumps every 20 minutes of operation time.
STRIKER PLATE FOR DB 26	
Weight	628 lbs (284 kg)
Diameter	22.5 in (57.15 cm)
Area	398 in² (2567.74 cm²)
Thickness	6 in (15.24 cm)
STRIKER PLATE FOR DB 20	
Weight	440 lbs (199 kg)
Diameter	17.75 in (45.08 cm)
Area	247 in² (1593.55 cm²)
Thickness	6 in (15.24 cm)
CUSHION MATERIAL	
Type	Monocast MC 904
Diameter-DB26	22.5 in (57.15 cm)
Diameter-DB20	17.75 in (45.08 cm)
Thickness	2 in (5.08 cm)
Elastic-modulus	285 ksi (1,965 mpa)
Coeff. of restitution	0.8
DRIVE CAP	
DB 26:	1,076 lbs (488 kg)
DB 20:	750 lbs (340 kg)
INSERT WEIGHT	
H-Beam insert for 12" (305 mm) and 14" (355 mm):	948 lbs (430 kg)
Large pipe insert for sizes 12" to 24" diameter:	1,830 lbs (830 kg)

Optional Variable Throttle.

Drive Base Assembly.

Anvil: 749 lbs

Striker plate: 628 lbs

Helmet: 1076 lbs

Adapter: 948 lbs

Total: 3401 lbs

Anvil: 749 lbs

Striker plate: 628 lbs

Helmet: 1076 lbs

Adapter: 948 lbs

This is the weight of
everything below the piston

Add the weight of the pile, and you have "X" for the equation.

#5 Make sure that the energy rating of the hammer is high enough to drive the piles

Use the driving equation with 0.1 inch per blow and the maximum stroke for that hammer. Refer to the *Bearing Formula* presentation.

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Forward the hammer info to Geology when you get it if:

There is a test pile (special)

You would like one of us on site during the start of driving

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6 Get the Type-A Certificate from CMS

Go To “Materials”

…then “Materials Report”

…then “Contract Finals”

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Non-Acceptance Tests Report

DTMT112
RUNDATE: 07 10 06
RUNTIME: 10:14 AM

KANSAS DEPARTMENT OF TRANSPORTATION
NON ACCEPTANCE TESTS REPORT - FINAL

PAGE: 4

CONTRACT: 503032043 M
PROJECT ID: K023 090 K 7333 01
CONTRACTOR ID: 00725

WORK TYPE: BRRPL
AREA OFFICE: 04
CONTRACTOR NAME: L & M CONTRACTORS, INC.

STATUS: FINAL
DISTRICT: 03

LINE #	ITEM CODE / MATL CODE	ITEM NAME / MATERIAL NAME	UNIT	SAMPLE ID	SI	UNIT / SAMPLE QTY	ORIGINAL QTY / RSLT	INSP TYPE	CURRENT QTY / TEST PERFORMED
998	099999	TESTED MATERIALS				EACH	0.000		0.000
	067010000	STEEL BEARING PILE	LNFT						
				00456078	M	609.600	CPLY	CTA	FREE FORM TEXT
				00468576	M	1 524.000	CPLY	CTA	FREE FORM TEXT
				00470725	M	121.920	CPLY	CTA	FREE FORM TEXT
				00471472	M	23.384	CPLY	CTA	FREE FORM TEXT
				00473445	M	259.080	CPLY	CTA	FREE FORM TEXT
	MATERIAL TOTAL :	------------------------------				2 537.984			
998	099999	TESTED MATERIALS				EACH	0.000		0.000
	161060100	CEMENT TY 1/2 BL/BAG	TONS						
				00487436	M	0.000	CPLY	VER	FREE FORM TEXT
				00497591	M	0.000	CPLY	VER	FREE FORM TEXT
	MATERIAL TOTAL :	------------------------------				0.000			
998	099999	TESTED MATERIALS				EACH	0.000		0.000
	999900312	CRUSHED GRAVEL (OFQ)	TONS						
				00497599	M	0.000	CPLY	VER	AGGREGATE QUALITY TEST
	MATERIAL TOTAL :	------------------------------				0.000			
998	099999	TESTED MATERIALS				EACH	0.000		0.000
	999900319	SAND/SAND GRAVEL(OFQ	TONS						
				00497578	M	0.000	CPLY	VER	AGGREGATE QUALITY TEST
	MATERIAL TOTAL :	------------------------------				0.000			

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DTMT130 Kansas Department Of Transportation PAGE - 1
Run Date: 07 10 06 Maintain Sample ID Record
Run Time: 10:03 AM

Sample Id: 00473445 SI: M
Inspector Id: 000905012 KELLY MARSHALL Resp Loc: MR Total Samples: 1
Type Insp: CTA Date Sampled: 09 29 03 Related Sample Id:
Type Test: 900 FREE FORM TEXT
Proj Id: K023 090 K 7333 01 Contract #: 503032043 M Line #: 998 Quantity: 259.080
Producer: 00035001 Name: NUCOR-YAMATO STEEL Loc: BLYTHEVILLE St: AR
Legal Desc: Mix Plant: Name:
Matrl Cd: 067010000 STEEL BEARING PILE Desc: A03-5201 Unit: m
Qty Represented: 259.080 Nbr of Items: 0 Qty Assigned: 0.000
Sampled From: PRODUCTION Ledge: Lot/Heat Nbr:
Lab: SER Name: SERVICE Dates::Shipped: 10 01 03 Received: 10 01 03
Test Start: 10 01 03 Est Compl: Act Compl: 10 02 03
Test Result: CPLY Authorized By: NAT VELASQUEZ BY KDM
Remarks:
L&M 1600-11 FINAL DISPOSITION SUBJECT TO CONDITION OF
MATERIAL WHEN USED AT PROJECT.
HEAT(QTNM), 218107(60.96), 218103(91.44) 219625(106.68)

There is no prequalified list for piling

All piling must go thru testing

7 Make Your Driving Equation Spreadsheet

It’s Form 217b in Forms Warehouse

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Delmag McKierman Terry (Diesel Hammer)

Summary

Hammer Wt.	3528	lbs
Cap/Anvil Wt.	2403	lbs
Pile Type	HP12x53	
Min. Res.	60	tons
Max. Res.	66	tons

Formula

$$P = \frac{1.6 \cdot W \cdot H}{S + 0.1 \cdot \left(\frac{X^{**}}{W}\right)}$$

Entry Data

Weight per foot of piling (lbs/ft):	53	lbs/ft.
Length of Pile:	43	feet
X:	4682	lbs
Minimum "S":	0.100	inches/blow
Maximum "S":	0.300	inches/blow
Maximum Hammer Drop	11	ft.
Minimum Hammer Drop	6	ft.

Field Blow count: 20

Computed Resistance (tons)

Penetration per 20 blows (in.)	2.000	2.400	2.800	3.200	3.600	4.000	4.400	4.800	5.200	5.600	6.000
Average Penetration per blow (in.) "S"	0.100	0.120	0.140	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300
Drop of Hammer "H" in feet.											
6.0	73	67	62	58	54	51	48	45	43	41	39
6.5	79	73	67	63	59	55	52	49	47	44	42
7.0	85	78	72	67	63	59	56	53	50	48	46
7.5	91	84	78	72	68	64	60	57	54	51	49
8.0	97	89	83	77	72	68	64	61	57	55	52
8.5	103	95	88	82	77	72	68	64	61	58	55
9.0	109	101	93	87	81	76	72	68	65	62	59
9.5	115	106	98	92	86	81	76	72	68	65	62
10.0	121	112	103	96	90	85	80	76	72	68	65
10.5	127	117	109	101	95	89	84	80	75	72	68
11.0	133	123	114	106	99	93	88	83	79	75	72

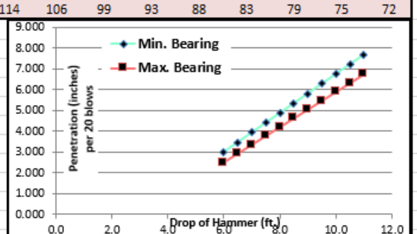
Drop of Hammer (Stroke) (ft.)

Calculated Bearing is HIGH

Calculated Bearing is GOOD

Calculated Bearing is LOW

Drop of Hammer "H" in feet.	Penetration required per 20 blows to reach Minimum Resistance (in.)	Penetration required per 20 blows to reach Maximum Resistance (in.)	
6.0	2.991	2.477	->
6.5	3.461	2.905	->
7.0	3.931	3.333	->
7.5	4.402	3.760	->
8.0	4.872	4.188	->
8.5	5.343	4.616	->
9.0	5.813	5.043	->
9.5	6.283	5.471	->
10.0	6.754	5.899	->
10.5	7.224	6.326	->
11.0	7.695	6.754	->



22

Penetration per 20 blows (in.)		2.000	2.400	2.800	3.200	3.600	4.000	4.400	4.800	5.200	5.600	6.000
Average Penetration per blow (in.) "S"		0.100	0.120	0.140	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300
Drop of Hammer (Stroke) (ft.)	Drop of Hammer "H" in feet.	**Computed Resistance (tons)**										
	6.0	73	67	**62**	58	54	51	48	45	43	41	39
	6.5	79	73	67	**63**	59	55	52	49	47	44	42
Calculated Bearing is HIGH	7.0	85	78	72	67	**63**	59	56	53	50	48	46
	7.5	91	84	78	72	68	**64**	**60**	57	54	51	49
	8.0	97	89	83	77	72	68	**64**	**61**	57	55	52
Calculated Bearing is GOOD	8.5	103	95	88	82	77	72	68	**64**	**61**	58	55
	9.0	109	101	93	87	81	76	72	68	**65**	**62**	59
	9.5	115	106	98	92	86	81	76	72	68	**65**	**62**
Calculated Bearing is LOW	10.0	121	112	103	96	90	85	80	76	72	68	**65**
	10.5	127	117	109	101	95	89	84	80	75	72	68
	11.0	133	123	114	106	99	93	88	83	79	75	72

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Do a Sample Calculation

Find the appropriate equation such as:

$$P = \frac{1.6 \quad W \quad H}{S + 0.1\ (X / W)}$$

Do a calculation by hand to get comfortable with the different variables and how they change things

Kansas Department of Transportation

8 Check Minimum Pile Length

Talk to someone in your office about what to do if you achieve the required resistance before plan length is reached.

It will probably be OK, but there may be concerns about scour and minimum pile length.

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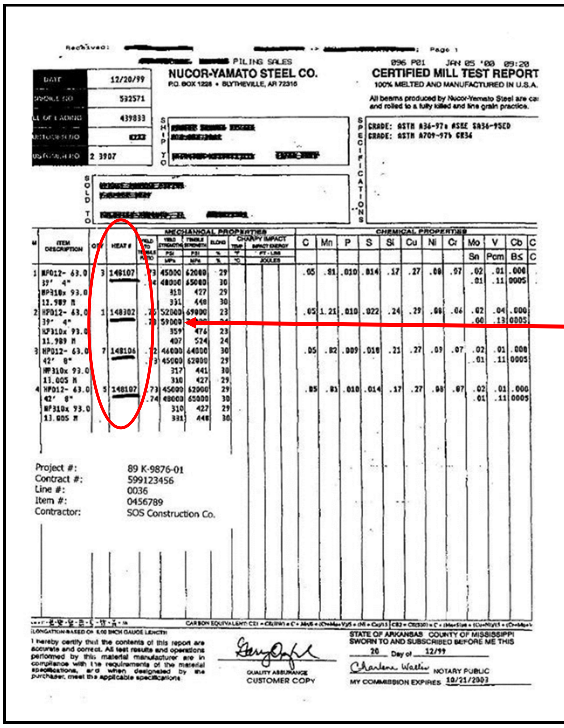
9 Check the Piling Itself

Check that the heat numbers on the certification or bill of lading matches the numbers on the piling

Kansas Department of Transportation



Received: [redacted] Page 1

[redacted] PILING SALES 096 P01 JAN 05 '00 09:20

NUCOR-YAMATO STEEL CO.
P.O. BOX 1228 • BLYTHEVILLE, AR 72316

CERTIFIED MILL TEST REPORT
100% MELTED AND MANUFACTURED IN U.S.A.
All beams produced by Nucor-Yamato Steel are cast and rolled to a fully killed and fine grain practice.

DATE	12/20/99
	532571
	439833
	4222
	2 3907

SHIP TO: [redacted]

SOLD TO: [redacted]

SPECIFICATIONS: GRADE: ASTM A36-97a A572 GR50 ... GRADE: ASTM A709-97b GR36

ITEM DESCRIPTION	QTY	HEAT #	YIELD STRENGTH PSI / MPa	TENSILE STRENGTH PSI / MPa	ELONG %	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Cb
1 HP012- 63.0 37' 4" HP310x 93.0 11.989 M	3	148107	45000 / 48000 / 310 / 331	62000 / 65000 / 427 / 448	29 / 30 / 29 / 30	.05	.81	.010	.014	.17	.27	.08	.07	.02 / .01	.01 / .11	.000 / .0005
2 HP012- 63.0 39' 4" HP310x 93.0 11.989 M	1	148302	52000 / 59000 / 359 / 407	69000 / 76000 / 476 / 524	23 / 23 / 23 / 24	.05	1.21	.010	.022	.24	.29	.08	.06	.02 / .00	.04 / .13	.000 / .0005
3 HP012- 63.0 42' 0" HP310x 93.0 13.005 M	7	148106	46000 / 45000 / 317 / 310	64000 / 62000 / 441 / 427	30 / 29 / 30 / 29	.05	.82	.009	.018	.21	.27	.09	.07	.02 / .01	.01 / .11	.000 / .0005
4 HP012- 63.0 42' 0" HP310x 93.0 13.005 M	5	148107	45000 / 48000 / 310 / 331	62000 / 65000 / 427 / 448	29 / 30 / 29 / 30	.05	.81	.010	.014	.17	.27	.08	.07	.02 / .01	.01 / .11	.000 / .0005

Project #: 89 K-9876-01
Contract #: 599123456
Line #: 0036
Item #: 0456789
Contractor: SOS Construction Co.

ELONGATION BASED ON 8.00 INCH GAUGE LENGTH

I hereby certify that the contents of this report are accurate and correct. All test results and operations performed by this material manufacturer are in compliance with the requirements of the material specifications, and when designated by the purchaser, meet the applicable specifications.

