

Structures Inspection Workbook

Certified Inspector
Training Program



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CIT Structures Introduction

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CIT Structures Instructors

- Ian Stringham – Garnett Construction Manager
- Cooper Bettis – Bridge Designer
- Ben Dyhouse – Bridge Designer



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What this class is and is not

- This **is** an introductory class dealing with some of the important aspects of inspecting structures.
- This **is** a class to help clue you into where to find the information to do your job successfully.
- This **is not** going to tell you everything you need to know to be a good inspector. That takes time and experience.



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Keys to being successful

- Relax and remember you can pass this class.
- Ask questions.
- Don't memorize the details/specs, they change too often. Learn how and where to find the details; Standard specifications, plans, special provisions, project specific special provisions.
- Be respectful to others.
- Enjoy yourself.



CIT – Structures Standard Specifications

SS--1

1

- What are they?
- Who are they for?
 - KDOT
 - The Contractor
 - Local Projects
 - Outside entities (FHWA, DWR, AASHTO)

2

1. Project Special Provisions:

- Specifications pertaining to an individual Project;

2. 2015 Special Provisions:

- Revisions or Additions to the Standard Spec.;

3. Plan Notes:

- Notes setting work limits and specifying Bid Items;

4. 2015 Standard Specifications:

- Overall standing parameters by which all works are constructed and paid for.



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- Division 150 – Equipment
- Division 200 – Earthwork
- Division 400 – Concrete
- Division 700 – Structures



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1. Project Special Provisions -Example

07-PS0425 (PS Label)
Sheet 1 of 3
10-23 KA-1826-01

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

OSTERBERG CELL LOAD TEST (DRILLED SHAFT)

1.0 DESCRIPTION

Conduct Osterberg Cell (O-Cell) load tests at the locations designated in the Contract Documents.

BID ITEM

Osterberg Cell Load Test (Drilled Shaft)

UNIT

Each

2.0 MATERIALS

Provide materials for the test drilled shaft according to SECTION 703.

Provide O-Cells with the minimum capacity (in each direction) designated in the Contract Documents. Provide O-Cells equipped with the necessary hydraulic lines, fittings, pressure sources, pressure gages, and telltale devices. Provide O-Cells from either:

LOADTEST, Inc.
2631-DNW 41st Street
Gainesville, FL 32606
Telephone: (800) 368-1138
or (352) 378-3717
Fax: (352) 378-3934

or

LOADTEST, Inc.
5402 S Klee Mill Rd, Suite 4
Sykesville, MD 21784
Telephone: (800) 436-2355
or (410) 552-1979
Fax: (410) 552-1843

The Engineer will accept the O-Cell based on brand name, compliance with the specified requirements, and visual inspection for condition at the point of usage.

Provide a recognized brand of portland cement and water from a source approved by the Engineer for the grout. The Engineer will accept the portland cement and water based on visual inspection.



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2. 2015 Special Provisions

2015 SPECIAL PROVISION

[List All Special Provisions](#) [Latest Version of Special Provisions](#) [Help](#)

Special Provision Divisions:

[100 - General Clauses and Convents](#)

[600 - Flexible Pavement](#)

[150 - Equipment](#)

[700 - Structures](#)

[200 - Earthwork](#)

[800 - Incidental Construction](#)

[300 - Stabilized Subgrade, Base and Shoulders](#)

[900 - Roadside Improvement, Planting, and Seeding](#)

[400 - Concrete](#)

[1000 - Materials](#)

[500 - Rigid Pavement](#)

Questions or Comments about Special Provisions may be sent to:

Construction - [Lee Ann Legge](#)

Materials - [Stacey Lowe](#)

[ALL](#) [LATEST](#) [100](#) [150](#) [200](#) [300](#) [400](#) [500](#) [600](#) [700](#) [800](#) [900](#) [MATERIALS](#) [HELP](#)



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2. 2015 Special Provisions

200- Earthwork

rev. 12/01/15

2015 SPECIAL PROVISION

[ALL](#) [LATEST](#) [100](#) [150](#) [200](#) [300](#) [400](#) [500](#) [600](#) [700](#) [800](#) [900](#) [MATERIALS](#) [HELP](#)

SECTION 200

SPECIFICATION NUMBER

TITLE

SECTION

[15-02001](#)

REMOVAL OF EXISTING STRUCTURES

202

400- Concrete

rev. 6/17/15

2015 SPECIAL PROVISION

[ALL](#) [LATEST](#) [100](#) [150](#) [200](#) [300](#) [400](#) [500](#) [600](#) [700](#) [800](#) [900](#) [MATERIALS](#) [HELP](#)

SECTION 400

SPECIFICATION NUMBER

TITLE

SECTION

[15-04001](#)

KANSAS CITY METRO MATERIALS

400



2. 2015 Special Provisions

700- Structures

rev. 09/28/16

2015 SPECIAL PROVISION

[ALL](#) [LATEST](#) [100](#) [150](#) [200](#) [300](#) [400](#) [500](#) [600](#) [700](#) [800](#) [900](#) [MATERIALS](#) [HELP](#)

SECTION 700

SPECIFICATION NUMBER

TITLE

SECTION

[15-07001](#)
[15-07002](#)
[15-07003](#)
[15-07003-R1](#)
[15-07003-R02](#)
[15-07004](#)
[15-07004-R01](#)
[15-07005](#)
[15-07006](#)
[15-07007](#)
[15-07008](#)
[15-07009](#)

BRIDGE PROJECT MARKER
PRESTRESSED CONCRETE MEMBERS
STRUCTURAL STEEL FABRICATION
STRUCTURAL STEEL FABRICATION
STRUCTURAL STEEL FABRICATION
STRUCTURAL METALS FABRICATION
STRUCTURAL METALS FABRICATION
QUALIFICATION OF FIELD WELDERS
EXPANSION JOINTS
DRILLED SHAFT (SPECIAL)
SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS
HIGH MAST LIGHT TOWERS

700
715
705
705
705
744
744
713
719
722
738



3. Plan Notes:

GENERAL NOTES

EMBANKMENT: Complete the embankment of the abutments as shown on the Bridge Excavation sheet prior to driving the abutment piling or commencing with the abutment footing excavation.

BRIDGE EXCAVATION: All excavation shall be Class III. See the Bridge Excavation sheet for the limits of pay excavation.

BACKFILL/COMPACTION: Compact backfill of the abutments and piers.

PILING: Drive all piling to penetrate or bear within the sand and gravel or the undifferentiated Pleistocene and Pleistocene deposits. Bedrock will not be encountered at this site. 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: 69.8 Tons
Pier No. 1: 80.6 Tons
Pier No. 2: 76.6 Tons
Pier No. 3: 80.6 Tons
Abutment No. 2: 69.8 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.

PILING SPLICE LOCATION: Integral pile splice locations and weld testing criteria for Abutments No. 1 & 2 will follow the "Standard Pile Details" sheet (BR10L).

TEST PILE SPECIAL: Drive the test pile special at the locations directed by the Engineer/Geologist or as on the Plans. Use (Pile Driver 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 load divided by Phi shown on the plans.

CONCRETE: Superstructure concrete is bid as Concrete (Grade 4.0M/AE#3A). Substructure concrete is bid as Concrete (Grade 4.0M/AE). If desired, the Contractor may use Concrete (Grade 4.0) in the footings and in the abutments below the construction joint. Base all exposed edges of all concrete with a 3/4" triangular bedding, except where noted on the plans. Construction joints are optional, but if used, place only at locations shown, or at locations approved by the Engineer.

REINFORCING STEEL: All reinforcing steel dimensions are to the centerline of bars, unless otherwise noted. All reinforcing steel, except the spiral bars, shall conform to the requirements of ASTM A615, Grade 60. Spiral bars may meet the requirements of either ASTM A615 (Gr. 40 or 60) or A63, and are included in the bid item "Reinforcing Steel (Gr. 60)". Where non-coated bars come in contact with epoxy-coated bars, they need not be coated.

CONSTRUCTION LOADS: Limited traffic is permitted on the new sub-structure once deck or any concrete bridge during the curing period, keep any exposed deck wet during the curing period. See KDOT Specifications Section 710 Tables 710-1 & 710-2 for additional information.

CONSTRUCTION JOINTS: The construction joints shown are optional with the Contractor. If used, place the construction joints only at locations shown or at locations approved by the Engineer.

SLOPE PROTECTION (Aggregate): Place Slope Protection (Aggregate) to the limits and thicknesses shown on the plans or as directed by the Engineer. Use Aggregate Stone for Ditch Lining as described in Section 1114.

DRIP LINE PROTECTION: Place a 10 foot wide mat of geotextile under the rock/rubble embankment on the berm and berm slopes and centered on the drip lines of the slab.



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4. 2015 Standard Spec.

<https://www.ksdot.gov/doing-business/highway-contractors/contractor-resources/specifications-for-state-road-and-bridge-construction>

KDOT Website: www.ksdot.gov

Now under "Doing Business" -> Highway Contractors -> Contractor Resources

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Department of Transportation

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4. 2015 Standard Spec.

<https://www.ksdot.gov/doing-business/highway-contractors/contractor-resources/specifications-for-state-road-and-bridge-construction>

The screenshot shows the Kansas Department of Transportation website. The header includes the Kansas logo and navigation links: I Want To..., About, Projects, Programs, Doing Business, Travel, and a search icon. A left sidebar lists various resources, including AASHTOWare Project Information, Specifications for State Road and Bridge Construction, Special Provisions, and various price indices. The main content area displays a table of resources with expandable sections. The 'Specifications and Special Provisions' section is expanded, showing a list of links: '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.', and 'Guidelines for Development, Review and Approval of Standard Specifications and Special Provisions'. The Kansas Department of Transportation logo is in the bottom right corner.

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4. 2015 Standard Specification

Typical information provided in each Section:

- Description (for Bid Items & Units)
- Materials
- Construction Requirements
- Measurement & Payment



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4. 2015 Standard Specifications

150- Equipment

[DIVISION 150 - EQUIPMENT](#)

151	COMPACTION EQUIPMENT
152	HAULING AND WEIGHING EQUIPMENT
153	MIXING PLANT FOR STABILIZED BASE AND SHOULDERS
154	CONCRETE PAVEMENT AND CONCRETE STRUCTURE EQUIPMENT
155	ASPHALT SURFACING AND ASPHALT PAVEMENT RECYCLING EQUIPMENT
	15-ER-1-R08 - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
156	ROADSIDE IMPROVEMENT EQUIPMENT
157	OTHER EQUIPMENT



4. 2015 Standard Specifications

200- Earthwork

[DIVISION 200 - EARTHWORK](#)

201	CLEARING AND GRUBBING
202	REMOVAL OF EXISTING STRUCTURES
	15-02001 - REMOVAL OF EXISTING STRUCTURES
203	RESETTING EXISTING CULVERTS
204	EXCAVATION AND BACKFILL FOR STRUCTURES
205	EXCAVATION AND EMBANKMENT FOR HIGHWAYS
206	SELECT SOIL
207	OVERHAUL
208	LINEAR GRADING
209	SPECIAL FILL
210	SALVAGING, STOCKPILING AND PLACING TOPSOIL
211	GEOFOAM LIGHTWEIGHT EMBANKMENT FILL
212	GEOFOAM LIGHTWEIGHT EMBANKMENT FOR VOID FILL
213	PREFABRICATED VERTICAL DRAIN
214	MECHANICALLY STABILIZED EARTH FILL
215	GRANULAR DRAINAGE BLANKET



4. 2015 Standard Specifications

400- Concrete

[DIVISION 400 - CONCRETE](#)

[401](#)
[402](#)
[403](#)
[404](#)
[405](#)

GENERAL CONCRETE
STRUCTURAL CONCRETE
ON GRADE CONCRETE
CONCRETE FOR PRESTRESSED CONCRETE MEMBERS
CURING ENVIRONMENT

[15-04001](#) - KANSAS CITY METRO MATERIALS

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4. 2015 S.S.

700- Structures

[DIVISION 700 - STRUCTURES](#)

[701](#) TEMPORARY SHORING
[702](#) CONTROLLED DEMOLITION
[703](#) DRILLED SHAFTS
[15-ER-1-808](#) - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
[704](#) PILING
[15-ER-1-808](#) - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
[705](#) STRUCTURAL STEEL FABRICATION
[15-07003-802](#) - STRUCTURAL STEEL FABRICATION
[706](#) BEARINGS AND PADS FOR STRUCTURES
[707](#) EXPANSION DEVICES
[708](#) FALSEWORK AND FORM CONSTRUCTION
[709](#) STEEL PERMANENT DECK FORMS
[710](#) CONCRETE STRUCTURE CONSTRUCTION
[711](#) REINFORCING STEEL
[712](#) STRUCTURAL STEEL CONSTRUCTION
[713](#) QUALIFICATION OF FIELD WELDERS
[15-07005](#) - QUALIFICATION OF FIELD WELDERS
[714](#) PAINTING STRUCTURAL STEEL
[715](#) PRESTRESSED CONCRETE MEMBERS
[15-07002](#) - PRESTRESSED CONCRETE MEMBERS
[716](#) POST-TENSIONING (Haunched Slab Bridges)
[717](#) BRIDGE OVERLAYS
[718](#) ELASTOMERIC CONCRETE
[719](#) EXPANSION JOINTS
[15-07006](#) - EXPANSION JOINTS
[720](#) SUBFORMING CONCRETE BARRIER FOR BRIDGES
[721](#) HANDRAIL FOR BRIDGES AND OTHER USES
[722](#) SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS
[15-07008](#) - SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS
[15-ER-1-808](#) - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
[723](#) SUBSTRUCTURE WATERPROOFING MEMBRANE
[724](#) BRIDGE BACKWALL PROTECTION SYSTEM
[725](#) ABUTMENT DRAINAGE SYSTEMS
[726](#) CONCRETE MASONRY COATING
[727](#) REPAIR (STRUCTURES)
[728](#) BRIDGE CURB REPAIR
[729](#) MULTILAYER POLYMER CONCRETE OVERLAY
[730](#) EPOXY RESIN CRACK REPAIR
[731](#) AREA PREPARED FOR PATCHING (EXISTING CONCRETE BRIDGE DECKS)
[15-ER-1-808](#) - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
[732](#) MACHINE PREPARATION (EXISTING CONCRETE BRIDGE DECKS)
[733](#) BRIDGE DRAINAGE SYSTEMS & DECK DRAIN EXTENSIONS
[734](#) STRUCTURAL PLATE STRUCTURES
[735](#) PRECAST REINFORCED CONCRETE BOX
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[15-07001](#) - BRIDGE PROJECT MARKER
[15-07007](#) - DRILLED SHAFT (SPECIAL)
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4. 2015 Standard Specification

Example- 703 Drilled Shafts:

Description – (Bid Items/Units)

703 - DRILLED SHAFTS

SECTION 703

DRILLED SHAFTS

703.1 DESCRIPTION

Construct drilled shafts by the cased or uncased method dependent on the project and document requirements.

BID ITEMS

Drilled Shaft (*) (**)
Permanent Casing (*) (Set Price)
Sonic Test (Drilled Shaft) (Set Price)
Core Hole (Investigative)

*Size

**Cased (If Contract Documents specify the cased method.)

UNITS

Linear Foot
Linear Foot
Each
Linear Foot



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4. 2015 Standard Specification

Example- 703 Drilled Shafts

- Materials

703.2 MATERIALS

a. Concrete. Unless otherwise shown in the Contract Documents, provide Grade 4.0 concrete that complies with SECTIONS 401, 402 and 1102. Provide a mix design with a target slump of 9 inches $\pm$ 1 inch. Do not withhold mix water at the plant and do not add water at the site.

b. Grout/Flowable Fill. For backfilling the cross-hole sonic testing pipes and core holes, provide cementitious grout (mixed according to the manufacturer's directions) that complies with DIVISION 1700.

Provide grout or flowable fill for backfilling the void space between the temporary and permanent casing with:

- 28 day strength of 1000 psi;
- mortar sand, FA-M (SECTION 1102) mixed with 2 bags of Type II portland cement per cubic yard; and
- water-to-cement ratio less than 1.

c. Granular Backfill Material. Provide granular backfill material for backfilling the void space between the temporary and permanent casing that is fine enough to fill the entire volume. The Engineer will accept the granular material based on a visual inspection.

d. Reinforcing Steel. Provide steel bars for concrete reinforcement that comply with DIVISION 1600.

e. Casing. Provide casing of sufficient thickness to carry the working stresses and loads imposed on the casing during construction. At a minimum, use 14-gage corrugated metal pipe (CMP) for the permanent casing.

If required, provide a permanent casing that is less than or equal to 1 inch out-of-round. The deviation of a chord from end to end shall be a maximum of 2 inches.

The Engineer will accept the casing based on compliance with the specified requirements, and visual inspection for condition.

f. Pipe for Sonic Testing. Provide pipe that complies with DIVISION 1900.



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4. 2015 Standard Specification

Example- 703 Drilled Shafts

- Const. Requirements

703.3 CONSTRUCTION REQUIREMENTS

a. General. Drilled shaft lengths shown in the Contract Documents are an estimate from the top of formation elevations determined from borings. Actual formation elevations encountered at each shaft, may require the actual length of each drilled shaft be adjusted. If the Engineer changes the drilled shaft lengths, the Contractor will be advised (in writing) of the revised bottom of rock socket elevation.

A minimum of 28 days before constructing the drilled shafts, submit an installation plan to the Engineer for review. Include the following:

- Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations;
- List of proposed equipment, such as cranes, drills, augers, bailing buckets, final cleaning equipment, dewatering equipment, slurry pumps, core-sampling equipment, tremies or concrete pumps and casing; and
- Details of concrete placement, including proposed operational procedures for tremie and pumping methods and method of achieving a sealed tremie or pump.

b. Investigative Core Hole. Provide NX sized (2.125 inches) core samples organized in descending elevation and stored in standard core cardboard boxes. Perform this work, from the existing ground surface elevation, 15 working days in advance of the drilled shaft construction, at locations shown in the Contract Documents or ordered by the Engineer. Extract and maintain a core of the foundation material from 4 feet above the top of the plan tip elevation to 6 feet below the plan tip elevation shown in the Contract Documents. Discard all material extracted above 4 feet above the top of the plan tip elevation. Maintain, protect and label (elevation and location) these samples for review by the KDOT. While drilling, prepare a continuous standard drilling/coring log. The logs shall remain with the sample for review. Survey the location of the core hole with the same construction tolerance as subsection 703.3c.

c. Excavating the Drilled Shaft. Prior to constructing drilled shafts, complete the excavation for the entire element.

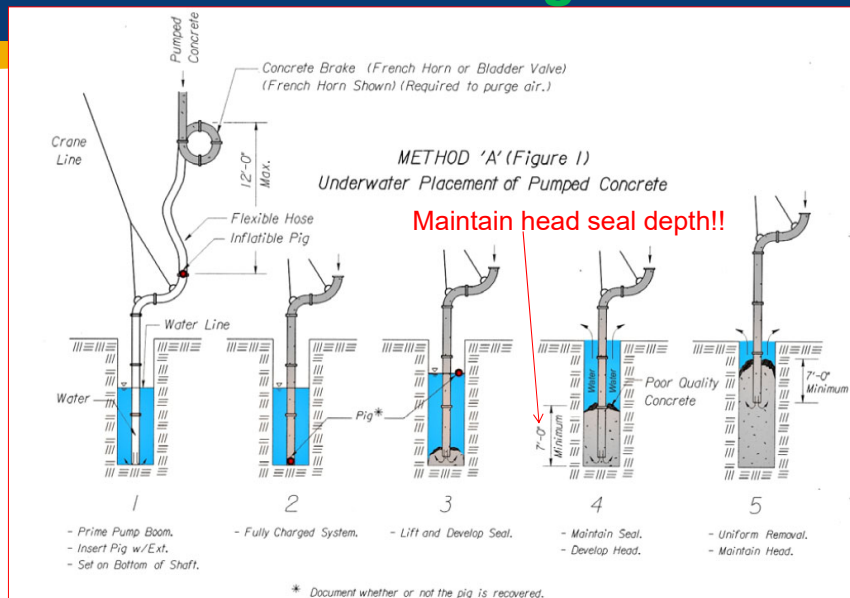
Locate the top of the shaft within 2 inches of the location shown in the Contract Documents. Unless otherwise shown in the Contract Documents, bore all shafts plumb to within a tolerance of 1 inch per 10 feet of length of shaft, not to exceed 6 inches over the full length of the shaft. The bottom of the shaft shall be nearly flat. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of $\pm 3/8$ inch per foot of diameter.

Depending upon site conditions and requirements in the Contract Documents, construct the drilled shaft by either the cased or uncased method:



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4. 2015 S.S. Figures



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4. 2015 Standard Specification



Example- 704 Piling Description – (Bid Items/ Units)

704.1 DESCRIPTION

Drive the specified types of piles to the penetration and bearing values shown in the Contract Documents.

BID ITEMS

Piles (*) (**)
Test Piles (*) (**)
Test Piles (Special) (*) (**)
Cast Steel Pile Points
Pre-Drilled Pile Holes

*Type: Cast-in-Place Concrete, Prestressed Concrete, Steel or Steel Sheet, Corrugated Metal Sheet *

**Size

*Black or Galvanized

UNITS

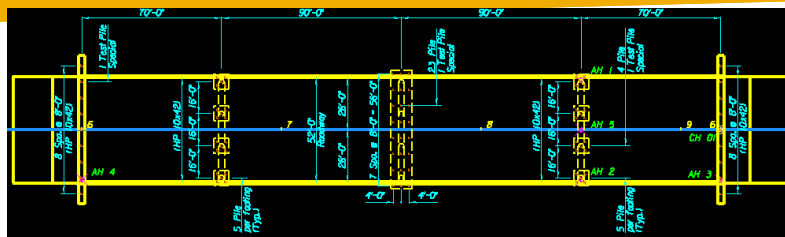
Linear Foot
Linear Foot
Linear Foot
Each
Linear Foot



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4. 2015 Standard Specification

Example- 704 Piling – Test Pile



704.4 Construction Requirements

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

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

When a restrike is required by the Engineer, follow subsection 704.4e.(3), for restrike procedures.

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



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4. 2015 Standard Specification

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

*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

Example- 704 Piling

TABLE 704-1: PILE FORMULAS,
(p. 700-19)



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4. 2015 Standard Specification

Example- 708 Falsework & Form Construction



-Description

-Bid Item

708.1 DESCRIPTION

Design and construct safe, adequate falsework to provide the necessary rigidity, support the loads imposed and produce the final structure to the lines and grades shown in the Contract Documents. Falsework is defined to be any temporary structure which supports structural members or form work.

BID ITEM

Falsework Inspection

UNITS

Lump Sum



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4. 2015 Standard Specification

Example- 708 Falsework & Form Construction



- Materials

Any grinding needs to be parallel to direction of beams.

708.2 MATERIALS

Use sound falsework piling to withstand driving, is reasonably straight, and is of sufficient size to provide the strength to safely carry the actual loads imposed. Use sound timber in good condition and free from defects that might impair its strength.

All approved metal or wood forms shall present a smooth surface, be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including placement and vibration of the concrete.

Do not use aluminum forms in contact with concrete.



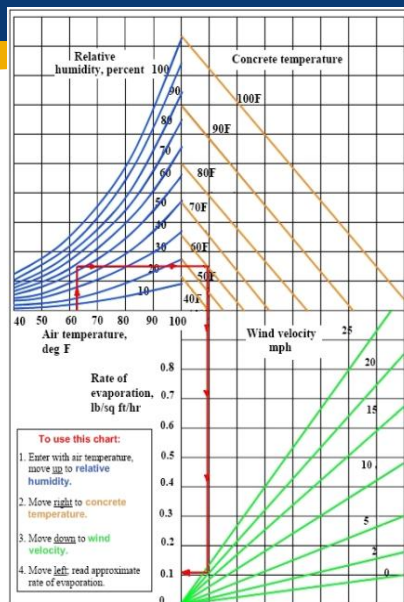
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4. 2015 Standard Specification

Example- 710 Concrete Structure Construction

Fig. 710-1,
Evaporation Rate Chart,
p. 700-42

(Goal is to eliminate plastic shrinkage cracks.)



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4. 2015 Standard Specification

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay)	14 Wet	After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application.
Bridge Overlays	7 Plus Curing Membrane	Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days.
Other formed surfaces	4 Formed	If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.

Example- 710 Concrete Structure Construction-
TABLE 710-1
p. 700-45
Minimum Cure Times



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4. 2015 Standard Specification

Example- 710 Concrete Structure Construction

Load Limits on Decks, TABLE 710-2 p. 700-46

Construction loads on the new bridge subdeck, new one-course deck or any concrete overlay are subject to the limitations in TABLE 710-2. The use of supplemental cementitious materials will require additional time before specified loading is allowed.

TABLE 710-2: CONCRETE LOAD LIMITATIONS ON BRIDGE DECKS		
Days after concrete is placed	Element	Allowable Loads
1*	Subdeck, one-course deck or concrete overlay	Foot traffic only.
3*	One-course deck or concrete overlay	Work to place reinforcing steel or forms for the bridge rail or barrier.
7* Δ	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10 * Δ (15)** Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Light truck traffic (gross vehicle weight less than 5 tons).****
14 * Δ (21)** Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Legal Loads; Heavy stationary loads with the Engineer's approval.***Overlays on new decks.
28	Bridge decks	Overloads, only with the State Bridge Engineer's approval.***

*Maintain the specified wet cure at all times (TABLE 710-1).

** All haunched slab structures.

*** Submit the load information to the appropriate Engineer. Information that will be required is the weight of the material and the footprint of the load, or the axle (or truck) spacing and the width, the size of each tire (or track length and width) and their weight.

****An overlay may be placed using pumps or conveyors until legal loads are allowed on the bridge.

Δ Increase time period by 3 days when supplemental cementitious materials are used October 1 thru April 30.



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All Specifications

- Read & Review all parts carefully
- When in doubt Ask and Investigate
- Do not abandon Common Sense

Thanks for Your Attention.



CIT Structures

Construction Manual



1

Construction Manual - 1

FOREWORD

This manual has been published to provide construction personnel engaged in inspection activities with a convenient guide for the procedures and methods that are acceptable for the construction of state highway projects under the supervision of the Kansas Department of Transportation.

The procedures, methods and guidelines herein are meant as a guide only and may be modified and/or revised to better fit any given situation or circumstance.

The Construction Manual is not intended as a textbook of highway engineering, but rather as a reference book of guidelines. It is essential that the user have a thorough understanding of the specifications as well as this manual.

Many of the guidelines herein contained are general in character and are not to be construed as replacing, modifying, or superseding any of the provisions of the specifications, plans or contract.

In keeping with the idea that the Highway Construction Industry is an, ever-changing entity, requiring constant re-evaluation of policy and procedures, the format was devised to provide for addition, change, and elaboration of content without the necessity of republishing the entire manual. Each recipient of this manual is requested to suggest needed additions and changes. The suggestions should be submitted through the appropriate channels to the office of the Bureau Chief of Construction and Materials. If revisions are necessary, they will be published by the Headquarters Construction staff and transmitted to the recipients of manuals, whose responsibility it shall be to post these revisions.



2

Construction Manual - 2

- Parts I – V
 - Part I General
 - Part II Contract Administration
 - Part III Surveying
 - Part IV Construction Inspection
 - Part V Materials and Testing



3

Construction Manual - 3

- Part I General (definitions and outlines)
 - Part 1.03.13 Field Engineer/Manager
 - Supervises and directs the activities of all personnel involved in the construction
 - Part 1.03.14 Project Engineer and Engineering Technicians
 - Directly responsible to the Field Engineer/Manager
 - Supervises and inspects operations
 - Keeps documentation records and makes reports



4

Construction Manual - 4

- Part I General (definitions and outlines)
 - Part 1.04.06 Contractor
 - Proper relations between the Contractor and KDOT personnel are of the utmost importance.
 - Adhere to the plan, specifications and contract requirements, as closely as possible.



5

Construction Manual - 5

- Part I General (definitions and outlines)
 - Part 1.04.08 Federal Highway Administration
 - The role of the Federal Highway Administration (FHWA) in relation to federally financed highway construction is to review and require modifications, as necessary, to construction oversight and material acceptance procedures to the extent necessary to be able to provide assurance to Congress that the Contractor constructs these projects in close conformance with approved plans, specifications and change orders.



6

Construction Manual - 6

- Part I General (definitions and outlines)
 - Part 1.05.01 Integrity
 - Absolute integrity on the part of all KDOT personnel is essential to maintain public confidence in KDOT.
 - Part 1.07.01 Safety
 - The Field Engineer and/or Project Coordinator are responsible for providing safety leadership at all time and safety enforcement, when necessary.
 - Safety is everybody's business.



7

Construction Manual - 7

- Part II Contract Administration
 - Part 2.04.01 Quantity Changes
 - There are several items of work which are bid on a "planned quantity" basis, and unless either party questions the planned quantity, payment is made on the basis of the planned amount.



8

Construction Manual - 8

- Part II Contract Administration
 - Part 2.07.02 Responsibility, Authority and Behavior of the Inspector
 - The Inspector is responsible for determining that the work is being constructed in accordance with the requirements of the Contract Documents. This does not give the Inspector the right to unnecessarily or willfully disrupt the operations of the Contractor.



9

Construction Manual - 9

- Part II Contract Administration
 - Part 2.10.01 Measurement and Payment
 - The Standard Specifications prescribes, in general, how measurements of quantity shall be made.
 - Therefore before making any measurements on a project, the Field Engineer should study the Plans, Specifications and Special Provisions to determine first, what is to be measured, and second how it is to be measured.



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Construction Manual -10

- Part II Contract Administration
 - **Part 2.11.03 Project Diary**
 - Documentation Manual & AASHTOWare Project Information.
 - Part 2.11.04 Field Records
 - Documentation Manual & AASHTOWare Project Information.



11

Construction Manual - 11

- Part III Surveying
 - Part 3.05.01 Benchmarks
 - Thoroughly check all benchmark elevations before any other level work is started.
 - Part 3.23 Surveys for Structures
 - Part 3.23.01 General
 - In staking out structures, set all lines and measurements absolutely correct.



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Construction Manual - 12

- Part III Surveying
 - Part 3.23.01 General
 - When possible, completely stake out the entire structure before structure construction begins.
 - Stake the line on the outside of all culverts and multiple-box bridges and offset the stakes a distance sufficient to clear the excavation.
 - Convey the system of staking each pier and abutment to all parties involved in the structure construction.



13

Construction Manual - 13

- Part III Surveying
 - Part 3.23.05 Elevations
 - Set at least two benchmarks near each structure.
 - Prior to placing concrete, set molding and check elevation.
 - Also check for elevation after the concrete has been placed, and just before the finishing operation.



14

Construction Manual - 14

- Part IV Construction Inspection
 - Part 4.05 Structures
 - Part 4.05.01 General
 - Review structure plans for possible errors in quantities and elevations.
 - Part 4.05.03 Inspection
 - The Inspector should check all the forms for line, elevation, plumbness, spacing, quality of lumber, bracing, strength, placement of reinforcing steel, etc. before any concrete is placed.



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Construction Manual - 15

- Part IV Construction Inspection
 - Part 4.05.04 Excavation
 - Part 4.05.05 Culvert Foundation
 - Part 4.05.06 Bearing Piles
 - After the Contractor completes the actual pile layout, it should be thoroughly checked by the inspector.
 - Before using any piling, it is the Inspector's responsibility to make certain that the material is tested and that the test reports are on file.



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Construction Manual - 16

- Part IV Construction Inspection
 - Part 4.05.06 Bearing Piles
 - a. Pile Lengths
 - b. Test Pile
 - c. Test Pile (Special)
 - d. Log of Continuous Pile Driving for Abutment and Pier Footings
 - e. Pile Driving Hammers
 - f. Driving Pile



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Construction Manual - 17

- Part IV Construction Inspection
 - Part 4.05.07 Drilled Shafts
 - Part 4.05.08 Superstructure
 - a. Falsework Construction
 - b. Structural Steel Construction
 - c. Structure Construction
 - d. Form Removal



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Construction Manual - 18

Computations of Quantities						
Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest
607	Asphalt Prime Coat	Emulsified Asphalt (*)	Ton		10 Gallons	.1 Ton
		Cutback Asphalt (*)	Ton		10 Gallons	.1 Ton
608	Asphalt Sealing	Cover Material (*)	CUYD	X	0.25 CU YD	CUYD
609	Single Asphalt Surface Treatment	Cutback Asphalt (*)	Ton		10 Gallons	.1 Ton
		Emulsified Asphalt (*)	Ton		10 Gallons	.1 Ton
610	Double Asphalt Surface Treatment	Asphalt Cement (*)	Ton		10 Gallons	.1 Ton
		Water (Flexible Pavement) (Set Price)	MGAL		0.1 MGAL	MGAL
		Manipulation (Asphalt Seal)	STA		0.1 STA	0.1 STA
		Manipulation (* & S.T.)	STA		0.1 STA	0.1 STA
611	Hot Mix Asphalt (HMA) - Commercial Grade	HMA - Commercial Grade (Class *)	Ton		20 LBS or 0.01 Ton*	Ton
		HMA - Commercial Grade (Class *) (Patching)	Ton		20 LBS or 0.01 Ton*	Ton
612	Milling	Milling	SQYD	X	0.1 FT	0.1 SQYD
			Ton		20 LBS or 0.01 Ton*	Ton
613	Ultrathin Bonded Asphalt Surface	HMA Surface (Ultrathin Bonded) (*) (**)	Ton		20 LBS or 0.01 Ton*	Ton
614	Plant Mix Asphalt Construction (BM-Mixes)	Aggregate for Asphalt Surface Course (*)	Ton		20 LBS or 0.01 Ton*	Ton
		Aggregate for Asphalt Base Course (*)	Ton		20 LBS or 0.01 Ton*	Ton
		Aggregate for Asphalt Surface Course (*) (Shoulders)	Ton		20 LBS or 0.01 Ton*	Ton
		Aggregate for Asphalt Base Course (*) (Shoulders)	Ton		20 LBS or 0.01 Ton*	Ton
		Asphalt Cement (**)	Ton		10 Gallons	.1 Ton
		Cutback Asphalt (**)	Ton		10 Gallons	.1 Ton
		Asphalt Core (Set Price)	Each		Each	Each
		Material for Asphalt Patching (Set Price) (**)	Ton		20 LBS or 0.01 Ton*	Ton
07-06002	Plant Mix Asphalt Construction - Commercial Grade (BM-Mixes)	Plant Mix Asphalt Mixture - Commercial Grade	Ton		20 LBS or 0.01 Ton*	Ton
		Plant Mix Asphalt Mixture - Commercial Grade (Patching)	Ton		20 LBS or 0.01 Ton*	Ton
07-06004	Asphalt Pavement - UGWC/KC/Kansas	Plant Mix Asphalt Mixture - Wyandotte County (*)	Ton		20 LBS or 0.01 Ton*	Ton
07-06010	HMA Base (Reflective Crack Interlayer (RCI))	HMA Base (RCI) (*)	Ton		20 LBS or 0.01 Ton*	Ton
		Quality Control Testing (HMA)	Ton		20 LBS or 0.01 Ton*	Ton
DIVISION 700						
701	Temporary Shoring	Temporary Shoring	Lump Sum		Lump Sum	Lump Sum
702	Corrugated Metal Sheet Piling	* Corrugated Metal Sheet Piling	LNFT		0.1 LNFT	LNFT
703	Drilled Shafts	Drilled Shaft (*) (**)	LNFT		0.1 LNFT	LNFT
		Permanent Casing (*) (Set Price)	LNFT		0.1 LNFT	LNFT
		Sonic Test (Drilled Shaft) (Set Price)	Each		Each	Each
		Core Hole (Investigative)	LNFT		0.1 LNFT	LNFT

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Computations of Quantities						
Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest
704	Piling	Piles (*) (**)	LNFT		0.1 LNFT	0.1 LNFT
		Test Piles (*) (**)	LNFT		0.1 LNFT	0.1 LNFT
		Test Piles (Special) (*) (**)	LNFT		0.1 LNFT	0.1 LNFT
		Cast Steel Pile Points	Each		Each	Each
		Pre-Drilled Pile Holes	LNFT		0.1 LNFT	0.1 LNFT
706	Bearings and Pads for Structures	Elastomeric Bearing Pad (*)	Each		Each	Each
		Bearing (*) (**)	Each		Each	Each
707	Finger Plate and Modular Expansion Device	Expansion Device (Finger Plate)	LNFT		0.1 LNFT	LNFT
		Expansion Device (Modular)	LNFT		0.1 LNFT	LNFT
708	Falsework and Form Construction	Falsework Inspection	Lump Sum		Lump Sum	Lump Sum
710	Concrete Structure Construction	Concrete (*) (**)	CUYD	X	0.1 FT	0.1 CUYD
711	Reinforcing Steel	Reinforcing Steel (*) (**)	LBS	X	0.1 FT	1 LB
		Reinforcing Steel (Repair) (*) (**)	LBS	X	0.1 FT	1 LB
712	Structural Steel Construction	Structural Steel (*) (**)	LB		LB	LB
		Structural Steel (Merchant Quality)	LB		LB	LB
		Welded Stud Shear Connectors	Each		Each	Each
		Bridge Drainage System	Lump Sum		Lump Sum	Lump Sum
			LNFT		0.1 LNFT	LNFT
			Each		Each	Each
			LBS		LB	LB
714	Painting Structural Steel	Bridge Painting (*)	Lump Sum		Lump Sum	Lump Sum
		Environmental Protection	Lump Sum		Lump Sum	Lump Sum
		Power Wash	Lump Sum		Lump Sum	Lump Sum
715	Prestressed Concrete Members	Prestressed Concrete Beams (*) (**)	LNFT		0.1 LNFT	LNFT
		Prestressed Concrete Panels	SQFT	X	0.1 FT	0.1 SQFT
716	Post - Tensioning (Haunched Slab Bridges)	Post - Tensioning for Slab Bridge	LBS	X	LB	LB
717	Silica Fume Overlay	Silica Fume Overlay (*) (**)	SQYD	X	0.1 FT	0.1 SQYD
		Material for Silica Fume Overlay (Set Price)	CUYD	X	0.1 FT	0.1 CUYD
719	Expansion Joint (Strip Seal Assembly) Preformed Elastomeric (Neoprene & Compression & Other)	Expansion Joint (*)	LNFT		0.1 LNFT	LNFT
721	Handrail for Bridges & Other Uses	Bridge Handrail (*) (**)	LNFT		0.1 LNFT	LNFT
		Handrail (*) (**)	LNFT		0.1 LNFT	LNFT
722	Sign Structures & Bridge Mounted Sign Attachments	Bridge Mounted Sign Attachment (*) (**)	Each		Each	Each
		Butterfly Overhead Sign Structure(*) (**)	Each		Each	Each
		Cantilever Sign Structure(*) (**)	Each		Each	Each
		Overhead Sign Structure(*) (**)	Each		Each	Each
		Overhead Sign Structure (Mast Arm Type) (*) (**)	Each		Each	Each