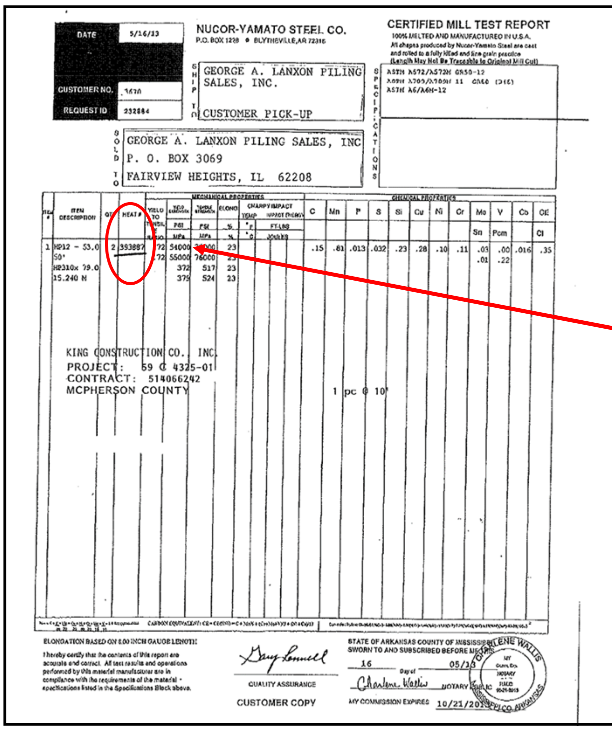
QUALITY ASSURANCE
CUSTOMER COPY

STATE OF ARKANSAS COUNTY OF MISSISSIPPI
SWORN TO AND SUBSCRIBED BEFORE ME THIS 20 Day of 12/99
NOTARY PUBLIC
MY COMMISSION EXPIRES 10/21/2003

Mill Certification

Heat Numbers

27



NUCOR-YAMATO STEEL CO.
P.O. BOX 1228 • BLYTHEVILLE, AR 72316

CERTIFIED MILL TEST REPORT
100% MELTED AND MANUFACTURED IN U.S.A.
All shapes produced by Nucor-Yamato Steel are cast and rolled to a fully killed and fine grain practice
(Length May Not Be Traceable to Original Mill Cut)

DATE	5/16/13
CUSTOMER NO.	3610
REQUEST ID	232684

SHIP TO: GEORGE A. LANXON PILING SALES, INC.
CUSTOMER PICK-UP

SOLD TO: GEORGE A. LANXON PILING SALES, INC
P. O. BOX 3069
FAIRVIEW HEIGHTS, IL 62208

SPECIFICATIONS: ASTM A572/A572M GR50-12; ASTM A709/A709M 11 GR50 (345); ASTM A6/A6M-12

ITEM DESCRIPTION	QTY	HEAT #	YIELD TO TENSILE RATIO	YIELD STRENGTH PSI / MPa	TENSILE STRENGTH PSI / MPa	ELONG %	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Cb	CE
1 HP12 - 53.0 50' HP310x 79.0 15.240 M	2	393087	72 / 72	54000 / 55000 / 372 / 379	75000 / 76000 / 517 / 524	23 / 23 / 23 / 23	.15	.81	.013	.032	.23	.28	.10	.11	.03 / .01	.00 / .22	.016	.35

KING CONSTRUCTION CO. INC.
PROJECT: 89 C 4325-01
CONTRACT: 514066242
MCPHERSON COUNTY

1 pc @ 10'

ELONGATION BASED ON 8.00 INCH GAUGE LENGTH

I hereby certify that the contents of this report are accurate and correct. All test results and operations performed by this material manufacturer are in compliance with the requirements of the material specifications listed in the Specifications Block above.

QUALITY ASSURANCE
CUSTOMER COPY

STATE OF ARKANSAS COUNTY OF MISSISSIPPI
SWORN TO AND SUBSCRIBED BEFORE ME 16 Day of 05/13
NOTARY
MY COMMISSION EXPIRES 10/21/2013

Mill Certification

Heat Number

28

STRAIGHT BILL OF LADING - SHORT FORM - Original - Not Negotiable

RECEIVED, subject to the classifications and tariffs in effect on the date of issue of this Original Bill of Lading.

BOL#: 44201
Date: 04/19/2012
Page: 1 of 1

MST Carrier SCAC: RAIL #:

the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated belo
carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery a
route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to
party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight
(1) in the Uniform Freight Classification in effect on the date hereof, if this is a rail, or a rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor c
hereby certifies that he is familiar with all the terms and conditions of said bill of lading, including those on the attachment thereof, set forth in the classification or tariff which governs t
shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Bill of Lading

SHIPPER (FROM)
SKYLINE STEEL FABRICATION
P.O. BOX 129
5896 HWY 18 EAST
ARMOREL, AR 72310

PRO #:

skylinesteel

CONSIGNEE (SOLD TO) SKYLINE-CO
SKYLINE-CO
655 BROADWAY
SUITE 560
DENVER, CO 80203

DELIVER TO (if different from Consignee)
L&M CONTACTORS, INC.
4.0 MI. S. & 1.1 MI. E. OF WESTFALL
WESTFALL KS 67455
C
620-786

CUST. ORDER#: 88703-1
OUR ORDER#: 88703
S&R

Heat Numbers

Check these numbers against the numbers on the piling stickers

SEND FREIGHT BILL TO: (if different than shipper above)

Freight charges are:
PREPAID
C.O.D. ______ AMOUNT
C.O.D. FEE ______
Prepaid Collect

(Signature of Consignor)

NO. PKGS	HM (X)/M	DESCRIPTION OF ARTICLES, KIND OF PACKAGE, SPECIAL MARKS AND EXCEPTIONS	*WEIGHT (subject to correction)	CLASS	NMFC	SUB
10		HP10X42X40' HT# 2-382253 1-382246 1-382255 1-382250 5-382251	16800			
14		HP12X53X30' HT# 5-381480 3-381462 6-381464	22260			

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NYS-USA
521407095
Size: HP10X42 250X62
Length: 55 FT 16.8 m
Grade: A572-50
Heat: 251019 RID: 521407095
Seq # 1847
Test pile
Abut 2
- NYS1 - 04/11/05
521407095

Sticker on Pile

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Check the Piling Itself

Inspect the piles to make sure they are the type called for in the contract

Sticker on Pile 1

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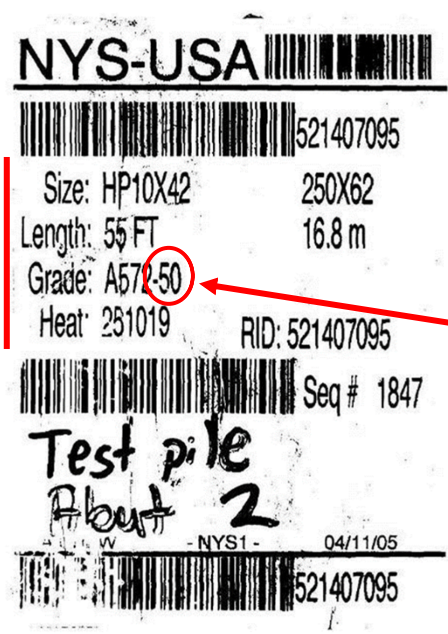

Sticker on Pile 2

All H-pile now used in KDOT bridges is Grade 50

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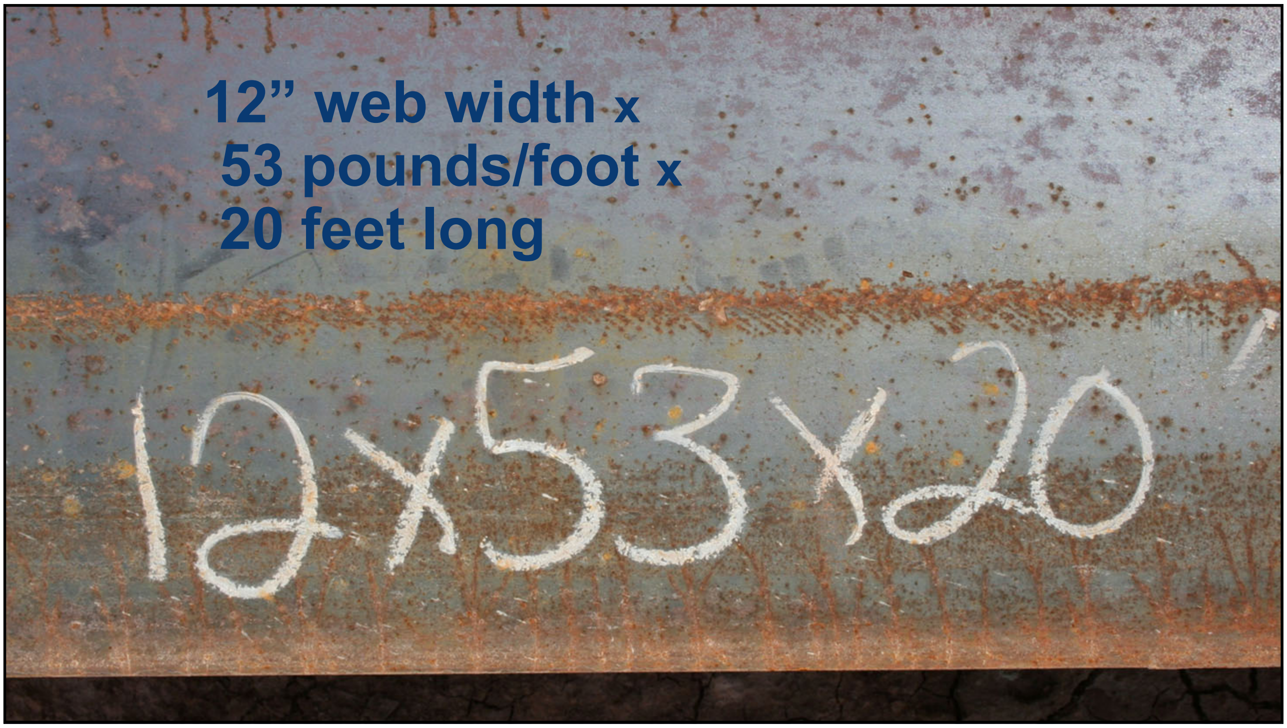

35

Check the Piling Itself

Inspect the piles for damage that might have occurred during shipment, or defects that were overlooked earlier

Pipe piles can get bent; concrete piles can get broken

H-piles can have bent flanges

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10 Measure and Mark the Piling

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37

10

Measure and Mark the Piling

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38

11 Make Sure the Contractor Brought the Hammer He Told Us He Was Bringing

AD ASTRA PER ASPERA
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Department of Transportation

39

12 Check the Hammer Cushion

40

Check the Hammer Cushion

Cushion must be made of a material approved to use on KDOT projects

What else?

Cushion must be made of a material approved to use on KDOT projects

Must be intact and at least 75% of its original thickness

Check the Hammer Cushion 1

Original thickness of cushion should be listed on the hammer data sheet

Ask contractor when cushion was last changed

Check to see if it looks OK

Pry it out of helmet if you think you need to measure its thickness

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13 Line up some help from the office

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13 Line up some help from the office 1

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45

14 Help the Contractor Verify that Piles are in the Correct Location

46

Make sure…..

Oh, never mind.

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47

15 Make Sure the Piles are Plumb

48

 # 16 Keep track of where your pile tip is.

Know the depth you should hit bedrock.

49

 # 17 Drive Pile to Plan Length or Required Resistance

50

If you drive to the required resistance before plan length is reached, check with Area Office for scour concerns or minimum pile length

If plan length is reached before the required resistance, call Area Office about a possible restrike

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18 Mark the Cut-off on the Pile

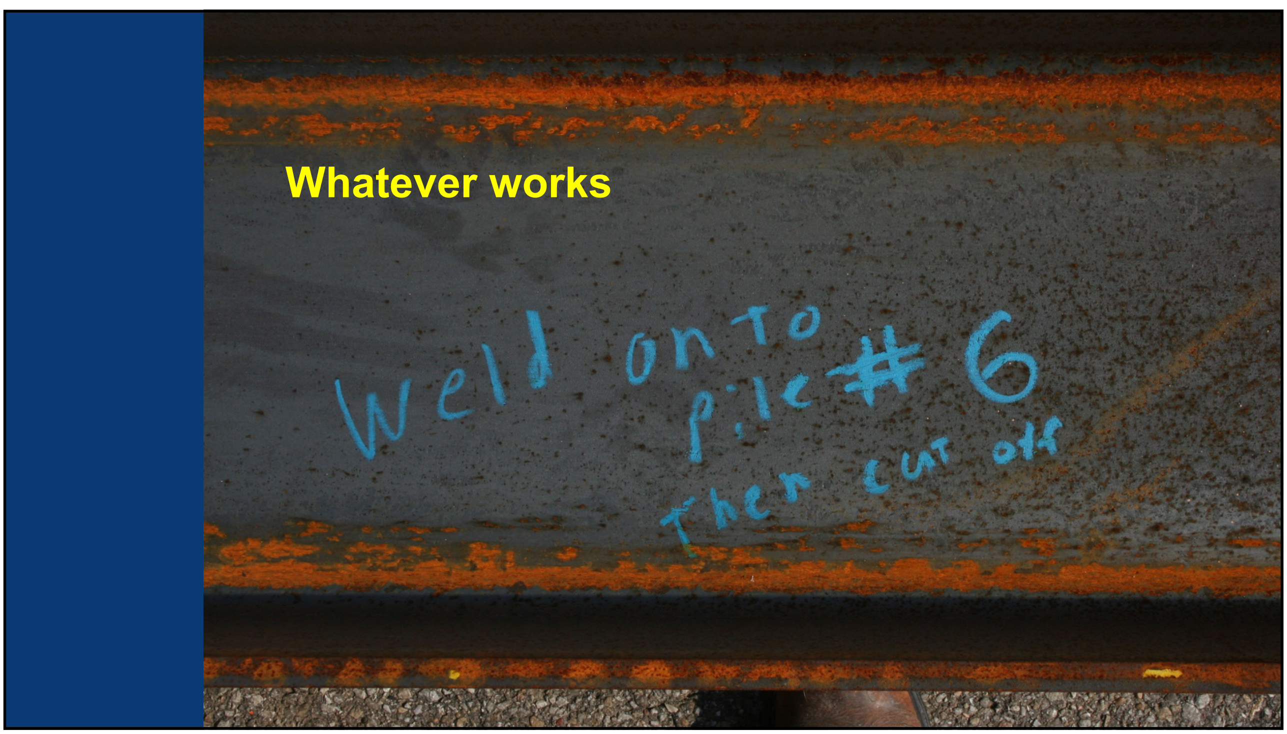
Help Contractor mark plan cut-off elevation on the pile after driving.