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Computations of Quantities

Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest	Minimum Pay to Nearest
722	Sign Structures & Bridge Mounted Sign Attachments (cont.)	Overhead Sign Structure (Single Tapered Tube)(*) (**)	Each		Each		Each
		Remove and Reset Sign Structure (***)	Each		Each		Each
		Reset Sign Structure (***)	Each		Each		Each
		Sign Structural Modification (***)	Each		Each		Each
723	Substructure Waterproofing	Substructure Waterproofing Membrane	SQYD	X	0.1 FT	0.1 SQYD	SQYD
724	Bridge Backwall Protection System	Bridge Backwall Protection System	SQYD	X	0.1 FT	0.1 SQYD	SQYD
725	Abutment Drainage Systems	Abutment Strip Drain	SQYD	X	0.1 FT	0.1 SQYD	SQYD
726	Concrete Masonry Coating	Concrete Masonry Coating	SQYD	X	0.1 FT	0.1 SQYD	SQYD
727	Repair (Structure)	Bridge Repair	Lump Sum		Lump Sum		Lump Sum
		Jacking of Existing Structure	Lump Sum		Lump Sum		Lump Sum
		Raise Expansion Device	Each		Each		Each
		Remove and Reset Expansion Device	Each		Each		Each
		Reset Existing Bearing	Each		Each		Each
728	Bridge Curb Repair	Bridge Curb Repair	LNFT		0.1 LNFT		LNFT
729	Multi-Layer Polymer Concrete Overlay	Multi-Layer Polymer Concrete Overlay	SQYD	X	0.1 FT	0.1 SQYD	SQYD
730	Epoxy Resin Crack Repair	Epoxy Resin Crack Repair	LNFT		0.1 LNFT		LNFT
731	Area Prepared for Patching (Existing Concrete Bridge Decks)	Area Prepared for Patching	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Area Prepared for Patching (Full Depth)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Area Prepared for Patching (Poured with Overlay)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Reinforcing Steel (Repair) (*) (**) (Set Price)	LBS	X	0.1 FT	1 LB	10 LBS
732	Machine Preparation (Existing Concrete Bridge Decks)	Machine Preparation (*)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
733	Hydrodemolition	Hydrodemolition	SQYD	X	0.1 FT	0.1 SQYD	SQYD
734	Structural Plate Structures	(*) Structural Plate Pipe (**) (***)	LNFT		0.1 LNFT		LNFT
		(*) Structural Plate Pipe Arch (**) (***)	LNFT		0.1 LNFT		LNFT
		(*) Structural Plate Arch (**) (***)	LNFT		0.1 LNFT		LNFT
735	Precast Reinforced Concrete Box	Reinforced Concrete Box (*) (Precast)	LNFT		0.1 LNFT		LNFT
07-07001	Bridge Project Marker	Bridge Project Marker	Each		Each		Each
07-07003	Heat Straightening (In-Place) of Damaged Structural Steel	Heat Straightening Repair	LNFT		0.1 LNFT		LNFT
07-07012	Expansion Joint (Membrane Sealant)	Expansion Joint (Membrane Sealant *)	LNFT		0.1 LNFT		LNFT
07-07018	Rolled Beam Detour Bridge	Erect and Remove Rolled Beam Detour Bridge	Lump Sum		Lump Sum		Lump Sum
		Furnish Rolled Beam Detour Bridge	Lump Sum		Lump Sum		Lump Sum

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- Part V Materials
 - Section 5.1 General
 - Section 5.2 Quality Control/ Quality Assurance
 - Section 5.3 Mix Design Methods
 - Section 5.4 Laboratory and Sample Identification
 - Section 5.5 Required Sample Sizes
 - Section 5.6 Aggregates
 - Section 5.7 Inspection and Sampling of Materials
 - Section 5.8 Nuclear Gauge



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- Part V Materials
 - Section 5.9 Sampling and Test Methods Forward
 - 5.9.17 KT-17 Sampling Freshly Mixed Concrete
 - 5.9.18 KT-18 Air Content of Freshly Mixed Concrete by the Pressure Method
 - 5.9.20 KT-20 Mass Per Cubic Foot (Meter), Yield and Air Content (Gravimetric) of Freshly Mixed Concrete
 - 5.9.21 KT-21 Slump of Portland Cement Concrete
 - 5.9.23 KT-22 Making and Curing Compression and Flexural Test Specimens in the Field



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- Part V Materials
 - Section 5.10 Calculations
 - Appendices
 - **Appendix A - Sampling and Testing Frequency Chart – Non-Quality Control/Quality Assurance**
- Appendix A is found in the back of the Part V, along with appendix B,C and D



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SAMPLING AND TESTING FREQUENCY CHART NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS						
CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)						
GRAVEL BASE						
Sec. 307 and 1106 (Continued)						
Combined Aggregate (continued)						
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACI			c
Completed Work	Field Density Tests (0.1 lb/ft ³ [1 kg/m ³] or 0.1% of optimum density)	KT-13 or KT-41	ACI			a
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACI			a
DIVISION 400						
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION						
Sec. 401, 402, 703, 710 and 717						
	Slump (0.25 in [5 mm])	KT-21	ACC			h
	Temperature (1 °F [0.5 °C])	KT-17	ACC			
	Mass per cubic foot (0.1 lb/ft ³ [1 kg/m ³])	KT-20	ACC			
	Air Content (0.25%)	KT-18, KT-19, or KT-20	ACC			
	Moisture in Aggregate (0.1 g or 0.01% of mass)	KT-24	VER		Minimum of 1 in AM and 1 in PM during concrete mixing operations.	
	Density of Fresh Concrete (0.1 lb/ft ³ [1 kg/m ³])	KT-36	ACI			a b

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Appendix A

2018
Revised 2018



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SAMPLING AND TESTING FREQUENCY CHART NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS						
CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE ACCEPTANCE SAMPLES & TESTS
DIVISION 400 (continued)						
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION						
Sec. 401, 402, 703, 710 and 717 (continued)						
	Permeability (0.01%, KT-73 or 10 coulomb, AASHTO T 277 or nearest 0.1 kD/cm, KT-79)	KT-73 or AASHTO T 277 or KT-79	VER	l	1 per mix design per project.	Acceptance of contractor's mix design by KDOT.
	Cylinders (1 lb [1 N], 0.1 in [1 mm], 1 psi [0.01 MPa])	KT-22 and KT-76	VER	k	Bridge Deck Only (all classes except thin overlay) Min. of 2 sets of 3 per pour or major mix design change and 1 set of 3 per 100 yds ³ (100 m ³).	
		KT-22 and KT-76	VER	k	Thin Overlays and Bridge Deck Surfacing Min. of 1 set of 3 per 150 yd ² (150 m ²) per placement or major mix design change.	

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Appendix A

2018
Revised 2018



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SAMPLING AND TESTING FREQUENCY CHART NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS						
CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	ACCEPTANCE SAMPLES & TESTS
DIVISION 400 (continued) PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION Sec. 401, 402, 703, 710 and 717 (continued)	Cylinders (1 lb/[1 N], 0.1 in [1 mm], 1 psi [0.01 MPa]) (continued)	KT-22 and KT-76			Drilled Shafts 1 set of 3 per shaft minimum and 1 of 3 set per 100 yd ³ (100 m ³). Other Construction (all classes) Min. of 2 sets of 3 per pour or major mix design change and one set of 3 per 100 yd ³ (100 m ³). Waive the 2 sets of 3 minimum for pours of less than 20 yd ³ (20 m ³) that are non- critical elements. (This includes all structural concrete not classified as bridge deck wearing surface - i.e. culverts, wash checks, ditch lining, bridge substructure, abutments, handrails, etc.)	

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Appendix A

2018
Revised 2018



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Construction Manual -27

The screenshot shows the Kansas Department of Transportation website. The navigation menu includes: I Want To..., About, Projects, Programs, Doing Business, and Travel. The 'Doing Business' menu is expanded, showing options like Access Management, Design Consultants, Highway Contractors, and Permits. A prominent banner at the bottom reads: 'DO NOT CLICK OR OPEN LINKS! KDOT does not collect tolls or ticket payments. REPORT FRAUDULENT TEXTS: www.ic3.gov'. There is also a 'Scam Alert' section on the left side of the banner.



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Construction
Manual



CIT Structures

Documentation



1. Documentation

- Definition
 - Source
 - Merriam-webster.com
 - The documents, records, etc. that are used to prove something or make something official
 - Dictionary.com
 - The use of documentary evidence

2.Documentation



3.Documentation

- What is to be documented?
 - Everything
 - Conversations; If you stated it or heard it, document it. Relevant to the contract documents. **Facts only!** No thoughts, opinions or hearsay.
 - Measurements; Actual and that which are physically conducted or calculated.
 - Length, width, depth
 - Feet, square feet, square yards, cubic yards
 - Pounds, tons
 - Equipment and personnel

4.Documentation

- How is to be documented?
 - Documentation Manual
 - I. **Purpose:** A uniform method, greater efficiency
 - II. **Scope:** Manual demonstrates by example, minimum reporting requirements
 - III. **Definitions:**
 - A. Field Book: A permanently bound book used for the entry of information. A computer is not considered a field book.



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5.Documentation

- How is to be documented?
 - Documentation Manual
 - III. **Definitions:**
 - D. Source Document: Any permanent record inscribed showing the origin of the information itself and such data. i.e. A **Field Book**:



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6.Documentation



7.Documentation

How and Where do I document?

Field Books

AWP (AASHTOWare)

8.Documentation



9.Documentation

Home Previous My Pages

On this page: Construction Materials Reference Data System Administration External Links

PROJECT KS ROLE for Area Project Manager User

Home Page News

Construction

- Change Order
- Contract Administration
- Contract Claims
- Contract Permits
- Contract Progress
- Contract Specific Authorities
- Contract Time
- Contract Vendor Assets
- Contractor Evaluation
- Daily Diary
- Daily Work Reports
- Daily Work Reports by Contract
- Meetings
- Payment Estimate Accounting
- Payment Estimate Approval Decisions
- Payment Estimates

Materials

- Acceptance Actions
- Action Relationships
- Daily Source Reports
- Find Sample
- Mix Design
- Product Group Sample Reviewer Assignment
- Sample Records

Reference Data

- Sources
- Special Provisions
- Vendors

System Administration

- Persons

External Links

- AASHTOWare Project Website
- Highway Contractors
- AWP Program Files
- KDOT Reports Portal
- KDOT Asphalt Spreadsheets
- KDOT Website
- Payroll XML
- Subcontractor Payment Activity
- Working Days Charred CCD Time Charred Report

Information about the AASHTOWare Project™ system and other AASHTOWare products, events, newsletters, and more
Information for Highway Contractors
Bid Item, Inspector, Material, and Producer Codes
Crystal Reports for Agency Users
HMA Spreadsheets
Internet
Resources for Using XML with AASHTOWare Project™ Payroll XML Resource Kit
Prompt Payment Report
Working Days Charred CCD Time Charred Report

10. Documentation

- **Diary** – AWP and field books should only have 4 things:
 - Weather
 - Day Charged if contractor worked
 - In the remarks, the Type should be “A-Project Diary, and the remarks box should only have either: “See DWR” if contractor worked or “Contractor did not work due to (reason)”
 - Controlling Operation – Drilled Shafts (usually taken from contractor's schedule)



11

11. Documentation

A screenshot of a web application titled "Contract Daily Diary Summary". The browser address bar shows "awp/#/DailyDiary/1085025/Summary". The page has a left sidebar with links: "General", "DWRs", "DWR Remarks", and "Contract Times". The main content area is divided into two columns. The left column contains fields for "Diary Date" (08/05/2025), "Author" (branden.dulin), "Weather" (800 - Sunny (Clear)), "Low Temperature" (69), "High Temperature" (88), "Diary Locked" (No), "Payment Est Num", and "Controlling Operation" (LINER PIPE). The right column contains a "Remarks" section with a table listing project details: Federal Project Number, State Project Number (1035-030 KA 6536-01), Entered By (Branden M Dulin), Entered Date (08/05/2025 10:19:13 AM), Last Updated By (Branden M Dulin), Last Updated Date (08/05/2025 10:19:13 AM), Contractor Working (Yes), and Payment Est Status. At the bottom, there is a "Remarks" section with a "Type" dropdown set to "A - Project Diary" and a "Remark" field containing "SEE DWR".

12

12. Documentation

DWR (Daily Work Report) in AWP but in a field book also – Should have all other pertinent information as shown in the AWP user guides and documentation manual.

- A Partial list of items to be noted in DWR's and Field Books
 - Orders given the contractor, and whom the order was given
 - Important discussions with the contractor
 - Equipment Used
 - Personnel on the project
 - Official Visitors and Inspections
 - Work or material rejected, and reasons
 - Time of shutting down or resuming of work, and explanations
 - Work done by contractor's forces during the day.
 - General purpose of work
 - Account of any time by contractor's personnel and equipment on disputed items of work.
 - Length and cause of any delays.
 - Arrival and departure of major equipment.
 - Record of telephone calls
 - Unusual conditions, if any, such as high water, bridge failures or slides.
 - Progress of staking and surveys made.

Many more then I could list



13

13. Documentation

Home Previous My Pages

Administration Overview Daily Work Reports Contract Administration Contract Daily Work Reports Contract Materials and Acceptance Actions Contract Progress Find Sample Items Payment Estimate Subco

Contract Daily Work Report Summary

Contract: 524046414 - CULVERT REPAIR

DWR Date: 08/05/2025 Inspector: branden.dulin Sequence: 1 Status: Draft

General	DWR Date	Remarks
Notes	08/05/2025	1
Contractors On Site	Inspector	Work Items Installed
Contractor Equipment	Q branden.dulin	0
Contractor Personnel	Dulin Branden M	Approval Date
Postings	Federal Project Number	Approved By
Acceptance Records	State Project Number	Payment Est Num
Force Account Contractors	I035-030 KA 6536-01	Payment Est Status
	Contractors Onsite	
	No	
	Attachments	
	No	
	Agency Views	Entered By
	0	branden.dulin - Branden Dulin
		Entered Date
		08/05/2025 10:18:15 AM
	Remarks	
	Type	Remark
	A - Project Diary	WD IS CHARGED- INSTALLED LINER PIPE ON SITES 15 AND 16.



14

14. Documentation

- Documentation Manual
 - **IV. Introduction to General Index:** The Index is broken down into separate divisions coinciding with the 2007 Standard Specification for State Road and Bridge Construction. Each division is further broken down into various example plates.



15

15. Documentation

- Documentation Manual
 - **V. Documentation of Field Records:** Documentation shall be made to substantiate payments. All field book entries should be made using 2H lead. Original entries, later determined to be error, shall not be erased. A line should be drawn through the incorrect details and the correct details should be entered directly above the stricken material. All corrections and reference notations should have the initials of the person making the corrections and notations.



16

16. Documentation

GENERAL INDEX

Division 100 - General

Index to Field Books
Inspector Verification
List of Contractor's Equipment
List of Contractor's Personnel

Division 150 Equipment

Division 200 - Earthwork

Division 300 - Stabilized Subgrade, Base and Shoulders

Division 400 - Concrete

Division 500 - Rigid Pavement

Division 600 - Flexible Pavement

Division 700 - Structures

Division 800 - Incidental Construction

Division 900 - Roadside Improvement

Source Documents for Pay Quantities

Computations of Quantities (Measure to – Pay to)



17.Documentation

- Section 700
 - Documentation Manual _ Drilled Shaft

[illegible]

18. Documentation

- Section 700
 - Documentation Manual _ Drilled Shaft

[illegible]

19

19. Documentation

- Section 700
 - Documentation Manual _ Piling

[illegible]

20

20. Documentation

- Section 700
 - Documentation Manual _ Piling

[illegible]

21. Documentation

- Section 700
 - Documentation Manual _ Piling

[illegible]

24.Documentation



25

25.Documentation

- #1 Rule about documentation...

**IF IT ISN'T DOCUMENTED, IT
DIDN'T HAPPEN!**

26

Documentation





Bridge Construction Manual

1

Locating Bridge Construction Manual

- Where do you find the Bridge Construction Manual?
- It is housed in the KDOT Bureau of Structures and Geotechnical Services home page under 'Fabricator Information'
- The direct link is:
<https://www.ksdot.gov/doing-business/highway-contractors/contractor-resources/bridge-construction-manual>

Fabricator Information

- [Future Steel Bridge Projects](#)
- [Future Prestressed Bridge Projects](#)
- [Future Post-tensioned Slab Bridge Projects](#)
- [Superstructure Codes](#)
- [Steel Fabricator Shop Capabilities](#)
- [Shop Welding Procedures](#)
- [Bridge Construction Manual](#)
- [KDOT Bridge Design Manual \(LFRD\) \(KART\)](#)



2

Bridge Construction Manual 3

Kansas Department of Transportation

Bridge Construction Manual

8.0 REINFORCED CONCRETE STRUCTURES

Table of Contents

8.1 General	1
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8.3 Description	1
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8.3.3 General Concrete Concerns.....	4
8.4 Materials	5
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8.4.2 Reinforcement.....	5
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8.4.5 Strip Drains.....	6
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8.5.2 Reinforcement Placement.....	9
8.5.3 Concrete Placement and Finishing.....	11
8.5.4 Mix Designs and Testing.....	13
8.5.5 Consolidation.....	13
8.5.6 Slip forming.....	16
8.5.7 Surface Finish.....	17
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8.6.2 Maximum 7 Load Limits.....	22
8.6.3 Minimum Strength Gain.....	23
8.6.4 Measurement and Payment.....	24
8.6.5 Field Testing & Concrete Batch Rejection.....	25
8.6.6 Ternary Mix Designs.....	25
Mix Design Examples	26
General Concrete Structure Checklist	28



Bridge Construction Manual 4

Kansas Department of Transportation

Bridge Construction Manual

8.6.5 Field Testing & Concrete Batch Rejection

A global "rule of thumb" does not necessarily exist to decide when the failure of a field test should be used to reject a batch of concrete because of the various structure types, concrete types, and the severity level of each test result. For example, if a test of air-entrained concrete for a pilecap resulted in 4.9% air (requirement is 6.5 +/- 1.5%), but all other tests were within tolerance, it would not be standard procedure to reject the entire load of concrete. The inspector could instead call the plant and draw attention to the need for slightly more air, and allow placement of the concrete. However, if the air result was 9.0% and the density of the concrete was 135 lbs/ft³, the load would be a firm candidate for rejection as two items are well outside the tolerance range for air and for density. That being said, it is not unreasonable to expect the first batch of concrete arriving on site to meet all specification requirements: density, air, slump, etc. The supplier needs to prove to the inspector they are capable of meeting all of the specification requirements and all of the requirements listed in the mix design. The level of quality of the concrete needs to first be established by the supplier before it is relied upon. It needs to be understood that KDOT will not sacrifice quality by letting the first few trucks act as the test batches to fine tune the final mix for the rest of the structure. Sub-standard concrete at the outset of a pour is not acceptable.

The concrete pour shall be planned as such that the total revolutions on the truck, concrete temperature, ambient temperature, can all meet section 401.8 of the KDOT specifications.

If the very first batch of concrete to arrive on site meets all specification requirements stated for the concrete, then testing taking place at regular intervals throughout the rest of the pour is simply verification of previous results. Testing during the middle of a pour takes place while the batch is being placed in the structure. Since the tests require a fair amount of time to complete, most of the batch of concrete is in the structure before test results are available.

If a test fails for a batch of concrete, it needs to be well documented and cylinders need to be made. Making cylinders and clearly documenting where the concrete was placed in the structure will provide a method to verify the final strength and durability of the cured concrete and will pinpoint the location of the concrete if the quality is low enough to require the contractor to remove the substandard concrete and replace with quality concrete. Making cylinders benefits both the contractor and KDOT. At times, cylinders are used to quantify the quality of questionable concrete, possibly allowing the contractor to leave the concrete in place because it has met minimum expectations for KDOT. It is vital the cylinders be cured under the same conditions as the concrete in the structure. If blankets have been placed to protect the structure concrete from the elements, the cylinders must be placed under the blankets, as well. This is commonly overlooked, but very important. If the cylinders are not cured under the same conditions as the concrete in the structure, they become an inaccurate representation of the concrete in the structure.



Bridge Construction Manual Overview

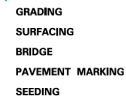
- Offer commentary on KDOT specifications
- Highlight good practices
- Introduction for inspectors, and designers
 - Pile Driving worked examples
 - Drilled Shaft guidance
 - Traps to avoid/be aware of during construction
- Only chapters with active hyperlinks are available
- Feel free to contact the instructors for structure related questions or guidance
- New Manual Under Review



PL-1

Project Index

Project Scope



Kansas
Department of Transportation

2

Title Sheet

INDEX OF SHEETS

- 1 TITLE SHEET
- 2-3 TYPICAL SECTIONS
- 4 FOUNDATION TREATMENT AND COMPACTION
- 5-14 PLAN-PROFILE SHEETS
- 15 R/W MONUMENTS
- 16 REINFORCED SOIL SLOPE DETAILS
- 17 RIP RAP DETAILS
- 18 DITCH LINING
- 19 PAVEMENT DETAILS
- 20 APPROACH SLAB DETAILS
- 21 MSG. APPROACH SLAB DETAILS
- 22 EXPANSION JOINT DETAILS
- 23 FLUME INLET DETAILS
- 24 GUARD RAIL LAYOUTS
- 25 GUARD RAIL DETAILS
- 26-30 CONCRETE END SECTIONS
- 31 RCB EXTENSION DETAILS
- 32-33 RCB AUXILIARY DETAILS
- 34 CULVERT EXTENSION DETAILS
- 35 BRIDGE NO. 77-58-K-77 (1962)
- 84 BRIDGE EXCAVATION
- 85 SUPPORTS AND SPACERS FOR REINFORCING STEEL
- 86 STANDARD PILE DETAILS
- 87 SUMMARY OF QUANTITIES
- 88-94 TEMPORARY PROJECT WATER POLLUTION CONTROL
- 95 TREE PLANTING DETAILS
- 96 SEEDING
- 97- PERMANENT SIGNING
- PAVEMENT MARKING
- SUMMARY OF QUANTITIES SURFACING
- CONSTRUCTION SEQUENCING
- TRAFFIC CONTROL
- EARTHWORK COMPUTATIONS
- CROSS SECTIONS

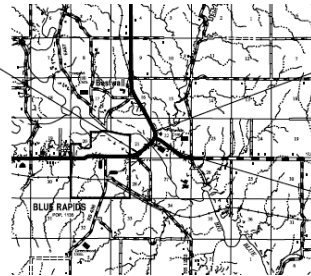
Location Description:

Bridge Sheets

Sta.
Br. No.
Span Lengths
Structure Type
Roadway Width

Sta. 60+75.00 BEGIN
Project No. 77-58 KA-0716-01
Sta. 60+75.00
Project 77-58-F-40971 (1949)

Sta. 63+30.00 END
Project No. 77-58 KA-0716-01
Sta. 63+30.00
Project 77-58-F-40971 (1949)



Sta. 60+75.25
Br. No. 77-58-14771062
165' 2" x 20' 10"
Continuous Composite Weathering Steel
Welded Plate Girder (WVCC) Span
47' Roadway



3

General Notes & Quantities

Summary of Quant.

Proj. & Sheet No.

Gen.
Notes

Bridge
Sheet
Index

Design
Code
Data

Item	Quantity	Unit	Notes
1. Concrete	1,234.56	cuyd	
2. Steel	1,234.56	lbs	
3. Riprap	1,234.56	cuyd	
4. Gravel	1,234.56	cuyd	
5. Sand	1,234.56	cuyd	
6. Earthwork	1,234.56	cuyd	
7. Paving	1,234.56	cuyd	
8. Seeding	1,234.56	sq ft	
9. Signage	1,234.56	sq ft	
10. Other	1,234.56	sq ft	

GENERAL NOTES

1. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

2. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

3. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

4. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

5. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

6. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

7. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

8. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

9. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

10. The bridge is to be constructed in accordance with the Kansas Department of Transportation Specifications for Highway Construction.

DESIGN CODE DATA

1. Design Load: HS-20

2. Design Speed: 55 mph

3. Design Life: 100 years

4. Design Temperature: 70°F

5. Design Wind Speed: 100 mph

6. Design Flood: 100 year

7. Design Seismic: 0.2g

8. Design Snow: 30 lbs/sq ft

9. Design Ice: 1.5 inches

10. Design Hail: 1.5 inches

LOAD RATING DATA

1. Load Rating: 10,000 lbs

2. Load Rating: 10,000 lbs

3. Load Rating: 10,000 lbs

4. Load Rating: 10,000 lbs

5. Load Rating: 10,000 lbs

6. Load Rating: 10,000 lbs

7. Load Rating: 10,000 lbs

8. Load Rating: 10,000 lbs

9. Load Rating: 10,000 lbs

10. Load Rating: 10,000 lbs

Load Rating Data

Title Block



4

General Notes & Quantities

[illegible]

Pile Type

Pile Lengths

- Anticipated Bearing Layer

PILING: Drive all piling to bear upon the limestone of the Neva Member. 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:

LRFD DESIGN PILE LOAD:
Design Loading (Tons/F
Abutment #1

<u>Strength</u>	<u>Service</u>	<u>Phi</u>
154	109	0.60

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.

(Should be same #
or somethings wrong)



General Notes & Quantities

EMBANKMENT: Complete the embankment at the abutments as shown on the Bridge Excavation sheet prior to driving the abutment piling or commencing with the abutment footing excavation.

BRIDGE EXCAVATION: Elevation 1092.90 shall designate the 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: Compact backfill at the abutments.

PILING: Drive all piling to bear upon the limestone of the Nova Member. 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 #1: 154 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.

REMOVAL OF EXISTING STRUCTURES: Removal of existing structure is included in the bid item, "Removal of Existing Structures", Lump Sum. With the exception of the steel cover plates over the roadway and the bridge number plate, all materials removed from the existing structure shall become the property of the Contractor. Remove this material from the site. Steel cover plates and bridge number plate shall be retained.

by KDOT.

EXISTING STRUCTURE: Plans of the existing structure are on file and available for inspection by qualified bidders at the State Bridge Office, KDOT, Eisenhower State Office Building, 700 SW Harrison, Topeka, KS.

BROKEN CONCRETE: Waste the broken concrete from the existing bridge on sites provided by the Contractor and approved by the Engineer.

DEMOLITION PLANS: This is a Category A Demolition. Submit detailed Demolition Plans to the Field Engineer per KDOT Specifications. No Demolition work will begin without approved Demolition Plans. A Licensed Professional Engineer is not required.

SLOPE PROTECTION (Riprap Stone): Place Slope Protection (Riprap Stone) to the limits and thicknesses shown on the plans or as directed by the Engineer.

REINFORCING STEEL: All reinforcing steel dimensions are to the centerline of bars unless otherwise noted. All reinforcing steel, except the spiral bars, shall conform to the requirements of ASTM A615, Grade 60. Spiral bars may meet the requirements of either ASTM A615 (Gr. 40 or 60) or A82, and are included in the bid item "Reinforcing Steel".

Where non-coated bars come in contact with epoxy coated bars, they need

not be coated.

CONCRETE: Superstructure concrete is bid as Concrete Grade 4.0(A)(XSA). Substructure concrete is bid as Concrete Grade 4.0(A). If desired, the Contractor may use Concrete Grade 4.0 in the footings and in the abutments below the construction joint. Bevel all exposed edges of all concrete with a $\frac{3}{4}$ " triangular molding, except where noted on the plans. Construction joints are optional, but if used, place only at locations shown.

PLACING SEQUENCE: The Contractor will adhere to the placing direction/sequence shown on the plans. Changes will be accepted only if the Contractor's Engineer adjusts the chamber diagram so that the fabricator can adjust the web chamber and headed stud anchor heights accordingly. This revised diagram will be approved by the design Engineer prior to

CONCRETE PLACING: Place and hand vibrate all concrete for Abutment #1

above the construction joint to the bottom of deck elevation just prior to the normal paving train operations. Do this work in a manner to avoid cold joints in either the slab or in Abutment #1.

CONSTRUCTION LOADS: Only foot traffic is permitted on the new sub-deck, one-course deck or any concrete overlay during the seven day curing period, keep any exposed deck wet during the 7-day curing period. See KDOT Specifications.

ABUTMENT STRIP DRAIN: See the General Notes on the "Abutment Strip Drain" sheet.

QUANTITIES: Items not listed separately in the Summary of Quantities are subsidiary to other items in the proposal.

TEMPERATURE: The design temperature for all dimensions is 60°F.

DIMENSIONS: All dimensions shown on the design plans are horizontal

GOVERNMENT BENCH MARKS: Preserve any National Geodetic Survey bench marks that are located on the project. Notify Mr. Monroe Rivers, NGS State Geodetic Advisor, Bureau of Design, KDOT, at (785)296-6835, if any government bench marks are in danger of being destroyed due to

GAGING STATION: Provide the United States Geological Survey (U.S.G.S.) with the labor and equipment necessary to access, remove, attach, support or anchor any new or existing stream gaging hardware to the bridge.

The labor and equipment required to perform this work will be considered subsidiary to the other bid items in the contract. Contact Jim Putnam at the U.S.G.S. to coordinate this work:
Jim Putnam
U.S. Geological Survey

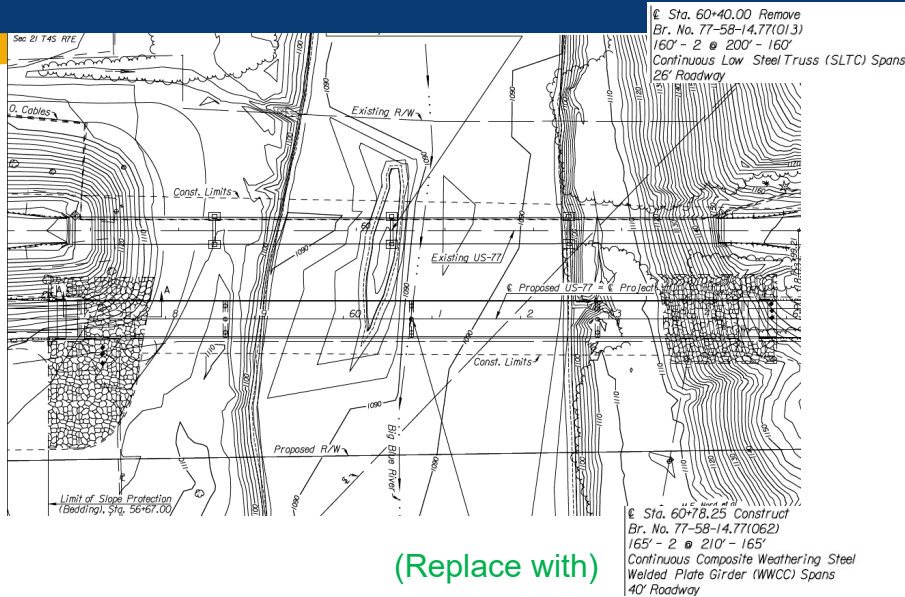
4821 Quail Crest Place
Lawrence, KS 66049-3839
Phone • 785-832-3541

(Not always the same on each Project so take your time and read each carefully)



Contour Map

(Remove what)



(Replace with)

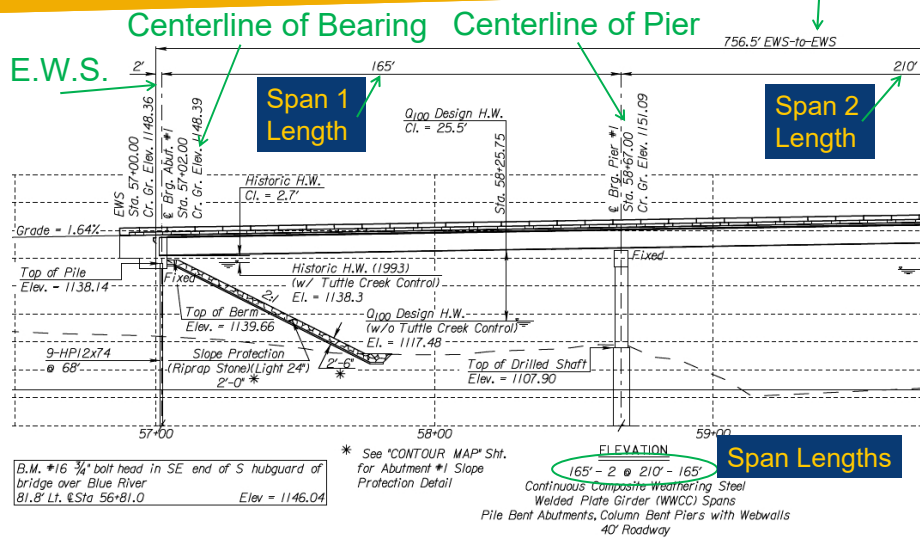


7

Construction Layout

Station & Elevation Info:

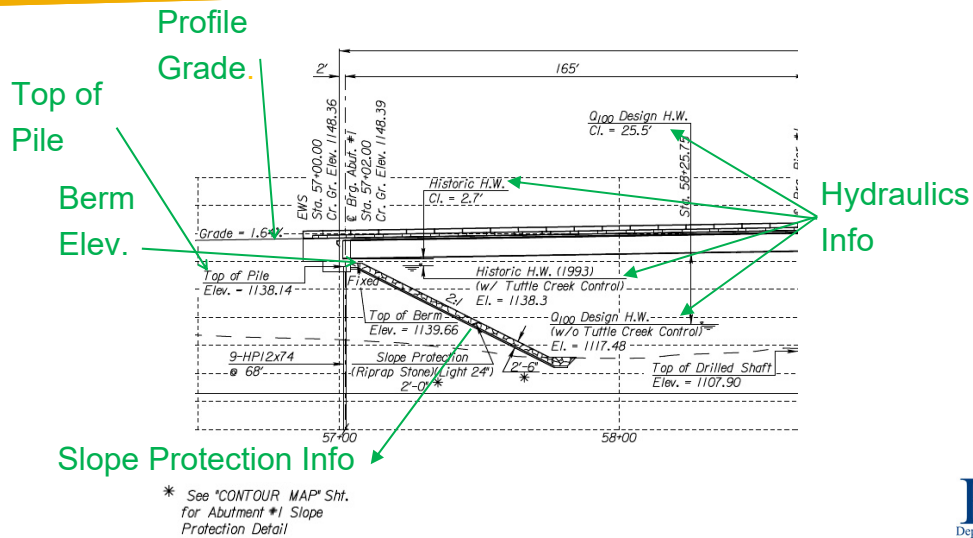
Br. Length: End to End



8

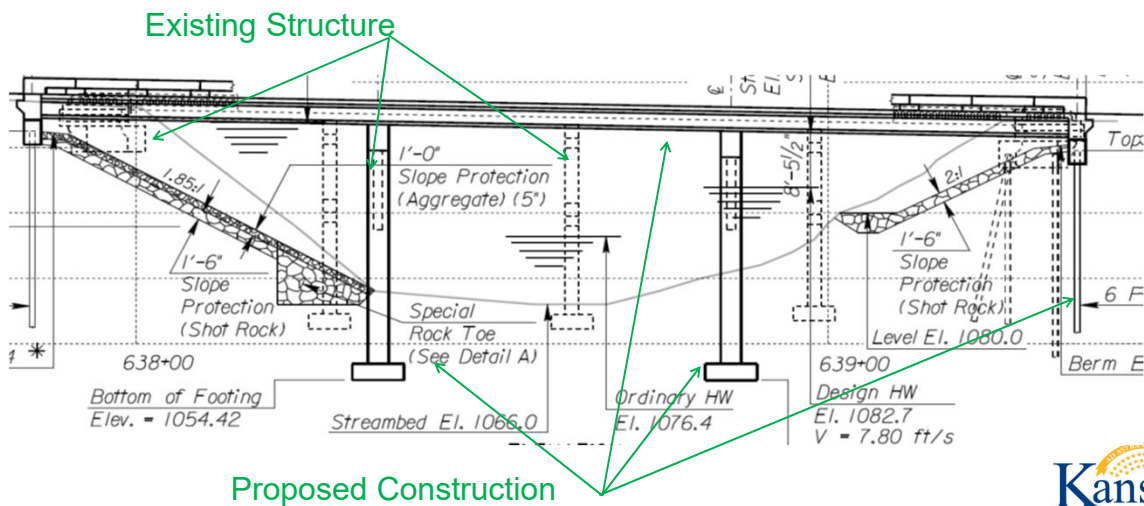


Construction Layout



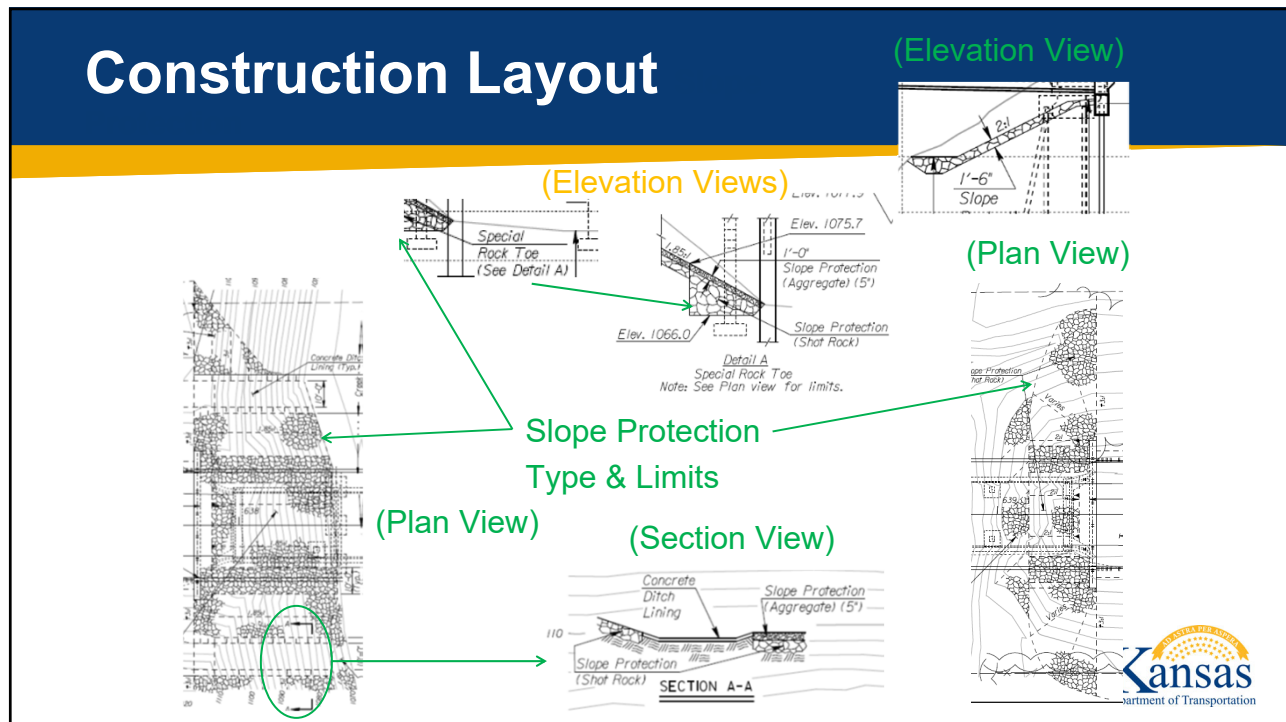
9

Construction Layout



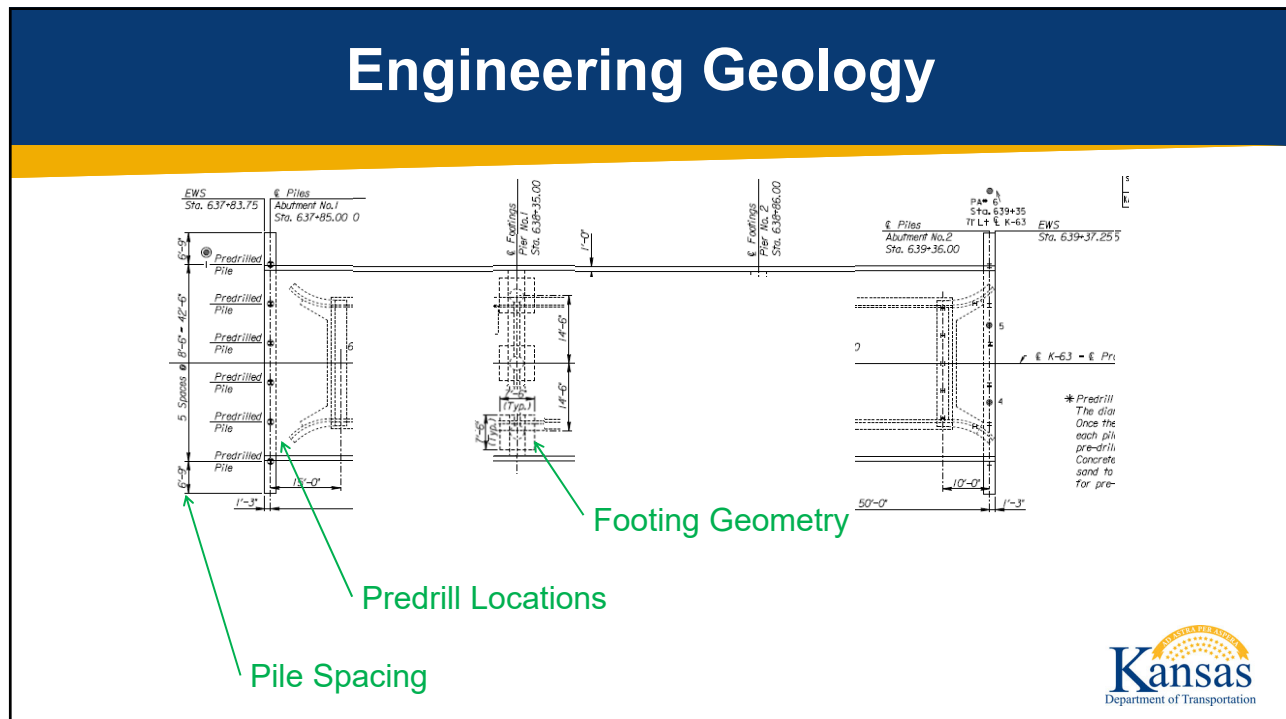
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Construction Layout



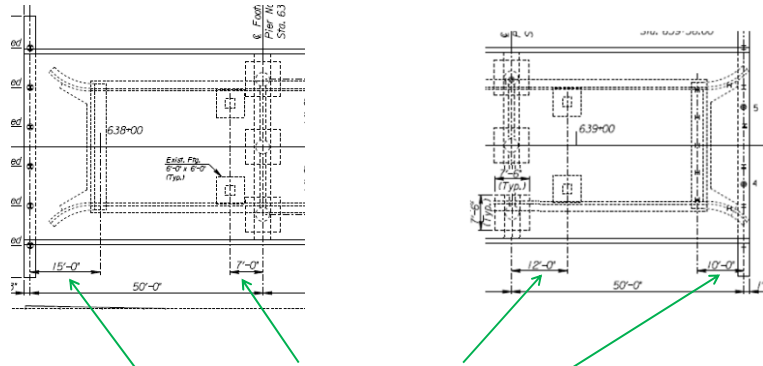
11

Engineering Geology



12

Engineering Geology

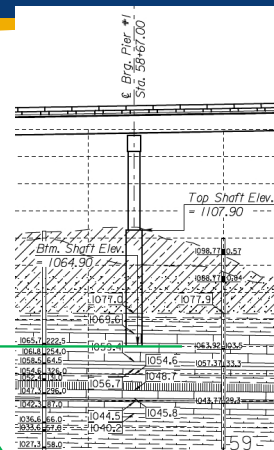
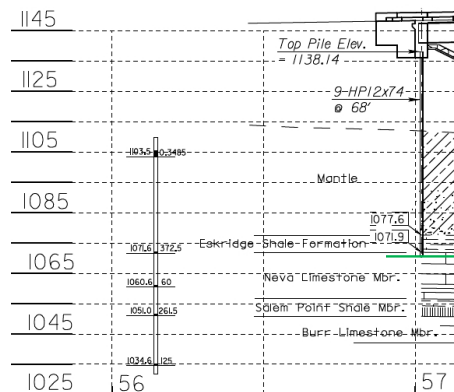


Clearance to Existing
Substructure Foundations

13

Engineering Geology

(Subsurface Elevations, Ft.)

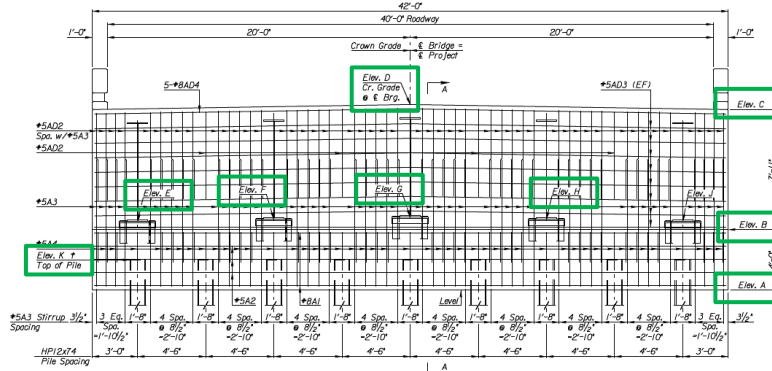


From Gen. Notes: *PILING: Drive all piling to bear upon the limestone of the Neva Member. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load*

14

Abutment Details

(Project Alignment & Geometry)



Elevations



15

Abutment Strip Drain

ABUTMENT STRIP DRAIN: The Bridge Contractor shall excavate to the limits shown on the Bridge Excavation sheet, grade the bottom of the backfill area, place the strip drain, and place the perforated pipe, the outlet pipe, the CMP, and the backfill. Guide post and coarse aggregate are subsidiary to this bid item. Guide post and coarse aggregate are not required if the CMP empties onto riprap.

BRIDGE BACKWALL PROTECTION SYSTEM: Apply a Bridge Backwall Protective System to the approach side of the abutments and the wings in accordance with KDOT Specifications and the manufacturer's recommendations. Cover the abutments and wings to the limits shown on the details. Prior to backfilling, repair any damage done to the system at no charge to the state.

Place perforated pipe next to the strip drain. Use non-perforated pipe outside the limits of the strip drain. Enclose the perforated pipe with the extension of the filter fabric.

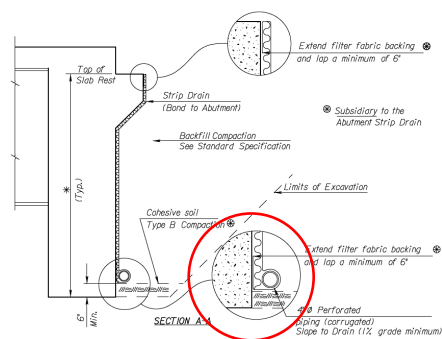
Compact the abutment backfill. See the KDOT Specifications.

Perforated pipe and non-perforated outlet pipe shall be corrugated polyethylene tubing conforming to the KDOT Specifications.

Fit the CMP and section with 1/4" galvanized mesh screen to prevent the entrance of rodents. Seal the joint between the outlet pipe and the end section with a joint sealer. Place coarse aggregate at the outlet end as shown.

Grade the bottom surface of the excavated area to drain. Backfill this area with a cohesive type soil. The soil should be a silty clay or clay under the Kansas Classification System with a minimum plasticity index of 13. Compact the material to Type B standards.

Place the outlet pipe on the downstream side of structures over streams and as shown or noted on other crossings (See the "Construction Layout" sheet).



SUMMARY OF QUANTITIES (Abutment #1)	
Abutment Strip Drain	X Sq. Yds.
Bridge Backwall Protection System	X Sq. Yds.
Items Subsidiary to Strip Drain	
4" Ø Perforated Pipe	38 Lin. Ft.
4" Ø Outlet Pipe	26 Lin. Ft.
6" Ø CMP	8 Lin. Ft.
Items Subsidiary to Slope Protection (Shot Rock)	
Geotextile Fabric	X Sq. Yds.



16

17



Pier Details

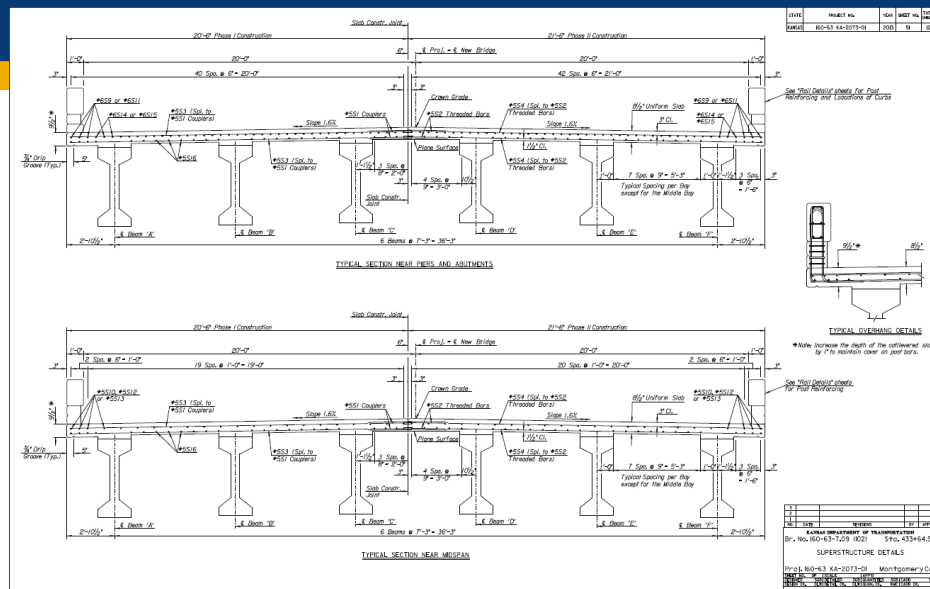
23



24

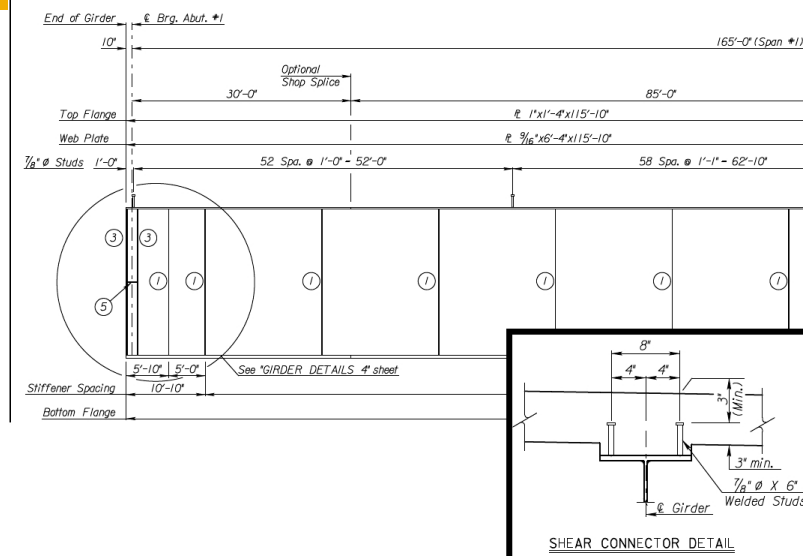


(Conc.) Typical Section



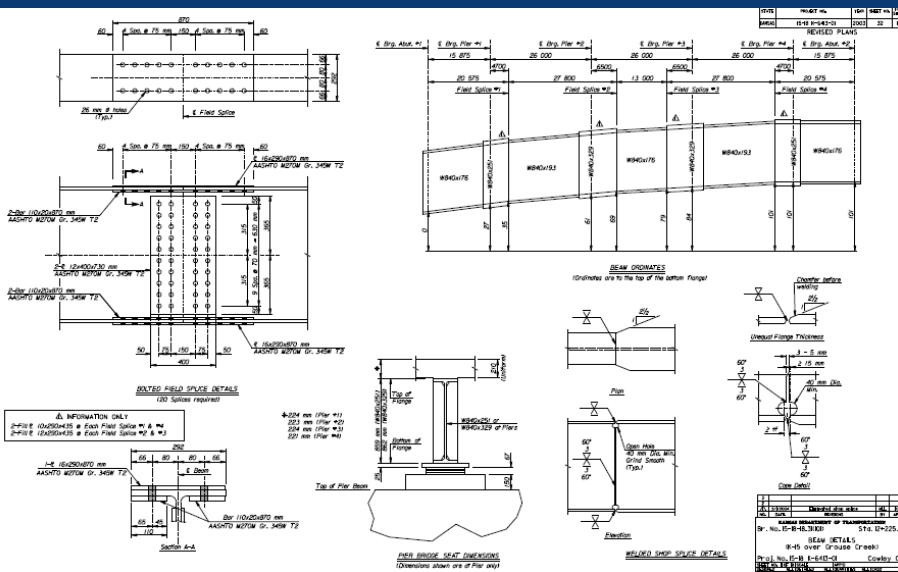
25

Headed Stud Anchor and Bearing Device Details



26

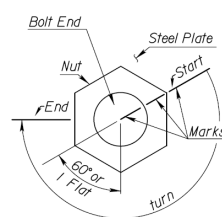
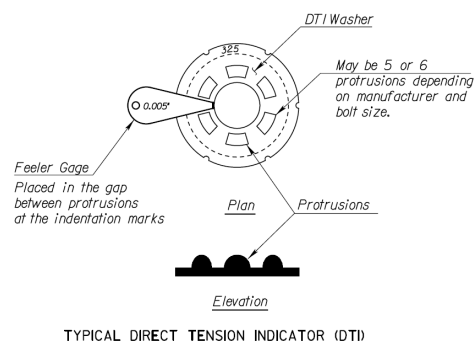
Steel Beam Details



PL-27



Steel Erection, Fit-up and Bolting

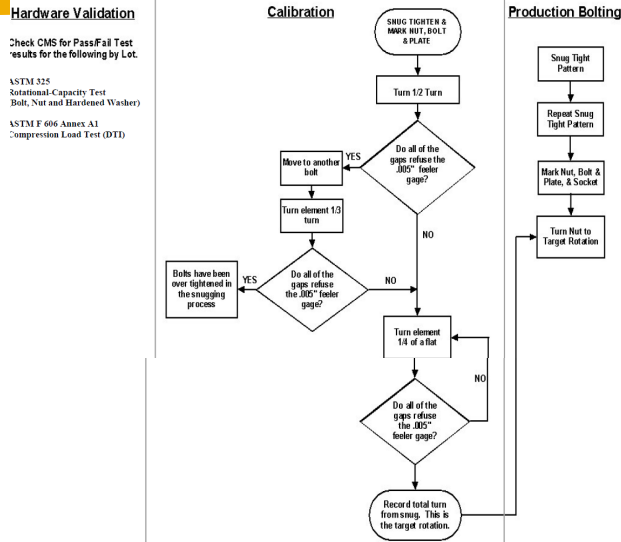


REQUIRED MARKING DETAIL
(shows calibrated turn - 3½
flats from snug tight condition).
Example only, calibrated turn may
be more or less than shown.



712 – STRUCTURAL STEEL CONSTRUCTION

FIGURE 712-1
Bolting Operation Flow Chart
Calibration Procedure



712.3 CONST. REQ'M.

b. Bolted Field Connections, p. 700-55, 56, 57

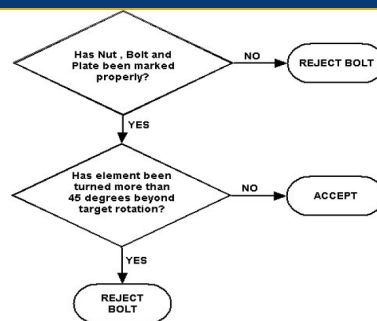
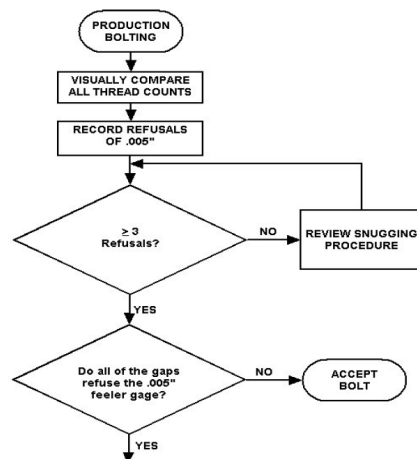


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712.3 CONST. REQ'M., Fig. 712-2 b. Bolted Field Connections, p. 700-60

712 - STRUCTURAL STEEL CONSTRUCTION

FIGURE 712-2 – Direct Tension Indicator Verification

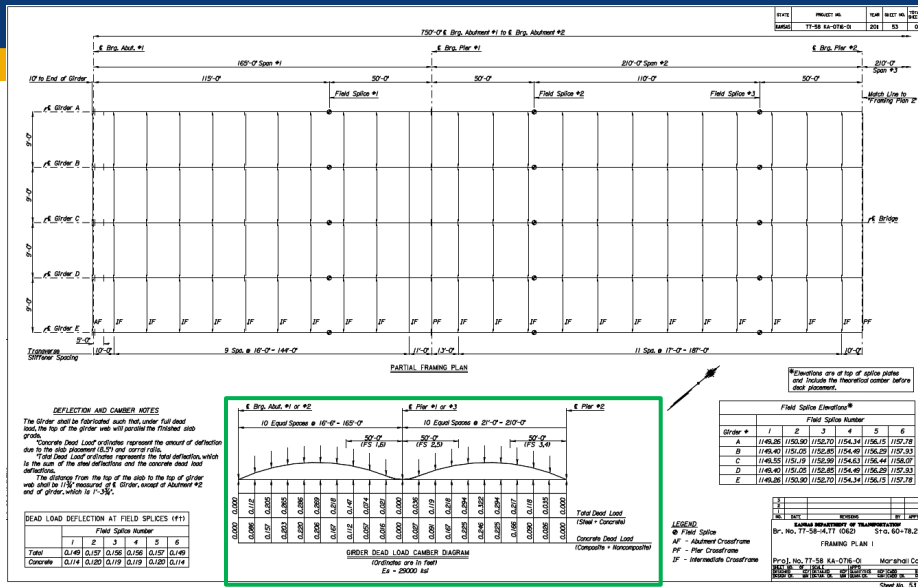


Bolt Size	DTI Spaces		Minimum Installation Refusals	
	A 325	A 490	A 325	A 490
5/8	4	5	2	3
3/4	5	6	3	3
7/8	5	6	3	3
1	6	7	3	4
1-1/8	6	7	3	4
1-1/4	7	8	4	4
1-3/8	7	8	4	4



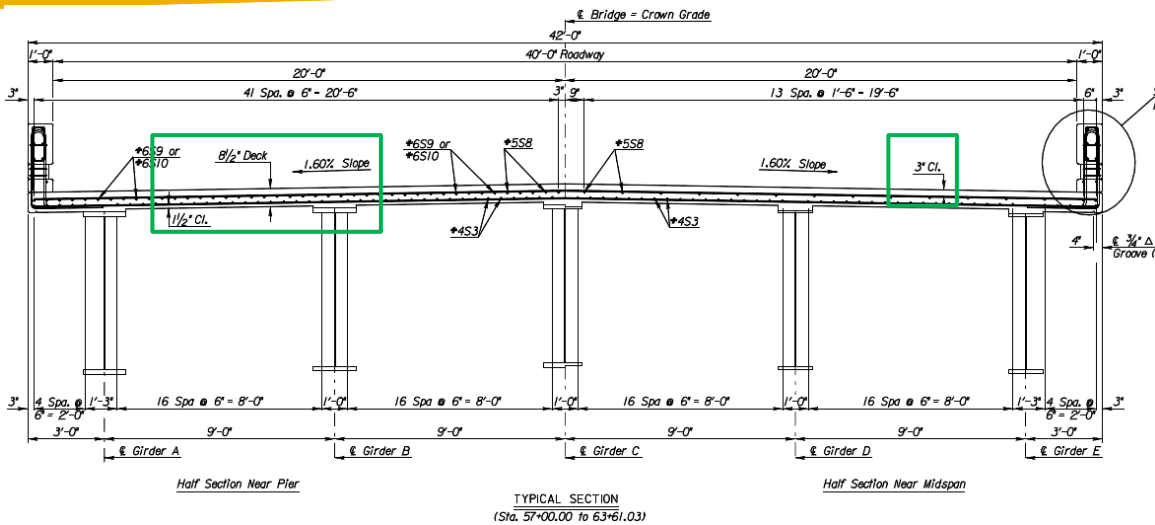
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Framing Plan



31

(Steel) Typical Section



32

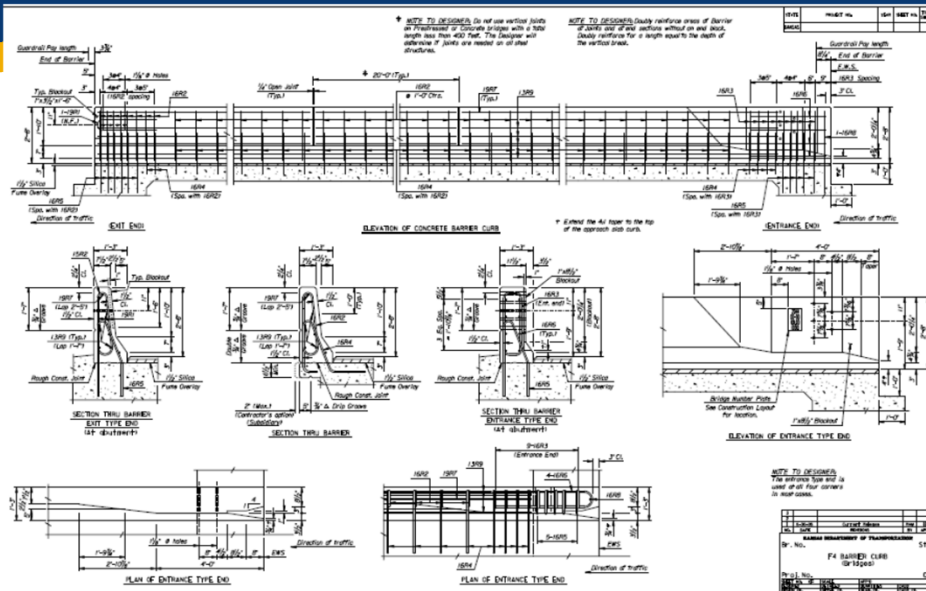
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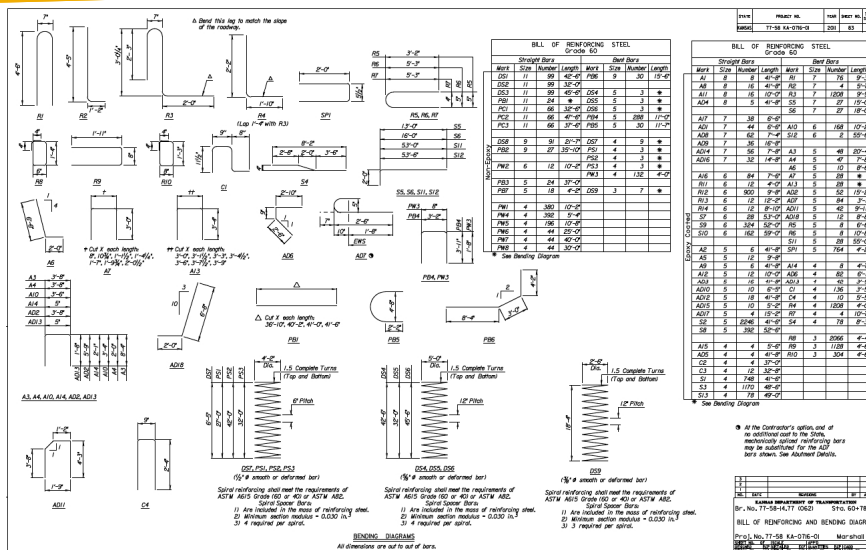


F4 Barrier Curb



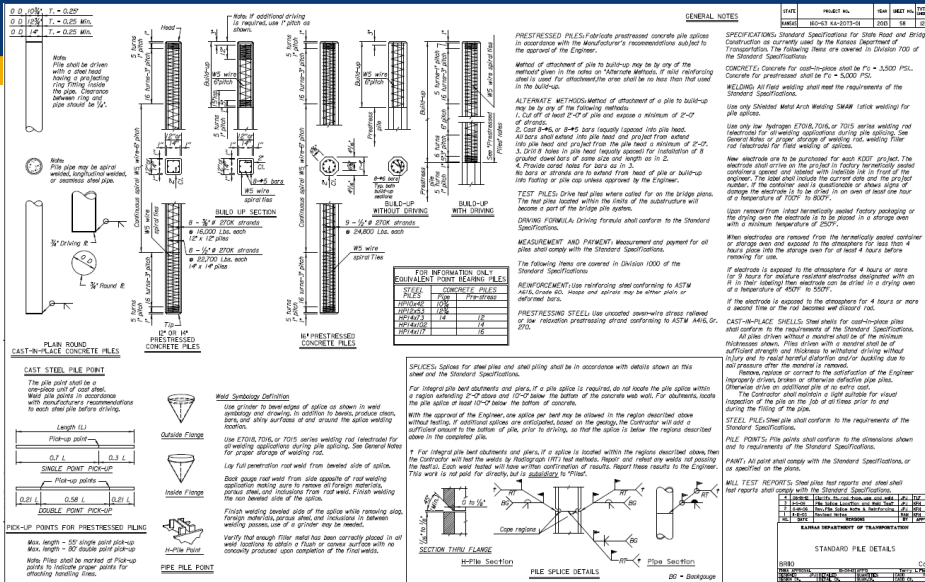
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Bill of Reinforcing Steel & Bending Diagrams

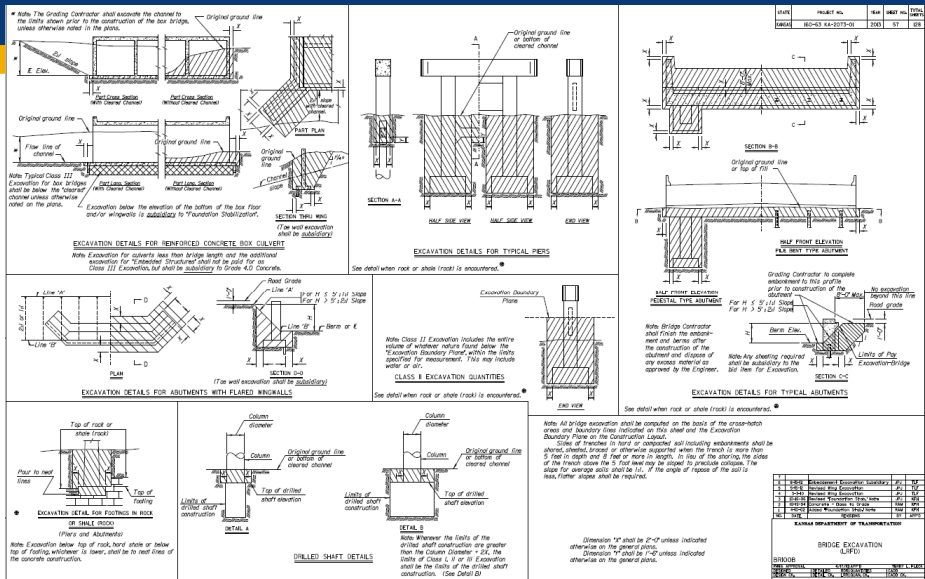


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Standard Pile Details



Bridge Excavation



Supports and Spacers for Reinforcing Steel

Final Thoughts:

Bridge Plans contain a lot of information – some of which is record keeping (hydraulics, scour, As-built changes, revisions, etc.) some of which is for initial construction.

Currently there are only 3 Bridge Squads.
Maintenance Plans are handled by a consultant sit-in, so if you ever have questions, or see something that doesn't quite add up, just email or call.

Thanks & Good Luck!!!





Concrete and Reinforcing Steel

1

Concrete – Division 400

TABLE OF CONTENTS

DIVISION 400 CONCRETE

SECTION	PAGE
401 - GENERAL CONCRETE	400-1
402 - STRUCTURAL CONCRETE	400-14
403 - ON GRADE CONCRETE	400-17
404 - CONCRETE FOR PRESTRESSED CONCRETE MEMBERS	400-22
405 - CURING ENVIRONMENT	400-25

400 - Concrete

Specification Number	Title	Section
15-04001*	Kansas City Metro Materials	400
15-04002	Structural Concrete	402
15-04002-R01*	Structural Concrete	402
15-04003*	On Grade Concrete	403
15-04004*	Concrete Prestressed Concrete Members	404
15-04005	General Concrete	401
15-04005-R01	General Concrete	401
15-04005-R02	General Concrete	401
15-04005-R03	General Concrete	401
15-04005-R04*	General Concrete	401

*Latest version of special provision



2

What is Concrete?

- Concrete (Division 400)

401.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregate	DIVISION 1100
Admixtures and Plasticizers	DIVISION 1400
Grade 2 Calcium Chloride.....	DIVISION 1700
Cement, Fly Ash, Natural Pozzolans, Silica Fume, Slag Cement and Blended Supplemental Cementitious.....	DIVISION 2000
Water	DIVISION 2400

- Strong in compression but weak in tension
 - Reinforcing Steel is designed to carry tension forces that concrete cannot resist on its own.



3

Concrete Grade

- Refers to the required 28 Day compressive strength
- Grade selected based on structural demand
- Grade 4.0 is the most common for reinforced concrete structures.

TABLE 401-3: CONCRETE STRENGTH REQUIREMENTS	
Specified 28 Day Compressive Strengths, minimum, psi f'_c	
Grade of Concrete:	Non Air Entrained/Air Entrained Concrete
Grade 7.0	7,000
Grade 6.0	6,000
Grade 5.0	5,000
Grade 4.5	4,500
Grade 4.0	4,000
Grade 3.5	3,500
Grade 3.0	3,000
Grade 2.5	2,500



4

Concrete Classification

- **(AE)**
 - Air-Entrained Concrete
- **(AE)(SW)**
 - Select Coarse Aggregate for Wear
- **(AE)(SA)**
 - Select Coarse Aggregate for wear and Absorption
- **(AE)(AI)**
 - Select Coarse Aggregate for wear and Acid Insolubility
- **(AE)(PB)**
 - Select Coarse Aggregate for use in Prestressed Beams

Division 1100 - Aggregates



5

Cement

- Structures will generally be dealing with the center row
- High Early Strength Concrete may be well suited for accelerated bridge projects
- Cements of differing types and or sources cannot be intermixed within any singular component of a structure.

TABLE 401-1: PORTLAND CEMENT & BLENDED HYDRAULIC CEMENT	
Concrete for:	Type of Cement Allowed
On Grade Concrete	Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type IL(x) Portland-Limestone Cement ¹ Type II Portland Cement
All Concrete other than On Grade Concrete.	Type I Portland Cement Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type IL(x) Portland Limestone Cement ¹ Type II Portland Cement
High Early Strength Concrete	Type III Portland Cement Type I, IP(x), IS(x), IT(Ax)(By), Type IL(x) ¹ or II Cement may be used if strength and time requirements are met.



6

Structural Concrete Specific Requirements

- Maximum water to cementitious ratio of 0.45 and a minimum cementitious content of 480 lbs per cubic yard.
- Air entrained concrete with a target air content of 6.5 ± 1.5 percent as specified in subsection 401.3i.
- See subsection 402.3e for additional requirements



7

Structural Concrete Slump

- Subsection 402.3f

f. Slump.

(1) Designate a slump for each concrete mix design that is required for satisfactory placement of the concrete application. Reject concrete with a slump that limits the workability or placement of the concrete.

(2) If the designated slump is 3 inches or less, the tolerance is $\pm 3/4$ inch, or limited by the maximum allowable slump for the individual type of construction.

(3) If the designated slump is greater than 3 inches the tolerance is $\pm 25\%$ of the designated slump.

(4) For drilled shafts the target slump just prior to being pumped into the drilled shaft is 9 inches. If the slump is less than 8 inches, redose the concrete with admixtures as permitted in **subsection 401.3k**.



8

Slump Tolerances

• Example #1

- The Specified Slump = 4"
- $4" > 3" \rightarrow$ Tolerance is $\pm 25\%$
 - $4" \times 25\% = 1"$
 - $4" - 1" = 3"$
 - $4" + 1" = 5"$
- The acceptable range is 3" to 5"

• Example #2

- The Specified Slump for a Bridge Deck = $2\frac{1}{4}"$
- $2\frac{1}{4}" < 3" \rightarrow$ Tolerance is $\pm \frac{3}{4}"$
 - $2\frac{1}{4}" - \frac{3}{4}" = 1\frac{1}{2}"$
 - $2\frac{1}{4}" + \frac{3}{4}" = 3"$
- The acceptable range is $1\frac{1}{2}"$ to 3"



9

Placement Time

• Non-agitated Concrete

- Place within 30 minutes of adding the cement to the water

• Agitated Concrete

- Use Table 401-5

TABLE 401-5: AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME		
T = Ambient Air Temperature at Time of Batching (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
$T < 75$	$1\frac{1}{2}$	All Cases
$75 \leq T < 90$	1	None
$75 \leq T < 90$	$1\frac{1}{2}$	Set Retarder
T_c = Concrete Temperature at time of placement (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
$90 \leq T_c$	$\frac{1}{4}$	All Cases
Other conditions contributing to quick stiffening of concrete	$\frac{1}{4}$	All Cases



10

Reinforcing Steel

- Division 700 Structures
 - Section 711 – Reinforcing Steel
- 4 Major Questions
 - Is it Clean and Free of heavy rust?
 - Is it properly
 - Tied?
 - Spaced?
 - Supported?
 - Is there adequate clearance ---
 - From the forms?
 - Between the mats?
 - From the top of concrete?
 - Is there a defined pattern?



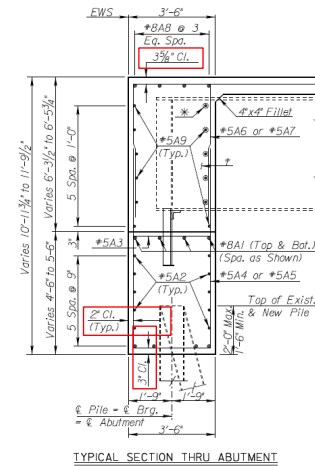
11

Reinforcing Steel Storage



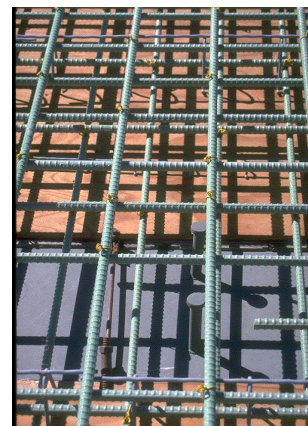
12

Abutment Reinforcing Steel



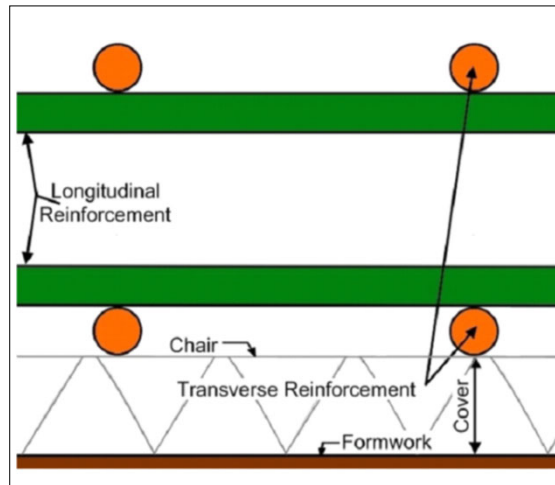
13

Reinforcing Steel on Steel Bridge



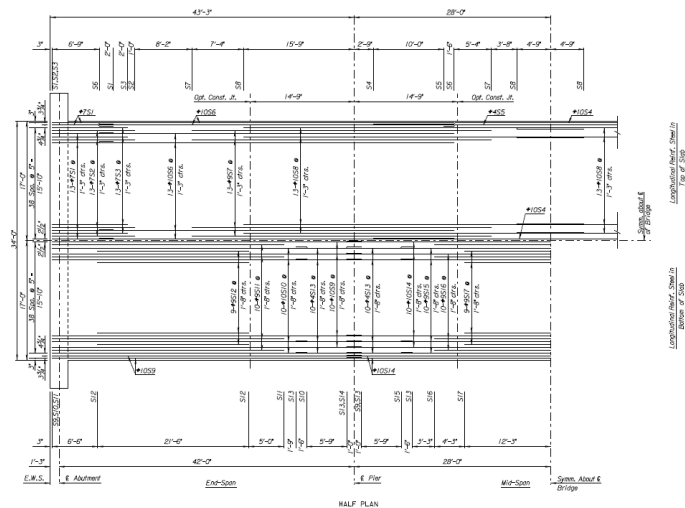
14

Reinforcing Steel Clearance



15

Reinforcing Steel in RCSH Detail



16

Reinforcing Steel in RCSH



17

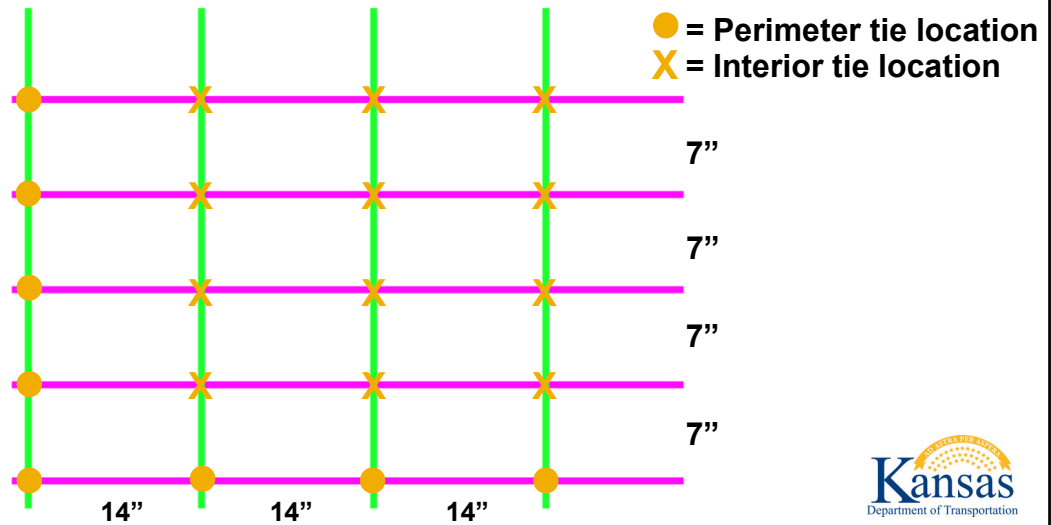
Construction Requirements

- Construction Requirements:
 - Remove heavy mill scale or rust
 - Check for proper bar spacing
 - Verify the bars are tied adequately
 - Spacing of ties meet requirements
 - Tie perimeter steel at all intersections
 - Tie rest of steel intersections at 24 inches or less in all directions
 - Verify the pattern
 - Check for adequate clearance



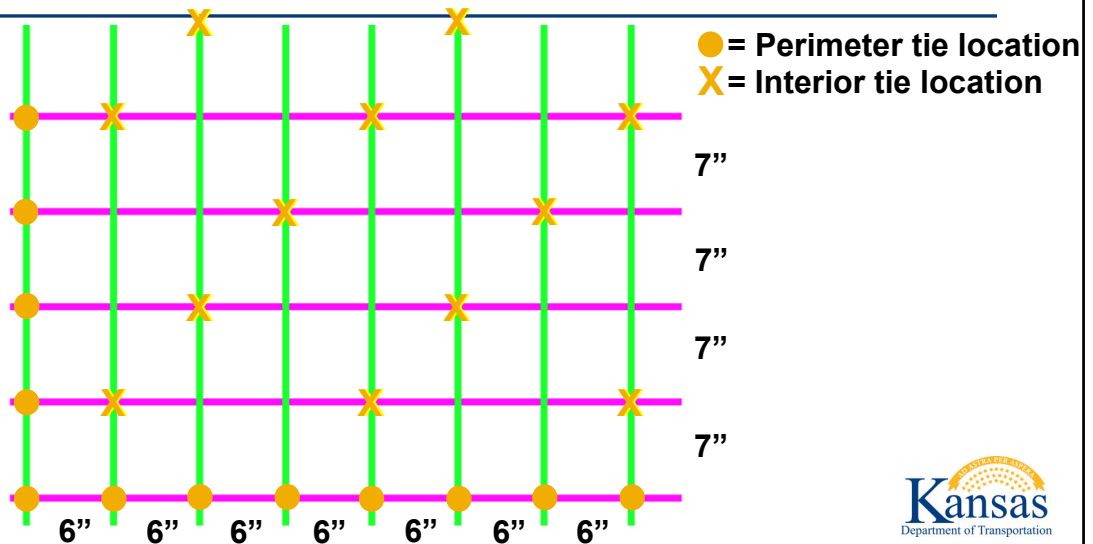
18

Reinforcing Steel Tie Pattern 1



19

Reinforcing Steel Tie Pattern 2



20

Epoxy Coated Reinforcing Steel

- Construction Requirements:
 - Use padded or non-metallic slings
 - Patch **ALL** cracks or defect in coating
 - Especially at Ends and Bends
 - Use plastic coated wire ties
 - Protect from UV light
 - Required to be covered for long term storage
 - Use plastic coated bar chairs



21

Table 711-1

TABLE 711-1: BAR SIZE WEIGHTS		
Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.