Mark the piece that was cut off, so that you know where it came from. You may need to use it to splice later.

Use a number or letter—just some way to keep track of it.


Some inspectors give each pile an ID before they are even driven.

55


Whatever works
Weld onto
pile #6
Then cut off

56

19 Have Someone Check Your Calculations

Before the contractor places any concrete around the piling, have a second person go over your resistance calculations.

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57

19 Have Someone Check Your Calculations

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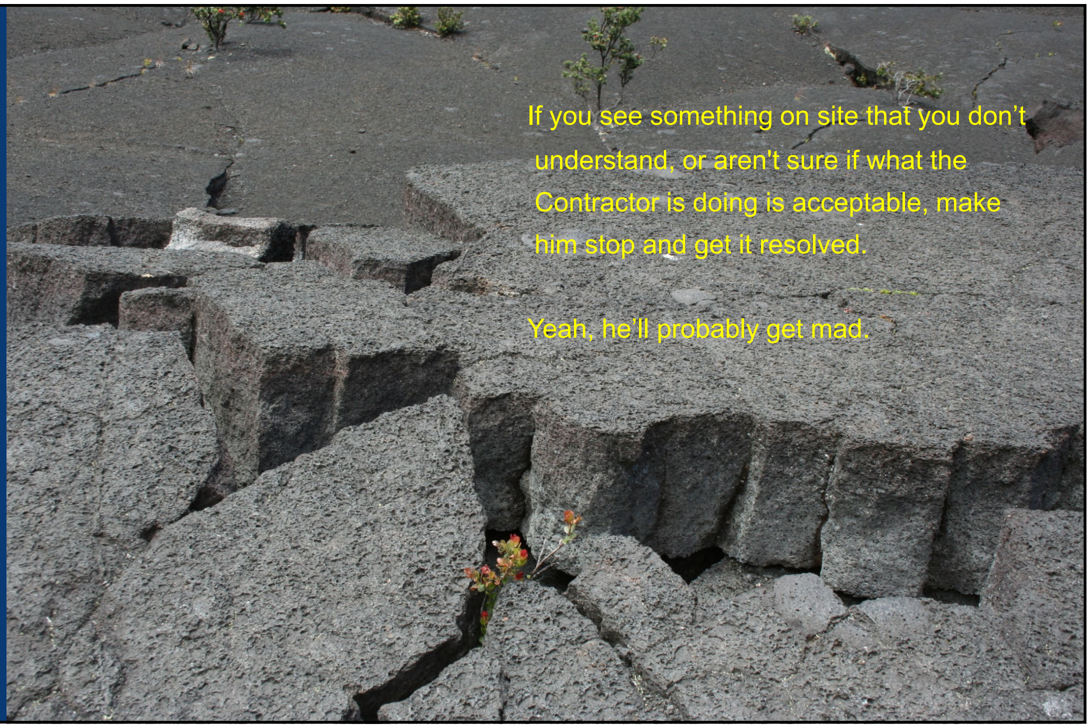

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You Aren't Alone!

If you have a question and can't reach your bosses, there are other people in KDOT who will help you:

your Regional Geologist

the Bridge Designer in Topeka
(Bureau of Structures and Geotech Services)

your District Construction Engineer

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Never text and drive pile

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Field Problems

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1

If a problem occurs, what do you do?

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2

STOP
DRIVING AND EVALUATE THE SITUATION

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Department of Transportation

Some Problem Scenarios

- Overdriving – encountering hard rock
- Target bearing not achieved
- Misalignment of hammer
- Hammer performance

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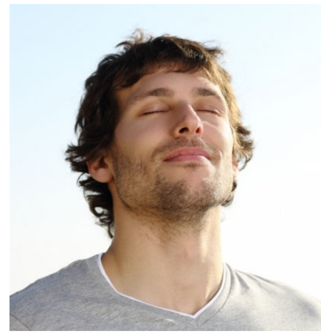
Department of Transportation

Problem Solving

- Take time to problem solve
  - What is happening
  - Check calculations
  - Check any level runs
  - Check the hammer
  - Check alignment; pile and hammer
  - Check length of pile
  - Review the Geology Bridge Sheet



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Problem Solving Continued

- Are you using the correct formula?
- Correct hammer specifications input?
- Using the Pile Driving Formula load?
- Wrong size pile?
- Wrong length pile?

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Solution Found!!

- Can you make the decision to correct it?

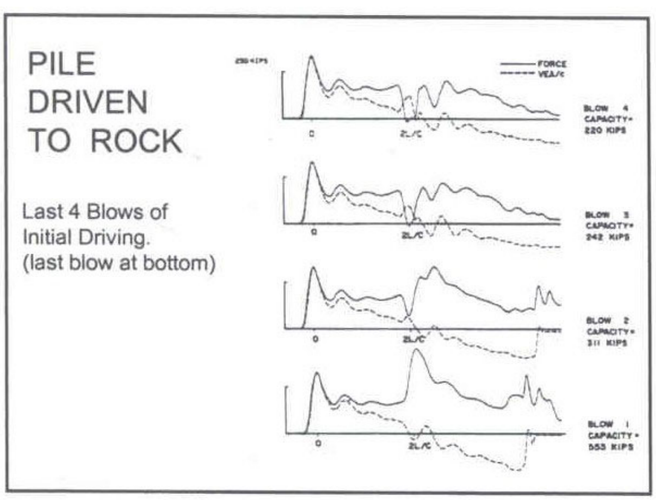
- Contact
  - Your Boss
  - Construction Engineer
  - Design Engineer

- Adjust and proceed with driving.

- Always document.

7

Driving to Hard Bedrock



220 kips
(110 tons)

242 kips
(121 tons)

311 kips
(156 tons)

555 kips
(278 tons)

8

Driving into hard bedrock

- Project north of Syracuse, KS
- Damaged H-pile
- The lower 7 feet of Pile #5 at Pier 1.
- Understand the geology!

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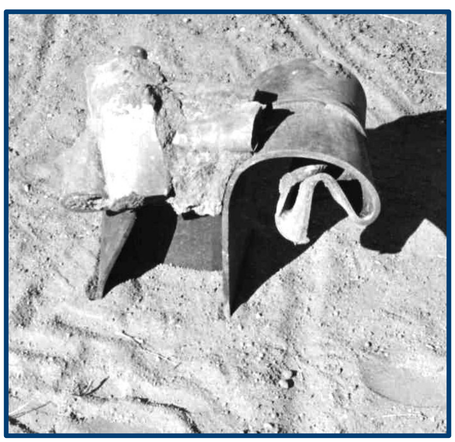
Driving into hard bedrock



- Same project
- Bottom 2.5 feet rolled,Pile #6, Pier 4

Top of pile damaged too

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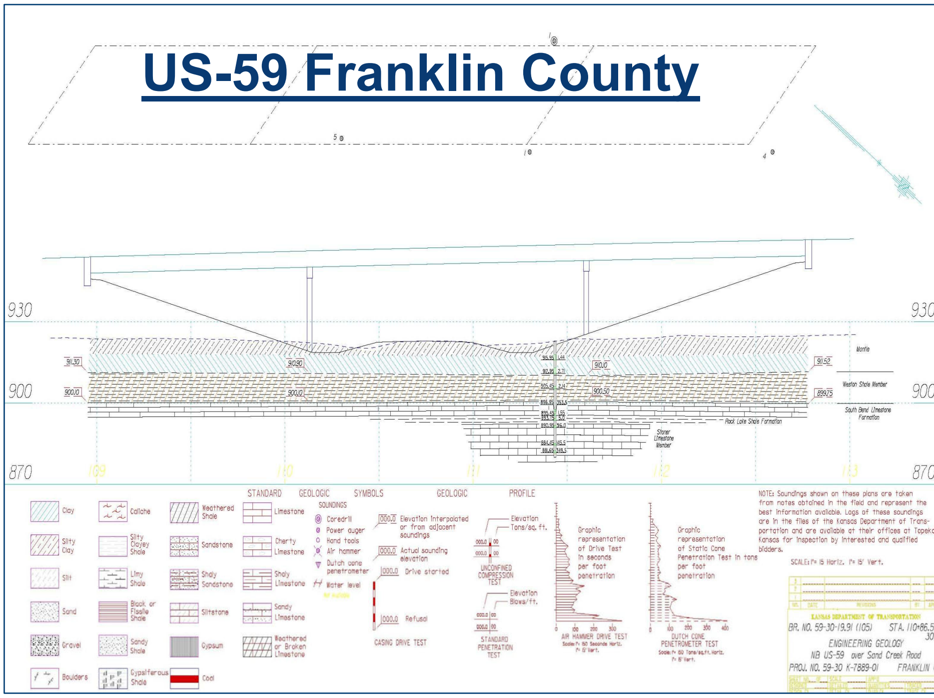
US-59 Franklin County



11

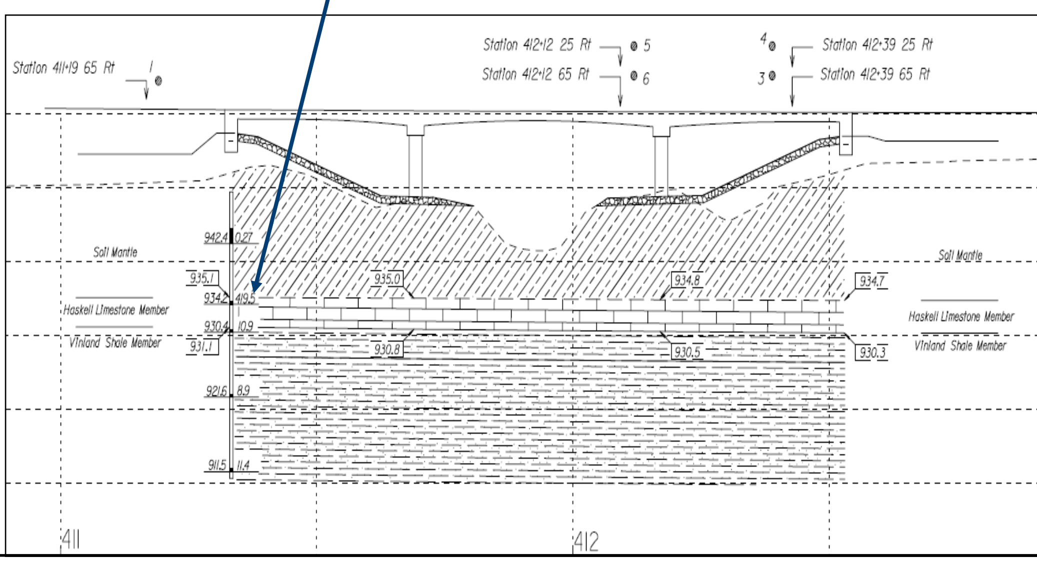
Driving into hard bedrock

12

Driving into hard bedrock

Driving into hard bedrock

- Will drive into hard limestone



Pile Alignment

Inspect the picture

- Which pile would concern you?

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Pile Alignment

Inspect the picture

- If you chose the 4th from the front, good job!

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Pile Alignment

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Pile Damage

- Damage to bottom of H-pile
- Probably weren’t getting bearing
- Led to inspect for damage

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Pile Damage

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19

Pile Damage

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20

Pile Alignment

Inspect the picture

- Which piling would concern you?
- Maybe this one is a little easier to, see?

Pile Extraction

Pile Damage

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23

Pile Damage

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24

Pile Damage

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25

Pile Damage

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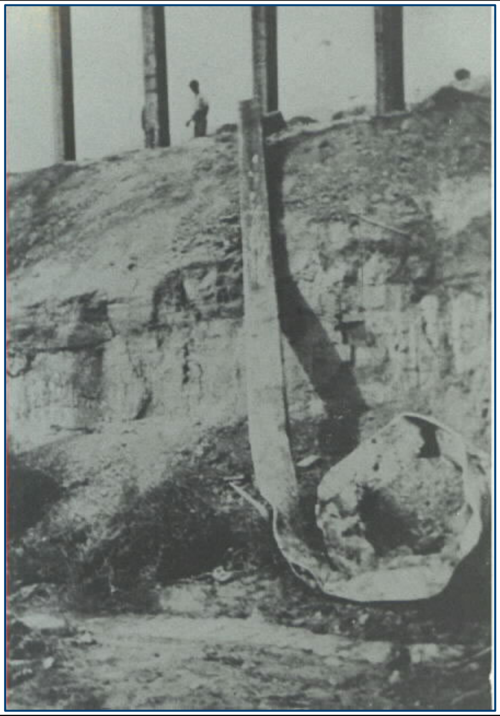
26

Pile Damage



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Hammer Alignment

- Can reduce the transferred energy.
- Can damage pile top
- Can give false blow count
- Pipe pile vulnerable

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Pipe Pile Damage

Mushrooming Caused by:
- Misalignment
- Hard driving
- Both?

Could Result in:
- Reduction of transferred energy
- Exaggerated blow count
- Exaggerated bearing capacity

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Pile Damage Suspected

- Is the damage bad enough to be of concern?
- Is the damage far enough down that the remaining good pile will carry the load?
- Can the pile be pulled and a new one driven?
- Do more piles need to be added to compensate for the damaged pile?

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Minor Damage to Top of Pile

- Target bearing not achieved and above plan tip
  - Stop Driving and cut off the damaged portion of the pile.
  - Check alignment of the hammer on the pile
  - Resume driving.
- Target bearing and minimum plan tip achieved.
  - Stop and cut pile off at cut off elevation
- If a restrike test is to be conducted on this pile, the top should be undamaged.

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Pile Damage Suspected

- Contact the Engineer
- Contact the Geology Section to conduct PDA.