22

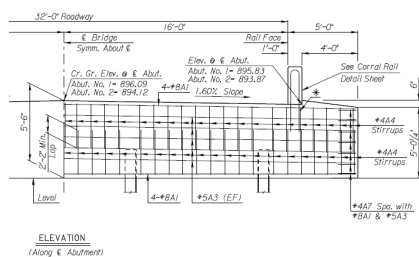
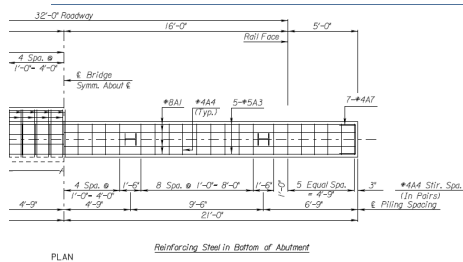
KDOT Measure and Payment

- Measure and Payment (Section 711.4)
- Table 711-1 for Weights
- Compute to the nearest 1.0 lb
 - N = number of bars of specific mark (A3, PB2, etc.)
 - L = length of specified bar
 - W = unit weight of bar size in (lb/ft) (Table 711-1)
- Total Mark Weight = $N \times L \times W$
 - Measured to the Nearest Pound
 - Paid to the Nearest Ten Pounds



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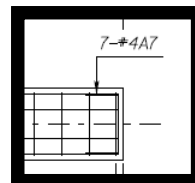
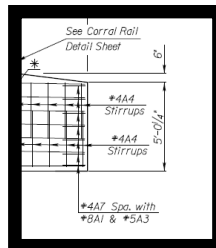
Bar Measurement Example 1



What is the total A7 weight?

- Count the Number of Bars:
 - 7 bars at each wing
 - 2 wings per abutment
 - 2 abutments per bridge

$$7 \times 2 \times 2 = 28 \text{ bars}$$



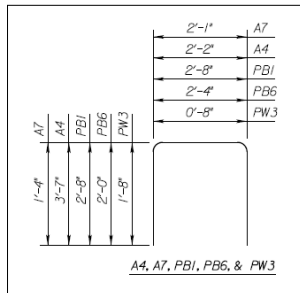
24

Bar Measurement Example 2

BILL OF REINFORCING STEEL Epoxy Coated - Grade 60							
Straight Bars				Bent Bars			
Mark	Size	Number	Length	Mark	Size	Number	Length
S4	#10	4	50'-6"	R1	#7	24	9'-3"
S6	#10	60	50'-6"	R2	#7	4	5'-7"
S8	#10	52	48'-6"	R3	#7	220	7'-9"
S9	#10	48	44'-0"	S1	#7	60	11'-3"
S10	#10	40	36'-3"	S2	#7	52	14'-3"
S14	#10	24	58'-0"	S3	#7	52	13'-3"
S7	#9	52	42'-8"	A2	#5	62	3'-11"
S11	#9	40	33'-0"	R5	#5	8	6'-6"
S12	#9	36	21'-6"	R6	#5	8	10'-8"
S15	#9	20	42'-6"				
S16	#9	20	33'-0"	A4	#4	164	9'-4"
S17	#9	18	24'-6"	A5	#4	62	6'-2"
A1	#8	16	41'-8"	A7	#4	28	4'-9"
				R4	#4	220	3'-2"
				R7	#4	4	10'-8"
R11	#6	24	8'-3"				
R12	#6	144	9'-8"	R8	#3	384	4'-4"
T1	#6	97	33'-8"	R9	#3	208	4'-6"
				R10	#3	52	4'-6"
A3	#5	20	41'-8"				
				T3-T18			∞
A6	#4	2	32'-8"				
S5	#4	2	30'-6"				
S13	#4	80	9'-3"				
T2	#4	82	33'-8"				
SC1	#4	78	6'-6"				

What is the total A7 weight?

- Calculate the Length of a single A7 bar:
 - $1'-4" + 1'-4" + 2'-1" = 4'-9" = 4.75 \text{ ft}$



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Bar Measurement Example 3

TABLE 711-1: BAR SIZE WEIGHTS		
Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

What is the total A7 weight?

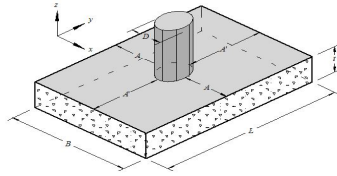
- Find the Unit Weight (lb/ft) of the Bar Size Being Calculated:
 - Bar Size = #4
 - Unit Weight = 0.668 lb/ft
- Total A7 Mark Weight
 - $28 \text{ bars} \times 4.75 \text{ ft / bar} \times 0.668 \text{ lb/ft} = 88.844 \text{ lb}$
 - Measured Weight = 89 lb
 - Paid Weight = 90 lb



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CIT Structures

Foundations



1. Foundations

- Types of Foundations
 - Spread Footings
 - Where scour is not a concern and rock with adequate bearing capacity is found near the surface.
 - Pile Footings
 - In many cases pile support footings will be recommended.
 - Drilled Shafts
 - When rock is not found near the surface.

2. Foundations

- Construction of Foundations
 - Staking
 - Specifications and Plan Details
 - Excavation
 - Placement of footing materials
 - Measurement and Payment



3

3. Foundations

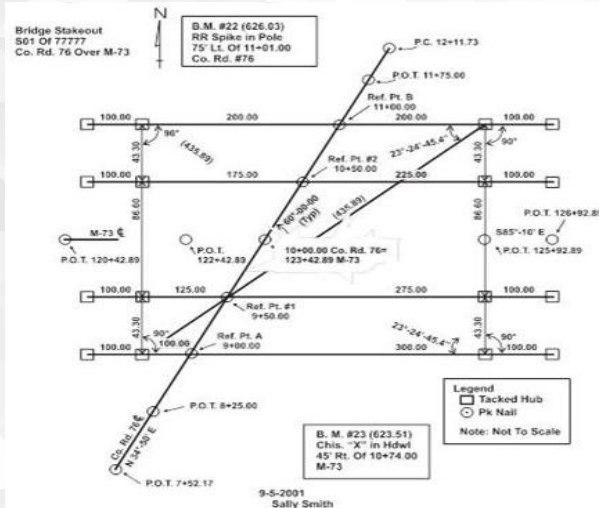
- Staking
 - Section 802 - Contractor Construction Staking
 - Control Stakes: Do not perform vertical control using GPS.
 - 802.3 c (2) Bridge. Prior to construction, set project control points and Critical Bridge Element control points for the horizontal and vertical location
 - See Table 802-1 Critical Bridge Elements
 - Independent survey under different surveyor
 - 802.3 c (3) Documentation. Provide and maintain a current copy of all field survey notebooks at the project site at all times.



4

4. Foundations

- Staking
 - Section 802 - Contractor Construction Staking



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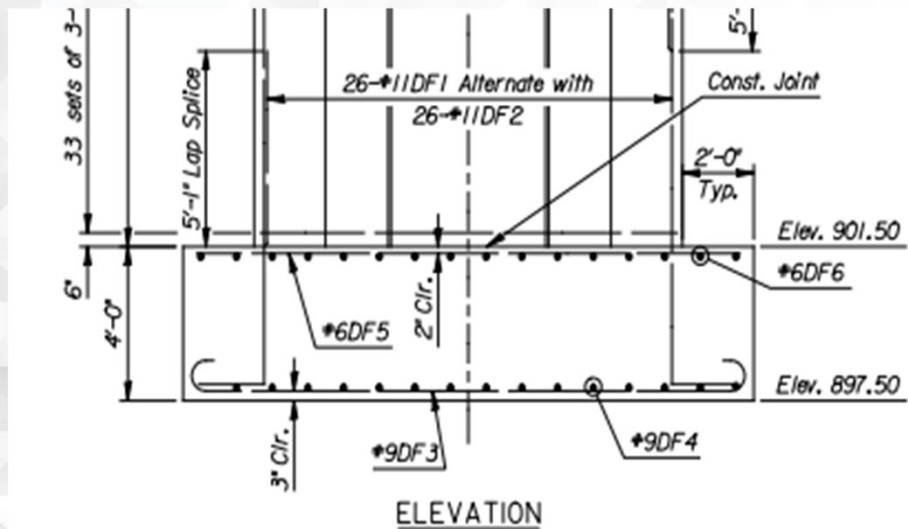
5. Foundations

- Staking
 - Section 802 - Contractor Construction Staking
 - Off-Set Stakes
 - Excavation will destroy the control point.
 - Be certain they are placing Off- Set stakes outside the excavation limits. Keep these stakes preserved.



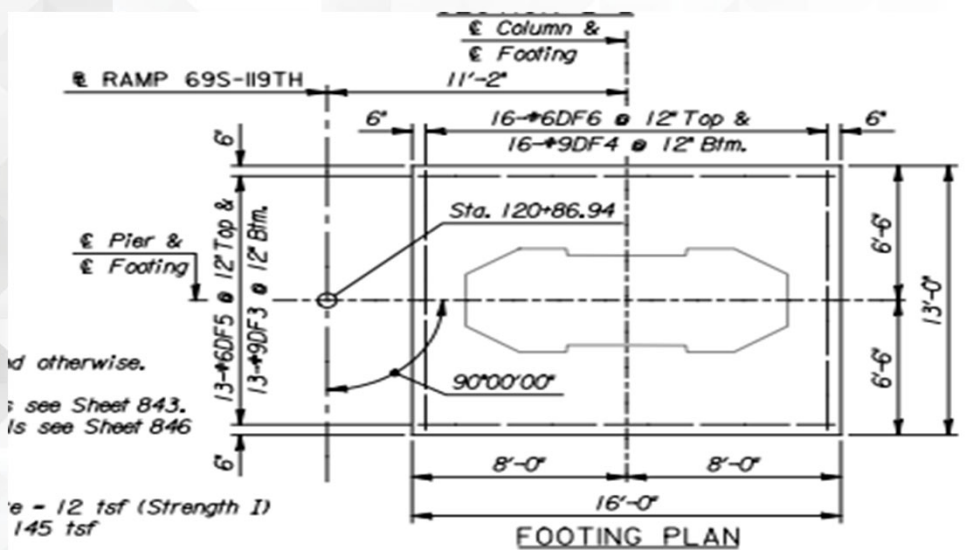
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8. Foundations - Plan Details – Spread Footing



9

9. Foundations - Plan Details – Spread Footing



10

10. Foundations

- Excavation
 - Section 204 - Excavation and Backfill for Structures
 - Class I Excavation: is the entire volume of whatever nature, except water, found above the Excavation Boundary Plane, with in the limits specified.
 - Class II Excavation: is the entire volume of whatever nature, including water, found below the Excavation Boundary Plane, with in the limits specified.
 - Class III Excavation: Bridge excavation not classified as Class I or Class II. Class III Excavation is the entire volume of whatever nature encountered including water, within the limits specified.



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11. Foundations

- Excavation
 - Spread Footing
 - Normally, the excavation should be carried to the elevation of the footing shown in the plans. A possible exception would be in the event that a satisfactory foundation in rock can be secured at a higher elevation. Contact the Bureau of Structures and Geotechnical Services.
 - Always compare the material encountered at the footing elevation with that shown on the plans and geology report.



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12. Foundations

- Excavation
 - Footings
 - Equipment – Excavators and Jackhammers



13

13. Foundations

- Excavation
 - Spread Footing
 - If the Engineer determines it is necessary to lower a footing below the elevation shown in the Contract Documents, the additional excavation is paid as follows:



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14. Foundations

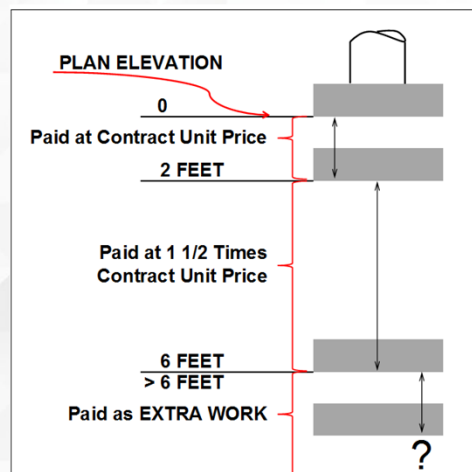
- Excavation
 - Spread Footing
 - 204.4 c. Measurement and Payment
 - Additional excavation up to and including 2 feet below the contract elevation is paid at the contract unit price.
 - Additional excavation from more than 2 feet up to and including 6 feet below the contract elevation is paid at 1½ times the contract unit price.
 - Additional excavation more than 6 feet below the contract elevation is paid as Extra Work, SECTION 104.



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15. Foundations

- Excavation
 - Spread Footing
 - 204.4 c. Measurement and Payment
 - Measure the quantity of CUYD's in each zone.
 - Change Order with new Prices



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16. Foundations

- Placement of footing materials
 - Spread Footing
 - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
 - Section 401 General Concrete, Section 402 Structural Concrete and Section 710 Concrete Structure Construction.



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17. Foundations

- Placement of footing materials
 - Spread Footing
 - Placing Rebar and Concrete



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18. Foundations

- Measurement and Payment
 - Spread Footing
 - Section 710 Concrete Structure Construction _ The Engineer will measure the various grades of concrete placed in the structure by the cubic yard. No deductions are made for reinforcing steel and pile heads extending into the concrete.
 - Section 711 Reinforcing Steel _ The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.



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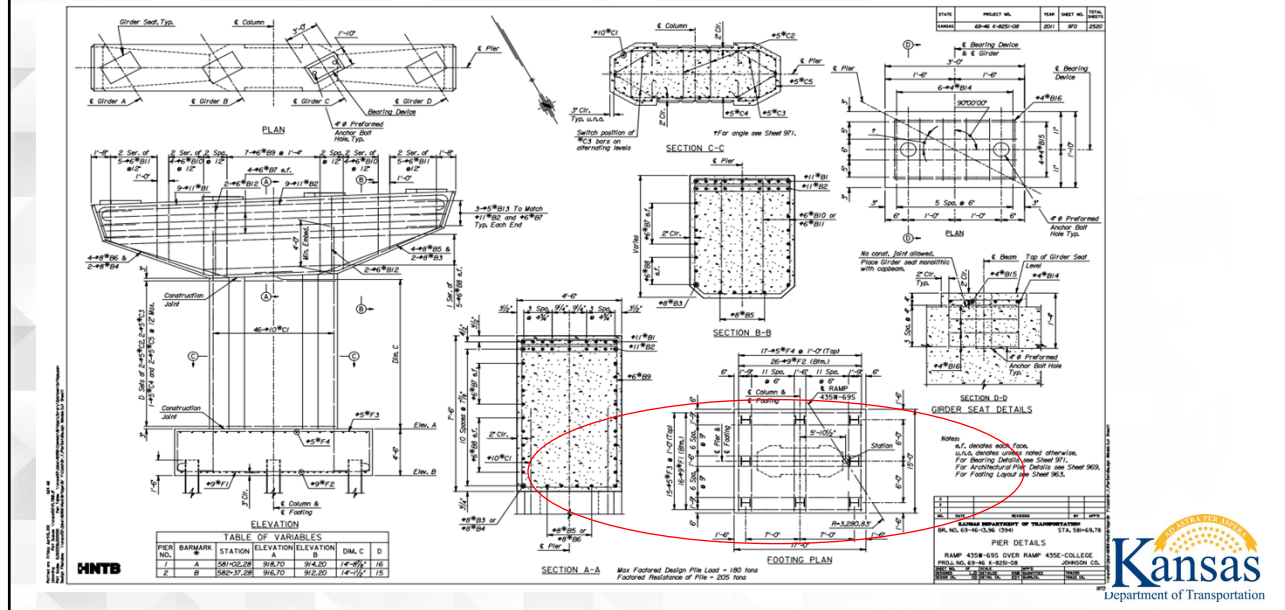
19. Foundations

- PILE FOOTING



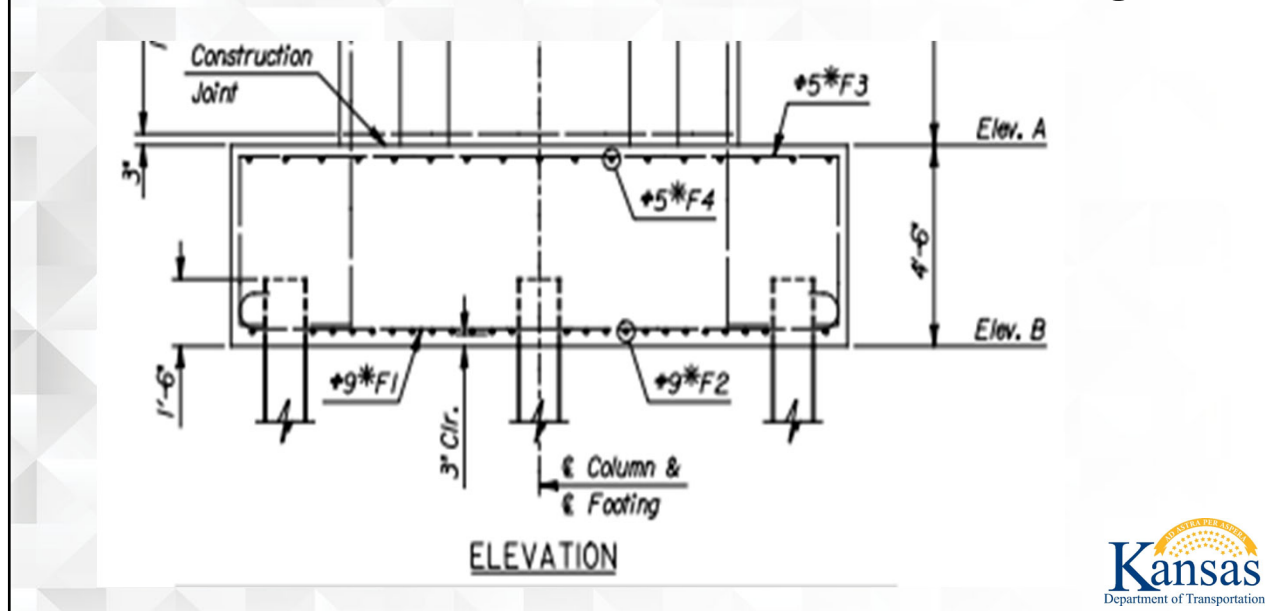
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20. Foundations – Plan Details – Pile Footing



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21. Foundations – Plan Details – Pile Footing



22

[illegible]

- Excavation
 - Pile Footing

- 

24. Foundations

- Excavation
 - Pile Footings
 - Pile Footing for Pier
 - Typically, the Engineer shall not have any need to change elevation of the footing.



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25. Foundations

- Excavation
 - Pile Footings
 - Pile Footing for Abutment



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26. Foundations

- Placement of footing materials
 - Pile Footing
 - Section 704 Piling and Section 1609 Steel Piling and Pile Points.
 - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
 - Section 401 General Concrete, Section 402 Structural Concrete and Section 710 Concrete Structure Construction.



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27. Foundations

- Placement of footing materials
 - Pile Footing
- Certified Material



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28. Foundations

- Placement of footing materials
 - Pile Footing
- Allowable Pile Hammer



29. Foundations

- Placement of footing materials
 - Pile Footing
- Placing Piling



30. Foundations

- Placement of footing materials
 - Pile Footing
 - Concrete Cap
- Placing Rebar and Concrete



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31. Foundations

- Measurement and Payment
 - Pile Footing
 - Section 704 Piling _ The Engineer will measure the length of steel pile, steel sheet pile, cast-in-place concrete pile and prestressed concrete pile remaining in the structure, by the linear foot.
 - Section 710 Concrete Structure Construction _ The Engineer will measure the various grades of concrete placed in the structure by the cubic yard.
 - Section 711 Reinforcing Steel _ The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.

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36. Foundations

- Excavation
 - Drilled Shafts
 - Specifications - Section 703 Drilled Shafts
 - Drilled shafts are considered where footing conditions require bearing to be carried to a rock formation an the following conditions exist:
 - The footing would have short piles
 - The water table is high
 - A spread footing foundation would be uneconomical
 - Concerns about pile driving i.e. overhead clearance



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37. Foundations

- Excavation
 - Drilled Shafts
 - Drilled shaft lengths shown in the Contract Documents are an estimate from the top of formation elevations determined from borings.
 - Actual formation elevations encountered at each shaft, may require the actual length of each drilled shaft be adjusted.
 - If the Engineer changes the drilled shaft lengths, the Contractor will be advised (in writing) of the revised bottom of rock socket elevation.



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38. Foundations

- Excavation
 - Drilled Shafts
 - Equipment – Excavators or Cranes with drill rig attachment
 - Auger Bits



39

39. Foundations

- Excavation
 - Drilled Shafts
 - Equipment – Excavators or Cranes with drill rig attachment
 - Core Barrels



40

40. Foundations

- Excavation
 - Drilled Shafts
 - Equipment –
Excavators or
Cranes with
drill rig
attachment
 - Clean Out
Buckets



41

41. Foundations

- Excavation
 - Drilled Shafts
 - Oversized for
Cased Method



42

42. Foundations

- Excavation
 - Drilled Shafts
 - Limestone excavated from the rock socket



43. Foundations

- Excavation
 - Drilled Shafts
 - Identify if excavation is classified as a Dry Shaft or Wet Shaft
 - Read your Specifications, when you are done reading them, read them again and again.
 - Have a copy of the specifications and plans on site at all times.
 - Have any additional correspondence that may have came from Geology. i.e. investigative core hole results

44. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
 - Section 401 General Concrete, Section 402 Structural Concrete and Section 703 Drilled Shafts



45

45. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Rebar cage rigged from crane



46

46. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Rebar cage rigged from cranes



47. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Rebar cage



48. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Spacers for clearance



49. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Sonic Tubes
 - Sonic Test all shafts placed by Wet pour method



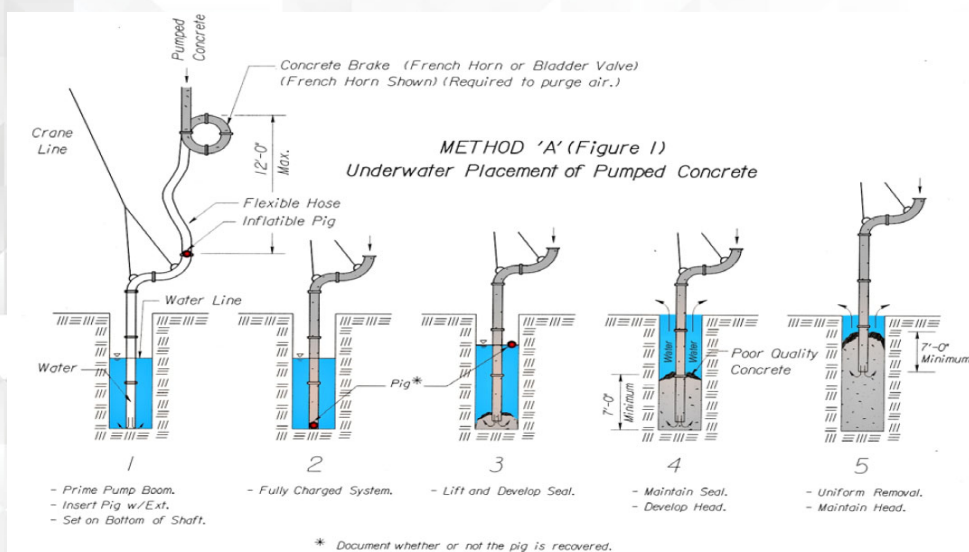
50. Foundations

- Placement of footing materials
 - Drilled Shafts
 - Concrete
 - Over pump Wet and Dry Pours – Provision 15-07015



51

51. Foundations



52

52. Foundations

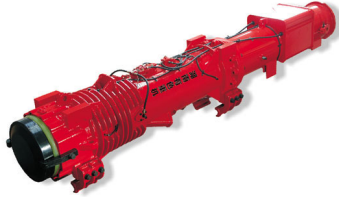
- Measurement and Payment
 - Drilled Shaft
 - Section 703 Drilled Shafts _ The Engineer will measure drilled shafts by the linear foot measured from the bottom of the rock socket to the top of the completed drilled shaft.

Foundations



CIT Structures

Pile Driving



1. Pile Driving

5.3 DRIVEN PILE

5.3.1 General

Driven piles are used as the foundation for almost all abutments in Kansas bridges. Likewise they are used as the foundation for many piers in Kansas bridges. Proper pile driving inspection is critical to a successful bridge project.

2. Pile Driving

What is a driven pile?

There are two types of driven piles: sheet pile and foundation pile. Sheet piles are long, interlocking, rolled steel plates used in retaining structures, such as walls and cofferdams. Foundation piles are long slender columns designed to be driven into the ground. Foundation piles will be discussed here.

Foundation piles are simply columns, designed to transmit surface loads to low lying soil or bedrock. These loads are transmitted by friction between the pile and ground and by point bearing through the end of the pile. The actual amount of frictional resistance or end bearing is dependent on the particular site conditions.

Foundation piles are made of steel, concrete, or timber. Of these materials, steel H-pile and cast-in-place pipe pile are most commonly used in Kansas. The material and size of pile to be used on a particular project are designated in the plans on the General Notes and Summary of Quantities Sheet.



3

3. Pile Driving Video



4

4. Pile Driving

- Pile Driving Inspection
 - Let's just start from the beginning



5

5. Pile Driving

- What are H piles?



6

6.Pile Driving

- First things first, right?



7.Pile Driving

- SECTION 704 – PILING

- BID ITEMS

- Piles (*) (**)

- Test Piles (*) (**)

- Test Piles (Special) (*) (**)

- Cast Steel Pile Points

- Pre-Drilled Pile Holes

- *Type: Cast-In-Place Concrete, Prestressed Concrete, Steel or Steel Sheet, Corrugated Metal Sheet +

- **Size

- +Black or Galvanized

UNITS

Linear Foot

Linear Foot

Linear Foot

Each

Linear Foot

8. Pile Driving

- SECTION 704
– PILING
Table 704-1: Pile Formulas

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

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9. Pile Driving

- Plan Sheets – Summary Sheet

ITEM		CLASS III EXCAVATION		CONCRETE		REINFORCING STEEL		STRUCTURAL STEEL		WELDED		PILE		PILE		PRE-DRILLED		MULTI-LAYER		SLOPE		BRIDGE		ABUTMENT		BRIDGE		BEARING		CONCRETE	
LOCATION		Cu. Yds.		Cu. Yds.		Lbs.		Lbs.		Lbs.		Each		Lbs.		Lbs.		Sq. Yds.		Cu. Yds.		Lump Sum		Sq. Yds.		Sq. Yds.		Each		Sq. Yds.	
ABUTMENT NO. 1		100	18.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
PIL. NO. 1		110	18.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
PIL. NO. 2		110	18.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
ABUTMENT NO. 2		110	18.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
SUBSTRUCTURE		305	228.2	362.8	30,500	4,660	117,899	134,282	2,778	1368	11,376	158	314	493	Lump Sum	52	99	8	1,693	2,028											
TOTAL		305	228.2	362.8	30,500	4,660	117,899	134,282	2,778	1368	11,376	158	314	493	Lump Sum	52	99	8	1,693	2,028											

*Excavation quantities for pile footings are calculated relative to existing ground.
 **Quantities are included in the superstructure total quantity.
 ***Reinforcing steel in the abutments placed above the construction joint is included in the superstructure total quantity.

17110 includes 4 @ 49' and 4 @ 41'.
 17110 includes 8 @ 24' and 8 @ 23'.

LFR RATING FACTORS	
RATING LEVEL	INVENTORY OPERATING
DESIGN LOAD	1.05 1.37
HL-93 Loading	1.05 1.37
2008 Manual for Bridge Evaluation	

LFD RATING FACTORS	
RATING LEVEL	INVENTORY OPERATING
TRUCK	1.33 2.55
HS-20 TRUCK (S17)	1.33 2.55
TYPE I & II (S17)	1.12
2002 LFD Rating, 17th Edition AASHTO	

INDEX OF BRIDGE DRAWINGS	
SHEET NO.	DRAWING TITLE
305	BRIDGE QUANTITIES & INDEX
306	GENERAL NOTES
307	CONSTRUCTION
308	CONSTRUCTION LAYOUT
309	ENGINEERING DESIGN
310	FOOTING LAYOUT
311	ABUTMENT DETAILS
312	PIER DETAILS
313	ARCHITECTURAL PIER DETAILS
314	PIER DETAILS
315	ELASTOMERIC BEARING DEVICE DETAILS
316	FRAMING BEAM
317	CRACKING DETAILS
318	ANCHORAGE DETAILS
319	ANCHORAGE DETAILS
320	MISCELLANEOUS STEEL DETAILS
321	SLAB BEAM
322	SLAB DETAILS

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10. Pile Driving

• Plan Sheets – Quantity Sheet

SUMMARY OF BRIDGE QUANTITIES															
ITEM	CLASS III EXCAVATION	CONCRETE		REINFORCING STEEL		STRUCTURAL STEEL		WELDED STUD SHEAR CONNECTOR	PILE (STEEL) (HP12x53)	PILE (STEEL) (HP14x89)	PRE-DRILLED PILE HOLE	MULTI-LAYER POLYMER CONCRETE OVERLAY	SLOPE PROTECTION (AGGREGATE)	BRIDGE DRAIN SYSTEM	
		(GRADE 4.0) (AE)	(GRADE 4.0) (AE/SA)	(GRADE 60)	(GRADE 60) (EPOXY COATED)	(A709) (GRADE 50W)	(A270) (GRADE 50WT3)								
LOCATION	Cu. Yds.	Cu. Yds.	Cu. Yds.	Lbs.	Lbs.	Lbs.	Lbs.	Each	Lin. Ft.	Lin. Ft.	Lin. Ft.	Sq. Yds.	Cu. Yds.	Lump S	
ABUTMENT NO. 1	100	18.6	**	-----	#2,550	-----	-----	-----	196	-----	-----	-----	264	-----	
PIER NO. 1	*110	97.6	-----	15,360	-----	-----	-----	-----	192	104	-----	-----	-----	-----	
PIER NO. 2	*115	96.6	-----	15,160	-----	-----	-----	-----	184	64	-----	-----	-----	-----	
ABUTMENT NO. 2	-----	16.4	**	-----	#2,110	-----	-----	-----	172	-----	-----	-----	229	-----	
SUBSTRUCTURE	325	229.2	-----	30,520	4,660	-----	-----	-----	368	376	168	-----	493	-----	
SUPERSTRUCTURE	-----	-----	362.8	-----	83,180	117,999	134,282	2,778	-----	-----	-----	914	-----	Lump S	
TOTAL	325	229.2	362.8	30,520	87,840	117,999	134,282	2,778	†368	††376	168	914	493	Lump S	

*Excavation quantities for pier footings are calculated relative to existing ground.

**Quantities are included in the superstructure total quantity.

†This Includes 4 @ 49' and 4 @ 43'.
††This Includes 8 @ 24' and 8 @ 23'.

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11. Pile Driving

• Plan Sheets – Quantity Sheet

PILE (STEEL) (HPI2x53)	PILE (STEEL) (HPI4x89)	PRE-DRILLED PILE HOLE	MULTI-LAYER POLYMER CONCRETE OVERLAY	SLOPE PROTECTION (AGGREGATE)	BRIDGE DRAINAGE SYSTEM
Lin. Ft.	Lin. Ft.	Lin. Ft.	Sq. Yds.	Cu. Yds.	Lump S
196	-----	-----	-----	264	-----
-----	192	104	-----	-----	-----
-----	184	64	-----	-----	-----
172	-----	-----	-----	229	-----
-----	-----	-----	-----	-----	-----
368	376	168	-----	493	-----
-----	-----	-----	914	-----	Lump S
†368	††376	168	914	493	Lump S

→ †This includes 4 @ 49' and 4 @ 43'.
 ††This includes 8 @ 24' and 8 @ 23'.

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12. Pile Driving

• Plan Sheets – Pile Designation

- HP 12 X 53
- “H” - pile
- 12” in width and depth
- Weighs 53 lbs. per foot

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13. Pile Driving – Plan Sheets – Engineering

GENERAL NOTES

CONSTRUCTION SPECIFICATIONS
Kansas Department of Transportation, Standard Specifications for State Road and Bridge Construction, 2007 Edition, and Special Provisions.

DESIGN SPECIFICATIONS
KASDOT LRFD Bridge Design Specifications, 4th Edition, with Interims through 2008. Load and Resistance Factor Design.

DESIGN LOADS
Live Load: HS-20
Dead Load: Design Dead Load includes an allowance of 15 psf for a future wearing surface.

UNIT STRESSES

	Concrete (Grade 4.0)	Concrete (Grade 4.0/AE)	Concrete (Grade 4.0/AE/SA)	Reinforcing Steel (Grade 60)	Structural Steel (A588/Grade 50W)	Structural Steel (A572/Grade 50W/3)
Concrete (Grade 4.0)	FC = 4.0 ksi	FC = 4.0 ksi	FC = 4.0 ksi			
Concrete (Grade 4.0/AE)		FC = 4.0 ksi	FC = 4.0 ksi			
Concrete (Grade 4.0/AE/SA)			FC = 4.0 ksi			
Reinforcing Steel (Grade 60)				Fy = 60 ksi		
Structural Steel (A588/Grade 50W)					Fy = 50 ksi	
Structural Steel (A572/Grade 50W/3)					Fy = 50 ksi	

Steel in members designated W20 (Grade 50W/3) shall conform to the mandatory supplemental input properties for Item B.

LRFD DESIGN FOUNDATION LOADS

	Strength I	Service I	Factored
Allowable Piling	180	135	135
Pier Piling	180	135	135

Maximum design loads listed above for the Strength I and Service I limit states include load factors for the respective load combination as defined in KASDOT LRFD Table 3.4.1-1. Resistance factors (φ) applied to the nominal resistance for the various foundation elements are as follows:

Steel Piles: HP 12x53 (ductile), φ = 0.65
HP 14x59 (stair), φ = 0.65

GEOTECH REPORT
The geotechnical information shown on the plans is the best information available. Copies of the Bridge Foundation Design Report (June 2009) and Report Addendum (October 2009) are available from KDOT. These reports are for informational only.

FOUNDATION INSPECTION
Contact the Lawrence Regional Geotech Office when construction begins on the pier foundations so that KDOT geotechnical personnel may observe the bedrock of the design bearing elevations.

CONTRACTOR CONSTRUCTION SURVEYING
Contractor Construction Surveying for clear span bridges requires two independent surveys. See KDOT Specifications.

RETAINING WALL SURVEY
Prior to construction of the abutment walls, the Contractor shall take field measurements of the partially constructed retaining wall at the southeast corner to confirm that, when completed, the wall will make up with the abutment as shown in the plans. If the alignment of the partially constructed retaining wall cannot be ascertained from plan dimensions, the Contractor will submit a retained abutment detail to illustrate corrective action necessary to ensure proper alignment of the two elements. Construction of abutment beam cannot commence until approval is received from the Engineer.

CONCRETE
Substructure concrete to be placed in accordance with the Concrete (Grade 4.0/AE/SA). Substructure concrete to be placed in accordance with the Concrete (Grade 4.0/AE). The Contractor may use Concrete (Grade 4.0) in the abutments below the abutment joint, pier, wing, and driven shafts, below the exposed edges of all concrete with a 3/4 inch triangular rebar, except as otherwise noted on the plans.

DECK PROTECTIVE SYSTEM
Deck coat of nonforming steel in the deck slab and rails. Place a 3/4 inch Multi-Layer Polymer Concrete Overlay over the entire deck as shown on the plans.

BRIDGE EXCAVATION
All excavation shall be Class II. See the Bridge Excavation sheet for the limits of pay excavation.

EMBANKMENT
Complete the embankment of the abutments as shown on the Bridge Excavation sheet prior to driving the abutment piling.

PILE
Drive all piling to penetrate the Lane Side Member and bear upon the Right-of-Way Line. Member. Overdriving of pile on hard bottom will result in damage to the pile. Piles damaged by overdriving must be removed and replaced. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. First pile tip elevations should be determined in the field based on force calculations. Drive all piling to the Pile Driving Formula Load of 180 tons.