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Trouble Achieving Target Bearing

- Check all calculations
- Check input parameters for bearing formula
- Check hammer
- Contact Engineer or supervisor
- Can a restrike test be conducted to evaluate soil set up?
  - If so, restrike pile in at least 24 hours
- May have to splice on more pile and continue the drive

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Target Bearing Achieved Early

- Check all calculations
- Check input parameters
- Check pile length
- Contact Engineer or supervisor

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Target Bearing Achieved Early

- If pile tip is close to plan tip elevation and **110%** of the **Pile Driving Formula Load** has not been reached, the pile can be driven to **110%** (if plan tip must be achieved)
- Is pile hitting an obstruction? (boulder, hard layer, old footing, another pile)
  - If so, what concerns will it cause.
- Is there enough pile length in place below cut off to satisfy lateral load and scour requirements and, if required, uplift requirements
  - If so pile can be cut off (always consult the Engineer)

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Hammer Performance

- If the hammer is not performing properly the bearing capacity can not be computed accurately
- Improperly functioning hammer:
  - May exaggerate the blow count
  - May give false set per blow information
  - May reduce pile driving ability
  - May simulate hard driving and high capacity in low-capacity conditions

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Hammer Performance

- Preignition in diesel hammer
  - Fuel starts to combust or fully combust before impact
  - Reduces ram impact velocity
  - Cushions the impact
  - Reduces transfer of energy to the pile, energy returned to the ram causing a high but false stroke
  - Low energy transfer results in high blow counts
- Can simulate hard driving and high-capacity condition at a potentially low soil resistance

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Hammer Performance

- Some things to look for
  - If you are getting a low set per blow yet a very small stroke, could be problems with hammer.
    - A low set per blow should indicate hard driving and you should have a large stroke.
  - Different looking exhaust
    - Fuel could be contaminated (water in fuel)
      - May not get the best fire on each stroke
  - Maybe the hammer just sounds much different than on the previous drive
    - Question the contractor if you feel something is wrong or different

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Preignition in Diesel Hammer

- Preignition in diesel hammer
  - Caused by overheated hammers
    - Lubrication oils start to burn
    - Fuel vaporizes prematurely due to excess heat
- Signs of Preignition
  - Black smoke while stroke is high
  - Flames in exhaust ports
  - Blistering paint
  - Oils and grease on outside smoking or burning
  - No obvious metal to metal impact ringing sound

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Preignition in Diesel Hammer

- If preignition is suspected:
  - Stop driving and let hammer cool down for at least 1 hour
  - Recommend the hammer be lubricated to replace any burnt off lubrication
  - Resume driving and monitor stroke and blow count
  - If stroke and blow counts are lower in the first few minutes of driving, preignition was probably occurring

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Hammer Performance

- Some performance problems and what to look for
  - May be hard to recognize but should be familiar with
- Water or dirt in fuel
  - White exhaust smoke and hollow sounding impacts
- Clogged fuel line (lack of fuel)
  - Little or no exhaust smoke
  - Low strokes
- Malfunctioning fuel pump or fuel injector
  - Inconsistent ram stroke and gray or black exhaust smoke

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Hammer Performance

- Low lubricating oil or malfunctioning oil pump
  - Lower than normal blows per minute
  - Reduced stroke
  - A quick check
    - see if ram is wet and shiny during drive when upper ram is visible
- Poor Compression-Worn piston or impact block rings
  - Short strokes even in hard driving
  - Easily checked by way of a “cold blow”

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Hammer Performance

- “Cold Blow” Procedure
  - Ram is picked up as if to start the hammer but the fuel line rope is kept stretched such that no fuel is pumped.
  - The ram is released and after impact the ram should bounce on the air trapped in the chamber. Each bounce can be heard.
  - Should get 5 to 10 good bounces.

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Be Aware!

Crane tipping while lowering the leads and hammer

Had to let the leads free fall to keep from tipping over

Note the slack cables

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Who to Contact

With all problems you should contact
- Your supervisor
- Engineer in charge
- Design Engineer

If needed you can contact the Geology Section for guidance or to have the PDA brought out

- Neil Croxton, Salina Regional Geologist
  - 785-640-2613
- Jason Kolb, El Dorado Regional Geologist
  - 316-251-6596
- Denny Martin, Chanute Regional Geologist
  - 620-902-6428
- John Barker, Topeka Regional Geologist
  - 785-291-3861

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Questions!

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KDOT Specifications for Piles and Pile Driving

1

Where do you find pile information?

KDOT Standard Specifications Book

2015 Edition

Division 700—Structures

Section 704 Piling

pages 700-15 to 700-21

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2

Where do you find pile information? 1

KDOT Standard Specifications Book

2015 Edition

Division 1600—Ferrous and Non-Ferrous Metals

Section 1609 Steel Piling and Pile Points

page 1600-18

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3

How to get to the 2015 Edition

Go to www.ksdot.gov

Hover over "*Doing Business*", then go to *"Contractor Resources", "Specifications and Special Provisions", and "Standard Specifications for State Road and Bridge Construction"*

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Contractor Resources
Permits
Harvesting Hay on Highway Right of Way
KDOT Utility Permit System (KUPS)
Request for KDOT Support for Discretionary Grants
Signs & Salvage
Kansas Highway Dedication Signing
Scam Alert
KDOT does not collect tolls or fines or request payment via text - don't click suspicious link
Report Scam Texts
DO NOT CLICK OR OPEN LINKS!
KDOT does not collect tolls or ticket payments
REPORT FRAUDULENT TEXTS:
www.ic3.gov
SCAM

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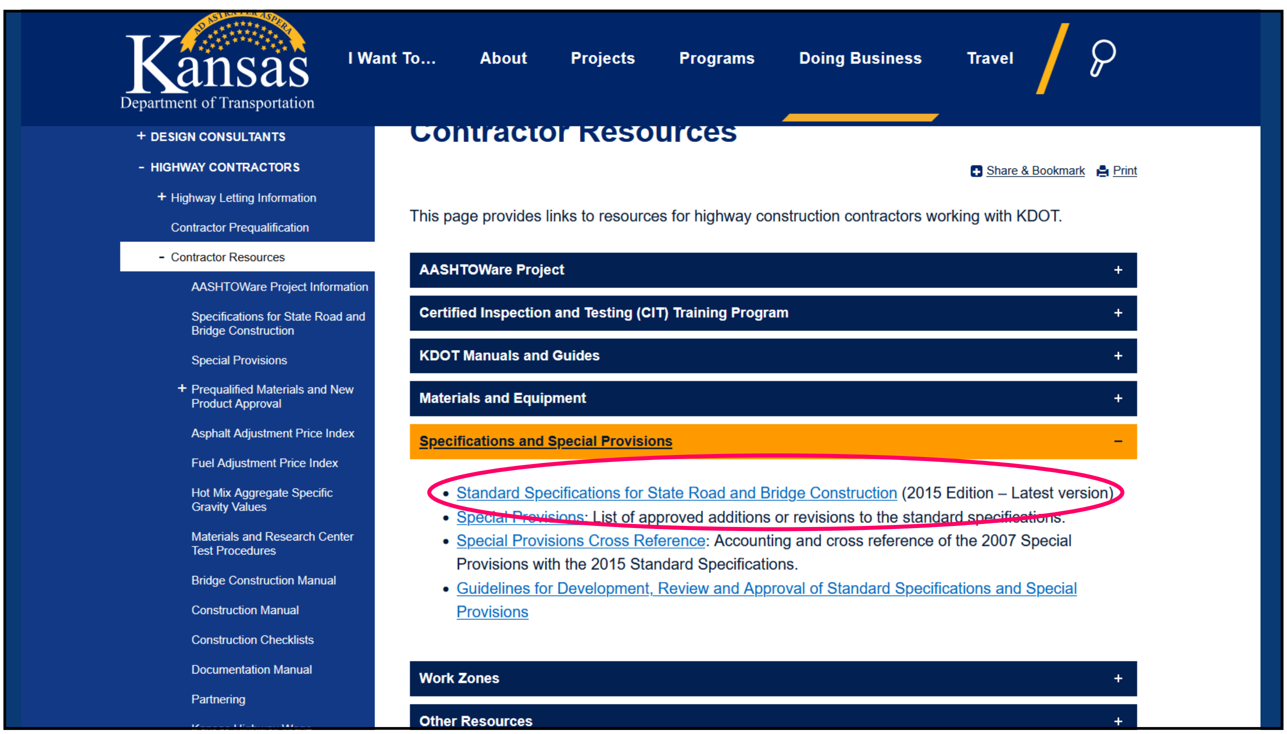
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Materials and Research Center Test Procedures
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This page provides links to resources for highway construction contractors working with KDOT.
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Certified Inspection and Testing (CIT) Training Program +
KDOT Manuals and Guides +
Materials and Equipment +
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• Standard Specifications for State Road and Bridge Construction (2015 Edition – Latest version)
• Special Provisions: List of approved additions or revisions to the standard specifications.
• Special Provisions Cross Reference: Accounting and cross reference of the 2007 Special Provisions with the 2015 Standard Specifications.
• Guidelines for Development, Review and Approval of Standard Specifications and Special Provisions
Work Zones +
Other Resources +

6

2015 Special Provisions

Below the 2015 Specifications is the link to Special Provisions.

There is currently one piling Special Provision.

That will change, so always check for more.

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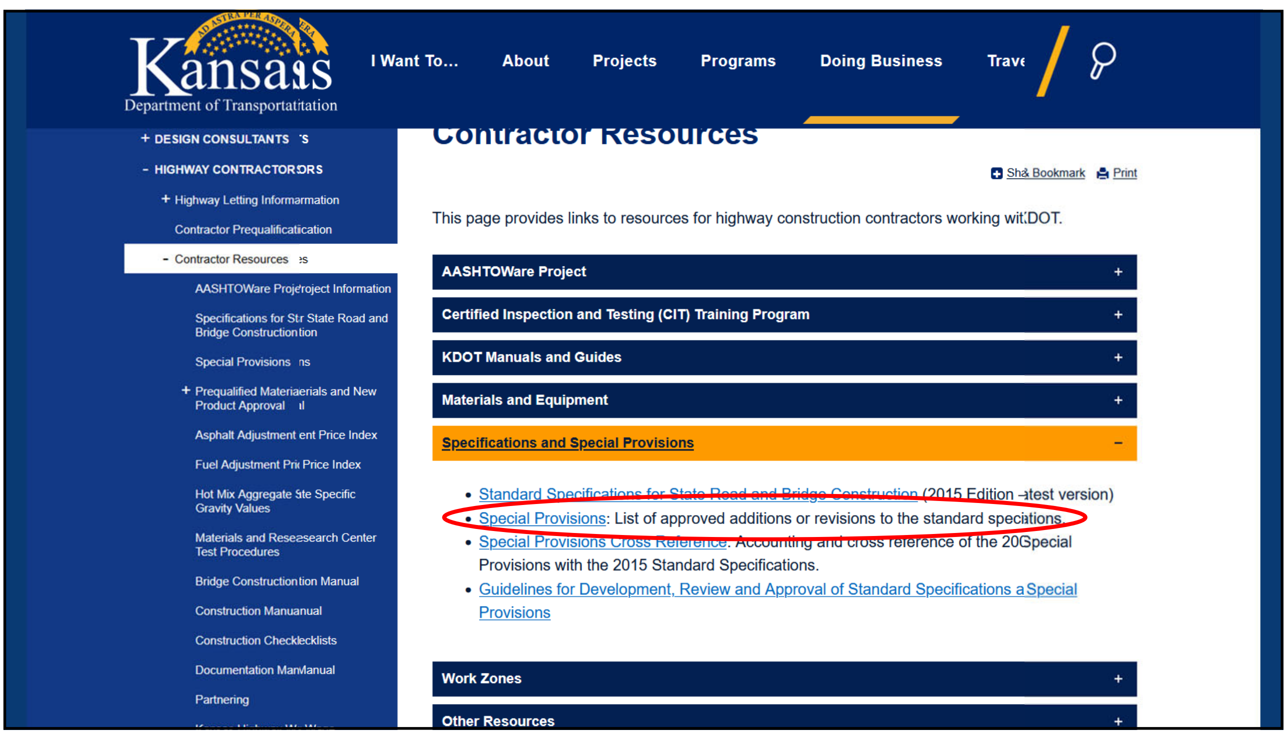

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2015 Special Provisions 1

15-07017

Adds a line about sheet pile to the bid items

We don't worry about sheet pile in this class

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The Bridge Construction Manual

Chapter 5.3 Driven Pile

Contains some practical information about bridge piling construction and inspection.

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The Bridge Construction Manual

Chapter 5.3 Driven Pile

General terminology and definitions, pile and hammer types, and the mechanics of pile driving, including formula examples

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The Bridge Construction Manual

Chapter 5.3 Driven Pile

We cover all this material in class.