As a minimum drive each pile to the last and penetration, but in no case shall the pile be driven to MORE THAN 100% 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.

ENCLOSING
All steel piles in the pier foundations shall be pre-drilled to the elevation shown on the Engineering design sheet. Pre-drilled pile holes shall be a minimum of 32 inches in diameter. After driving, the holes shall be backfilled with Grade 3.0 Concrete. The pile will be kept plumb during the backfilling operation.

BACKFILL CONNECTION
Contact KDOT if the abutments and piers.

SLOPE PROTECTION (APPROPRIATE)
Place a 12 inch blanket of Slope Protection (Appropriate) of the abutments to the limits shown on the plans as directed by the Engineer. Gravel and appropriate for the slope protection shall meet the requirements of State for Aggregate Ditch Lining and have a D₅₀ of 4 inches.

BRIDGE GENERAL PROTECTION SYSTEM
Apply a Bridge General Protection System to the approach side of the abutments and wingwalls in accordance with KDOT Specifications and the manufacturer's recommendations. Cover the abutment to the limits shown in the details, not including the top of the concrete rest. Prior to backfilling, repair any damage done to the system or to extra cost to the State.

ABUTMENT STRIP DRAIN
See the General Notes on the "Abutment Strip Drain" sheet.

SUBSTRUCTURE CONCRETE STAIN PROTECTION AND SANDBLASTING
Protect the exposed surface of the piers and the front face of the abutments (by covering with polyethylene sheeting or other approved method) prior to erecting the structural steel and until the deck slab has been placed. Prior to applying the Concrete Masonry Coating, sandblast the pier and front face of the abutment to a uniform appearance by removing all old paint, old concrete form lines, etc. This work will be subject to structural steel.

CLASTER FOR BEARING DEVICES
Bearing devices shall be fabricated with an elastomer satisfying the Shear Modulus as specified on the bearing device detail sheets tested and reported per KASDOT M-251, Section 8.8.4 in accordance with Low Temperature Grade 3 requirements. A Type 4 certification for elastomeric bearing device is required for construction.

FALSEWORK
A Licensed Professional Engineer shall design the falsework details. Details shall bear the seal of the Engineer.

FALSEWORK INSPECTION
For the sequence of construction shown in the plans, this structure has falsework plan requirements which are considered "Category 2" by KDOT specifications. If falsework deficiencies or variations from the approved and posted plans are found, the falsework design Engineer of record will provide written approval of the changes, if for the convenience of the Contractor the falsework becomes "Category 1" either by changes to the construction sequence or by the use of non-typical supports. The inspection and review requirement of "Category 1" will be fully enforced, but if no cost to the State, "Category 2" falsework inspection is not paid for directly, but is subject to other bid items.

CONCRETE PLACING SEQUENCE
The sequence of placing concrete in the slab and curbs shall be as shown, or the Contractor may submit an alternate placing sequence for review. Submit the alternate placing sequence to the Engineer at the Preconstruction Conference. Include the proposed rate of concrete placement in C.I. form, the pour capacity, placement direction, construction joint location, a description of the equipment used in placing the concrete, proposed abutments, and the quantity of concrete in each placing segment. Any additional cost for the Contractor's alternate plan of placing concrete, including abutments, shall be at the Contractor's expense and shall be considered subject to the bid item "Concrete (Grade 4.0/AE/SA)". Approval of the Contractor's alternate sequence is required prior to placement of concrete in the deck. Place and hand vibrates all concrete for the abutments above the construction joint to the bottom of deck elevation. Just prior to the normal paving train operations. Do this work in a manner to avoid cold joints in either the slab or in the abutment.

CONTRACTOR LAYOUT
Only fast markings is permitted on the new deck during the seven day curing period. Keep any exposed deck wet during the 7-day curing period. See KDOT Specifications Section 710 Table 710-2.

POLYMER OVERLAY
Reinforce the bridge deck surface using a butyl tape attached to the finishing machine. When the site and temperature requirements of the specifications are met, profile grind, place a polymer overlay, and apply polymer overlay markings on the bridge deck. When the site and temperature requirements are not met, complete any required profile grinding and apply temporary pavement markings. Apply the polymer overlay according to the test section criteria and temperature shown on the current specifications. Apply polymer overlay to the vertical face of the bridge barrier to the first break in geometry.

CONCRETE MASONRY COATING
Exposed concrete faces of the bridge piers, barriers, and slab fascia will be coated with an appropriate masonry coating within the limits as indicated in the plans. All surfaces to be coated shall be prepared with a light brush sandblast prior to application. The form release agent used on concrete surfaces will be removed by the Contractor within the limits shown in the plans. The application of the coating compound on surfaces to be coated is prohibited. All labor, materials and incidentals required to perform this work shall be paid for as "Concrete Masonry Coating" in accordance with the KDOT Specifications.

DECK FORMING
Steel or precast concrete stay-in-place forms will not be allowed.

CONSTRUCTION Joints
The construction joints shown are optional with the Contractor. If used, place the construction joints only at locations shown or at locations approved by the Engineer.

TEMPERATURE
The design temperature for all dimensions is 60°.

QUANTITIES
Items not listed separately in the Summary of Quantities are subject to other items in the project.

OVERSIGHTS
All dimensions shown on the design plans are horizontal dimensions unless otherwise noted. Make necessary allowances for roadway grade and cross slope.

BRIDGE NUMBER PLATE

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	69-46 (R-402)-02	2011	258	259

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14. Pile Driving – Plan Sheets – Engineering

PILING:

Drive all piling to penetrate the Lane Shale Member and bear upon the Raytown Limestone Member. Overdriving of pile on hard bedrock will result in damage to the pile. Piles damaged by overdriving must be removed and replaced. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Final pile tip elevations should be determined in the field based on force calculations. Drive all piling to the Pile Driving Formula Load of:

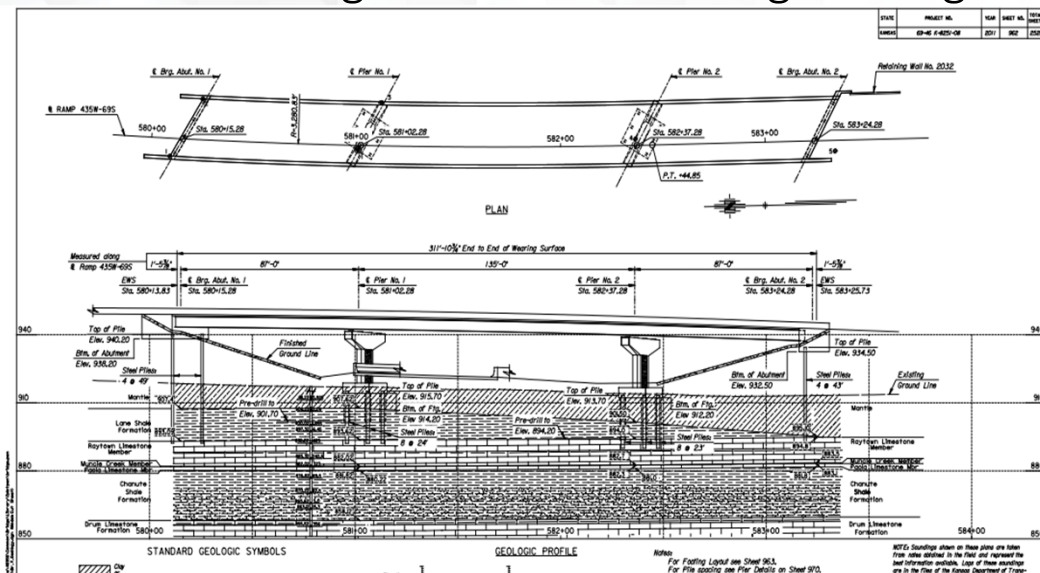
Abutments	108 tons
Piers	180 tons

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.



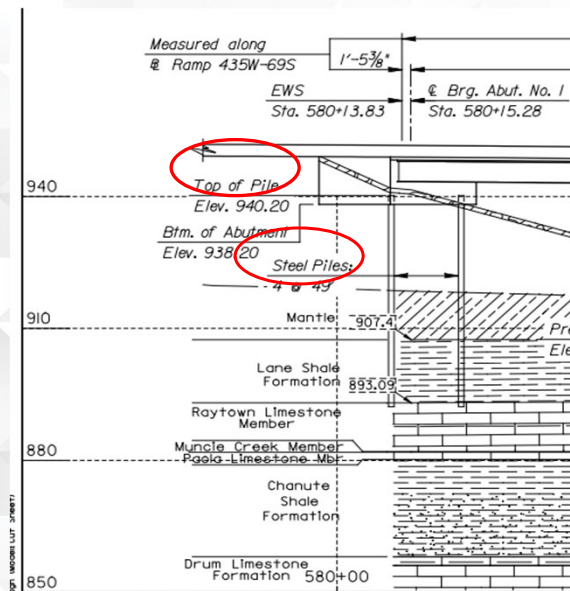
15

15. Pile Driving – Plan Sheets – Engineering



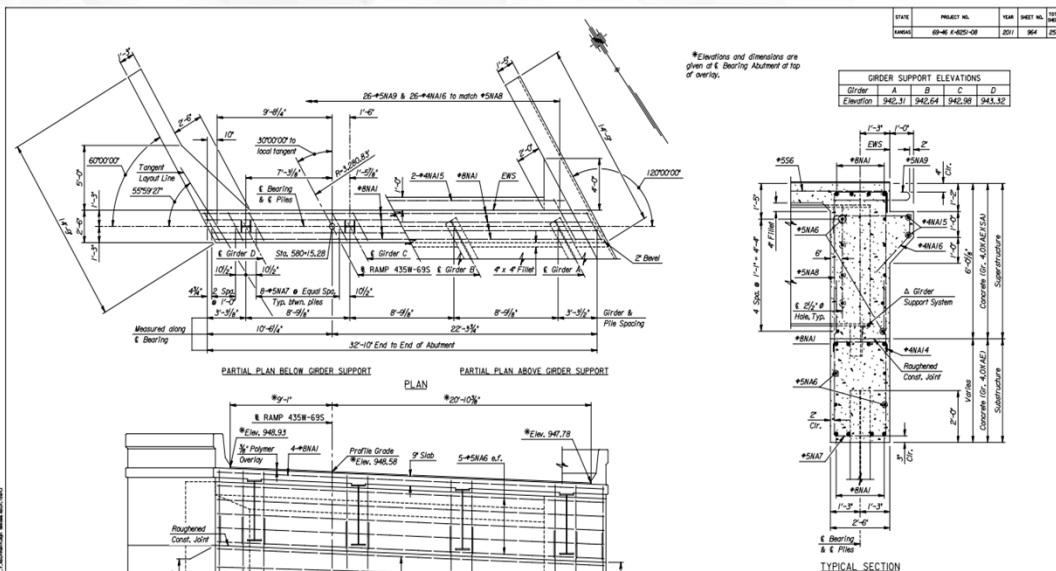
16

16. Pile Driving – Plan Sheets – Engineering Geology



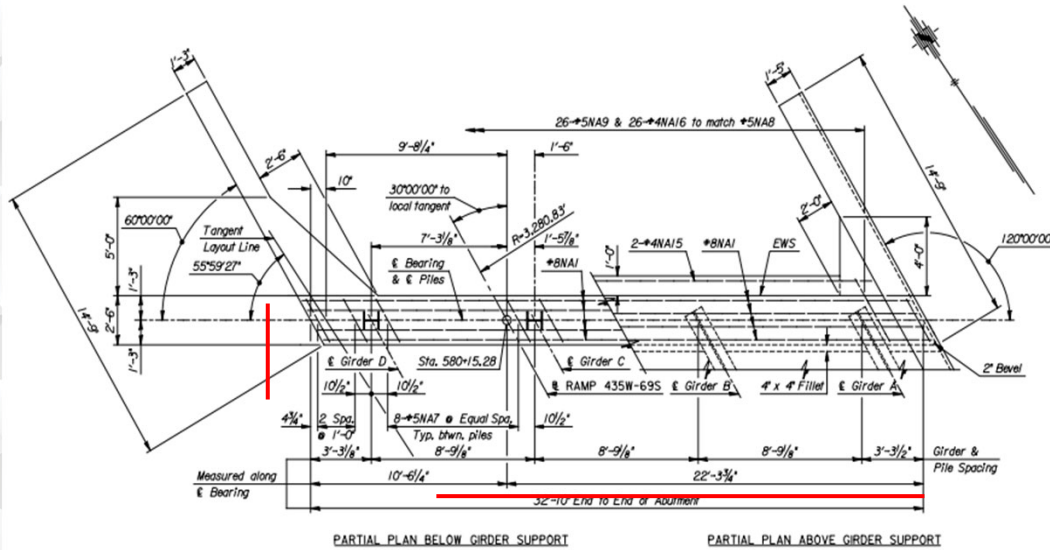
17

17. Pile Driving – Plan Sheets – Engineering



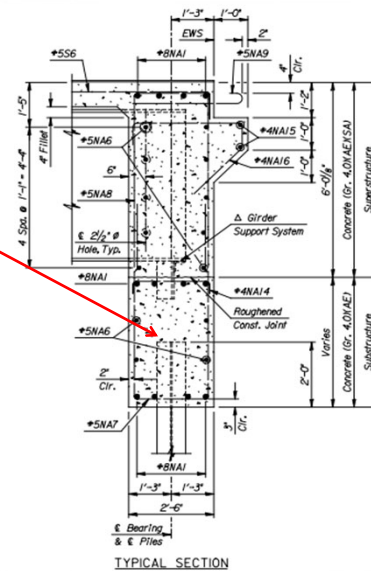
18

18. Pile Driving – Plan Sheets – Abutment



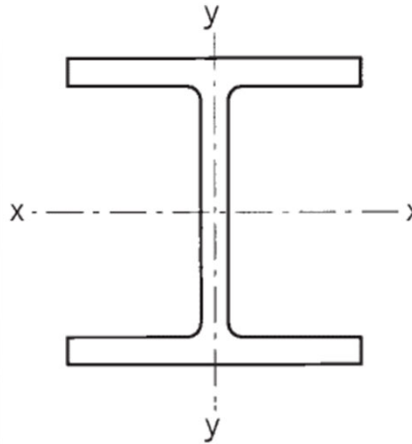
19

19. Pile Driving – Plan Sheets – Abutment Details



20

- Plan Sheets – Pile orientation
- Strong Axis - y
- Weak Axis - x



- DOT Form - 217

[illegible]

22. Pile Driving

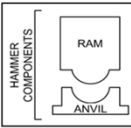
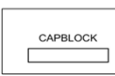
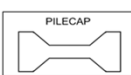
- From the Contractor – Hammer Specs
- Delmag

Delmag Product Specifications, models D6-32 through D30-32/33 (for models D36-32/33 through D200-42, see below)							
Models	D6-32	D8-22	D12-42	D16-32	D19-42	D25-32/33	D30-32/33
Maximum Batter							
standard/extended	13	12	15/11	15/11	15/11	15/11	15/11
Piston Weight (lbs)	1322	1762	2820	3528	4015	5513	6615
Energy per Blow (adj)							
max (ft lbs)	13500	20100	33990	40200	43225	66380	75452
min (ft lbs)	6300	9434	15660	18871	20540	29486	35383
Bearing Capacity* (tons)	68	90	157	201	216	332	377
Blows per Minute							
min/max	38/52	36/52	35/52	36/52	35/52	35/52	36/52
Consumption							
Diesel fuel (gal/hr)	0.7	1	0.95	1.45	1.45	2.11	2.64
Lubrication oil (gal/hr)	0.16	0.26	0.26	0.26	0.26	0.26	0.26
Capacity							
Diesel fuel (gal)	5	5.28	6.34	20	20	17.7	17.7
Lubrication oil (gal)	1.3	1.58	1.72	5	5	5.02	5.02
Operating Weights (approx)							
Hammer only (lbs)	5440	5870	7800	8900	9500	14100	15200
Hammer w/ typical drive cap (lbs)	6640	7070	8800	10100	10700	16100	17200
Anvil (impact block)	370	370	620	753	753	1360	1360
Dimensions (in)							
Overall length	196	231	233	233	233	256	256
Hammer length	150	185	186	186	186	207	207
Hammer len. w/ ext.	--	--	--	219	219	246	246
Hammer depth-rear	14	14	14	14	14	19	19
Hammer depth-front	14	14	14	14	14	18	18
Guiding							
Standard (box leads)	8" x 21"	8" x 21"	8" x 21"	8" x 21"	8" x 21"	8" x 27"	8" x 27"
Optional	12"/14" spud	12"/14" spud	8" x 27"	8" x 27"	8" x 27"	8" x 32"	8" x 32"
			12"/14" spud	12"/14" spud	12"/14" spud	14" spud	14" spud

23

23. Pile Driving

- From the Contractor – Pile and Driving Equipment Data
- DOT Form – 217aa

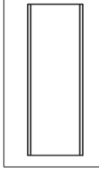
Notice to Contractors	
Pile and Driving Equipment Data	
Test Pile/Test Pile (Special), Section 704, Division 700, 2007 Standard Specifications	
Project No. _____	County _____
Contract No. _____	Structure Name/No. _____
Pile Contractor or Subcontractor _____	
	Manufacturer _____ Model _____ Type _____ Serial No. _____ Rated Energy _____ (ft-lb) @ _____ Length of Stroke (ft) Fuel Setting _____ Modifications _____
	Material _____ Thickness _____ (inches) Area _____ (ft²) Modulus of Elasticity (E) _____ (psi) Coefficient of Restitution (e) _____
	Weight _____ (lb) Material _____ Area _____ (ft²) Modulus of Elasticity (E) _____ (psi) Coefficient of Restitution (e) _____
	Material _____ Area _____ (ft²) Modulus of Elasticity (E) _____ (psi) Coefficient of Restitution (e) _____
Revision 10/2008	DOT Form 217AA

24

24. Pile Driving

- From the Contractor – Pile and Driving Equipment Data
- DOT Form – 217aa

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

Revision 10/2008 DOT Form 217AA



25

25. Pile Driving

- From the Contractor – Mill Certification and BOL
- From Topeka - Certification

DATE 2/27/12

CUSTOMER NO. 3670

REQUEST ID 166562

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

SKYLINE STEEL
CAHABA PLACE, SUITE 200
4908 CAHABA RIVER ROAD
BIRMINGHAM, AL 35243

CERTIFIED MILL
100% MELTED AND MANUFACTURED
All shapes produced by Nucor and rolled to a fully killed and finished condition.
(Length May Not Be Traceable)

ASTM A572/A572M GR50-
ASTM A709/A709M-11
ASTM A6/A6M-11

SKYLINE STEEL GEORGIA OFFICE
3250 PEACHTREE INDUS BLVD
SUITE 107
DULUTH, GA 30096

ITEM #	ITEM DESCRIPTION	QTY	HEAT #	MECHANICAL PROPERTIES								CHEMICAL PROPERTIES							
				YIELD TO TENSILE RATIO	YIELD STRENGTH	TENSILE STRENGTH	ELONG	CHARPY IMPACT		C	Mn	P	S	Si	Cu	Ni	Cr		
					PSI	MPa	PSI	MPa	%									TEMP °F	IMPACT ENERGY FT-LBS
1	HP12 - 53.0	3	379406	.71	57000	80000	23												
	50'			.72	56000	78000	22												
	HP310x 79.0				393	552	23												
	15.240 M				386	538	22												



26

26. Pile Driving

- What have we done so far?
 - Read the specifications.
 - Familiarized ourselves with the plans.
 - Know quantity, lengths and bearing capacity.
 - Know orientation and placement within the foundation.
 - Began setting up final documentations.
 - Began setting up field notes for actual pile driving.



27

27. Pile Driving

- What have we done so far?
 - Know our Ordered and Accepted Lengths.
 - Know the Pile dimension and weight.
 - Know the Pile hammer to be used.
 - Know our Pile driving formula.



28

28. Pile Driving

- Ready to Drive Pile

LEADS



29. Pile Driving

- Ready to Drive Pile

HAMMER



30. Pile Driving

- Driving Pile
 - Check for correct Piling used
 - Check heat number
 - Pile Points if specified



31

31. Pile Driving

- Driving Pile
 - Determine placement
 - Check Axis
 - Check spacing



32

32. Pile Driving

- Driving Pile
 - Check for Plumb
 - Set Pile

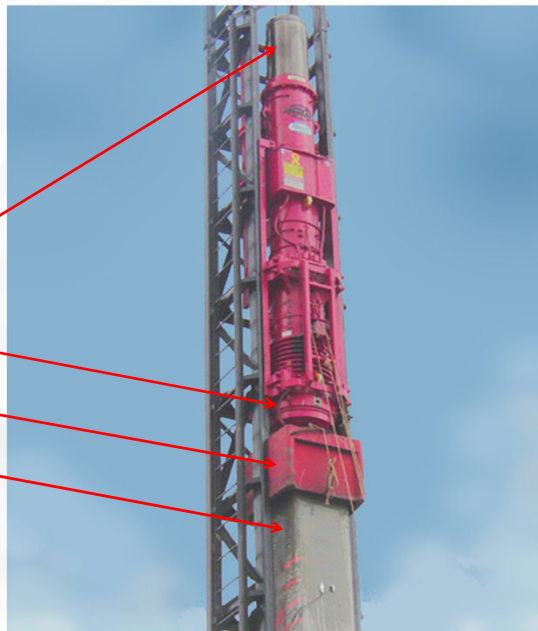


33

33. Pile Driving

- Driving Pile
 - Leads and Hammer
 - Ram (striking part)
 - Anvil
 - Cap
 - Pile

Once pile driving begins it is a very quick and fluid motion



34

34. Pile Driving

- Driving Pile

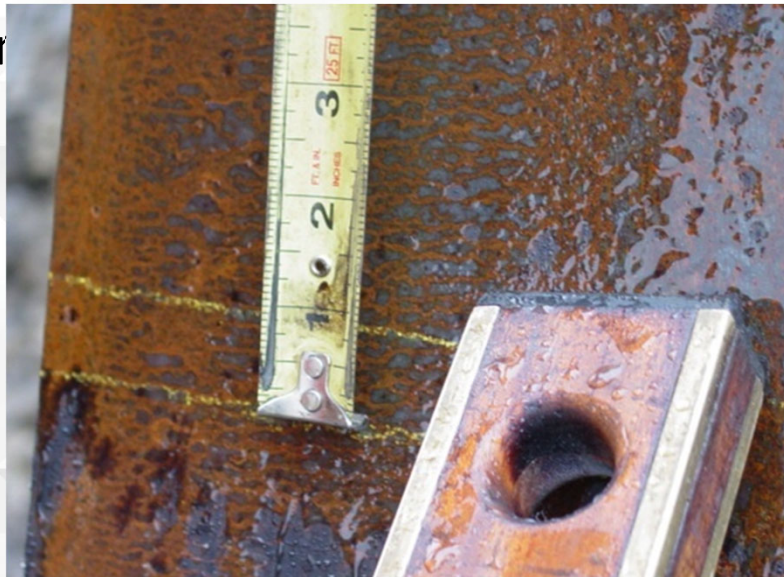
- Mark distance of penetration
- Count blows



35. Pile Driving

- Driving Pile

- Measure distance of penetration in 20 blows
- Average



36. Pile Driving

• Driving Pile

- Check height of drop
- Compensate for the distance through the hammer
- Mark hammer and leads 1' increments



37

37. Pile Driving

• We know our Pile formula, right?

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

*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

38

38. Pile Driving

- Delmag Diesel Hammer Pile Formula

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



39

39. Pile Driving

- P= safe bearing power in pounds
- W= weight in pound, of striking part of hammer
- H= height of fall in feet
- S= the average penetration in inches per blow for the last 20 blows for diesel hammers
- X= weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving



40

40. Pile Driving

- P= safe bearing power in pounds
- W= 4,190 lbs. (striking part of hammer)
- H= 10 feet (height of hammer drop)
- S= 0.15 (3 inches /20 blows)
- X= 4550 lbs. (2597 lbs. pile (49'x53) + 1953 lbs. cap and/or anvil)



41

41. Pile Driving – Delmag Diesel Hammer Pile Formula

W = weight (lbs) of striking part of Hammer

H = height of hammer drop (ft)

$$P = \frac{1.6 * 4190 * 10}{0.15 + 0.1(4550/4190 **)}$$

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

X = weight (lbs) of the pile plus the weight of cap and anvil



42

42.Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(4550/4190^{**})}$$



43

43.Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(1.09^{**})}$$

** Diesel quantity x/w shall not be < 1



44

44. Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15 + 0.109}$$



45

45. Pile Driving

- Delmag Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.259}$$



46

46. Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = 258,842 \text{ lbs.}$$



47

47. Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{258,842 \text{ lbs.}}{2000}$$

2000

$$P = 129 \text{ tons}$$



48

48. Pile Driving

- Delmag Diesel Hammer Pile Formula

P = 129 tons

Plans called out 108 tons

Don't drive over 110%



49

49. Pile Driving

- Driving Pile
- Over driven pile

• OUCH...!



50

50. Pile Driving

• Diesel Hammer Pile Formula

- Back figure and solve for “S” prior to driving the pile. Have these notes with you as the pile driving is being performed.
- The actual driving of the pile goes rather quickly; you need to be prepared with instructions to the contractor and inform him that satisfactory bearing has been achieved.
- If you feel there is a problem, contact Geology.

51

51. Pile Driving

• Solve for

• “S”

• Range {

Diesel Hammer for 35 foot pile

	100 ft. Wt. of pile and accessories				Hammer blow at surface		Length of Pile		Hammer blow at Pile		SPW		Minimum Bearing		Maximum Bearing	
	3000				1480		35		42		1		77.9		85.7	
Inches	Drop of the Hammer in Feet															
in feet	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	
20 blows	107	117	128	139	149	160	171	181	192	203	213	224	235	245	256	
0.250	101	111	121	131	141	152	162	172	182	192	202	212	222	232	243	
0.500	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	
0.625	91	101	110	119	128	137	146	155	165	174	183	192	201	210	219	
0.750	87	96	105	113	122	131	140	148	157	166	175	183	192	201	209	
0.875	83	92	100	109	117	125	134	142	150	159	167	175	184	192	200	
1.000	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192	
1.125	77	84	92	100	108	115	123	131	138	146	154	161	169	177	184	
1.250	74	81	89	96	103	111	118	126	133	140	148	155	162	170	177	
1.375	71	78	85	92	100	107	114	121	128	135	142	149	156	164	171	
1.500	68	75	82	89	96	103	110	117	123	130	137	144	151	158	165	
1.625	66	73	79	86	93	99	106	113	119	126	132	139	146	152	159	
1.750	64	70	77	83	90	96	102	109	115	122	128	134	141	147	154	
1.875	62	68	74	81	87	93	99	105	111	118	124	130	136	142	149	
2.000	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	
2.125	58	64	70	76	81	87	93	99	105	111	116	122	128	134	140	
2.250	56	62	68	73	79	85	90	96	102	107	113	119	124	130	136	
2.375	55	60	66	71	77	82	88	93	99	104	110	115	121	126	132	
2.500	53	59	64	69	75	80	85	91	96	101	107	112	117	123	128	
2.625	52	57	62	67	73	78	83	88	93	99	104	109	114	119	125	
2.750	51	56	61	66	71	76	81	86	91	96	101	106	111	116	121	
2.875	49	54	59	64	69	74	79	84	89	94	99	103	108	113	118	
3.000	48	53	58	62	67	72	77	82	86	91	96	101	106	110	115	
3.125	47	52	56	61	66	70	75	80	84	89	94	98	103	108	112	
3.250	46	50	55	59	64	69	73	78	82	87	91	96	101	105	110	
3.375	45	49	54	58	63	67	71	76	80	85	89	94	98	103	107	
3.500	44	48	52	57	61	65	70	74	78	83	87	92	96	100	105	
3.625	43	47	51	55	60	64	68	73	77	81	85	90	94	98	102	
3.750	42	46	50	54	58	63	67	71	75	79	83	87	91	95	100	
4.000	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	
4.125	39	43	47	51	55	59	63	67	71	74	78	82	86	90	94	
4.250	38	42	46	50	54	58	62	66	70	73	77	81	85	89	93	
4.375	38	41	45	49	53	57	61	65	69	72	76	80	84	88	92	
4.500	37	41	44	48	52	56	60	64	68	71	75	79	83	87	91	
4.625	36	40	43	47	51	54	58	62	65	69	72	76	80	84	88	
4.750	36	39	43	46	50	53	57	60	64	68	71	75	79	82	86	
4.875	35	38	42	45	49	52	56	59	63	66	70	73	77	80	84	
5.000	34	38	41	45	48	51	55	58	62	65	69	72	75	79	82	
5.125	34	37	40	44	47	51	54	57	61	64	67	71	74	77	81	
5.250	33	36	40	43	46	50	53	56	60	63	66	70	73	76	80	
5.375	33	36	39	42	46	49	52	55	59	62	65	68	72	75	79	
5.500	32	35	38	42	45	48	51	54	58	61	64	67	70	74	77	

52

52. Pile Driving

- 2nd example Delmag Diesel Hammer – 40' (shorter pile)
- P= safe bearing power in pounds
- W= 4,190 lbs. (striking part of hammer)
- H= 10 feet (height of hammer drop)
- S= 0.15 (3 inches /20 blows)
- X= 4073 lbs. (2120 lbs. pile (40'*53) + 1953 lbs. cap and/or anvil)



53

53. Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{1.6 * 4190 * 10}{0.15 + 0.1(4073/4190 **)}$$



54

54. Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15 + 0.1(4073/4190^{**})}$$



55

55. Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15 + 0.1(0.97^{**})}$$

** Diesel quantity x/w shall not be < 1



56

56.Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(1.00)}$$

** Diesel quantity x/w shall not be < 1



57

57.Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.10}$$



58

58. Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.25}$$



59

59. Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{268,160 \text{ lbs.}}{2000}$$

$$P = 134 \text{ tons}$$



60

60. Pile Driving

- 704.4 c. Driving Piles

- Completed pile driving –
 - Check position of pile

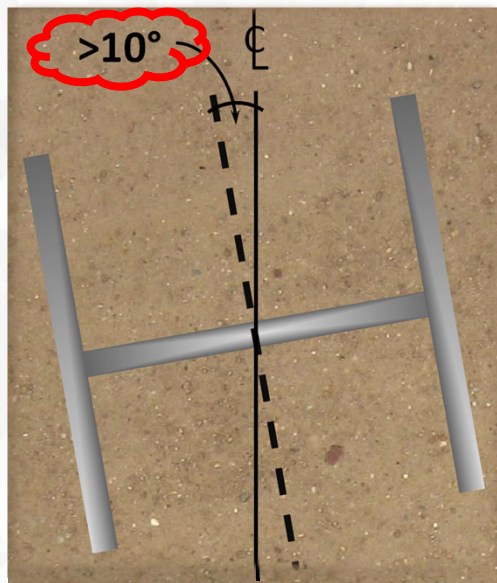


61. Pile Driving

- 704.4 c. Driving Piles
- Do not force misaligned piles into proper position.
- If the pile is 35 feet or less in length, the maximum allowable variation from the vertical or battered lines - $\frac{1}{4}$ inch per foot of length.
- If the pile is greater than 35 feet in length, the maximum allowable variation from the vertical or battered lines - $\frac{1}{8}$ inch per foot of length.
- The maximum allowable variation on the head of the driven pile from the position - 2 inches for piles used in bents, and 6 inches for foundation piles.

62. Pile Driving

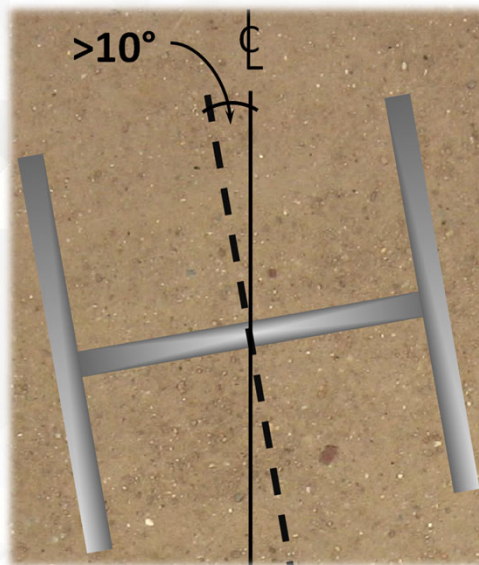
- 704.4 c. Driving Piles
- Drive all piles in the orientation shown on the Plans. If the axial orientation of the pile rotates or twists by more than 10° ,



63

63. Pile Driving

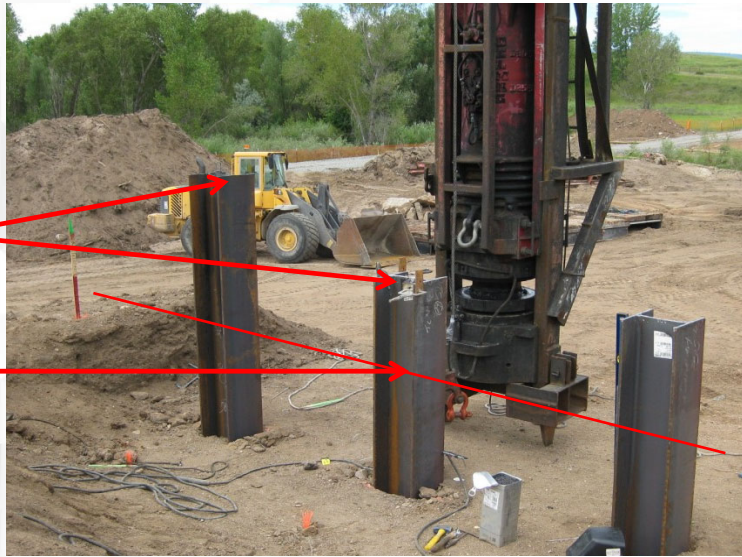
- the Field Engineer will contact the Bureau of Structures and Geotechnical Services.



64

64. Pile Driving

- Pile elevation after driving to determine pay pile and cut-off
- Pile Cut-Off
- Pile remaining in structure



65. Pile Driving

- 704.5 MEASUREMENT AND PAYMENT
 - The Engineer will measure the length of steel pile, steel sheet pile, cast-in-place concrete pile and prestressed concrete pile remaining in the structure, by the linear foot.
 - The Engineer will measure each cast steel pile point used.

66.Pile Driving

- 704.5 MEASUREMENT AND PAYMENT

- If after driving the ordered and accepted length of pile, plan bearing is not achieved and additional pile is required, the Engineer will measure for payment each pile splice needed to lengthen the pile to achieve bearing.



67

67.Pile Driving

- 704.5 MEASUREMENT AND PAYMENT

- The Engineer will measure pile cut-off by the linear foot for Pile (*) (**). Pile cut-off is the difference between the length of pile ordered and accepted and the actual length of pile remaining in the structure.
- Payment for pile splices at 4 times the contract unit price of the type of pile spliced is full compensation for the specified work.



68

68.Pile Driving

- 704.5 MEASUREMENT AND PAYMENT

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



69

69.Pile Driving

- 704.5 MEASUREMENT AND PAYMENT

- Steel Pile _ Unit price \$55.00 lft
- Table 704-2 _ 75% of unit price
- $\$55.00 \times 75\% = \41.25
- lft cut-off determined by DOT Form 217 = 12.35'
- Amount added to contract = \$509.44



70

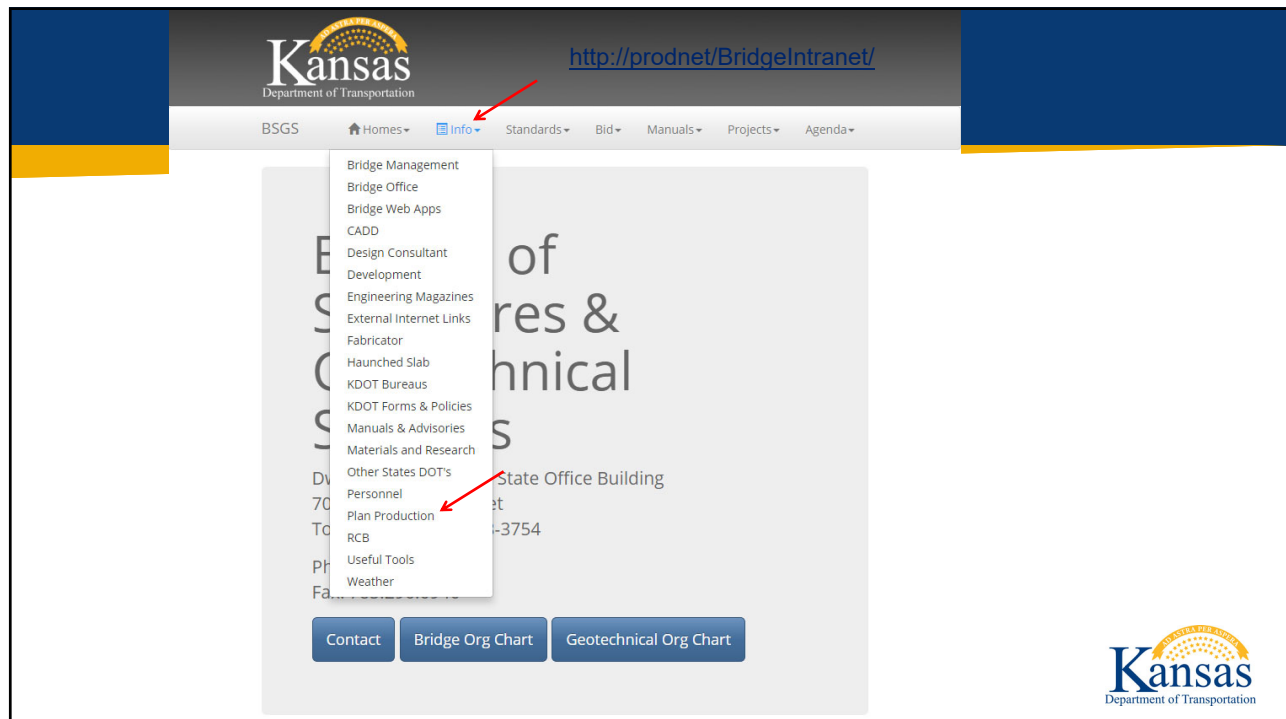
70.Pile Driving



708- Falsework & 710 -Form Construction

F&F-1

1



2

Plan Production

RCB

Useful Tools

Weather

Plan Production

- Bid Tabs
- Bridge Bid Items
- Consultant Shop Drawings
- • Plan Review Summary Information (Revised 10-24-2012)
- Plans in U.S. Customary Units
- Posting Electronic Files for Letting
- Railroad Grade Separation Guidelines 2007
- Revised Plans Procedure
- Revised Plans Transmittal Memo Example
- Revised Shop Drawing
- Road Memo "Earthwork Computation Report and Alignment & Cross Section Report"
- Shop Drawing Distribution
- Shop Drawing Letter Email Distribution
- Stamping PDF Plans

BSGS Intranet



3

Timeline for Submittals:

(Covered in S. Spec.
105.10 Plans & Working
Drawings) (p. 100-43)

Plan Review Summary Information									
Information	# of Plan Copies	Lead Time Required	Specs to Review	Note Numbers to Review	P.E. Stamp Required	Plan Review	Recommend	Approval	
Plan Type									
Shop Details	Consultant	*	Project Specific	101 106 705 707 709 716 719 721 722 735 1609	5200 6000 6010 6100 6110 6111 6115 6620 6625 7410	No	No	**	
	In House	*	Project Specific			No	Yes	**	
Shoring	Standard	*	3 weeks	701	30 35 300 1000	Yes	Yes	Yes	
	Railroad	*	6 weeks	702					
Falsework	Category (1)	*	4 weeks	105 708 710 710	4100 4105 4115 7000 7010 7010	Yes	Yes	Yes	
	Category (2)	*	4 weeks	105 708 710 710	4100 4106 4110 4120	Yes	District Policy		
Erection	Category A	(1)		105 708	3000 3010 5210	6521 6522 6523	No	No	No
	Category B	*	4 weeks	710 SP07-07004	6420 6520	6521 6522 6523	Yes	Yes	Yes
	Category C	*	4 weeks				Yes	Yes	Yes
Demolition	Category A	(1)		105 708 710	3000 3010 5210	6521 6522 6523	No	No	No
	Category B	*	4 weeks	710 SP07-07004	5210 6420	9001 9002	No	No	No
	Category C	*	4 weeks	07014	6520	9003	Yes	Yes	Yes
Pour Sequence	Discuss Possible Changes at Precon Meeting	*	2 Weeks	105 708 SP07-0711	4240 4200 5100 7110 7110 7210 7215 7300		No	Yes	Yes

Based on project complexity, the specifications and the notes listed in this document may only be the base of what is required.