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To get to this Manual online

www.ksdot.gov

Hover over "Doing Business"

Go to *"Highway Contractors"*, then *"Contractor Resources", "KDOT Manuals and Guides", "Bridge Construction Manual", and Section 5.3 "Driven Piles"*

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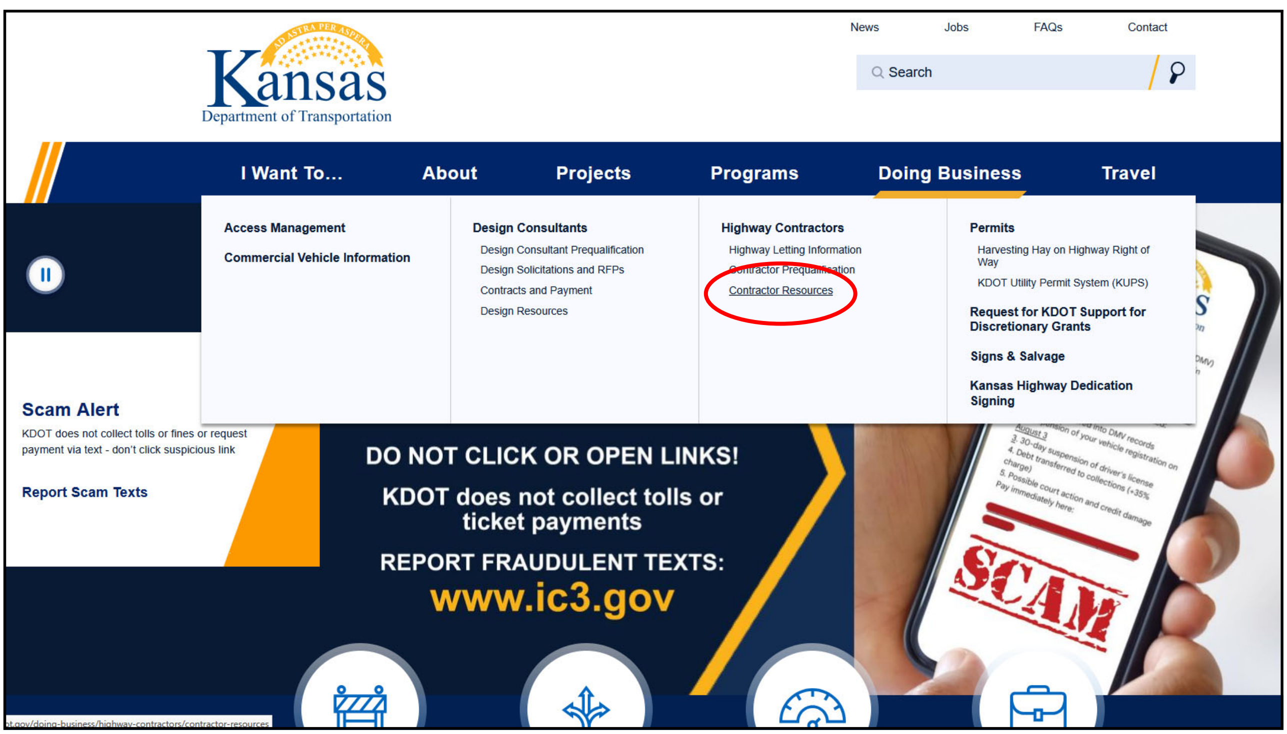

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www.ksdot.gov/doing-business/highway-contractors/contractor-resources

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Getting to the Bridge Construction Manual

AASHTOWare Project Information

Specifications for State Road and Bridge Construction

Special Provisions

+ Prequalified Materials and New Product Approval

Asphalt Adjustment Price Index

Fuel Adjustment Price Index

Hot Mix Aggregate Specific Gravity Values

Materials and Research Center Test Procedures

Bridge Construction Manual

Construction Manual

Construction Checklists

Documentation Manual

Partnering

Kansas Highway Wage Determinations

+ PERMITS

REQUEST FOR KDOT SUPPORT FOR DISCRETIONARY GRANTS

SIGNS & SALVAGE

Certified Inspection and Testing (CIT) Training Program +

KDOT Manuals and Guides –

- Bridge Construction Manual: Reference book of guidelines for the procedures and methods acceptable for the construction of bridges in Kansas.
- Construction Manual: Reference book of guidelines for the procedures and methods acceptable for the construction of state highway projects in Kansas.
- Construction Stormwater and Pollution Control: Access to KDOT's Stormwater Pollution Prevention Plan (SWPPP) that will be used on all highway construction projects administered by the department.
- Documentation Manual: Reference of recording methods to meet reporting requirements on construction of state highway projects in Kansas.
- Technical Advisories and Policies: Search for specific documents by title, keyword, or reference number.
- Utility Accommodation Policy
- Several other manuals are available through KDOT's Authentication and Resource Tracking (KART) page. This service requires creating a free account.

Materials and Equipment +

Specifications and Special Provisions +

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www.ksdot.gov/doing-business/highway-contractors/contractor-resources/bridge-construction-manual

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Getting to the Bridge Construction Manual

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Hot Mix Aggregate Specific Gravity Values

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Bridge Construction Manual

Construction Manual

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Doing Business » Highway Contractors » Contractor Resources »

Bridge Construction Manual

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The Bridge Construction Manual is intended to better communicate the intent of the plans, Standard Specifications for State Road and Bridge Construction, Special Provisions, and Project Special Provisions to KDOT Inspectors, Contractors and Design Consultants.

Section	Title	Date Updated
1.0	Introduction	10/26/11
2.0	Contractor Construction Staking	5/21/13
3.0	Temporary Detour Bridges	1/1/07
4.0	Excavation and Embankments - UNDER DEVELOPMENT	
4.1	MSE Walls	8/28/08
5.0	Foundation General - UNDER DEVELOPMENT	
5.3	Driven Pile	5/21/13
5.4	Drilled Shafts	1/11/08
6.0	Formwork, Falsework and Temporary Structures General	9/9/09
6.1	Chapter 16 - Bridge Design Manual	12/21
7.0	Reinforcement - UNDER DEVELOPMENT	
8.0	Reinforced Concrete Structures	4/26/12
9.0	Structural Steel	1/1/07

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Division 700—Structures
Section 704.3 Pile Driving Equipment

(a) General

Size needed to develop the energy necessary to drive piles at least 0.1” per blow at the required resistance on the plans (the Pile Drive Formula Load)

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Division 700—Structures
Section 704.3 Pile Driving Equipment 1

(a) General

(1) Open-end Diesel Hammer

Equip with a device extending above ram cylinder to permit visually determining hammer stroke at all times.

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Division 700—Structures
Section 704.3 Pile Driving Equipment 2

(a) General

(3) Weight of the striking part of air hammers used shall be a minimum of ⅓ the weight of the pile and drive cap

Minimum weight of striking part is 2,750 pounds

Division 700—Structures
Section 704.3 Pile Driving Equipment 3

b. Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Concrete Piles.

Gravity hammer—minimum weight 3500 pounds

Gravity hammer—maximum drop 12 feet

Division 700—Structures
Section 704.3 Pile Driving Equipment 4

b. Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Concrete Piles.

Diesel or air—maximum fall 90% of the maximum fall recommended by manufacturer

Minimum 6000 foot-pounds energy per blow

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Division 700—Structures
Section 704.3 Pile Driving Equipment 5

c. Hammers for prestressed concrete pile

- Only driven with diesel or air hammer unless otherwise noted
- Hammer must develop 1 foot-pound of energy for each pound of weight driven
- Minimum energy of hammer is 6,000 foot-pounds per blow

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Division 700—Structures
Section 704.3 Pile Driving Equipment 6

d. Vibratory hammers

- Used only when specified in Contract document
- If used, 1 of 10 piles must be load tested using an impact hammer (diesel or air) with suitable energy

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Division 700—Structures
Section 704.3 Pile Driving Equipment 7

e. Additional Equipment

The plant and equipment provided for air hammers shall have capacity to maintain the pressure at the hammer specified by the manufacturer.

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Division 700—Structures
Section 704.3 Pile Driving Equipment 8

e. Additional Equipment

If Contractor cannot drive pile to the required penetration and/or bearing capacity, he must bring a bigger hammer. If the Engineer approves, he may resort to jetting or pre-drilling at his own expense.

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Division 700—Structures
Section 704.3 Pile Driving Equipment 9

e. Additional Equipment

Use of the pile driving analyzer may be required when minimum requirements are not met

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Division 700—Structures
Section 704.3 Pile Driving Equipment 10

f. Leads

Constructed to allow freedom of movement of the hammer

Except where piles are driven through water, the leads shall be long enough so that followers are not needed

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Remember what a follower is ?

If you search for a picture of a “follower” on the interwebs, this is one of the things that shows up.

The interwebs are great, eh?

29

Followers are used as an extension of the pile between the hammer and the pile head

30

Division 700—Structures
Section 704.3 Pile Driving Equipment 11

f. Leads

Long enough to permit them to be spiked into the ground before driving starts

Division 700—Structures
Section 704.3 Pile Driving Equipment 12

g. Hammer Cushion

Required on all impact pile driving hammers except gravity hammers

Inspect before driving at each bridge or after driving for 100 hours

Replace cushion when thickness is reduced by 25% or it appears to be deteriorating.

Division 700—Structures
Section 704.3 Pile Driving Equipment 13

g. Hammer Cushion

A striking plate is placed on the cushion to insure uniform compression of the cushion material

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Division 700—Structures
Section 704.3 Pile Driving Equipment 14

g. Hammer Cushion

Made of “durable manufactured material”

- Micarta (Conbest)—fabric and phenol
- Nylon—2” blocks
- Hamortex- metallized paper reels
- Force 10, Forbon, Fosterlon
- Aluminum

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Division 700—Structures
Section 704.3 Pile Driving Equipment 15

(h) Pile Driving Head

Use driving head adequate for distributing the hammer blow to the pile

Guided by the leads and not free-swinging

Should fit the pile head adequately

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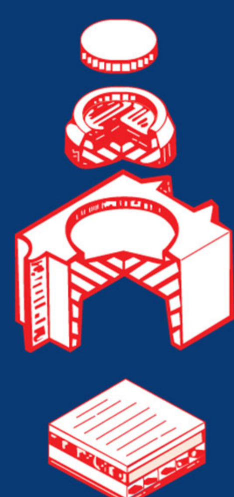
Pile Driving Head

Another name for the Pile Helmet



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Division 700—Structures
Section 704.3 Pile Driving Equipment 16

i. Water Jets

Only used with permission from the Engineer

If used:

Number of jets and volume and pressure of water sufficient to erode material

Power enough to deliver at least 100 psi pressure from ¾" jet nozzles

Division 700—Structures
Section 704.3 Pile Driving Equipment 17

i. Water Jets

Jets shall be withdrawn at least 5 feet from the desired final penetration depth and the pile driven the last 5 feet with an approved hammer

Section 704.4
Construction Requirements

a. Order Lists, Piles, and Test Piles

Piles

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

Section 704.4
Construction Requirements 1

a. Order Lists, Piles, and Test Piles

Piles

For piles and test piles, submit the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of driving piling. The Engineer (that's you) will forward this information for a Test Pile (Special) to the Chief Geologist.

Section 704.4
Construction Requirements 2

a. Order Lists, Piles, and Test Piles

When Engineer requires a restrike, follow **subsection 704.4e.** for restrike procedures

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Section 704.4
Construction Requirements 3

a. Order Lists, Piles, and Test Piles

Drive test piles at specified locations

Engineer will use test pile information to determine pile tip elevation

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Section 704.4
Construction Requirements 4

a. Order Lists, Piles, and Test Piles

If multiple hammers are used on a project with test piles, drive a test pile with each hammer

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Section 704.4
Construction Requirements 5

b. Test Pile (Special)

Pile Driving Analyzer used to monitor test pile

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Section 704.4
Construction Requirements 6

b. Test Pile (Special)

Notify Engineer (John) minimum 5 working days prior to test.

Allow 1½ hours for pile to be prepared for test

Allow safe and reasonable access to pile

a personnel lift is **very** handy for this, if the contractor has one

The Engineer will use the PDA results to provide the Contractor with a blow count for production driving.

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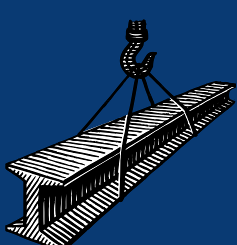
Section 704.4
Construction Requirements 7

c. Driving piles

Piles can be driven with a gravity, diesel or air hammer

or

Combination of pre-drilled holes or water jetting and a hammer



Refer to Subsection 704.3 for pile driving equipment

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Section 704.4
Construction Requirements 8

c. Driving piles

Drive piles at the locations and to lines shown on plans

Use leads long enough to be spiked into ground

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Section 704.4
Construction Requirements 9

c. Driving piles

Do not drive piles until excavation for footing, webwall, or abutment is complete