* Electronic submittal conforming to 105.10 (b) of the Standard Specifications for State Road and Bridge Construction

** General Compliance Stamp



4

Plan Review Summary Information								
Information Plan Type	# of Plan Copies	Lead Time Required	Specs to Review	Note Numbers to Review		P.E. Stamp Required	Plan Review	Recommend Approval
Falsework	Category (1)	*	4 weeks	105 708 710	4100 4105 4115 4120	4130 4140 7800 7810	Yes	Yes
	Category (2)	*	4 weeks	105 708 710	4100 4106 4110 4120	4130 4140 7800 7820	Yes	District Policy

Based on project complexity, the specifications and the notes listed in this document may only be the base of what is required.

* Electronic submittal conforming to 105.10 (b) of the Standard Specifications for State Road and Bridge Construction

* * General Compliance Stamp



5

105.10 b. Plans & Working Drawings:

105.10 PLANS AND WORKING DRAWINGS

a. Plans. The Secretary may provide plans showing lines, grades, roadway typical cross-sections, all structures, and a summary of contract pay items. Steel bridge plans show only general features. Keep one set of plans on the Project site.

→ **b. Working Drawings.** Submit an electronic copy of working drawings in Adobe PDF (Portable Document Format) file format, with a maximum internal page size of 17 inches by 11 inches. For each deliverable (falsework plans for a structure, shop drawings for structural elements which will be fabricated, etc.), submit the copy in one transmission, with the sheets consecutively numbered, and with no duplications of sheets.

c. Timely Submittal. Provide all working drawings to the Field Engineer or designated KDOT office at the time the Progress Schedule/Network Schedule identifies or at a date that allows the reviewing Engineers at least 15 business days to review the drawings. If the Contractor desires the drawings be reviewed in less than 15 business days, notify the Field Engineer or designated KDOT office that the time for review and approval is critical. While KDOT will attempt to accommodate the Contractor's time frame, KDOT makes no guarantee that KDOT will complete the review process in less than 15 business days.

d. Timely Review. Within 15 business days after the Contractor has provided initial or revised working drawings to the Field Engineer or designated KDOT office, the Field Engineer or designated KDOT office will review and either approve or reject the drawings. If rejected, correct and resubmit revised working drawings for the Engineer's approval. Allow the Field Engineer and other reviewing Engineers a reasonable time for subsequent review and approval. The Contractor assumes all risk of delay incurred for revisions and the Engineer's review of these revisions. If KDOT fails to accept or reject initial or revised drawings within 15 business days, the Contractor may seek compensation under **subsection 104.6** for additional time or acceleration costs.

e. Responsibility for Working Drawings. The Contractor has sole responsibility for the adequacy and accuracy of the working drawings. The Engineer's approval of the working drawings is for KDOT's benefit, not to ensure Contractor quality control. The Engineer's review and/or approval are not intended as an undertaking of the Contractor's duty to provide adequate and accurate working drawings.

(p. 100-43)



6

Falsework vs. Formwork

Falsework:

- Temporary Construction used to support vertical loads during construction
- “Works” to hold the structure up

Formwork:

- Temporary Structure to mold concrete into desired shape until hardened
- “Forms” the concrete



7

708.3 a. Falsework Design:

(p. 700-35)

- Contractor is responsible for Falsework Design Plans by a licensed P.E.
- Field Engineer submits Falsework Plans to Bridge (or Local Projects if structure is on City or County System)
- Bridge/Local P. will review Falsework Drawings and remit to Field Engineer



8

708.3 a. Design Requirements:

708.3 CONSTRUCTION REQUIREMENTS

a. Falsework Design.

(1) General Falsework Design Requirements. Design falsework according to the KDOT Bridge Design Manual, Falsework Design, Analysis and Inspection.

Include the type, size, grade and finish of all lumber used. Provide adequate details of the proposed method of construction. The Engineer may request additional information.

In designing forms and centering, regard concrete as a liquid. In computing loads, assume a weight of 150 pounds per cubic foot for the vertical pressure, and a minimum of 85 pounds per cubic foot in computing horizontal pressure.

Do not place cast-in-place shear bolts, coil inserts or other devices used as falsework support in pier columns without the approval of the Engineer. Through bolts are permitted. Do not drill and grout bolts or other devices into the pier columns unless shown in the Contract Documents.

(2) Category 1 Structures. On the structures listed below, submit to the Engineer for review (See SECTION 105) by the State Bridge Office (SBO) (or Bureau of Local Projects) and, if applicable, the railroad company, 7 copies of detailed falsework plans designed and sealed by a Professional Engineer.

- All structures over or under railroad tracks; (Cat 1: Bridge or Local Projects)
- All structures built over highways or streets carrying traffic;
- All structures requiring falsework that directly carries highway traffic loads during construction;
- Deck overhangs greater than beam depth or greater than 54 inches;
- Superstructure forming with "non-typical" support (i.e. needlebeams); and
- All structures that require falsework plans to be submitted to the SBO (or Bureau of Local Projects) as noted in the Contract Documents.

(3) Category 2 Structures. If not included in the Category 1 structures above, submit to the Engineer for review (See SECTION 105) by the Field Engineer, 3 copies of detailed falsework plans designed and sealed by a Professional Engineer on the Category 2 structures listed below. (Cat 2: Field Engineer or District E.)

- All cast-in-place span structures supported on falsework;
- Concrete Box Structures with cell spans greater than 16 feet or cell heights greater than 14 feet;
- Decks with girder spacing equal to or greater than 14 feet; and
- Substructure forming with "non-typical" support.

(p.700-35)



708.3 a. Design Requirements:

- When computing loads, concrete is treated as a liquid. (p.700-35)
- No cast-in-place shear bolts, coils, or other devices to support falsework in piers
- Through-bolts are permitted
- Do not drill and grout bolts or other devices unless stated in contract documents
- Know the difference between Category 1 and Category 2 Structures (pg. 700-35)



Construction Requirements: Section 708.3 b. (p. 700-36)

b. Falsework Construction. Adhere to all falsework details.

Drive falsework piling to a satisfactory depth and bearing value to support all falsework that is not founded on rock, shale or thick deposits of other compact material in their natural beds. Do not use mudsills on earth, sand, gravel and similar materials, unless otherwise noted in the Contract Documents. Do not support falsework on any part of the structure, except the footings, without written approval from the Engineer. The number and spacing of falsework piling, the adequacy of sills, caps and stringers, and the amount of bracing in the falsework framing is subject to approval of the Engineer.

If the falsework piling or vertical members are of sufficient length to cap at the desired elevation for the horizontal members, cap them and construct frames to the proper elevation. If falsework piling are not of sufficient length, extend them using an approved pile splice. Do not use wedges at pile splices. Cut the ends of the piling or vertical members square for full bearing. If vertical splices are necessary, the abutting members shall be of the same approximate size, with the ends cut square for full bearing. Provide an adequate splice to maintain rigidity of the joint, including inserting a #9 reinforcing bar 18 inches into each end of the abutting members.

Upon completion, remove all forms and falsework according to **SECTION 710**. Pull or cut off falsework piling 12 inches below low water level, the natural ground or the bottom of a channel change. On grade separation structures, pull or cut off the falsework piling 12 inches below subgrade elevation of the roadbed that the piles are driven into. Pull or cut off all other falsework piling 12 inches below finished grade.

Unless the Contract Documents provide for permanent camber, construct the falsework to provide only sufficient camber to prevent final settlement below the finish grades shown in the Contract Documents. Use adequate hardwood wedges or screw jacks in all falsework construction, and place and adjust them to provide the proper form alignment. If required, provide a means for adjusting forms to offset any excessive settlement. When screw jacks are used, adequately brace and secure them to prevent tipping of the jacks in any direction.



11

708.3 b. Falsework Construction

(p. 700-36)

- **Pile splicing should be avoided**
 - **When approved, spliced pieces should be nearly the same diameter, ends squared, and the joint should be braced and banded. (See Bridge Construction Manual for Example)**
- **Provide some means for measuring Settlement during concrete placement**



12



13

Falsework Inspection Requirements: Section 708.3 c. (p. 700-36)

c. Falsework Inspection Requirements. For Category 1 structures, the falsework designer of record shall make a Falsework Inspection of the as-built falsework for substantial compliance with the falsework plans prior to placing concrete in the structure.

Conduct an on-site review of the falsework. Items to be reviewed include but are not limited to:

- The condition of the materials used for piling, cross bracing, beams, plywood decking, shims and jacks.
- The size and spacing of all structural members regarding their compliance to the submitted falsework plan.
- The condition and compliance of all splices.

Provide written documentation to the Engineer stating the falsework as-built is acceptable and in compliance with the original sealed plans. If the falsework is not in compliance, make corrections to the falsework or submit a revised, sealed falsework design prior to the placement of any concrete. When modifications are made to the falsework, the designer of record shall make Falsework Inspections until written documentation is provided to the Engineer stating that the falsework is in compliance, at no additional cost to KDOT.

For Category 2 falsework plans, conduct a walk-through review of the falsework with the Field Engineer, prior to placing concrete in the structure. Variations and deficiencies from the plan will be noted in writing and supported with photos or sketches. Forward the documentation to the falsework designer. The designer must respond in writing that the deficiencies are minor and the falsework is in substantial compliance, or must propose a new falsework plan which addresses the deficiencies.

The Engineer will refuse approval to proceed with other phases of the work if the falsework is determined to be unsafe or inadequate to properly support the subjected loads.

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Falsework Inspection Requirements: Section 708.3 c. (p. 700-36)

Category 1

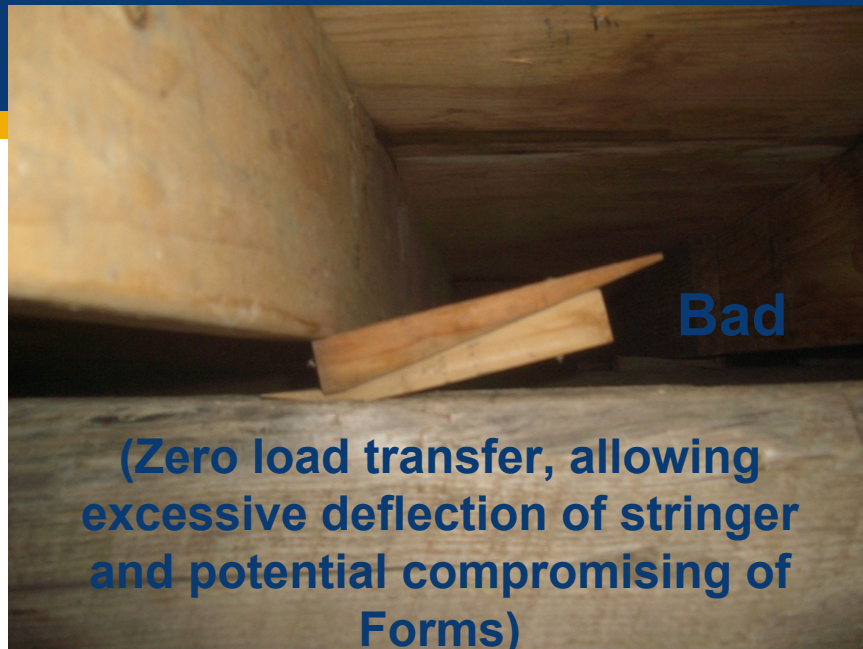
- Check condition of all materials used in Falsework
- Check the size and spacing of all members are in compliance with Falsework Plans
- The condition and compliance of all splices
- Provide written documentation of Falsework as-built approval

Category 2

- Conduct a walk-through review with the Field Engineer before placing concrete



15



16

**(Beginning Span: 1
Superstructure Formwork)**

**(Elevation View – Span: 1
& 2 Superstructure
Falsework)**

11 16 '95



17

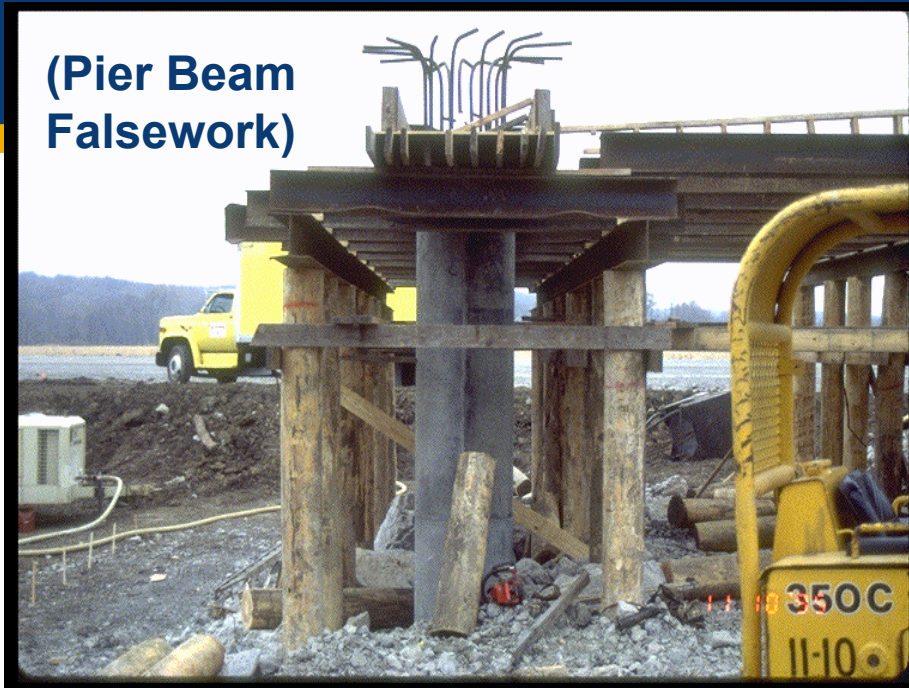
(Abutment Formwork)

(Falsework Pile Cutoff)



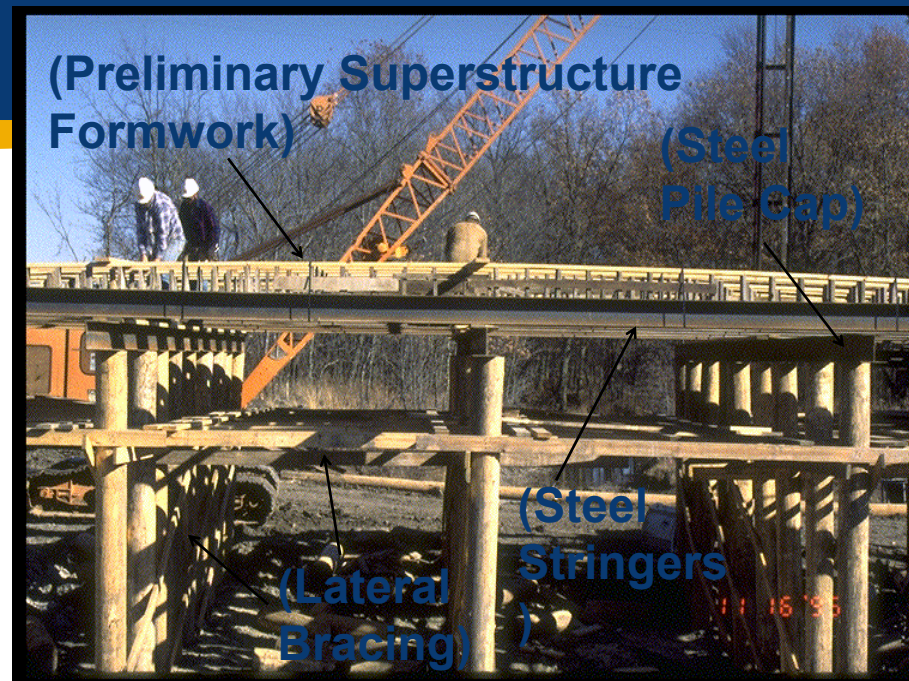
18

**(Pier Beam
Falsework)**



19

**(Preliminary Superstructure
Formwork)**



20



21



22



Deck Overhangs:

FALSEWORK Plans
required if:

Overhang > Depth

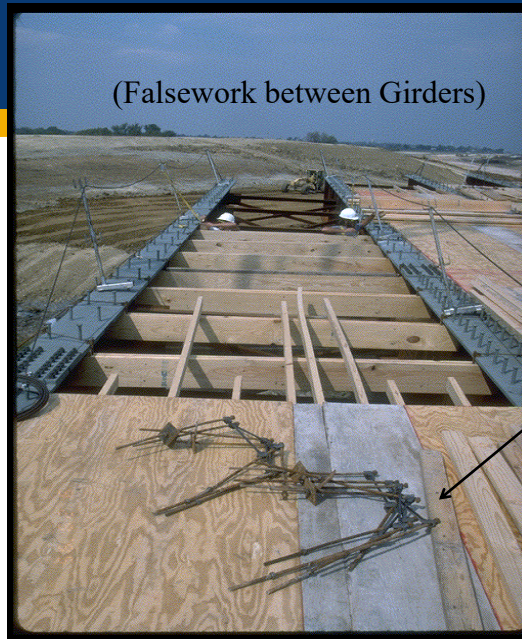
-or-

Overhang > 54 inches



23

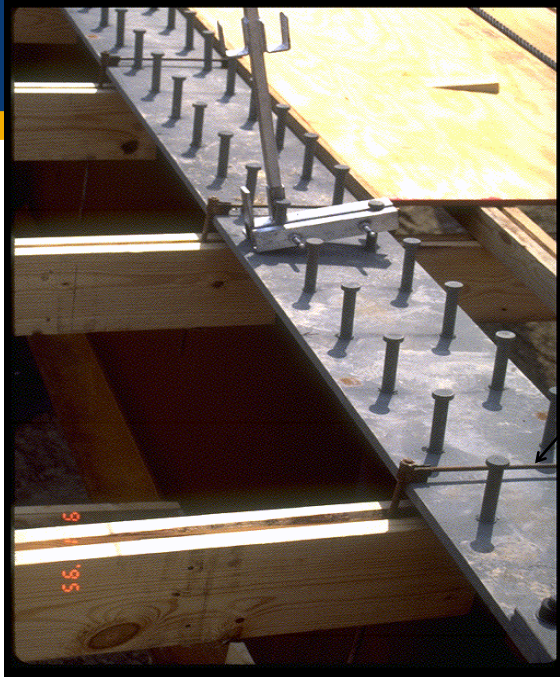
(Falsework between Girders)



(Formwork Hangers)



24



(NEVER
Weld Hangers)



25



(Tall
Falsework
& Formwork)



26

**(Submit
to Local
Projects for
Review)**



27

Formwork:

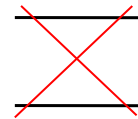
**708.3 d.
(p. 700-36)**



28

Formwork:

- Wood/plywood shall be sound & installed with grain running in the same direction
- Mortar-tight, with no warping or bulging
- No permanent aluminum deck forms
- Oil formed surfaces with clear, paraffin based oil
- Moisten wood forms with water before placement
- Bevel all exposed edges with $\frac{3}{4}$ " triangular molding



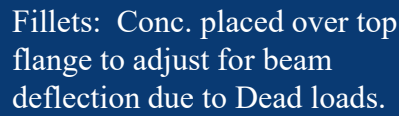
29



What are Fillets and why are they used?



30



Will be smallest over Piers.

	E. Spig. Abut. # 1		% Pier No. 1		% Pier No. 2		Sym. Abut. # of Bridge	
	10 Spac. @ 7.0' = 70'-0"		10 Spac. @ 9.0' = 90'-0"		10 Spac. @ 9.0' = 90'-0"			
	Field Sp. No. 1		Field Sp. No. 2		Field Sp. No. 3			
	19'-4"		19'-4"		19'-4"			
Steel Dead Load	0.000	0.000	0.005	0.005	0.005	0.005	0.005	0.000
Concrete Dead Load (Composite = Non-Comp.)	0.005	0.000	0.005	0.000	0.005	0.000	0.005	0.000
Total Dead Load (Steel + Concrete)	0.000	0.000	0.010	0.005	0.010	0.005	0.010	0.000

DEAD LOAD DETENTION DIAGRAM AT TENTH POINTS
 (All deflections are in ft./in.)
 (ES = 29,000 ksi)



Removal of Forms:
710-Conc. Construction, p. 700-40



Removal of Forms: 710-Conc. Construction

- **CURING:** Figure 710-1 (p. 700-42)
- **CURE TIMES:** Table 710-1 (p. 700-45)
- **LOAD LIMITS:** Table 710-2 (p. 700-46)
- **REMOVAL OF FORMS:** Table 710-3 (p. 700-48)



33



34

Removal of Forms:

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column.							4 ^Δ [2]*
2. minimum before placing concrete for the pier beam							7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam							2 ^Δ
2. minimum before placing concrete for the pier beam							4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.							NA

Table 710-3 (p. 700-48)

Δ - increase the time period 3 days when supplemental cementitious materials are used Oct 1 – April 30

*, **, *** or + - refer to Note below Table



35

(Type) Structural Element:

(P.B. Formwork) on Single Col.:

(P.B. Falsework) on Multiple Col.:

(Forms/Falsework) for Decks:

Box Culverts Roofs:

Box Culvert Walls & Wings:

(Col. Forms) on Pile Cap Footings:

(Col. Forms) on Spread Footings:

(Duplicate, ignore):

(P.B. Forms), 1- Column:

(P.B. Forms), Multiple Columns:

(Col. Forms) Drilled Shafts:

Box Culverts Floors on Rock:

Box Culverts Floors on Soil:

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column.							4 ^Δ [2]*
2. minimum before placing concrete for the pier beam							7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam							2 ^Δ
2. minimum before placing concrete for the pier beam							4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.							NA



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* Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 65% of the specified f'_c . To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.

** Do not set girders or beams on the pier beams until the falsework under the pier beams is removed.

*** Remove the formwork from subdecks or one-course decks within 6 weeks after the deck has been placed.

+ Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 75% of the specified f'_c . To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.

Δ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.

* - reduce by days if attain 65% f'_c

** - **Do Not set beams on pier beam** until falsework under pier beam is struck

*** - remove formwork within 6 weeks of placement

+ - reduce days if attain 75% of f'_c

Δ - increase the time period 3 days when supplemental cementitious materials are used Oct 1 – April 30



37

Cantilevered Pier:

(Pier Beam)

Span Length = (Ft.)
(Formwork supported from single Col.)

10' or Less = 7 days Δ [4]*
>10' = 10 days Δ [6]*

(Single Col.)

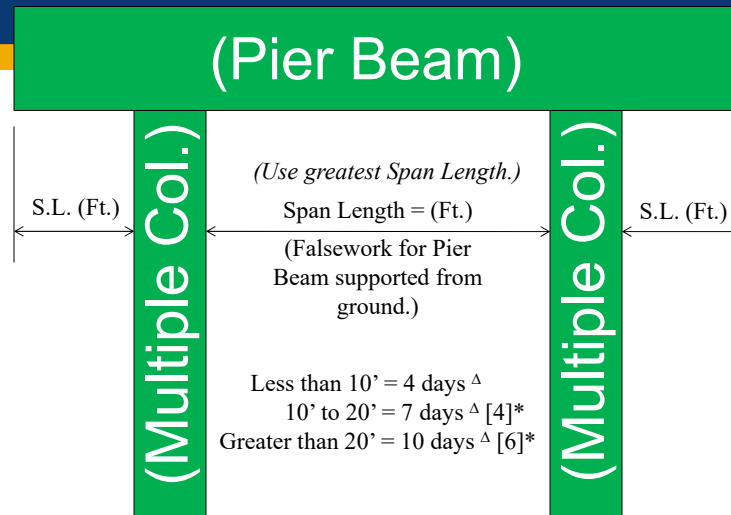
Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.

* = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets 65% of f'_c .



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Column Bent Piers:

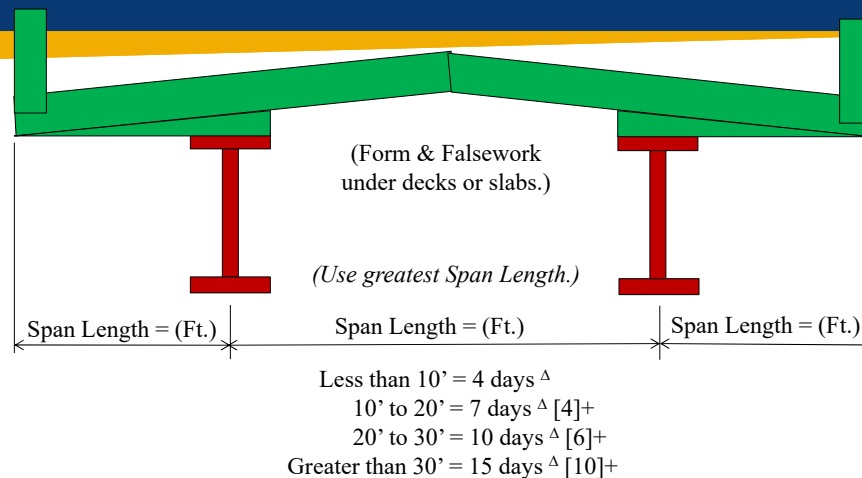


Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
 * = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets 65% of f'_c .



39

Decks & Slabs:

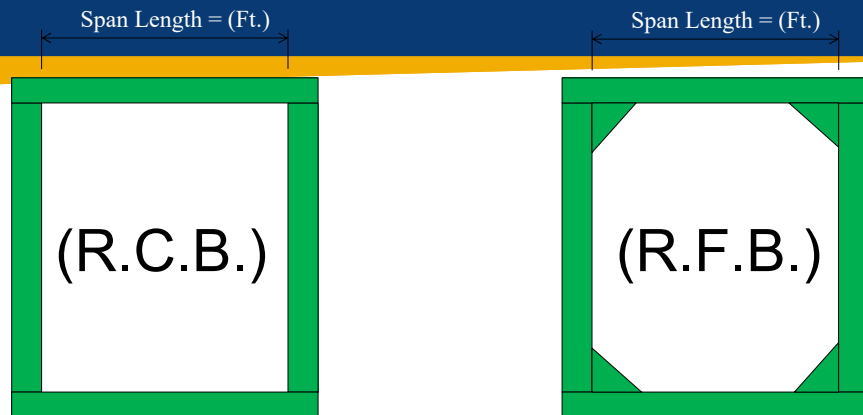


Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
 + = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f'_c .



40

R. C. Culvert Roof Slabs:



10' or Less = 7 days Δ [4]
 10' to 20' = 7 days Δ [4]
 Greater than 20' = 10 days Δ [6]

Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
 + = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets **75% of f'c.**



41

Example Questions

Q1: Concrete columns for a 3-column bent pier were poured yesterday. How long from concrete placement can pier beam formwork erection start?

1. Structural Element?

3-Column Bent

2. Type of Work?

Pier Beam Formwork



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TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers -							
1. minimum before supporting forms and reinforcing steel for the pier beam on the column.							4 ^Δ [2]*
2. minimum before placing concrete for the pier beam							7 ^Δ [4]*
Columns for bent piers -							
1. minimum before erecting formwork and reinforcing steel for the pier beam							2 ^Δ
2. minimum before placing concrete for the pier beam							4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred							NA

1. Structural Element?

3-Column Bent

2. Type of Work?

Pier Beam

Formwork

= 2 Days



43

Example Questions:

Q2: How long from initial (3 column) pour before placing concrete for the pier beam?

1. Structural Element?

3-Column Bent

2. Type of Work?

Pier Beam Concrete placement



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TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam							4 ^Δ [2]* 7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam							7 ^Δ [4]* 4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.							NA

1. Structural Element?

3-Column Bent

2. Type of Work?

Pier Beam

Concrete

= 4 Days



45

Q3: The concrete deck for a steel girder bridge was placed on October 15th. The width of the deck is 60'. There are 6 girders spaced at 9'-0". No test specimens were made. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

Deck, girders spaced at 9 Ft.

2. Type of Work?

removal of Deck Forms



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1. Structural Element?
Deck, 9 Ft. span

2. Type of Work?
Removal of Forms

= 4 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.	4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns	2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4 ^Δ [2]* 7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2 ^Δ 4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA



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Example Questions:

Q4: The concrete deck for a steel girder bridge was placed on October 15th. The width of the deck is 60'. There are 6 girders spaced at 9'-0". No test specimens were made. Supplemental cementitious materials were added. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?
Deck, girders spaced at 9 Ft with S.C.M.'s, Δ = add 3 Days
2. Type of Work?
removal of Deck Forms



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1. Structural Element?
Deck, 9 Ft. span

2. Type of Work?
*Removal of
Forms*

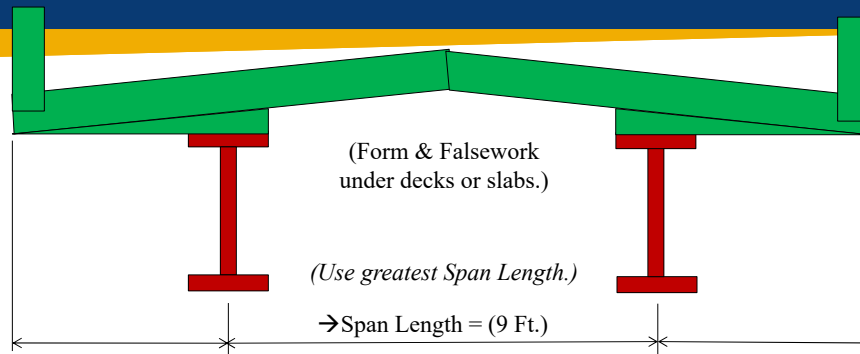
4 Days

*Δ = add 3 Days
Total = 7 Days*

Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*	10 ^Δ [6]*	
Type of Work	Time (Days)					
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.	4 ^Δ [3]*					
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*					
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns	2 ^Δ					
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*					
Columns for cantilevered piers -						
1. minimum before supporting forms and reinforcing steel for the pier beam on the column.	4 ^Δ [2]*					
2. minimum before placing concrete for the pier beam	7 ^Δ [4]*					
Columns for bent piers -						
1. minimum before erecting formwork and reinforcing steel for the pier beam	2 ^Δ					
2. minimum before placing concrete for the pier beam	4 ^Δ [2]*					
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 ^Δ					
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2 ^Δ					
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4 ^Δ [2]*					
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA					

49

Decks & Slabs:



→ Less than 10' = 4 days ^Δ
 10' to 20' = 7 days ^Δ [4]+
 20' to 30' = 10 days ^Δ [6]+
 Greater than 30' = 15 days ^Δ [10]+

4+3= 7 Days

→ Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
 + = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f'c.

50

Q5: The concrete deck for a prestressed concrete beam bridge was placed yesterday. The width of the deck is 60'. There are 5 girders spaced at 11'-0". No test specimens were made. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

Deck, girders spaced at 11 Ft.

2. Type of Work?

removal of Deck Forms



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1. Structural Element?

Deck, 11 Ft. span

2. Type of Work?

Removal of Forms

= 7 Days

Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^d [4]*	10 ^d [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^d			7 ^d [4]*	10 ^d [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^d			7 ^d [4]*	10 ^d [6]*	15 ^d [10]*
RCB and RFB top slabs not re-shored		7 ^d [4]*		7 ^d [4]*	10 ^d [6]*	
Type of Work						Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.						4 ^d [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns						4 ^d [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns						2 ^d
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns						4 ^d [2]*
Columns for cantilevered piers - 1. minimum before erecting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam						4 ^d [2]* 7 ^d [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam						2 ^d 4 ^d [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns						2 ^d
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel						2 ^d
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel						4 ^d [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.						NA



52

Example Questions:

Q6: How many days if grade 4.0 concrete (4000 psi) is specified, and test specimens broke at a strength of 3100 psi after 4 days?

1. Structural Element?

Deck, girders spaced at 11 Ft.

+ Cylinders made, broke on Day 4

Requirement for: + = reduce days if attain 75% of f'_c

$0.75(4000) = 3000$ psi Needed

break of 3100 > 3000 req'd, OK.

Remove forms on Day 4 after breaks.

2. Type of Work?

removal of Deck Forms



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1. Structural Element?

Deck, 11 Ft. span

2. Type of Work?

Removal of Forms

*= [4] Days
if + cylinders made
broke above Req'd.?*

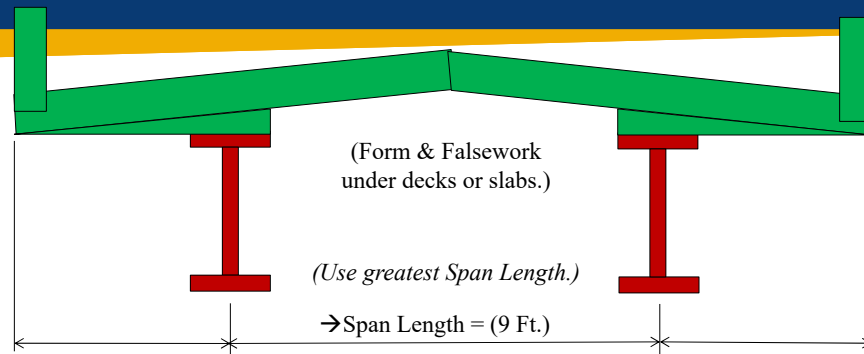
Yes. = Remove at 4 Days.

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footings Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footings supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam							4 ^Δ [2]* 7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam							2 ^Δ 4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.							NA



54

Decks & Slabs:



→ Less than 10' = 4 days ^Δ
 10' to 20' = 7 days ^Δ [4]⁺
 20' to 30' = 10 days ^Δ [6]⁺
 Greater than 30' = 15 days ^Δ [10]⁺

4+3= 7 Days

→ ^Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
 + = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f'c.



55

End.

Thanks !!!



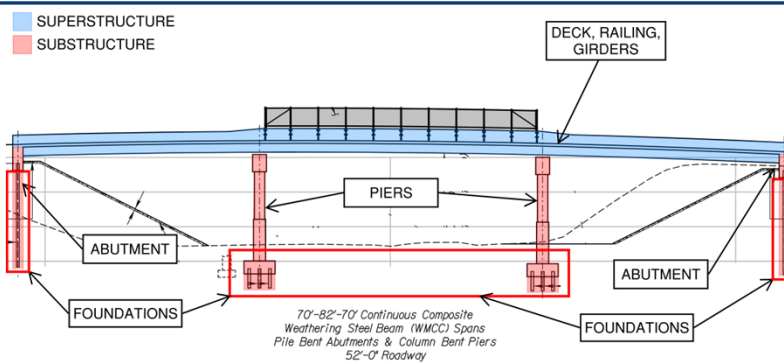
56



Substructures

1

Superstructure vs. Substructure



2

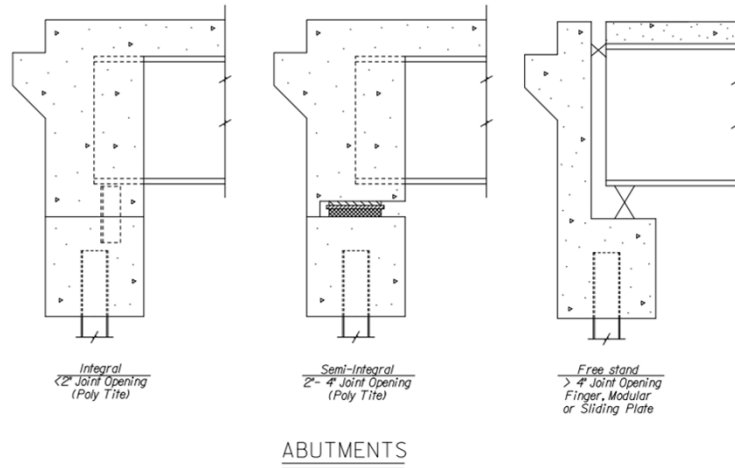
Types of Substructures

- Types of Substructures
 - Abutments
 - Used at the ends of the bridge to retain the embankment and carry the vertical and horizontal loads from the superstructure to the substructure.
 - Pier
 - Element supporting the superstructure located between the bridge abutments.
 - Walls
 - MSE - Mechanically Stabilized Earth.

Types of Abutments 1



Types of Abutments 2

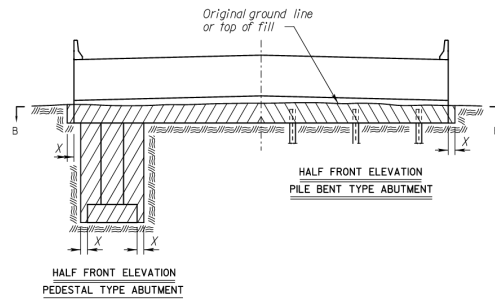


Abutment Wings

- Straight Wings
 - Wings are aligned with abutment
 - Most used
 - Whenever possible, KDOT prefers the use of straight wings.
- U-Type
 - Wings are parallel to roadway
 - Used when grading around the bridge is restricted and/or there are other geometric restrictions.

Abutment Foundations

- Pile Bent Abutments
 - Most common
- Column Bent Abutments
 - Used only when required by geology or when other special conditions exist.
- Pedestal Type Abutment



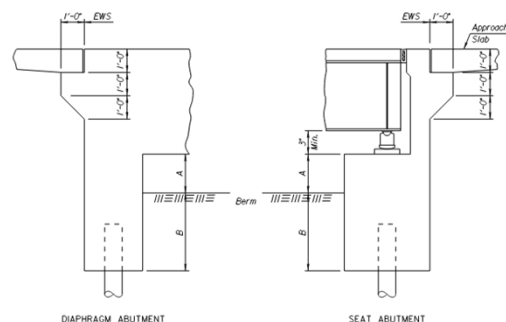
7

Abutment Berm Considerations



Improper Berm Placement!

Figure 2.1.3-1 Bridge Seat Clearance



Item	A	B
Slab Bridges and Box Girders	2'-0"	1'-6"
Girder Bridges	1'-0"	2'-0"

8

Abutment MSE Wall Considerations



- Flexible Element
 - MSE Wall
- Inflexible Element
 - Bridge Abutments
- Allow elements to move independently



9

Types of Piers

- Pile Bent Piers (Wall Pier)
 - A row of multiple piles encased in a concrete webwall
 - Economical and normally used on low-level, short-span bridges.
 - Generally not used for grade separations
- Column Bent Piers
 - Typically 3 to 5 columns for standard roadway widths.
- Single Column Piers (Hammer Head Pier)
 - More economical when used in high level bridges or in large river crossings.



10

Column Bent Pier



Pile Bent Pier (Wall Pier)



13



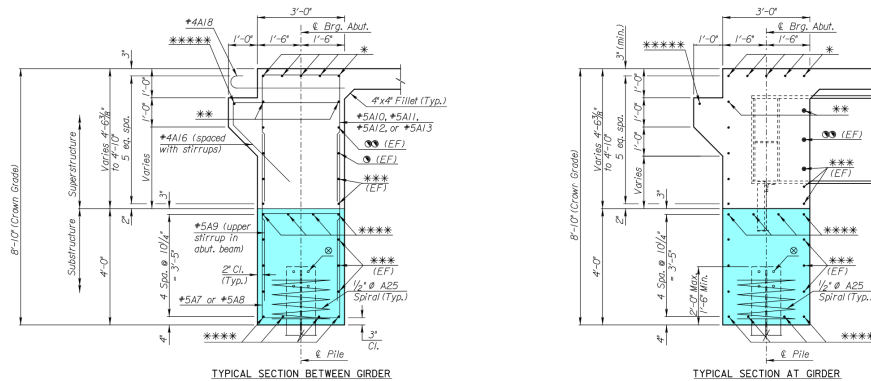
The technical drawing consists of two views of Abutment #2:

- Elev. I (Side View):** Shows the profile of the abutment. The top width is divided into segments of 7'-0", 3'-0", 1'-0", 29'-0" (Phase II), and 18'-0". Vertical dimensions include 2'-0" for the parapet height, 8'-6 1/4" for the main stem height, and 4'-0" for the base thickness. Reinforcement includes #5A10, #5A5 (EF), #5A4 (EF), #5A3 (EF), #5-#8A19, #5A11, #5A12, #5A15 (Typ.), #5A13 (stirrups), #5A8 (Typ.), #5A9, #5A7 (Typ.), #5A15 (Typ.), #5A21 (EF), #4-#8A1, #4-#8A19, #5A2 (EF), #5A6 (EF), and #5A22 (EF). A slope of 1:60X is indicated.
- Elev. II (Front View):** Shows the front elevation with three beams labeled Beam A, Beam B, and Beam C. Horizontal dimensions at the bottom are 4'-6", 8'-3", 6'-6", 6'-6", and 3'-3". Spacing details include "4 Spa. @ 11\" = 3'-8\"", "8 Spa. @ 10 3/4\" = 5'-11\"", "6 Spa. @ 10 1/2\" = 5'-2\"", "6 Spa. @ 10 1/2\" = 5'-2\"", and "3 Spa. @ 9 1/4\" = 2'-8\"". Other labels include "Level", "Elev. F", "1/2\" @ A25 Spiral (Typ.)", and "Beam A", "Beam B", "Beam C".

A note at the bottom states: "(Looking Upstream) @ Abutment #2, Abutment #1 (Similar)".



Construction of Substructures 2

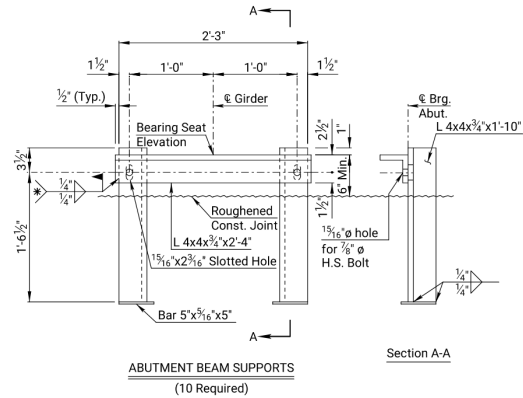


Abutment Construction 1

- Abutments
 - Soil foundation cut to grade, level clear of debris
 - Contractor may use a commercial grade concrete leveling pad. This also assists in placement of form work. Must be to grade, can not be considered part of structure.
 - Verify re-steel, bar size length, bends and spacing. Tied adequately.
 - Bar chairs in good condition. (epoxy bars = epoxy chairs)

Abutment Construction 2

- Abutments
 - Check form measurements
 - Check Bar spacing
 - Verify beam seats and/or girder chairs.
 - Girder Supports placed in the substructure concrete



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Abutment Construction 3



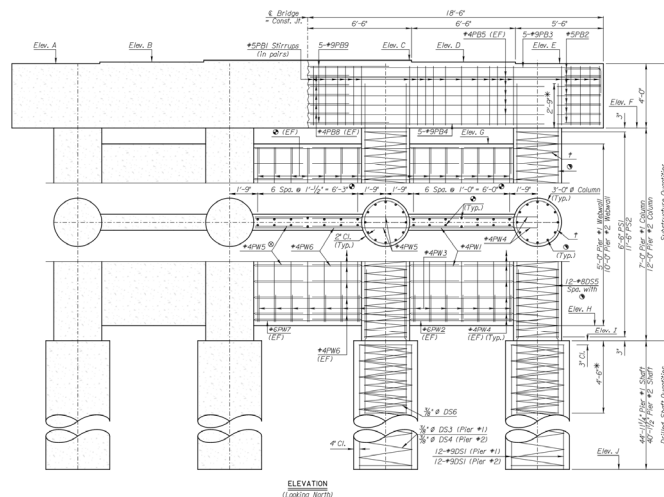
18

Abutment Construction 4



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Pier Construction 1



20

Pier Construction 2

- Piers
 - Column Forms
 - Check diameter
 - Free of rust
 - Form release
 - Not out of round
 - Column Rebar
 - Check diameter
 - Bar size / spiral spacing
 - Not racked



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Pier Construction 3

- Pier Column
 - Verify re-steel, bar size, length, bends and spacing.
 - Tied adequately.
 - Verify lap lengths and embed lengths of rebar.
 - Check that forms are clean, and plumb.
 - Check that elevation of top of can is determined and cut dimension to top of concrete is recorded.
 - Determine if through bolts are being used.



22

708.3 CONSTRUCTION REQUIREMENTS

- **a. Falsework Design.**

- Do not place cast-in-place shear bolts, coil inserts or other devices used as falsework support in pier columns without the approval of the Engineer. Through bolts are permitted. Do not drill and grout bolts or other devices into the pier columns unless shown in the Contract Documents.



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Pier Construction 4

- Bottom of Pier Cap Elevation / Top of Can Elevation



24

710.3 Construction Requirements 1

- **b. Handling and Placing Concrete**

- Place concrete to avoid segregation of the materials and displacement of the reinforcement.
- Fill each part of the form by depositing the concrete as near to the final position as possible.
 - Do not drop concrete in the forms a distance of more than 5 feet, unless confined by clean, smooth, closed chutes or pipes.
- Obtain sample concrete for slump and air test requirements at the discharge end of the piping.
- Do not use chutes, troughs or pipes made of aluminum.



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Concrete Placement 1



26

Concrete Placement 2



27

710.3 Construction Requirements 2

- **g. Removal of Forms and Falsework**
 - Do not remove forms and falsework without the Engineer's approval.
 - Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **Table 710-1**
 - Under normal conditions, the Engineer will allow removal of forms and falsework according to **Table 710-3**



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710.3 Construction Requirements 3

- **Table 710-1: Minimum Cure Times and Curing Mediums**
- Table 710-2: Concrete Load Limitations on Bridge Decks
- **Table 710-3: Minimum Strength Gain Time Before Removal of Forms & Falsework (Days)**



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Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Saturated burlap covered with white polyethylene sheeting during the 14-day period. See subsection 710.3e.(5) .
Bridge decks (full-depth decks with no overlay) Bridge Overlays (new and existing structures)	14 Wet Plus 7 Curing Membrane	Saturated burlap covered with white polyethylene sheeting during the 14-day period. See subsection 710.3e.(5) . After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and saturated burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require saturated burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.



Table 710-1

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TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)						
Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4] [†]	10 ^Δ [6] [†]	15 ^Δ [10] [†]
RCB and RFB top slabs not re-shored		7 ^Δ [4] [†]		7 ^Δ [4] [†]	10 ^Δ [6] [†]	
Type of Work						Time (Days)**
Walls, Wing Walls and vertical sides of RCB and RFB structures						4 ^Δ [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns						4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns						2 ^Δ
Columns for cantilevered piers -						
1. minimum before supporting forms and reinforcing steel for the pier beam on the column.						4 ^Δ [2] [†]
2. minimum before placing concrete for the pier beam						7 ^Δ [4] [†]
Columns for bent piers -						
1. minimum before erecting formwork and reinforcing steel for the pier beam						2 ^Δ
2. minimum before placing concrete for the pier beam						4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns						2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel						2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel						4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.						NA



Table 710-3

* Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 65% of the specified f'_c . To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.

** Do not set girders or beams on the pier beams until the falsework under the pier beams is removed.

*** Remove the formwork from subdecks or one-course decks within 6 weeks after the deck has been placed.

† Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 75% of the specified f'_c . To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.

Δ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.

** See SECTION 204.

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Table 710-1 Example

What is the minimum cure time required for a formed bridge abutment beam to be considered completely cured? What must be done if the forms are removed before the end of the specified cure period?

Formed sides and ends of bridge wearing surfaces and bridge curbs	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.
Other formed surfaces		



32

Table 710-3 Examples 1 & 2

- Q1: A drilled shaft was poured on April 15th. The drilled shaft concrete used supplemental cementitious materials. What is the minimum strength gain time required before erecting forms and reinforcing steel for the columns?
- Q2: The columns for a bent pier were poured on May 1st. What is the minimum number of days required before erecting formwork and reinforcing steel for the pier beam? What is the minimum number of days before placing concrete for the pier beam? Assume no concrete cylinders have been tested.



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Table 710-3 Examples 3 & 4

- Q3: A pier beam for a column bent pier with falsework supporting the pier beam was poured on May 15th. The spans between the columns are 15'-0". Concrete cylinders were tested and broke at 70% of the specified f'c. What is the minimum strength gain time before removing the forms for the pier beam?
- Q4: What is the minimum strength gain time for the removal of forms from an abutment? Assume no supplemental cementitious materials were used and no concrete cylinders have been tested.



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Table 710-3 Examples (Q1)

Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 ^Δ
--	----------------

- ^Δ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.
- Since supplemental cementitious materials were used and the date was between October 1st and April 30th, the minimum strength gain time required before erecting forms and reinforcing steel for the columns is **5 days**.



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Table 710-3 Examples (Q2)

Columns for bent piers -	
1. minimum before erecting formwork and reinforcing steel for the pier beam	2 ^Δ
2. minimum before placing concrete for the pier beam	4 ^Δ [2]*

- ^Δ Does not apply due to the date, even if supplemental cementitious materials were used.
- * Does not apply because the contractor did not break cylinders.
- The minimum number of days required before erecting formwork and reinforcing steel for the pier beam is **2 days**.
- The minimum number of days before placing concrete for the pier beam is **4 days**.



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Table 710-3 Examples (Q3)

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)						
Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*	10 ^Δ [6]*	

- ^Δ Does not apply due to the date, even if supplemental cementitious materials were used.
- * Does apply because the concrete was shown to have attained at least 65% of f'c.
- The minimum strength gain time before the removal of forms and falsework for the pier beam is **4 days**.



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Table 710-3 Examples (Q4)

Type of Work	Time (Days)**
Walls, Wing Walls and vertical sides of RCB and RFB structures	4 ^Δ [3]*

- Walls, Wing Walls and vertical side of RCB and RFB structures would apply to abutments.
 - ^Δ Does not apply because supplemental cementitious materials were not used.
 - * Does not apply because the contractor did not break cylinders.
- The minimum strength gain time is **4 days**.



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Measurement and Payment

- Concrete Structure Construction 710.4
 - The Engineer will measure the various grades of concrete placed in the structure by the cubic yard. No deductions are made for reinforcing steel and pile heads extending into the concrete.
- Reinforcing Steel 711.4
 - The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.

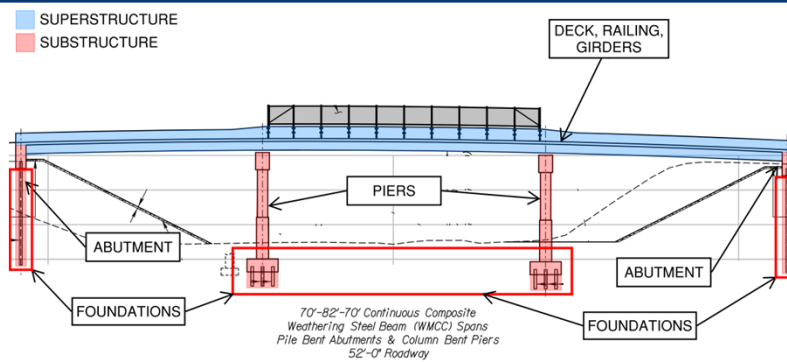




Superstructures

1

Superstructure vs. Substructure



2

Plan Orientation

- Normal

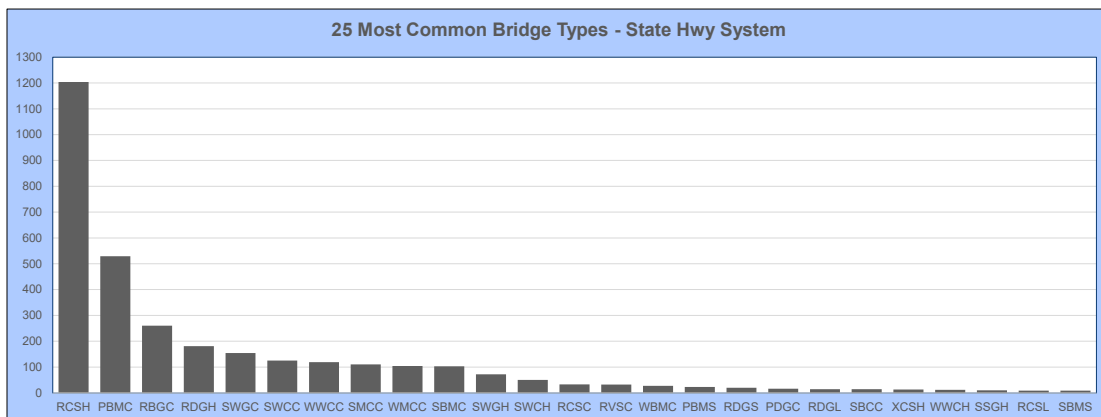


- Skewed



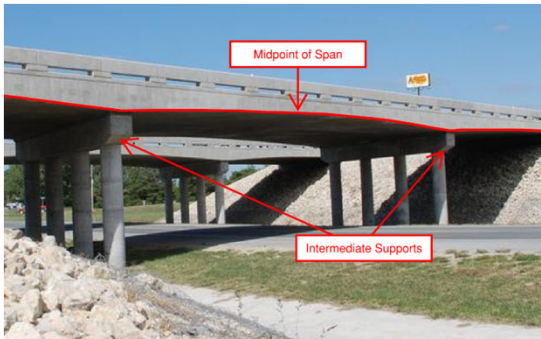
3

Clear Span Structures in Kansas



4

Reinforced Concrete Haunched Slab



- Maximum Span = 72'
- Falsework
 - A GREAT deal of Falsework Required
- Heavy Reinforcement
- Lengthy Curing Period
- Very Stout Bridge



5

RCSH Falsework



6

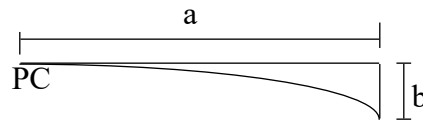
Parabolic Haunch Formula

- Theory

- The vertical ordinate will vary with the square of the distance from the PC.

- Any Ordinate = $\frac{(\text{distance from PC})^2 * b}{a^2}$

- Area = $(a*b)/3$



RCSH Reinforcing Steel



Prestressed Concrete Beam/Girder

- Spans from 60' to 110' are typical
- Component Construction
 - Rapid Assembly
- Special Deck Forming Considerations
 - Temporary Diaphragms
 - Camber Correction
 - Overhangs
 - Composite Designs



9

Fabrication



10

Structural Steel Beam / Girder 1

- Generally Longer Spans > 110'
 - Lewis and Clark Viaduct Maximum Span = 375'
- Bolting and Welding Required
 - Experienced Labor and Inspection
- Special Deck Forming
- Very Flexible
- May Require Painting



11

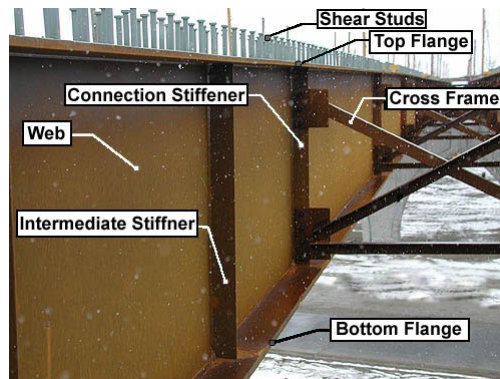
Structural Steel Beam / Girder 2



12

Structural Steel Girder 3

- Basic Parts
 - Flanges
 - Webs
 - Stiffener
 - Bearing
 - Intermediate
 - Connection
 - Longitudinal
 - Girder Ends
 - Cross-Frames / Diaphragms
 - Bolts and Splices
 - Studs (field applied or shop applied)



Structural Steel Beam / Girder 4



Structural Steel Beam / Girder 5



Steel Bridge Construction 1

- Basic Beam/Girder Types
 - Rolled Beam
 - From the mill
 - I shaped
 - Mill camber only (no vertical curve or dead load camber)
 - Usually not horizontally curved
 - Plate Girder
 - Fabricated from plates in the shop
 - I shaped
 - Cambered for vertical dead load
 - Can be horizontally curved

Steel Bridge Construction 2

- Basic Materials
 - Weathering Steel (members, fasteners, washers, and DTI's)
 - Top of top flange painted
 - 2D way from joint painted, Encased +2 inches
 - Fascia and bottom on Plate girders with drainage over the side
 - Non-Weathering Steel (Painted)
 - Galvanized (Joints)



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Structural Steel - Erection

- The contractor will provide:
 - Detailed plan for the erection of the structure (not for simple structures).
 - Shop details.
 - Camber diagrams.
 - List of field bolts (lot numbers and certifications).
 - Copy of the shipping statement showing a list of parts and their mass.
- Three Steps to Structural Steel Erection
 1. Assembly
 2. Fit-Up
 3. Bolting
- These are three separate inspectable operation.
- Successful erection relies on proper substructure construction.



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Steel Bridge Construction 3

- Erection Bolt must be clearly identifiable as an erection bolt. They are the contractor's property and are only for contractor's ease of erection. They are not production bolts.
- Production bolts will arrive to the job in sealed kegs, tubs, or buckets. They will have their producer's mark and grade stamped on the head. Once a production bolt has been fully tightened it may not be retightened and used as a production bolt. It has become an erection bolt.



Bridge Decks & Bridge Deck Overlays

Decks: 400 (Mud) & 700 (Structures)

Overlays: 731 (Area Prep. for Patching),
732 (Machine Prep.),
717 (Conc. OL),
729 (Poly OL)

BD-1

1

710.3 Construction Requirements

- Get **very** familiar with this specification!!!!
- Lots of information, won't be able to cover all of it
- Know **where** to look

BD-2



2

710.3 - CONSTRUCTION REQUIREMENTS (b. Handling & Placing Conc.) p. 700-40

b. Handling and Placing Concrete. At a progress project meeting prior to placing concrete, discuss with the Engineer the method and equipment used for deck placement; include the equipment for controlling the evaporation rate, procedures used to minimize the evaporation rate, and method to place saturated burlap within the specified 15 minute limit

Fogging using hand-held equipment may be required by the Engineer during unanticipated delays in the placing, finishing or curing operations. If fogging is required by the Engineer, do not allow water to drip, flow or puddle on the concrete surface during fogging, placement of absorptive material, or at any time before the concrete has achieved final set.

When needed, produce a fog spray from nozzles that atomize the droplets and a system capable of keeping a large surface area damp without depositing excess water. Use high pressure equipment that generates a minimum of 1200 psi at 2.2 gpm, or low pressure equipment having nozzles capable of supplying a maximum flow rate of 1.6 gpm.

Use a method and sequence of placing concrete approved by the Engineer. Do not place concrete until the forms and reinforcing steel have been checked and approved. Before placing concrete, clean all forms of debris. Drive all foundation piling in any one pier or abutment before concrete is poured in any footing or column of that pier or abutment.

On bridges skewed greater than 10°, place concrete on the deck forms across the deck on the same skew as the bridge, unless approved otherwise by State Bridge Office (SBO). Operate the bridge deck finishing machine on the same skew as the bridge, unless approved otherwise by the SBO.

Maintain environmental conditions on the entire bridge deck such that the evaporation rate is less than 0.2 lb/sq ft/hr. This may require placing the deck at night, in the early morning or on another day. The evaporation rate (as determined in the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2) is a function of air temperature, concrete temperature, wind speed and humidity.



3

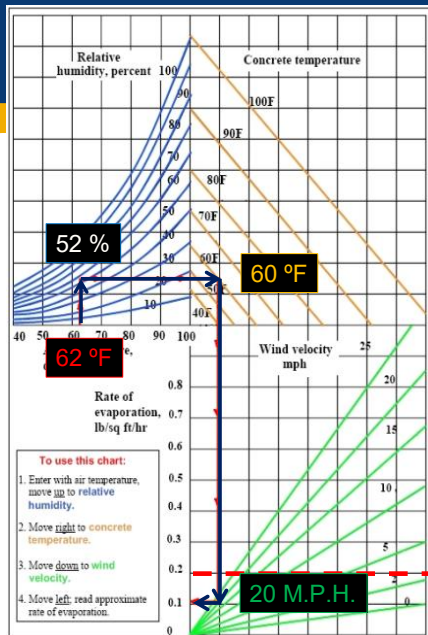
710.3 Construction Requirements b. Handling & Placing Concrete

- Project Progress Meeting
 - Method and Equipment for deck placing
 - Evaporation rate control equipment
 - Method to place burlap in 15-minute limit
- Skewed bridges greater than 10° will place concrete on the skew unless stated otherwise by the State Bridge Office
 - Same goes with Finishing
- Maintain an evaporation rate of less than 0.2 lb/sqft/hr
 - Figure 710-1



4

Evaporation Rate Chart, Fig. 710-1, p. 700-42



- 62° ambient temperature
- 52% relative humidity
- 60 concrete temperature
- 20 mph wind velocity

Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture for various weather conditions. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft²/hr (1.0 kg/m²/hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate is less than 0.2 lb/ft²/hr (1.0 kg/m²/hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.

(Fog/ with Wind Breaks)

(No Fog)



5



(Fog)



6

710.3 - CONSTRUCTION REQUIREMENTS (b. Handling & Placing Conc.) p. 700-40

Just prior to and at least once per hour during placement of the concrete, the Engineer will measure and record the air temperature, concrete temperature, wind speed and humidity on the bridge deck. The Engineer will take the air temperature, wind and humidity measurements approximately 12 inches above the surface of the deck. With this information, the Engineer will determine the evaporation rate by using KDOT software or by using **FIGURE 710-1** (Figure 2.1.5 from the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2).

When the evaporation rate is equal to or above 0.2 lb/ft²/hr, take actions (such as cooling the concrete, installing wind breaks, sun screens etc.) to create and maintain an evaporation rate less than 0.2 lb/ft²/hr on the entire bridge deck.

Place concrete to avoid segregation of the materials and displacement of the reinforcement. Do not deposit concrete in large quantities at any point in the forms, and then run or work the concrete along the forms.

Deposit the concrete in the forms in horizontal layers. Perform the work rapidly and continuously between predetermined planes. Vibrate through each plane.

Fill each part of the form by depositing the concrete as near to the final position as possible. If the chutes for placement of concrete are on steep slopes, equip them with baffle boards or assemble in short lengths that reverse the direction of movement. Do not drop concrete in the forms a distance of more than 5 feet, unless confined by clean, smooth, closed chutes or pipes.

Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not disturb the forms, or place any strain on the ends of projecting reinforcement.

If placing concrete by pumping, place the concrete in the pipeline to avoid contamination or separation of the concrete, or loss of air by fitting the pump with a concrete brake (e.g. french horn or bladder valve) at the end of the pump boom. Obtain sample concrete for slump and air test requirements at the discharge end of the piping.

Do not use chutes, troughs or pipes made of aluminum.

Uniformly consolidate the concrete without voids.



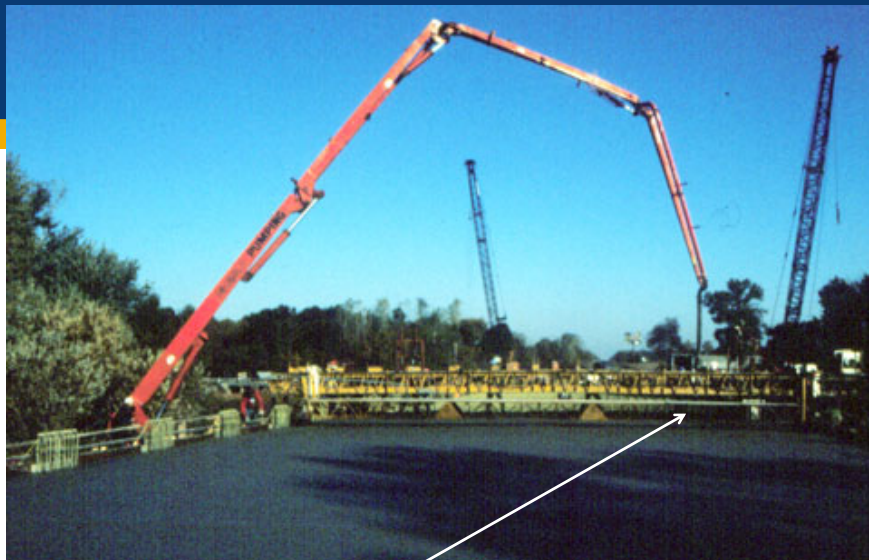
7



Pump Truck circa
1990



8



(Take mud samples from wherever the boom is during deck placement to get representative sample.)



9

(b. Handling & Placing Conc.) p. 700-40

Accomplish consolidation of the concrete on all span bridges that require finishing machines by means of a mechanical device on which internal (spud or tube type) concrete vibrators of the same type and size are mounted (**subsection 154.2**). Observe special requirements for vibrators in contact with epoxy coated reinforcing steel as specified in **subsection 154.2**. Provide stand-by vibrators for emergency use to avoid delays in case of failure.

Operate the mechanical device so vibrator insertions are made on a maximum spacing of 12-inch centers over the entire deck surface. Provide a uniform time per insertion of all vibrators of 3 to 15 seconds, or until the course aggregate settles below the surface of the concrete, unless otherwise designated by the Engineer. Provide positive control of vibrators using a timed light, buzzer, automatic control. Smoothly extract the vibrators from the concrete at a rate to avoid leaving any large voids or holes in the consolidated concrete. Do not drag the vibrators horizontally through the concrete.

Use hand held vibrators (**subsection 154.2**) in inaccessible and confined areas such as along hubguards. When required, supplement vibrating by hand spading with suitable tools to provide required consolidation. Reconsolidate any voids left by workers.

The method used for transporting concrete batches, materials or equipment over previously placed single pour (non-overlaid) floor slabs or floor units, or over units of structures of continuous design types is subject to approval by the Engineer.

Do not operate bridge deck finishing equipment on previously placed concrete spans until:

- A minimum of 72 hours on structures that are fully supported with falsework; (**Haunched Slabs**)
- A minimum of 72 hours on structures with concrete girder spans with concrete decks; and (**Prestressed**)
- A minimum of 96 hours on structures with steel girder spans with concrete decks.

(**Plate Girders or Rolled Beams**)

The time delays begin after the day's pour has been completed.

Follow **TABLE 710-2** for load limitations after concrete placement. Prior to permitting approved traffic on the bridge deck, construct temporary bridge approaches and maintain them in a condition to prevent damage to the bridge ends.



10



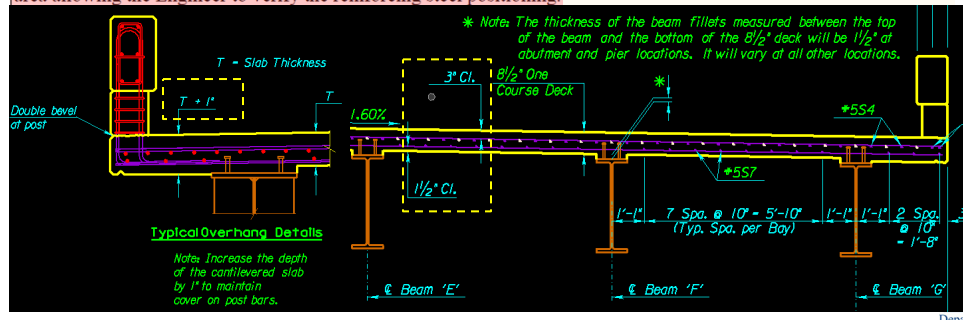
(Mud placement, Single Drum Screed, Gang Vibrators)
(CHECK/RECORD Cover & Fillet Depths at 10th Points)

11

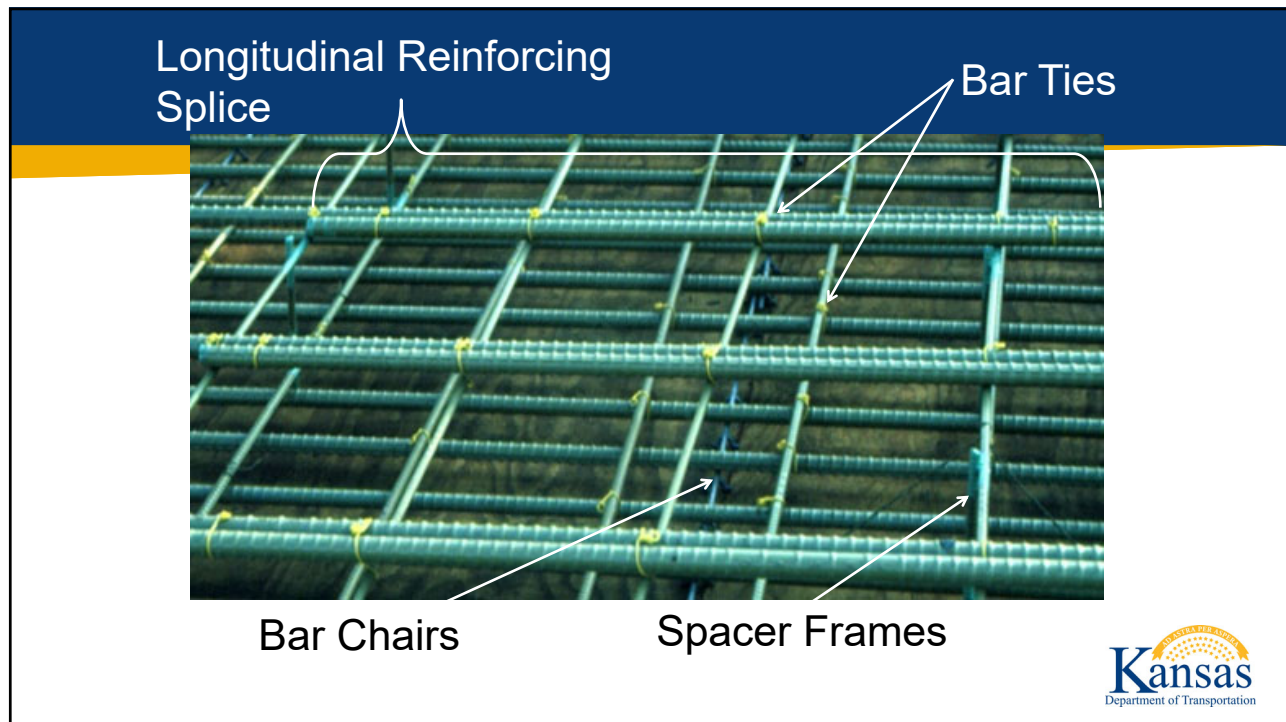
710.3 - CONSTRUCTION REQUIREMENTS (d. Finishing) p. 700-43 (location not in sequence)

(Calculate fillet depths at each of the 10th points from survey for depth checks during pour. Dry run of screed machine. Verify clearance checks at each 10th point.
Record screed arm height.)

Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.



12



13



14

710.3 - CONSTRUCTION REQUIREMENTS

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding 1/8 inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see subsection 710.3f. for grooving requirements.



15



Float Train c. '90 (Transverse Grooving now done by multi-blade diamond arbor, see Sub-Sec. f., p. 700-46)



16

710.3 - CONSTRUCTION REQUIREMENTS (e. Curing & Protection) p. 700-44

e. Curing and Protection.

(1) General. Cover concrete surfaces according to **TABLE 710-1**. Cure all pedestrian walkway surfaces in the same manner as the bridge deck. The determination of the time requirement for curing commences after all the concrete for the placement is in place and finished. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Maintain a damp surface until the wet burlap is placed. Fully saturate burlap before placing on concrete surface. Cover all concrete surfaces with saturated burlap within 15 minutes after finishing the concrete, do not mar concrete during placement of the wet burlap. Maintain the curing so that moisture is always present at the concrete surface.

Place and weight down the burlap so it will remain in intimate contact with the surface covered.

When an impermeable sheeting material is used, lap each unit 18 inches with the adjacent unit. Place and weight down the impermeable sheeting material so it will remain in intimate contact with the surface covered. When any burlap or impermeable sheeting material becomes perforated or torn, immediately repair it, or discard and replace it with acceptable material.

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS

Bridge decks (full-depth decks with no overlay)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application.
	Plus	
Bridge Overlays	7 Curing Membrane	Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.



17

710.3 - CONSTRUCTION REQUIREMENTS (e. Curing & Protection) p. 700-44



(Type 2 liquid membrane)



18

Bridge Deck Overlays



Sections:
731 (Area Prep. for Patching)
732 (Machine Prep.)
717 (Conc. OL)

729 (Poly OL)



19

731 – AREA PREP. FOR PATCHING (a. General p. 700-116)



731.1 DESCRIPTION

Perform all work necessary to remove all asphalt material and unsound concrete from the existing bridge or the designated area to the depth specified in the Contract Documents, or as designated by the Engineer.

BID ITEMS

Area Prepared for Patching
Area Prepared for Patching (Full Depth)
Area Prepared for Patching (Poured with Overlay)
Area Prepared for Patching (Set Price)
Area Prepared for Patching (Full Depth) (Set Price)

UNITS

Square Yard
Square Yard
Square Yard
Square Yard
Square Yard

731.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete	SECTIONS 401 & 402
Aggregates for Concrete Not On Grade	SECTION 1102
Concrete Curing/Precure Materials	DIVISION 1400
Reinforcing Steel	DIVISION 1600
Epoxy Resin Base Bonding Systems	DIVISION 1700
Rapid Set Concrete Patching Materials*	SECTION 1716

*When specified in the Contract Documents.

On bridge decks that do not receive a concrete overlay, use coarse aggregate complying with SECTION 1102, except grading must adhere to TABLE 731-1.

TABLE 731-1: AGGREGATE GRADATION	
Sieve Size	Percentage Retained
3/4" "	0
1/2" "	0-10
3/8" "	15-50
#8	90-100



20

731 – AREA PREP. FOR PATCHING (a. General p. 700-116)

731.3 CONSTRUCTION REQUIREMENTS

a. General (All Decks). Remove asphalt material and unsound concrete as shown in the Contract Documents and as designated by the Engineer, to the depth required to reach sound concrete and rust free reinforcing steel. Dispose of removed material on sites approved by the Engineer.

Unless specifically noted in the Contract Documents, the Contractor may choose to remove unsound concrete by other means capable of removing the required concrete, without injury to the sound concrete and reinforcing steel.

Unless specifically noted in the Contract Documents, the Contractor may **not** choose to remove unsound concrete by hydrodemolition. When hydrodemolition is allowed, remove the required concrete, without injury to the sound concrete and reinforcing steel. When hydrodemolition is allowed and used as the method of removal, the Engineer will determine the areas of unsound concrete after hydrodemolition.

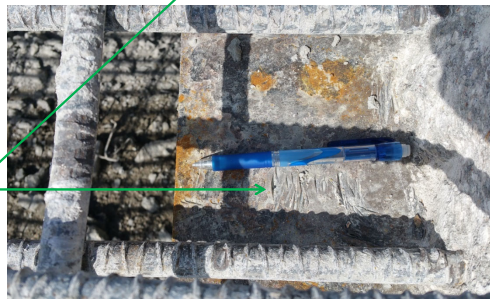
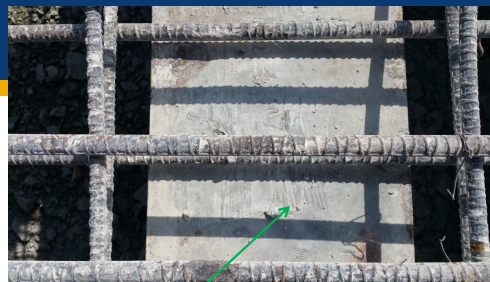
Do not use jack hammers or chipping hammers heavier than the nominal 15-pound class on any partial depth concrete removal. Jack hammers up to the nominal 30-pound class may be used in areas of full depth patching to within 6 inches of the edges of the designated areas. Do not use chipping hammers heavier than a nominal 15-pound class to remove the 6-inch edge. Operate jack hammers and chipping hammers at an angle to prevent damage to the sound concrete.



21



1. Locate and mark beams if working on a steel structure.
2. Work carefully to **NOT** gouge or damage Top Flange during removal.
3. If damaged, beams will be repaired at No Cost to the State.

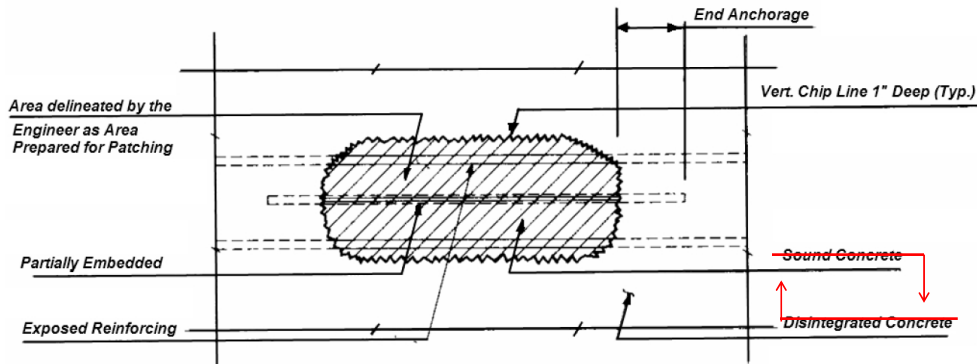


22

Fig. 731-1 is CONFUSING!!