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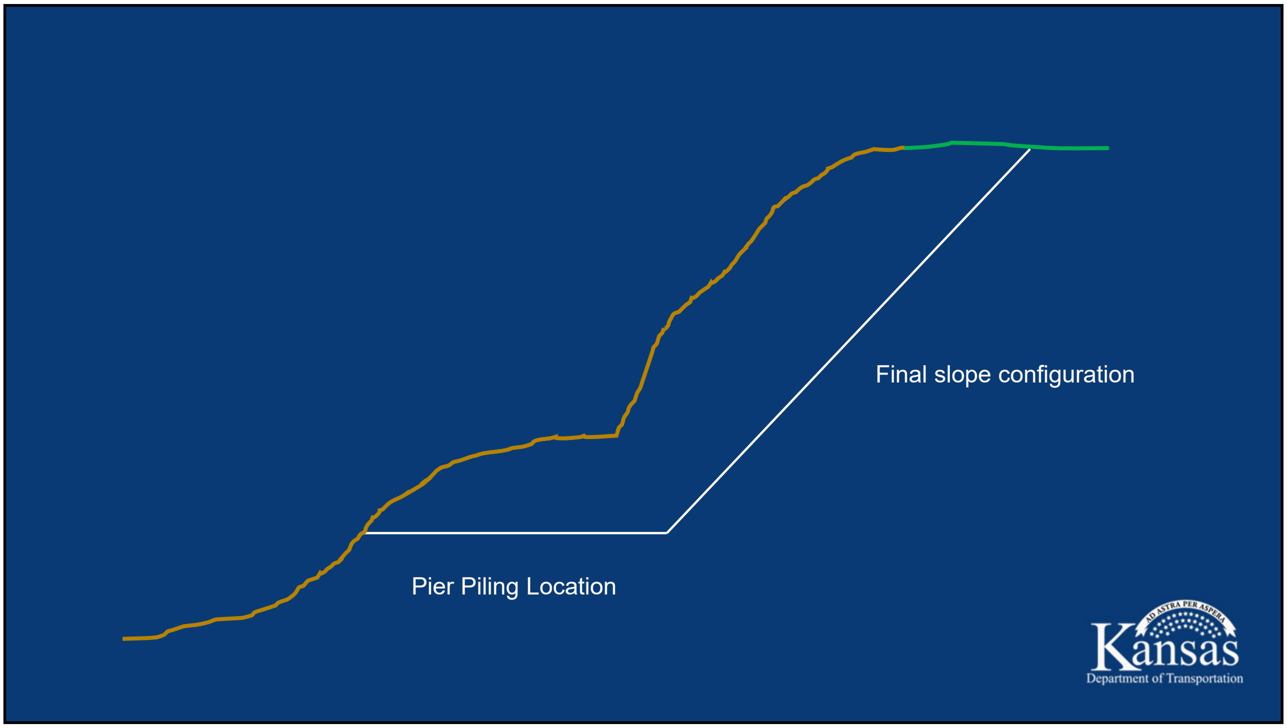
Final slope configuration
Pier Piling Location
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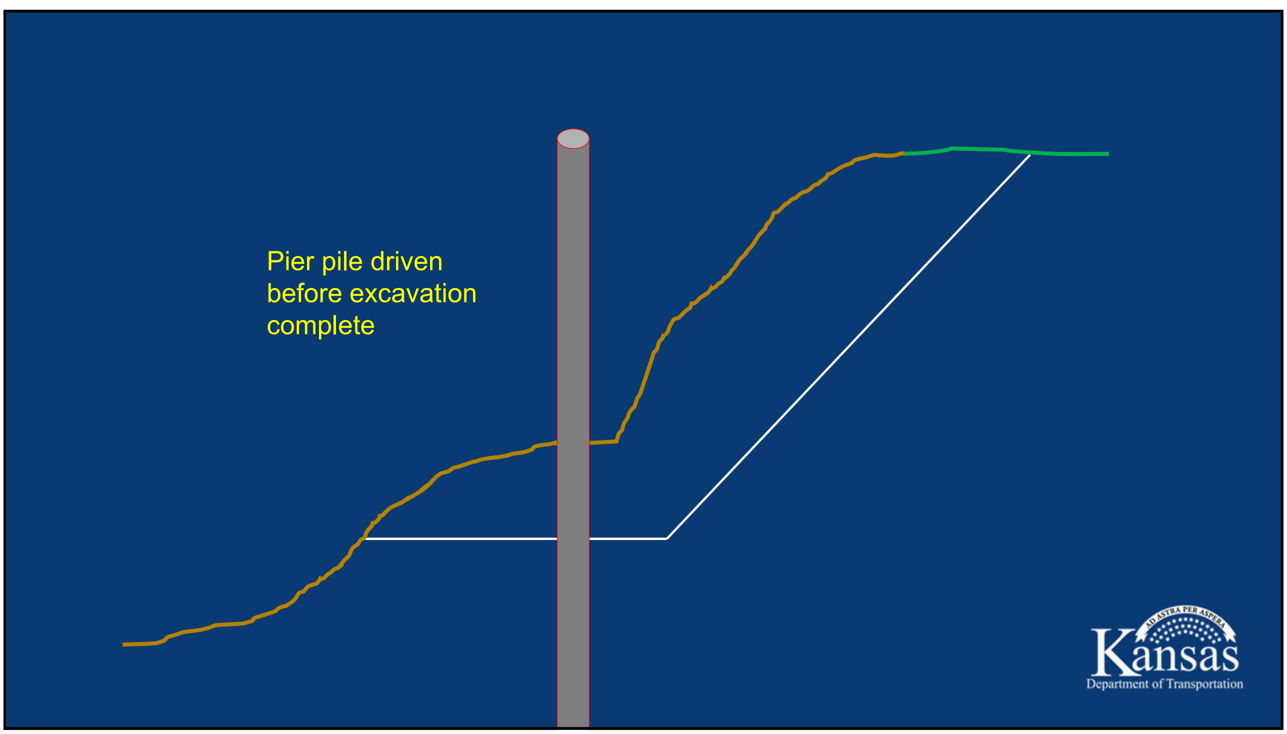
Pier pile driven
before excavation
complete
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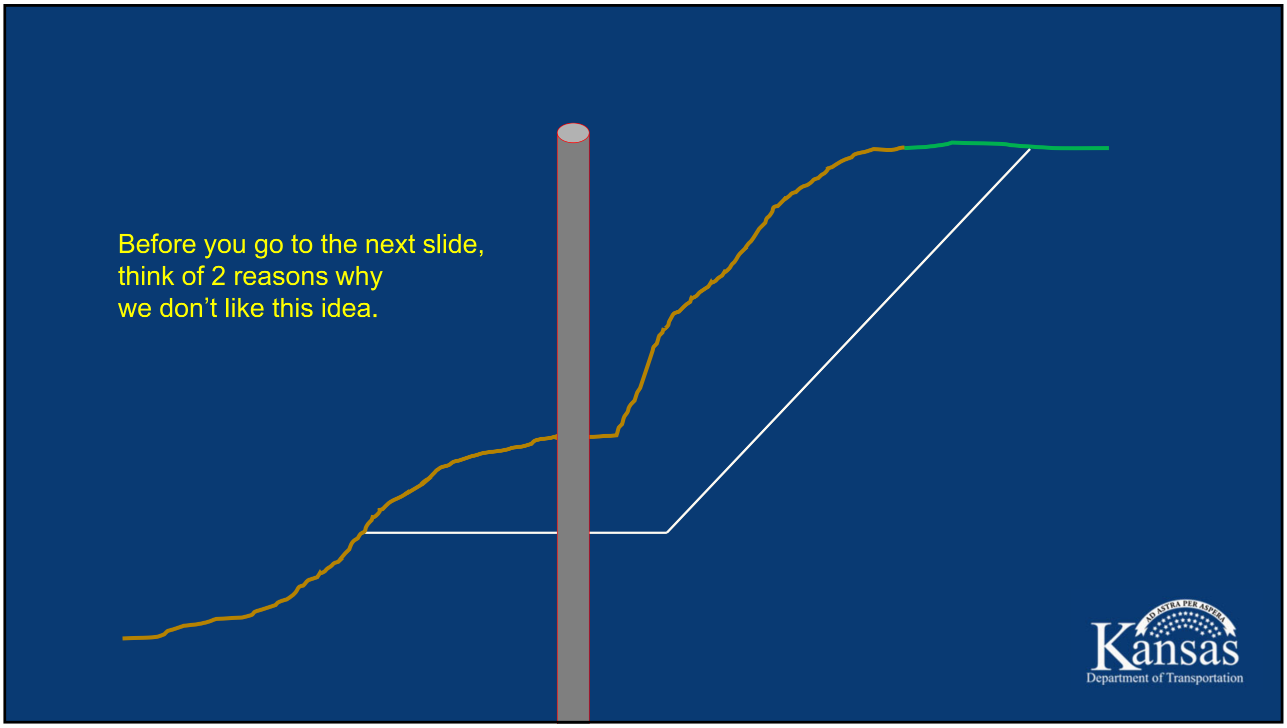
Before you go to the next slide,
think of 2 reasons why
we don't like this idea.
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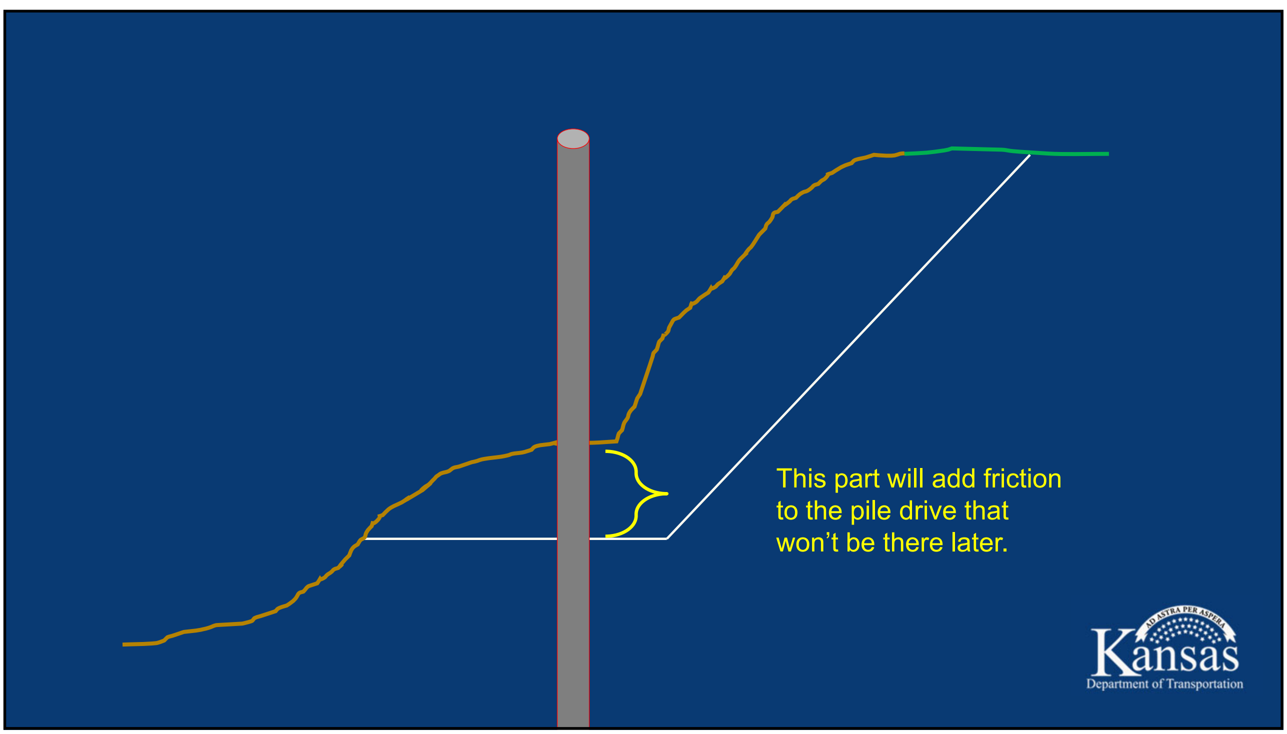
This part will add friction
to the pile drive that
won't be there later.
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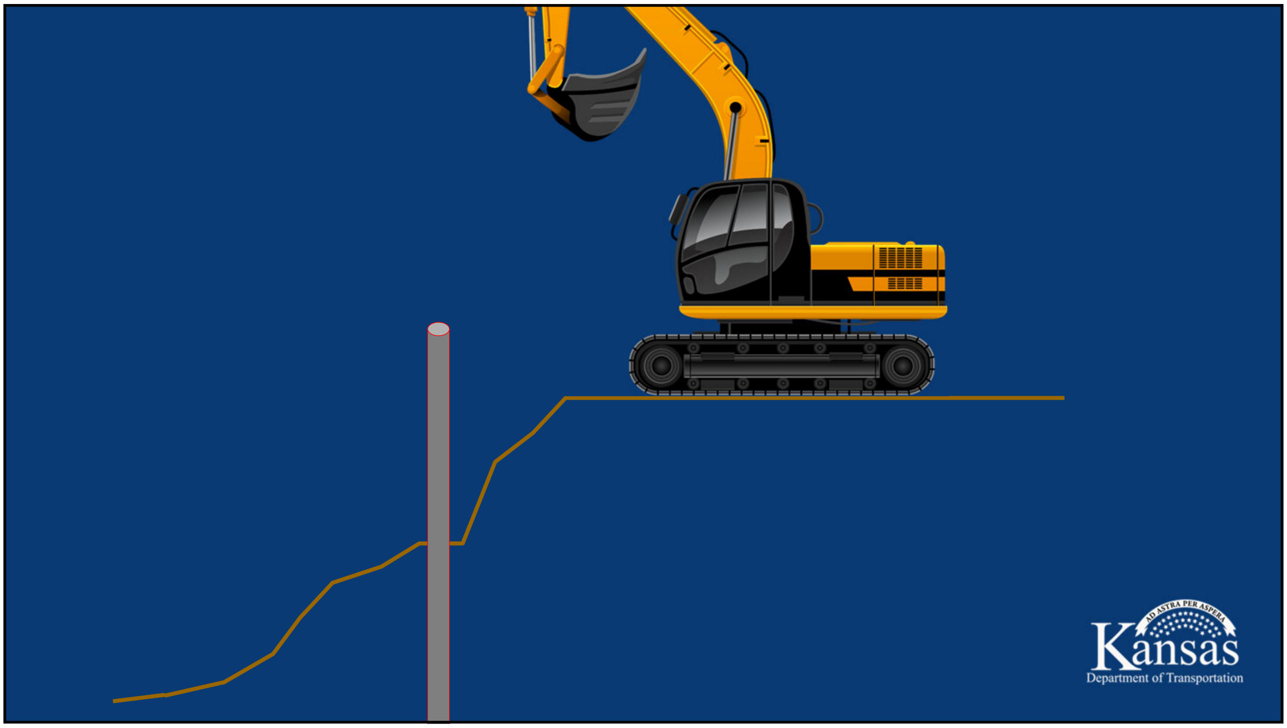

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Section 704.4
Construction Requirements 10

Don’t allow a contractor to ignore this spec.

Release
the hounds….

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Section 704.4
Construction Requirements 11

c. Driving piles

Drive all piles for a footing or abutment before placing any concrete in the footing or abutment unless pile is over 20 feet from concrete, or unless concrete has cured 24 hours

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Section 704.4
Construction Requirements 12

(c) Driving piles

Drill pile holes as shown on the plans

Maximum allowed diameter of predrill holes is 3” greater than pile diameter

If predrilling not specified, Contractor may predrill if Engineer approves

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704.4 Construction Requirements 13

(c) Driving piles

After pile is driven, backfill with loose sand or material specified on plans

If concrete is specified for backfill, use adequate slump and vibration to eliminate voids around pile

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Section 704.4 Construction Requirements 14

c. Driving piles

Drive all piling perpendicular to long axis of pile

Use pile caps (helmets) on all piles

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Section 704.4
Construction Requirements 15

c. Driving piles

For pile caps of concrete piles and prestressed concrete piles, use a suitable cushion next to the pile

Pile helmets for steel piles must have grooves to accommodate the shape of the pile

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Section 704.4
Construction Requirements 16

c. Driving piles

On pipe piles, the helmet must have an interior guide (mandrel) that sticks into the pile at least 6 inches.

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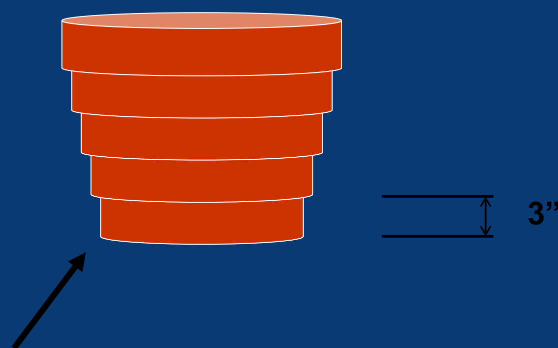
Section 704.4
Construction Requirements 17



Most of the time, each step on a guide is 3”.
So we need 2 steps inside a pipe pile.

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Section 704.4
Construction Requirements 18

c. Driving piles

It is not necessary to have 6 inches of the interior guide up against the pile itself.

Just a total of 6 inches.

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No reason--I just think this painting is cool

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Section 704.4 Construction Requirements 19

c. Driving piles

Use full-length pile where practical

Splice steel pile where shown on plans or with permission of Engineer

Provide experienced welder, qualified under Section 713 to make the welded splices for steel pile

(Section 713 is Qualification of Field Welders)

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Section 704.4 Construction Requirements 20

c. Driving piles

Contractor must correct any failed splices at his own expense

Section 704.4 Construction Requirements 21

c. Driving piles

Avoid extensions, splices, or build-ups of prestressed concrete piles

Plans will show method for splicing concrete piles

There are no instructions for splicing concrete piles in the Specs

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Section 704.4
Construction Requirements 22

c. Driving piles

Replace any damaged pile with new, longer pile

--crushing or spalling of concrete pile

--deformation of steel pile

An additional pile may be driven next to damaged pile, if approved by Engineer

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Section 704.4
Construction Requirements 23

c. Driving piles

Do not force misaligned piles into position

Remove and replace any pile not in its proper location with new, longer pile

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Will the pile tip straighten out by doing this?

Is it a good idea to deliberately bend a piece of structural steel in a bridge?

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Section 704.4
Construction Requirements 24

Tolerance to Vertical

Straight
(Vertical)

Oops…

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Section 704.4
Construction Requirements 25

Tolerance to Vertical

Oops…

72

Section 704.4
Construction Requirements 26

Tolerance to Vertical

Variation
from Vertical

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AD ASTRA PER ASPERA
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If you have enough pile sticking out of the ground, just measure it directly
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Section 704.4
Construction Requirements 27

c. Driving piles

Tolerances to Vertical or Battered Lines

Piles 35 feet or shorter: ¼” per foot of length

Piles longer than 35 feet: 1/8” per foot

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Driving Tolerances to Vertical—Example

You are driving H-piles into chalky limestone for a 3-pier bridge over Big Possum Creek in southern Gove County. The piers are supported by small pile groups. The order length for piling in Pier 3 is 28 feet. You stop driving when you notice one of the piles seems to be crooked. How can you check to see if it’s in spec?

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Driving Tolerances to Vertical—Example

Pile Length—28 feet

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Driving Tolerances to Vertical—Example

Pile Length—28 feet

Tolerance for piles shorter than 35 feet is ¼ inch per foot of pile

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Driving Tolerances to Vertical—Example

Pile Length—28 feet

Tolerance for piles shorter than 35 feet is ¼ inch per foot of pile

You have a 4-foot long level.

4 feet x ¼ inch / foot = ?

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Driving Tolerances to Vertical—Example

4 feet x ¼ inch / foot = 1 inch

You would measure the distance it is out of plumb, and contact the Bridge Office if it exceeds one inch.

When using a 4-foot level to check, you either have ½" or 1" leeway, depending on the pile length.

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Section 704.4
Construction Requirements 27.5

c. Driving piles

Tolerances to Vertical or Battered Lines

If you don't have enough pile sticking out to measure it directly, have the location surveyed and measure how far off it is. Then back-calculate.

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Section 704.4
Construction Requirements 28

c. Driving piles

Tolerances to Position of Pile Head (Elevation of Top of Pile)

Piles in bents: 2"

Foundation piles (pile groups): 6"

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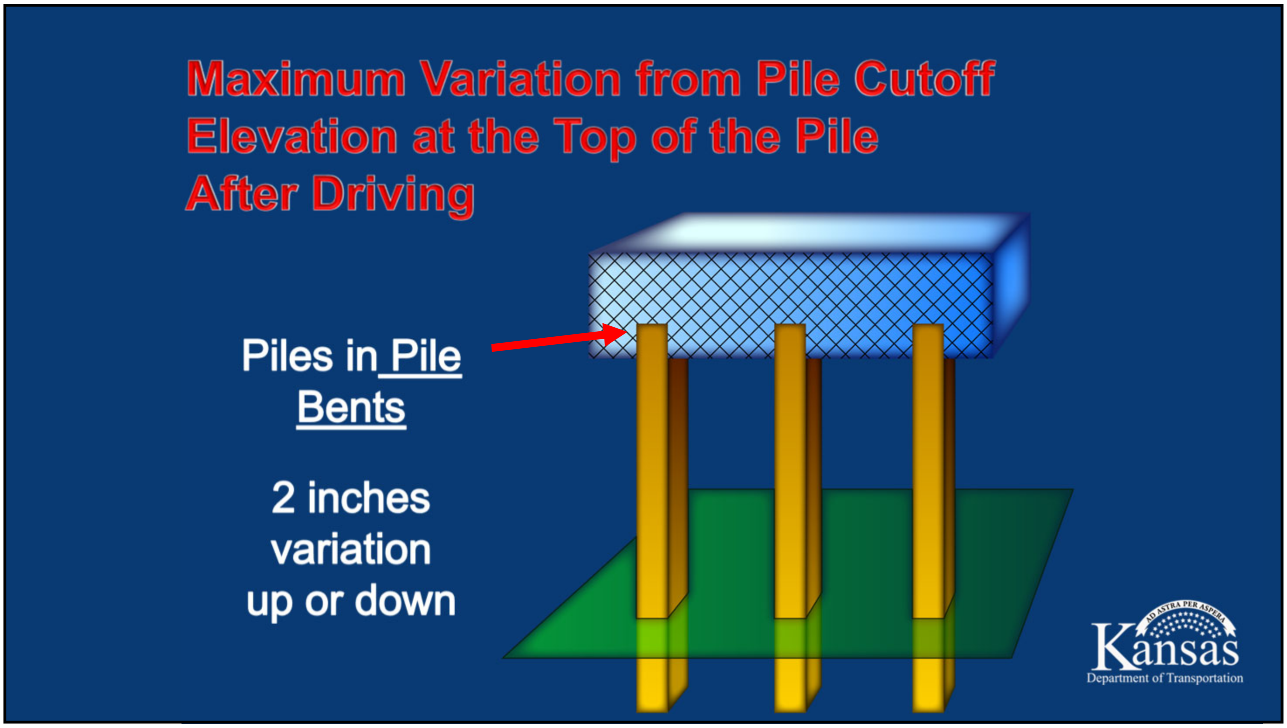
Maximum Variation from Pile Cutoff Elevation at the Top of the Pile After Driving
Piles in Pile Bents
2 inches variation up or down
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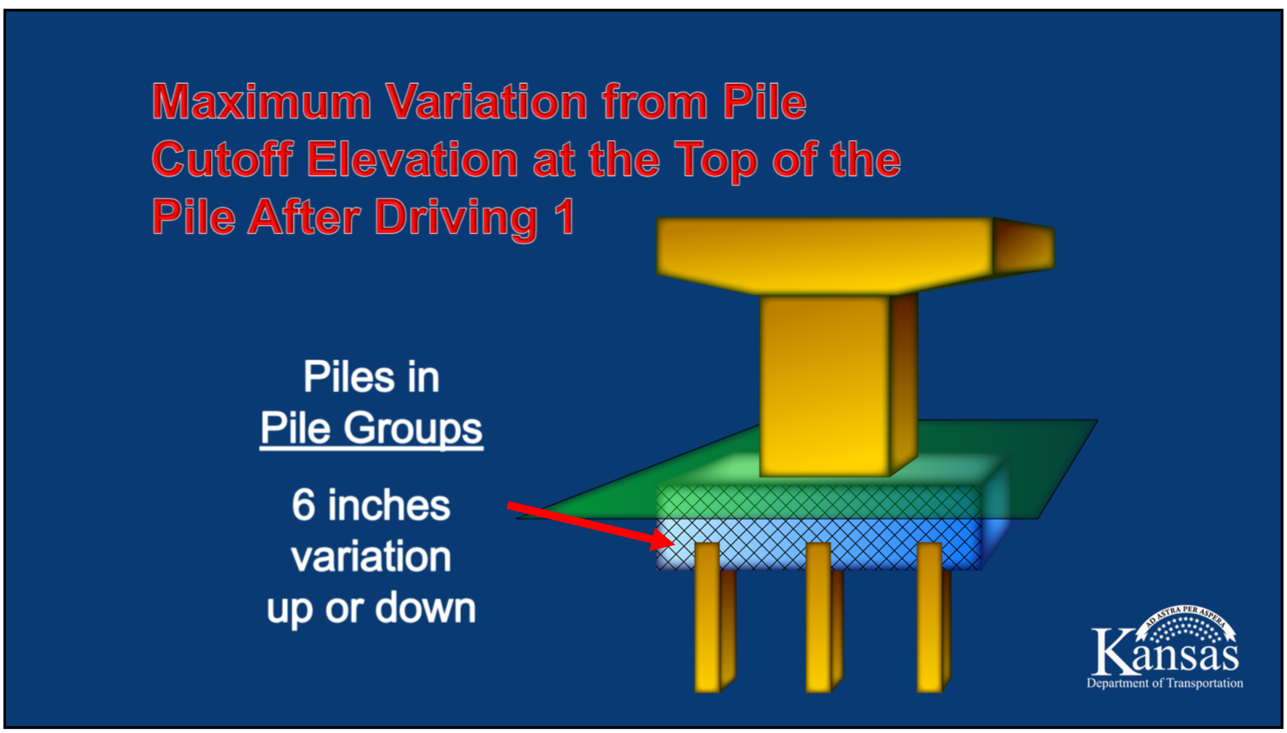
Maximum Variation from Pile Cutoff Elevation at the Top of the Pile After Driving 1
Piles in Pile Groups
6 inches variation up or down
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Section 704.4
Construction Requirements 29

c. Driving piles

Drive all piles in the orientation shown on the Plans. If the axial orientation of the pile rotates or twists by more than 10^{o}, the Field Engineer (that's you) will contact the bridge designer in Topeka.

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Isn’t the hammer supposed to keep this from happening?

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H H H H H H H

Typical Pile Bent Abutment

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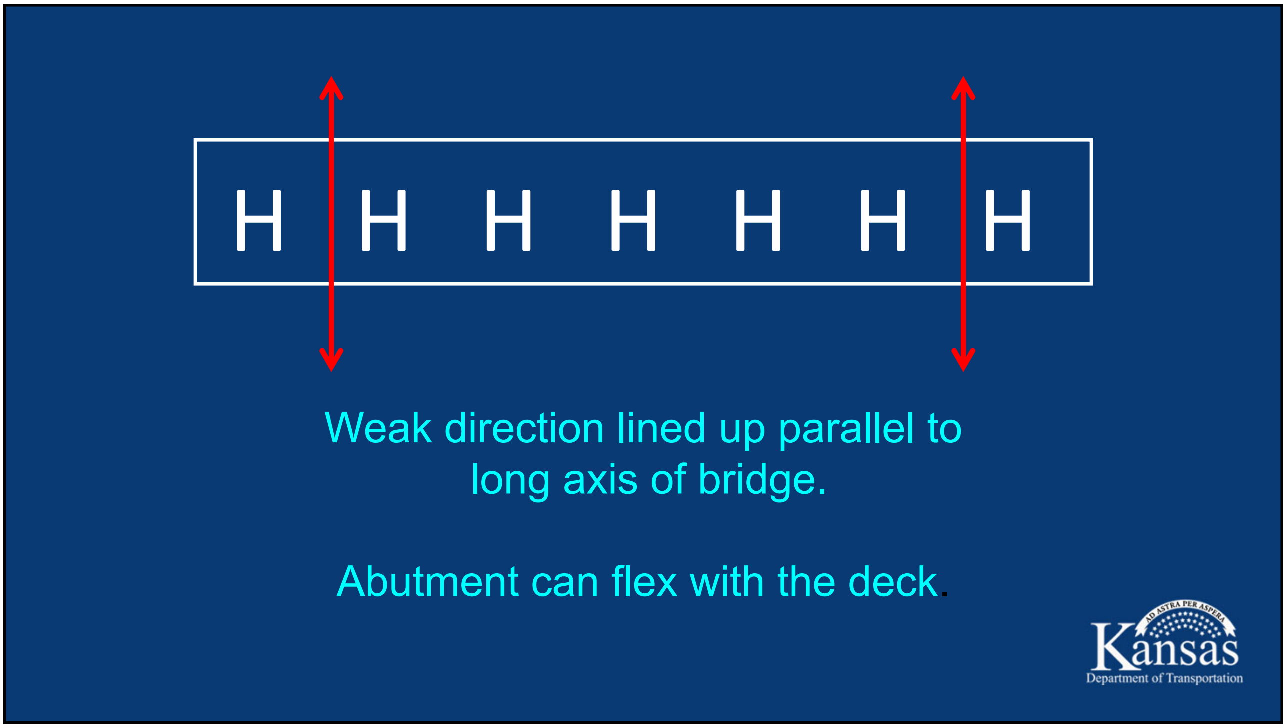
H H H H H H H
Weak direction lined up parallel to
long axis of bridge.
Abutment can flex with the deck.
AD ASTRA PER ASPERA
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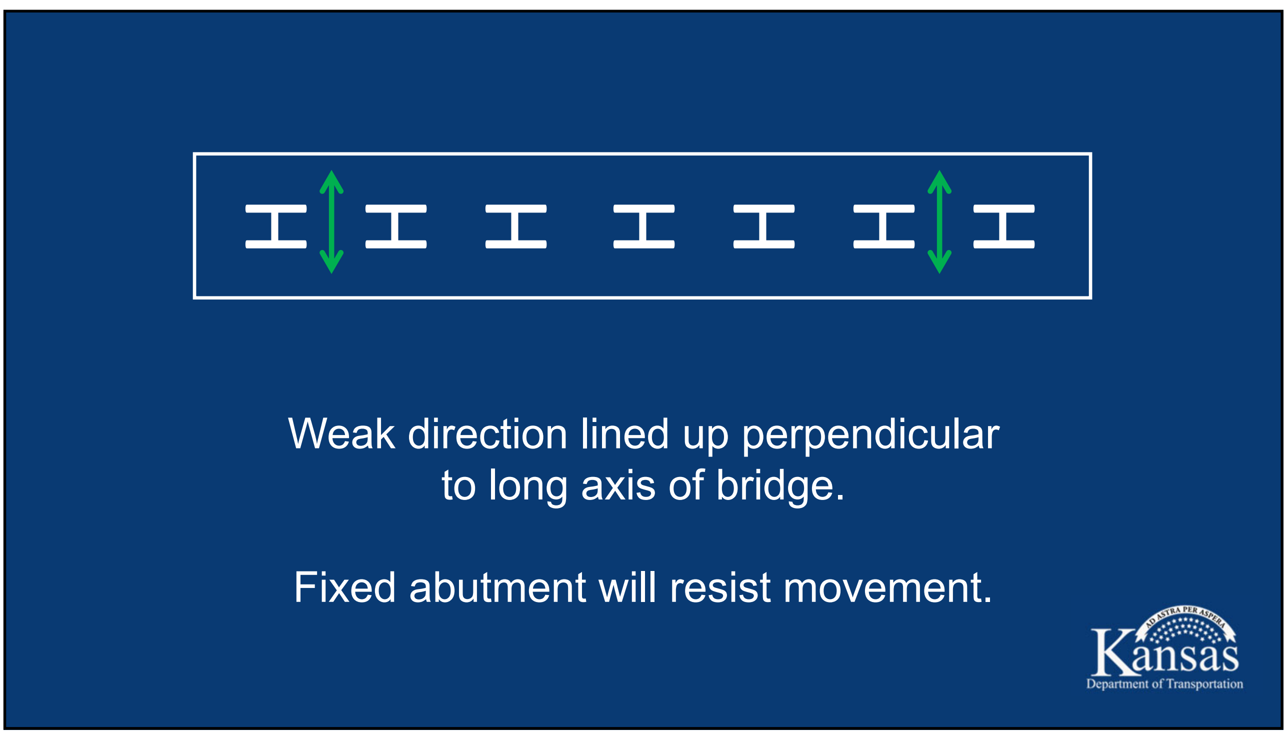
Weak direction lined up perpendicular
to long axis of bridge.
Fixed abutment will resist movement.
AD ASTRA PER ASPERA
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Section 704.4
Construction Requirements 30

c. Driving piles

Re-drive all piles pushed up by adjacent pile driving or any other cause

Section 704.4
Construction Requirements 31

d. Bearing Values and Required Penetration

Drive piling to the specified bearing value, penetration, and pile tip elevation

Stop driving if 1.1 times the minimum resistance (pile drive formula load) is attained

Section 704.4
Construction Requirements 32

d. Bearing Values and Required Penetration

Stop driving if the pile will be damaged before the minimum requirements are met

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Section 704.4
Construction Requirements 33

d. Bearing Values and Required Penetration

If required bearing can't be obtained, the number of piling may be increased with the approval of the Engineer (bridge engineer in Topeka)

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Section 704.4
Construction Requirements 34

d. Bearing Values and Required Penetration

This would only be done after splicing and restriking have been tried.

Adding piling is rarely needed.

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Section 704.4
Construction Requirements 35

TABLE 704-1: PILE FORMULAS		
Hammer	**Pile Type**	**Formula**
Gravity	Timber	$P = \frac{2\ W\ H}{S + 1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S + 0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S + 0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S + 0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S + 0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S + 0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers
** For diesel hammers, the quantity X/W shall not be less than 1.
P = safe bearing power in pounds

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Section 704.4
Construction Requirements 36

d. Bearing Values and Required Penetration

Formulas only apply when:

Hammer falls freely

Penetration is quick and uniform

No significant bounce after the strike

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Section 704.4
Construction Requirements 37

d. Bearing Values and Required Penetration

If water jets used, determine bearing capacity after jets have been removed

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Section 704.4
Construction Requirements 38

d. Bearing Values and Required Penetration

If a different brand of **diesel** hammer is used besides the 3 listed in the Formula Table, use 80 % (0.80) of the manufacturer's listed energy rating in the formula to determine bearing capacity.

Section 704.4
Construction Requirements 39

d. Bearing Values and Required Penetration

For an **air** hammer, use 100 % of the manufacturer's listed energy rating in the formula to determine bearing capacity and to check if the hammer is large enough.

Section 704.4
Construction Requirements 40

e. Pile Restrike Procedure

If pile doesn't get resistance within a few feet of plan elevation, a restrike may be used

Call the Regional Geology Office for help

Section 704.4
Construction Requirements 41

e. Pile Restrike Procedure

(1) No test piles called for on bridge and PDA not available

Drive all piles in group to within 2 feet of plan

Leave them alone for at least 24 hours

Section 704.4
Construction Requirements 42

e. Pile Restrike Procedure

Warm up hammer far from piles to restrike

Immediately restrike 20% of piles in group, minimum of 2 piles per group

Restrike piles farthest from each other

When possible, restrike those with lowest resistance during driving

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Section 704.4
Construction Requirements 43

e. Pile Restrike Procedure

Strike a pile with warm hammer for 20 blows or until it moves 4 inches, whichever comes first

Record penetration for every 5 blows

If pile moves less than ½ inch, stop restrike after 10 blows

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Section 704.4
Construction Requirements 44

e. Pile Restrike Procedure

(1) No test piles called for on bridge and PDA not available

Calculate resistance based on average penetration for *first 5 blows*

Resistance for all piling in group is the resistance calculated for that one pile. Pretty sweet, huh?

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Section 704.4
Construction Requirements 45

e. Pile Restrike Procedure

If calculated resistance is too low, splice and resume driving

Look sad and say "doh"….

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Section 704.4
Construction Requirements 46

e. Pile Restrike Procedure

(2) Test pile called for on bridge and PDA not available

Treat the test pile as you would a common restrike, using the above rules.

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Section 704.4
Construction Requirements 47

e. Pile Restrike Procedure

(3) Test Pile (Special) called for on bridge or PDA is available

Follow recommendations of the Regional Geologist

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Section 704.4
Construction Requirements 48

f. Pile Cut-off and Pile Painting

(1) After piles are driven, cut them off at the designated elevation

If capping is required, make the connection as shown in the Contract

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Section 704.4
Construction Requirements 49

f. Pile Cut-off and Pile Painting

Pieces cut off become property of KDOT, if the Engineer wants them.

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Section 704.4
Construction Requirements 50

(f) Pile Cut-off and Pile Painting

Some Area Engineers or Area Construction Engineers automatically salvage pieces longer than 5 or 6 feet.

Others try to decide whether their KDOT area will need piling pieces in the near future.

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This is one way of cutting off a pile…

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Section 704.4
Construction Requirements 51

f. Pile Cut-off and Pile Painting

(1) Pile pieces not wanted by the Engineer become the property of the Contractor

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Section 704.4
Construction Requirements 52

f. Pile Cut-off and Pile Painting

(2) Paint the exposed steel of piling using the same kind of paint and number of coats as used for structural steel of bridge

Paint the piling in the field

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Section 704.4
Construction Requirements 53

f. Pile Cut-off and Pile Painting

(2) If no painting specified in plans:

Use prime coat of inorganic zinc

Use acrylic or polyurethane finish coat

See Division 700

Section 704.4
Construction Requirements 54

f. Pile Cut-off and Pile Painting

(2) Paint the piling for a distance of one

foot below :

Bottom of channel

Top of embankment

Natural ground

Normal low-water elevation

Section 704.4
Construction Requirements 55

g. Cast-In-Place Concrete Piles

(also called “Shell Piles” and “Closed-end Pipe Piles”)

After steel shells are driven, remove all loose material from inside shells

Fill the shells with Grade 3.5 concrete unless the plans say otherwise

Section 704.4
Construction Requirements 56

g. Cast-In-Place Concrete Piles

Don’t place concrete in shells until all driving within 15 feet is finished

or

Until all piles for that bent are driven

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Section 704.4
Construction Requirements 57

g. Cast-In-Place Concrete Piles

If that isn’t possible, stop driving until concrete in all piles for that bent has cured at least 7 days

Remove water from inside the shells before placing concrete

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g. Cast-In-Place
Concrete Piles

Vibrate the concrete in the upper 15 feet of the shell

Section 704 Piling
704.5 Measurement and Payment

The Engineer *(that's you)* will measure:

Length of steel piling left in bridge, by linear foot

Length of concrete pile from the tip to the place where it is cut to connect with the cap or footing

Do not include the length of reinforcing steel at the top of prestressed concrete piles

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Section 704 Piling
704.5 Measurement and Payment 1

The Engineer *(that's you)* will measure:

Actual length of ordered and accepted test piles by the linear foot

Each cast steel pile point used

Section 704 Piling
704.5 Measurement and Payment 2

The Engineer *(that's you)* will measure:

Each pile splice needed that wasn't called for in the plans

In other words, when we had to splice because the geology didn't behave

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Section 704 Piling
704.5 Measurement and Payment 3

For all types of steel and concrete pile, if a splice is needed and not shown on the plans, the cost of the splice is :

4 times the contract unit price per foot of the pile type

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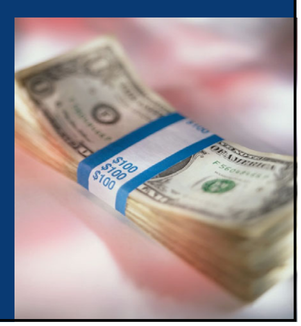
Contract unit cost of steel H-pile = $32.00 per foot

The cost of a splice for this type of pile is 4 times the contract unit price per foot

The splice would cost
$36.00 X 4 = $144.00



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Section 704 Piling
704.5 Measurement and Payment 5

Do *not* measure for payment :

Splices shown on the plans

Splices the contractor did for his own convenience

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Section 704 Piling
704.5 Measurement and Payment 6

The Engineer *(that's you)* will measure:

Predrilled holes by the linear foot

Measure from bottom of hole to the bottom of footing *(pile cap)* or abutment

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Section 704 Piling
704.5 Measurement and Payment 7

If the Contractor drills deeper than the plans call for, do not measure the extra depth

If Contractor uses predrilling for his convenience, do not measure for payment

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Section 704 Piling
704.5 Measurement and Payment 8

The Engineer *(that's you)* will measure:

Pile cut-off by the linear foot

Pile cut-off is the difference between the length of pile ordered and accepted and the actual length of pile remaining in the bridge

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Section 704 Piling
704.5 Measurement and Payment 9

Length Ordered and Accepted

---- Length left in bridge

= Length of pile cut-off

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Section 704 Piling
704.5 Measurement and Payment 10

TABLE 704-2: PILE CUT-OFF PAYMENT	
Pile Type	**% of Contract Unit Price Paid**
Cast-in-place (Shell)	60
Pre-stressed concrete	75
Steel	75
Steel Sheet	75

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Section 704 Piling
704.5 Measurement and Payment 11

Steel Pile = 75% of the Contract unit price for steel piles

Prestressed Concrete Pile = 75% of the Contract unit price for prestressed concrete piles

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Section 704 Piling
704.5 Measurement and Payment 12

Cast-in-place concrete piles = 60% of the contract unit price for concrete piles

Steel Sheet Pile = 75% of the contract unit price for steel sheet piles

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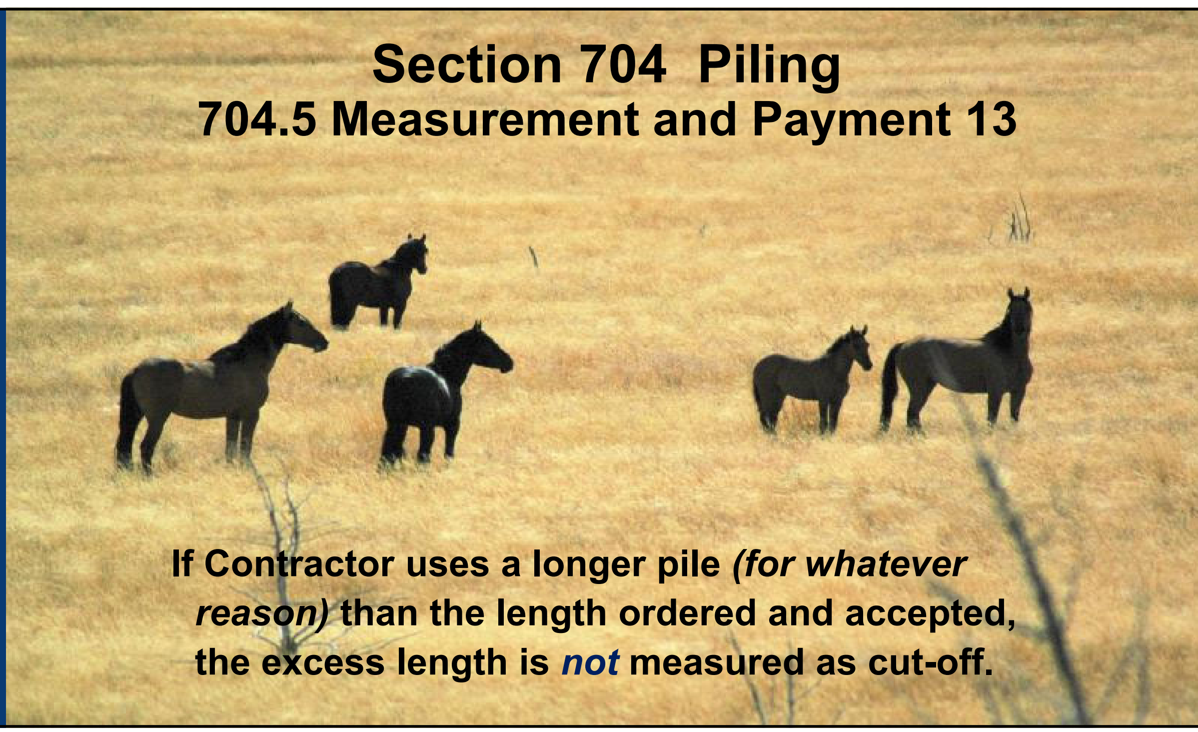

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Materials Section 1609
Steel Piling and Pile Points

Page 1600-18

Steel Pile:

- Explains type of steel accepted (ASTM)
- Discusses types of welds on pipe pile
- Lists the diameter tolerances on pipe pile

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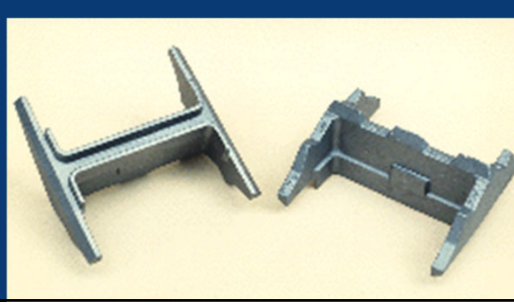
Materials Section 1609
Steel Piling and Pile Points 1

Page 1600-18

Pile Points:

- Fabricated or cast from steel
- References ASTM Standards



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And that’s it! You made it. Let us know if you have any questions. Good luck on the test.