(1) Reinforcing. Remove all scale and heavy rust from steel bars. When concrete is removed by jack hammers, wet sandblasting is prohibited. If reinforcing is left exposed, and signs of rust appear, the Engineer may require that the cleaning be repeated. Do not cut, stretch or damage any exposed reinforcing steel. Do not break the bond between the reinforcing steel and concrete where bars are partially exposed yet remain anchored in sound concrete, near the ends or where more than half the bar is beneath the concrete removal line. See FIGURE 731-1.

FIGURE 731-1



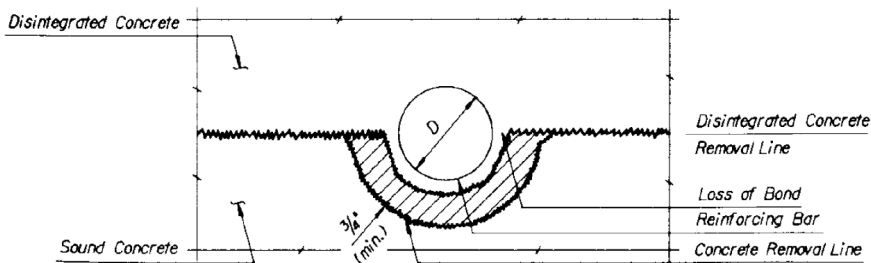
23

731 – AREA PREP. FOR PATCHING (a. General p. 700-116)

(2) Bonding of Reinforcing Steel.

(a) Top Layer of Transverse Reinforcing Bars. Where the bond between existing concrete and the top layer of transverse reinforcing steel has been destroyed (FIGURE 731-2), remove the concrete adjacent to the bar to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of $\frac{3}{4}$ inch. A bar may be considered bonded by the Engineer even if less than $\frac{1}{2}$ the bar depth is embedded in concrete.

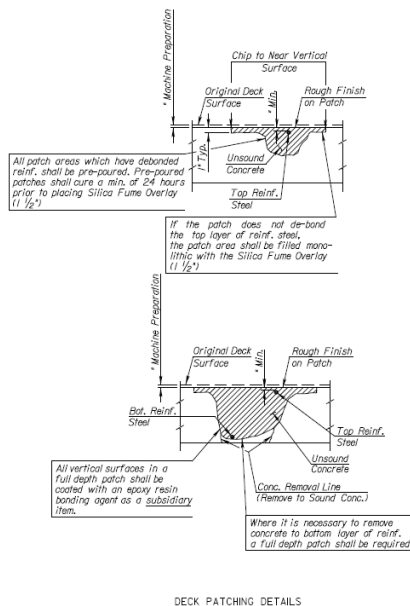
FIGURE 731-2



(b) All Reinforcing Bars Other Than the Top Layer of Transverse Bars. Where more than $\frac{1}{2}$ the diameter of the steel is exposed (FIGURE 731-3), or where the bond between existing concrete and reinforcing steel has been destroyed (FIGURE 731-2), remove the concrete adjacent to the bars to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of $\frac{3}{4}$ inch.



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MACHINE PREPARATION (): This item shall consist of preparing the deck for a SFO by removing concrete from the roadway surface of the bridge deck to a depth of _____ inches. See KDOT Specifications.

AREA PREPARED FOR PATCHING: This item shall consist of removing unsound concrete and bituminous patches from the bridge deck, cleaning reinforcing bars, filling the removed patched areas with concrete and preparing the entire area of the deck for SFO. Quantity shown is an estimate of the areas involved. The exact areas shall be determined by tapping, before, during and after chipping operation to ensure that all unsound concrete has been removed. See KDOT Specifications.

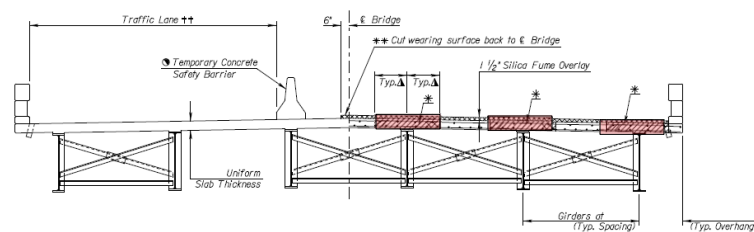
FULL DEPTH PATCHING: Forms shall be provided to enable placement of concrete in areas of full depth removal of bridge slab. The forms may be suspended from existing reinforcing bars by wire ties or a method approved by the Engineer may be used. See KDOT Specifications for method of measurement and basis of payment.

REINFORCING IN BRIDGE DECK: Care should be exercised to prevent cutting, stretching or damaging exposed reinforcing steel. Extreme care should be exercised to avoid breaking the bond between the reinforcing steel and concrete where bars are partially exposed yet remain anchored in sound concrete. Reinforcing steel damaged, cut, or deteriorated shall be replaced as directed by the Engineer. Sufficient reinforcement bars and minimum splice length required. Replacement of bars damaged by the Contractor shall be supervised by the Area Foreman for Reinforcing.

SILICA FUME OVERLAY: This item shall consist of cleaning the concrete surface and placing the 1½ inch SFO. See KDOT Specifications.

SILICA FUME OVERLAY CONSTRUCTION JOINTS: All vertical construction joints in the overlay and the vertical joint between the overlay and the curbs shall be cleaned by sandblasting, and then painting the joints with an approved Concrete Masonry Coating 72 hours after placement of the Silica Fume Overlay.

REPAIR OF EPOXY COATED REINFORCING STEEL: Replace any epoxy coating that is removed from the reinforcing steel during the concrete removal process. Thoroughly clean damaged areas with a stiff wire brush to remove dirt and damaged coating. Apply an approved patching material in accordance with manufacturer's recommendations. Avoid dripping any patching material onto existing concrete that will have new concrete placed against it. See KDOT Specifications.



④ The type of traffic delineator to be used is found in the traffic control sheets.

See "Construction Staging" sheet for traffic lane and roadway widths.

▲Girder Spacing /4 or as directed by the Engineer.

****Note:** Cutting the wearing surface back to € Bridge, concrete removal, all material, equipment, and labor necessary for this item shall be Subsidiary to other items.

* **PATCHING SEQUENCE:** When large areas of full depth patches are needed in this area, they shall be patched in segments. The segments of full depth patch shall be a maximum of 8'-0" in length parallel to the centerline of bridge with a minimum of 8'-0" between segments. After the patches in the initial segments have cured, the areas between the segments shall be patched. The segmental patching will not be required if adequate shoring is provided to support the deck and curbs.

SUMMARY OF QUANTITIES			
ITEM	UNITS	QUANTITY	
Machine Preparation ()	Sq. Yds.		
Area Prepared for Patching	Sq. Yds.		
Area Prepared for Patching (Full Depth)	Sq. Yds.		
Silica Fume Overlay (1 1/2")	Sq. Yds.		
Reinforcing Steel (Rebar) (Grade 60) (Epoxy Coated) (Set Price)	Lbs.		
Material for Silica Fume Overlay (Set Price)	Cu. Yds.		
HMA-Commercial Grade (Class A)	Tons		

† See KDOT Specifications when hydroblasting is used for machine preparation.

MINIMUM REBAR SPLICE LENGTHS		
Existing Bar Size	Minimum Splice Lengths (inches)	
	Existing Gr. 40 ksi Bars	Existing Gr. 60 ksi Bars
#4	12"	16"
#5	13"	20"
#6	16"	24"
#7	20"	30"
#8	20"	39"
#9	33"	49"
#10	42"	62"
#11	61"	77"

Note: If splicing epoxy coated reinforcing steel, increase the above splice lengths by 20%.

■ Lap lengths are based on a Class B splice. Use the minimum splice length corresponding to the grade of the existing reinforcing in the deck.

731-DECK PATCHING - GIRDER BRIDGE



SECTION 731-DECK PATCHING
PART 1: PATCHING SEQUENCE

DECK PATCHING SEQUENCE (SLAB, BOX & T-GIRDER)

BRIDGE NO.

CO. PRICE

DECK PATCHING SEQUENCE
(Showing sequence for one lane only, other lane similar)

* Span Length / 4 or as directed by the Engineer.

SUMMARY OF QUANTITIES

ITEM	UNITS	QUANTITY
Machine Preparation ()	Sq. Yds.	
Area Prepared For Patching	Sq. Yds.	
Area Prepared For Patching (Full Depth)	Sq. Yds.	
Silica Fume Overlay (1 1/2")	Sq. Yds.	
Reinforcing Steel (Repair) (Grade 60) (Epoxy Coated) (Self Price)	Lbs.	
Material for Silica Fume Overlay (Self Price)	Cu. Yds.	
HMA-Commercial Grade (Class A)	Tons	

† See KDOT Specifications when hydroblasting is used for machine preparation.

PATCHING SEQUENCE: The concrete removal shall be completed in stages, beginning with removal of deteriorated concrete in Area (1). If more than 15 longitudinal bars in Area (1) are debonded for a distance of greater than 4 ft. along the bars, the concrete removal shall stop and the patch area filled with Concrete Grade 4.0 (AE). The patch shall cure a minimum of 3 days before concrete removal resumes in that area. Following the completion of work in Area (1), concrete removal may begin in Area (2). Concrete removal shall not begin in Area (2) until the patching concrete in adjacent Area (1) has cured a minimum of 3 days. The maximum size of any full depth patch shall be limited to 4 ft. x 8 ft. in any direction. Fully debonded bars in Area (2) shall be limited to the same 4 ft. x 8 ft. maximum patch size. All patching and BWS concrete shall cure according to the Specifications prior to allowing traffic on that lane.

MINIMUM REBAR SPICE LENGTHS

Existing Bar Size	Minimum Splice Lengths (Inches)	
	Existing Gr. 40 ksi Bars	Existing Gr. 60 ksi Bars
#4	12"	16"
#5	13"	20"
#6	15"	24"
#7	20"	30"
#8	26"	39"
#9	33"	49"
#10	42"	62"
#11	51"	77"

Note: If splicing epoxy coated reinforcing steel, increase the above splice lengths by 20%.

‡ Lap lengths are based on a Class B splice. Use the minimum splice length corresponding to the grade of the existing reinforcing in the deck.

731-DECK PATCHING

- SLAB BRIDGE

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732 – MACHINE PREP.

(p. 700-121)

732.1 DESCRIPTION

Prepare the bridge deck surface for a concrete bridge deck overlay by removing the existing concrete and asphaltic material from bridge deck and approaches as shown in the Contract Documents.

BID ITEM

Machine Preparation (*)

*Thickness

UNITS

Square Yard

732.2 MATERIALS - None specified.

732.3 CONSTRUCTION REQUIREMENTS

Remove concrete and asphaltic materials from the existing surface to the specified depth over the area of the deck by means of milling or cutting procedure capable of removing the specified material without injury to the sound concrete.

When specified, mill the approaches according to the Contract Documents.

732.4 MEASUREMENT AND PAYMENT

The Engineer will measure machine preparation by the square yard. Milling of approaches is subsidiary to the machine preparation bid item.

Payment for "Machine Preparation" at the contract unit price is full compensation for the specified work.

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717 – BRIDGE OVERLAYS

p. 700-91

717.1 DESCRIPTION

Construct the portland cement concrete overlay as shown on the Contract Documents.
When Bridge Deck Grooving is a bid item in the contract, perform the grooving as shown in the Contract Documents.

BID ITEMS

Portland Cement Concrete Overlay (*)
Material for Portland Cement Concrete Overlay (Set Price)
Bridge Deck Grooving

* Thickness

UNITS

Square Yard
Cubic Yard
Square Yard

717.2 MATERIALS

Provide materials that comply with the applicable requirements.

Grade 4.0 (AE) Concrete ⁺	SECTIONS 401 & 402
Aggregate for Concrete Not On Grade.....	DIVISION 1102
Precure/Finishing Aid Material ⁺⁺	DIVISION 1400
Concrete Curing Materials	DIVISION 1400
Concrete Masonry Coating	DIVISION 1700

⁺Use concrete that meets requirements for low permeability concrete (LPC) as specified in DIVISION 400.

⁺⁺When silica fume is used as an SCM, the use of Precure/Finish Aid may be used according to the manufacturer's instructions.

For overlays use Supplemental Cementitious Materials at allowable substitution rates as listed in TABLE 401-2.



717.3 – BRIDGE OVERLAYS – Const. Req.

(b. Surface Prep.) p. 700-92

TABLE 717-1: PORTLAND CEMENT CONCRETE OVERLAY PRODUCTION REQUIREMENTS

Total Placed Surface Area per Bridge (Square Yards)	Minimum Cubic Yards per Hour
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5

b. Preparation of Surface. Prior to placement of concrete, sand or shot blast the surface followed by an air blast to the bottom 3 inches of hubguard, and edges against which concrete is to be placed to remove all dirt, oil, pavement marking and other foreign material, as well as any unsound concrete, laitance and curing material from the surface. Wet sand blasting may be used only with approval of the Engineer. It is desired that the surface be roughened by the sand or shot blast to provide satisfactory bond with the surfacing concrete. Protect metal deck drains and areas of the curb or railing above the proposed surface from the sand or shot blast.

Check the finish machine clearance above the prepared surface before concrete is placed to obtain the thickness specified in the Contract Documents.

A minimum of 2 hours before the placing of the concrete overlay, use clean water to thoroughly wet any concrete surfaces to which the concrete is to bond against. Blow or broom away all free water immediately ahead of the placing operation. Bonding surfaces should be maintained in a damp condition with no free water.



717.3 – BRIDGE OVERLAYS (c. Placing Concrete) p. 700-92

c. Placing Concrete. Place and fasten the screed rails in position to obtain finished concrete at the required profile. Place the supporting rails upon which the finishing machine travels outside the area to be concreted. A hold-down device shot into concrete is prohibited, unless the concrete is to be subsequently overlaid. Hold-down devices of other types leaving holes in exposed areas will be approved provided the holes remaining are grouted full. Methods for anchoring and supporting the rails and the concrete placing procedure require approval by the Engineer.

Locate longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

Placing of the overlay is prohibited when conditions on the bridge deck are such that the evaporation rate is estimated to equal or exceed 0.2 pounds per square foot per hour, or is predicted to exceed that rate during the course of the placement, unless corrective measures listed in **subsection 710.3b**, are taken to reduce the evaporation rate to below 0.2 pounds per square foot per hour.

Fogging may be necessary during placement of the overlay. Accomplish fogging according to **subsection 710.3b**.

The evaporation rate will be rechecked with the measures in place, using the procedures outlined above.

The elapsed time between depositing the concrete on the deck and final screeding may not exceed 15 minutes, unless otherwise authorized by the Engineer.

Manipulate and mechanically consolidate new concrete to a minimum of 98% of the consolidated unit weight and screed to final grade. In irregular areas or along the curb where the finishing screed does not reach, hand tamp with a 6-inch by 6-inch metal plate device to assist in consolidation and bonding of the concrete. When concrete for partial depth patches is placed with the overlay, apply additional vibration or hand tamping in the patch areas to assist in consolidation and bonding of the concrete.



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717.3 – BRIDGE OVERLAYS (f. Weather Limitations) p. 700-93

f. Weather Limitations. See **SECTION 401**. Also, discontinue concreting operations when a descending air temperature in the shade and away from artificial heat falls below 45°F except with written approval from the Engineer. Do not start or resume operations until an ascending air temperature reaches 40°F, or if night time temperatures are expected to fall below 35°F.



BD-32



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729 – MULTI-LAYER POLY OVERLAYS

p. 700-109

729.1 DESCRIPTION

Prepare the surface of the reinforced concrete bridge deck and construct a multi-layer polymer concrete overlay (overlay) as shown on the Contract Documents.

Provide an overall combination of labor and equipment with the capability of proportioning and mixing the polymer resin components and placing the primer and aggregate, in accordance with this specification and the manufacturer/supplier's recommendations.

BID ITEM

Multi-Layer Polymer Concrete Overlay

UNITS

Square Yard

729.2 MATERIALS

a. General.

(1) Proportion all polymer materials according to the manufacturer/supplier's recommendations.

(2) Provide the Engineer with a copy of the polymer materials manufacturer/supplier's mixing and application recommendations.

(3) If concrete bridge deck patching is specified, polymer concrete materials may be used for patching of the concrete bridge deck. See **SECTION 731**.

b. Epoxy. Provide a Type III epoxy resin as defined in **DIVISION 1700**.

c. Polyester. Provide a polyester resin as defined in **DIVISION 1700**.

d. Aggregate.

(1) Provide FA-C aggregate meeting **TABLE 1102-5** and **TABLE 1102-6**, or

(2) As provided by the polymer concrete overlay supplier in a prequalified system, **DIVISION 1700**.



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729 – MULTI-LAYER POLY OVERLAYS

p. 700-109

729.3 CONSTRUCTION REQUIREMENTS

a. General. Wet cure concrete on new bridge decks for 14 days and allow the deck to dry for 21 days before applying the overlay.

Portland cement concrete patches require a minimum cure period of 28 days before application of the overlay.

At the preconstruction conference, discuss the patching material and the corresponding curing period. Submit changes, including a written statement from the polymer manufacturer/supplier recommending changes, to the Engineer for approval.

b. Equipment. Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment

(a) Shot blasting equipment capable of producing a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch. Final acceptance is based on testing procedures as outlined in KT-70, Part V.

(b) Shot/Sand blast equipment capable of producing the required surface relief on the deck adjacent to bridge rails and barriers and areas not accessible with shot blast equipment.

(c) Empty shot blasters and dispose of waste material a minimum of 50 feet from the prepared bridge deck. On long structures empty shot blasters on the unprepared surface a minimum of 50 feet from prepared surface to prevent contamination of the deck by return of dust to the prepared surface.

(d) The Engineer must approve the use of scarifiers, scrubbers or milling machines.



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729 – MULTI-LAYER POLY OVERLAYS

p. 700-110

(e) Wet sand blasting is prohibited.

(2) Mechanical Application Equipment.

(a) Polymer mixing and distribution system capable of accurate and complete mixing of the polymer resin and hardening agent, verification of the mix ratio and uniform and accurate distribution of the polymer materials at the specified rate on 100% of the work area.

(b) A self-propelled aggregate spreader (if required) capable of uniform and accurate application of the dry aggregate over 100 % of the work area.

(c) An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material.

(d) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

(3) Hand Application Equipment.

(a) Calibrated containers for accurate measurement of the polymer components.

(b) Paddle type mixer or other mixing device capable of accurate and complete mixing of the polymer resin and hardening agent.

(c) Notched squeegees and brooms capable of spreading the polymer material in accordance with this specification and the manufacturer/supplier's recommendations.

(d) Aggregate spreader capable of uniform and accurate application of the dry aggregate.

(e) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.



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729 – MULTI-LAYER POLY OVERLAYS

p. 700-110

c. Preparation of Surface.

(1) When specified, perform any required repairs under **SECTION 731** and cure repairs, before preparation of the surface, unless placed with the overlay.

(2) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(3) Close deck drains so the overlay materials will not pass through the drains.

(4) Remove any remaining contamination of the prepared deck surface or surface of subsequent courses. Sand blast or bush hammer contaminated areas to produce an acceptable surface for placement of the overlay.

(5) As the final preparation for the placement of the overlay, make a complete cleanup by shot blasting and/or other approved means, followed by an air blast with dry, oil free air or vacuum. Brooming is not acceptable. Remove all pavement marking, loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation and curing materials from patches and other foreign material from the surface of the deck.

(6) Produce a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch.

(7) Place the first coat of the overlay within 24 hours of preparing the deck surface. Prepared surfaces exposed for more than 24 hours must be lightly sand blasted prior to application of the overlay.



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729 – MULTI-LAYER POLY OVERLAYS, Continued...

- d. Placing the Multi-Coat Poly
- e. Face of Curbs, Barriers and Rail
- f. Application Rates
- g. Curing
- h. Testing
- i. Correction of Unbonded Areas
- j. Weather Limitations

... Basically, if you get one of these Projects, read through it as best you can, then call Dan Wadley at Materials and he'll come out and help you.



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Thanks!!!



38

CIT Structures

Curing



1.Curing

- Curing mediums
 - Wet Burlap
 - Liquid membrane-forming compounds
 - White polyethylene sheeting
 - Formwork

2.Curing - 15-07011-R01 - 710.3 e. Curing and Protection

(1) General. Cover concrete surfaces according to TABLE 710-1. Cure all pedestrian walkway surfaces in the same manner as the bridge deck. The determination of the time requirement for curing commences after all the concrete for the placement is in place and finished. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Maintain a damp surface until the saturated burlap is placed. Fully saturate burlap before placing on concrete surface. Cover all concrete surfaces with saturated burlap within 15 minutes after finishing the concrete, do not mar concrete during placement of the saturated burlap. When times of delay are expected to exceed 15 minutes, cover all concrete that has been placed, but not finished, with saturated burlap. Maintain the curing so that moisture is always present at the concrete surface.

Place and weight down the saturated burlap so it will remain in intimate contact with the surface covered.

When an impermeable sheeting material is used, lap each unit 18 inches with the adjacent unit. Place and weight down the impermeable sheeting material so it will remain in intimate contact with the surface covered. When any burlap or impermeable sheeting material becomes perforated or torn, immediately repair it, or discard and replace it with acceptable material.



3

3.Curing

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Saturated burlap covered with white polyethylene sheeting during the 14-day period. See subsection 710.3e(5) .
Bridge decks (full-depth decks with no overlay) Bridge Overlays (new and existing structures)	14 Wet Plus 7 Curing Membrane	Saturated burlap covered with white polyethylene sheeting during the 14-day period. See subsection 710.3e(5) . After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and saturated burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require saturated burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.



4

4.Curing – 710.3 e. Curing and Protection

(2) Liquid Membrane Forming Compounds. Use spraying equipment capable of supplying a constant and uniform pressure to provide uniform distribution at the rates required. Agitate the liquid membrane forming compound continuously during application. The surface must be kept wet from the time it is finished until the liquid membrane forming compound is applied. Apply liquid membrane forming compound at a minimum rate per coat of 1 gallon per 200 square feet of concrete surface. Give marred or otherwise damaged applications an additional coating. If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage from the rain, or if the film is damaged by any other means, apply a new coat of the membrane to the affected portion equal in curing value to the original application.



5

5.Curing – 710.3 e. Curing and Protection

(3) Bridge Subdecks and Decks. Provide a work bridge to facilitate application of all curing materials. Maintain the curing so that moisture is always present at the concrete surface.

Maintain the saturated burlap in a fully wet condition using misting hoses, self-propelled, machine-mounted fogging equipment with effective fogging area spanning the deck width, moving continuously across the entire burlapcovered surface, or other approved devices until the concrete has set sufficiently to allow foot traffic. At that time, place soaker hoses on the saturated burlap, and supply running water continuously to maintain continuous saturation of all burlap material to the entire concrete surface. For bridge decks with superelevation, place a minimum of 1 soaker hose along the high edge of the deck to keep the entire deck wet during the curing period.

If the concrete surface temperature is above 90°F, do not use polyethylene sheeting in direct sunshine during the day for the first 24 hours of the specified curing period (TABLE 710-1).



6

6.Curing – 710.3 e. Curing and Protection

(5) Cold Weather Curing. If concrete is placed in cold weather, comply with SECTION 401. If concrete is placed and the ambient air temperature is expected to drop below 40°F during the entire specified curing period, prior to beginning concrete placement, provide materials on site to maintain the concrete temperature between 40 and 90°F as measured on the surface of the concrete. Suitable materials consist of straw, additional burlap or other blanketing materials or housing and artificial heat.

Keep the surface of the concrete moist by the use of an approved moisture barrier such as saturated burlap or polyethylene sheeting or both as defined in TABLE 710-1. Maintain the moisture barrier in intimate contact with the concrete during the entire specified curing period.

(6) Thermal Shock. After the completion of the required curing period, remove the curing and protection to prevent rapid cooling of the concrete so that the concrete temperature does not fall more than 25°F during the first 24 hours.



7

7.Curing

- Foundations and Substructures
 - In the Forms with Burlap and Poly
- Footings
- Abutments
- Pier Columns and Caps



8

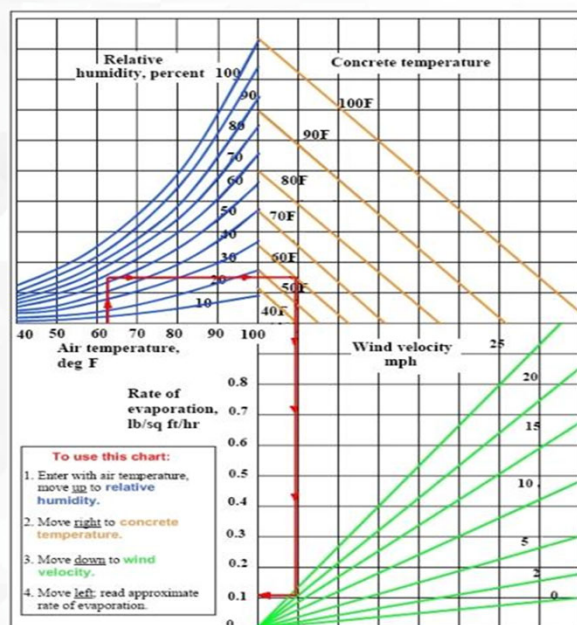
8.Curing

- Superstructure
 - Bridge Decks
 - Starts with Environmental Conditions
 - Evaporation Rate
 - $< 0.2 \text{ lb/sq ft/hr}$
 - Fogging 1200 psi / 2.2 gpm or low rate 1.6gpm



9.Curing

- Superstructure
 - Bridge Decks
 - Figure 710-1
 - Equal to or above $0.2 \text{ lb/ft}^2/\text{hr}$, take actions to create and maintain an evaporation rate less than $0.2 \text{ lb/ft}^2/\text{hr}$



10.Curing

- Superstructure
- Figure 710-1

Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft² /hr (1.0 kg/ m² /hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate is less than 0.2 lb/ft² /hr (1.0 kg/m² /hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.



11

11.Curing

- Superstructure
- **Cover within 15 minutes**
- Fully Saturate burlap before placing on concrete surface



12

12.Curing

- Superstructure
- Place and weight down burlap so it will remain in intimate contact with the surface covered



13

13.Curing

- Superstructure
- Do not mar concrete during placement
- Maintain damp surface



14

14.Curing

- Superstructure
- Maintain the wet burlap in a fully wet condition
- Place Soaker Hoses, supply running water continuously



15

15.Curing

- Superstructure
- When impermeable sheeting is used, lap each unit 18"



16

16.Curing

- Superstructure
- If the concrete temperature is above 90 degrees, do not use polyethylene sheeting in direct sunlight for the first 24 hours



17.Curing

- 710.3 e. Curing
- Table 710-1
- Minimum Cure Times and Curing Mediums
- Note the specified type of liquid membrane

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays)	14	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge subdecks (decks with overlays)	Wet	
Bridge decks (full-depth decks with no overlay)	14	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
	Plus	
Bridge Overlays	7	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Other unformed or exposed surfaces	7	
Formed sides and ends of bridge wearing surfaces and bridge curbs	4	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.
Other formed surfaces	Formed	

18.Curing

• Superstructures

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay)	Plus	After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application.
Bridge Overlays	7 Curing Membrane	Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.



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19.Curing

• Superstructures

Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days.
Other formed surfaces		If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.



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20.Curing

- Superstructures
- Load Limits during cure period Table 710-2

TABLE 710-2: CONCRETE LOAD LIMITATIONS ON BRIDGE DECKS		
Days after concrete is placed	Element	Allowable Loads
1*	Subdeck, one-course deck or concrete overlay	Foot traffic only.
3*	One-course deck or concrete overlay	Work to place reinforcing steel or forms for the bridge rail or barrier.
7*. ^Δ	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10*. ^Δ (15)**. ^Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Light truck traffic (gross vehicle weight less than 5 tons).****
14*. ^Δ (21)**. ^Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Legal Loads; Heavy stationary loads with the Engineer's approval.***Overlays on new decks.
28	Bridge decks	Overloads, only with the State Bridge Engineer's approval.***

21

21.Curing

- Superstructures
- Load Limitations during cure period
- Table 710-2
- 3 days placing reinforcing steel and form work
- Maintain wet cure



22

22.Curing

- Superstructures
- Load Limitations during cure period
- Table 710-2
- 14 days Legal Loads
- Maintain wet cure



Curing





Concrete and Reinforcing Steel Test Review

1

Keys to being successful

- Relax and remember you can pass this class.
- Ask questions.
- Don't memorize the details/specs, they change too often. Learn how and where to find the details; Standard specifications, plans, special provisions, project specific special provisions.
- Be respectful to others.
- Enjoy yourself.



2

Concrete and Reinforcing Steel Review 1

- Concrete Slump:
 - The designated slump for a concrete mix design is 3". What is the acceptable slump range?
 - Designate a slump for each concrete mix design that is required for satisfactory placement of the concrete application. Reject concrete with a slump that limits the workability or placement of the concrete.
 - If the designated slump is 3 inches or less, the tolerance is $\pm \frac{3}{4}$ inch, or limited by the maximum allowable slump for the individual type of construction.
 - If the designated slump is greater than 3 inches the tolerance is $\pm 25\%$ of the designated slump.
 - For drilled shafts the target slump just prior to being pumped into the drilled shaft is 9 inches. If the slump is less than 8 inches, redoes the concrete with admixtures as permitted in **subsection 401.3i**.
 - Do not designated a slump in excess of 5 inches for all other structural concrete.



3

Concrete and Reinforcing Steel Review 2

- Concrete Slump:
 - The designated slump for a concrete mix design is 3". What is the acceptable slump range?
 - $3" \leq 3" \rightarrow$ Tolerance is $\pm \frac{3}{4}"$
 - $3" - \frac{3}{4}" = 2\frac{1}{4}"$
 - $3" + \frac{3}{4}" = 3\frac{3}{4}"$
 - The acceptable range is $2\frac{1}{4}"$ to $3\frac{3}{4}"$



4

Concrete and Reinforcing Steel Review 3

- Placement Time:
 - If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? No set retarding admixture is added.



5

Concrete and Reinforcing Steel Review 4

- 401.8 – Mixing, Delivery and Placement Limitations
- Non-agitated Concrete – place within 30 minutes of adding the cement to the water
- Agitated Concrete – use Table 401-5

TABLE 401-5: AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME		
T = Ambient Air Temperature at Time of Batching (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
T < 75	1 ½	All Cases
75 ≤ T < 90	1	None
75 ≤ T < 90	1 ½	Set Retarder
T _c = Concrete Temperature at time of placement (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
90 ≤ T _c *	¾	All Cases
Other conditions contributing to quick stiffening of concrete	¾	All Cases



6

Concrete and Reinforcing Steel Review 5

- Placement Time:
 - If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? No set retarding admixture is added.
- **The maximum time allowed for placement of the concrete after water is added to the mix is 1 hour (See 401.8.a)**



7

Concrete and Reinforcing Steel Review 6

- Placement Time:
 - If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? A set retarding admixture is added.
- **The maximum time allowed for placement of the concrete after water is added to the mix is 1.5 hours (See 401.8.a)**



8

Concrete and Reinforcing Steel

Review 7

- Placement Time:
 - What is the maximum time allowed for placement of agitated concrete if the ambient air temp. is 99° F and the concrete temp. at the time of placement is 90° F? No set retarding admixture is added.
 - **The maximum time allowed for placement of the concrete after water is added to the mix is 45 minutes (See 401.8.a)**
 - If concrete temp. $\geq 90^{\circ}\text{F}$, 45 min. placement time



Falsework & Form Construction Review

F&F-1

1

Example Questions:

Q1: Concrete columns for a single column bent pier were poured yesterday. How long from concrete placement can pier beam formwork erection start?

1. Structural Element?

Single Column Bent

2. Type of Work?

Pier Beam Formwork

2

1. Structural Element?

Deck, 7.25 Ft. span

Type of work?

*Removal of
Forms*

= 4 Days

Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*	10 ^Δ [6]*	
Type of Work		Time (Days)				
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.		4 ^Δ [3]*				
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns		4 ^Δ [2]*				
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns		2 ^Δ				
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns		4 ^Δ [2]*				
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam		4 ^Δ [2]* 7 ^Δ [4]*				
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam		2 ^Δ 4 ^Δ [2]*				
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns		2 ^Δ				
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel		2 ^Δ				
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel		4 ^Δ [2]*				
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.		NA				

5

Example Questions

Q3: The concrete deck for a steel girder bridge was placed on October 15th. The width of the deck is 60'. There are 6 girders spaced at 7'-3". No test specimens were made. Supplemental cementitious materials were added. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

*Deck, girders spaced at 7.25 Ft
with S.C.M.'s*

2. Type of Work?

removal of Deck Forms

6

1. Structural Element?
Deck, 7.25 Ft. span

2. Type of Work?
Removal of Forms

4 Days ←

$\Delta = \text{add 3 Days}$

Total = 7 Days

Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.	4 ^Δ [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns	2 ^Δ
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4 ^Δ [2]* 7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2 ^Δ 4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA



7

Example Questions:

Q5: Wing Walls for a RFB was placed October 3rd. No Supplemental Cementitious materials were added. How many days between the concrete placement and the removal of forms if no test specimens were made?

1. Structural Element?
Wing Walls

2. Type of Work?
removal of Wing Wall Forms



8

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7 ^Δ [4]*	10 ^Δ [6]*				
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*		10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*		15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*		10 ^Δ [6]*	
Type of Work							Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.							4 ^Δ [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns							2 ^Δ
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns							4 ^Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam							4 ^Δ [2]* 7 ^Δ [4]*
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam							2 ^Δ 4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns							2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel							2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel							4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.							NA

9

Example Questions:

Q6: Same structure as Q5. How many days if grade 4.0 concrete (4000 psi) is specified, and test specimens broke at a strength of 2800 psi after 3 days?

1. Structural Element?

Deck, girders spaced at 11 Ft.

+ Cylinders made, broke on Day 4

Requirement for: *+ = reduce days if attain 65% of f'c*

0.65(4000) = 2600 psi Needed

break of 2800 > 2600 req'd, OK.

Remove forms on Day 3 after breaks.

2. Type of Work?

removal of Wing Wall Forms

10

1. Structural Element?

Wing Walls

2. Type of Work?

*Removal of
Forms*

= [3] Days

*if * cylinders made
broke above Req'd .?*

*Yes. = Remove at 3
Days.*

Type of Work	Span Length (feet)					
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on columns		7 ^Δ [4]*	10 ^Δ [6]*			
Column Bent Piers - Falsework supporting pier beam**	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4 ^Δ			7 ^Δ [4]*	10 ^Δ [6]*	15 ^Δ [10]*
RCB and RFB top slabs not re-shored		7 ^Δ [4]*		7 ^Δ [4]*	10 ^Δ [6]*	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to SECTION 204, until 3 days after forms are removed.	4 ^Δ [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Spread Footing founded in rock - minimum before erecting forms and reinforcing steel for columns	2 ^Δ
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4 ^Δ [2]*
Columns for cantilevered piers -	
1. minimum before supporting forms and reinforcing steel for the pier beam on the column.	4 ^Δ [2]*
2. minimum before placing concrete for the pier beam	7 ^Δ [4]*
Columns for bent piers -	
1. minimum before erecting formwork and reinforcing steel for the pier beam	2 ^Δ
2. minimum before placing concrete for the pier beam	4 ^Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 ^Δ
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2 ^Δ
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4 ^Δ [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA



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700 STRUCTURES		
701	TEMPORARY SHORING	700-1
702	CONTROLLED DEMOLITION	700-2
703	DRILLED SHAFTS	700-6
704	PILING	700-15
704.1	DESCRIPTION	700-15
704.2	MATERIALS	700-15
704.3	PILE DRIVING EQUIPMENT	700-15
a.	General	700-15
b.	Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Conc. Pile	700-15
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d.	Vibratory Hammers	700-16
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f.	Leads	700-16
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704.4	CONSTRUCTION REQUIREMENTS	700-17
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704.5	MEASUREMENT AND PAYMENT	700-21
705	STRUCTURAL STEEL FABRICATION	700-22
706	BEARINGS AND PADS FOR STRUCTURES	700-32
707	EXPANSION DEVICES	700-33
708	FALSEWORK AND FORM CONSTRUCTION	700-35
709	STEEL PERMANENT DECK FORMS	700-39



12

Say there was a question about the **(finished) smoothness of a bridge deck**: where would one look?

705	STRUCTURAL STEEL FABRICATION	700-22
706	BEARINGS AND PADS FOR STRUCTURES	700-32
707	EXPANSION DEVICES	700-33
708	FALSEWORK AND FORM CONSTRUCTION	700-35
709	STEEL PERMANENT DECK FORMS	700-39
710	CONCRETE STRUCTURE CONSTRUCTION	700-40
710.1	DESCRIPTION	700-40
710.2	MATERIALS	700-40
710.3	CONSTRUCTION REQUIREMENTS	700-40
	a. Falsework and Forms	700-40
	b. Handling and Placing Concrete	700-40
	c. Construction Joints, Expansion Joints and End of Wearing Surface Treatment	700-42
	d. Finishing	700-43
	e. Curing and Protection	700-44
	f. Grinding and Grooving	700-46
	g. Removal of Forms and Falsework	700-47
	h. Bridge Number Marking	700-49
710.4	MEASUREMENT AND PAYMENT	700-49

13

710 CONCRETE STRUCTURE CONSTRUCTION

710.3 CONSTRUCTION REQUIREMENTS

d. Finishing

700-43

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding 1/8 inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see subsection 710.3f. for grooving requirements.



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710 CONCRETE STRUCTURE CONSTRUCTION

710.3 CONSTRUCTION REQUIREMENTS

d. Finishing

700-43

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding ¼ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see subsection 710.3f. for grooving requirements.



15

**Say there was a question about the form removal
for ornamental (structural) rubbed finish work:
where would one look?**

705	STRUCTURAL STEEL FABRICATION	700-22
706	BEARINGS AND PADS FOR STRUCTURES	700-32
707	EXPANSION DEVICES	700-33
708	FALSEWORK AND FORM CONSTRUCTION	700-35
709	STEEL PERMANENT DECK FORMS	700-39
710	CONCRETE STRUCTURE CONSTRUCTION	700-40
710.1	DESCRIPTION	700-40
710.2	MATERIALS	700-40
710.3	CONSTRUCTION REQUIREMENTS	700-40
	a. Falsework and Forms	700-40
	b. Handling and Placing Concrete	700-40
	c. Construction Joints, Expansion Joints and End of Wearing Surface Treatment	700-42
	d. Finishing	700-43
	e. Curing and Protection	700-44
	f. Grinding and Grooving	700-46
	g. Removal of Forms and Falsework	700-47
	h. Bridge Number Marking	700-49
710.4	MEASUREMENT AND PAYMENT	700-49

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710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
g. Removal of Forms and Falsework

700-47

g. Removal of Forms and Falsework. Do not remove forms and falsework without the Engineer's approval. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **TABLE 710-1**.

If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**. Remove forms on handrails, ornamental work and other vertical surfaces that require a rubbed finish as soon as the concrete has hardened sufficiently that it shall not be damaged.

Under normal conditions, the Engineer will allow removal of forms and falsework according to **TABLE 710-3**. The determination of the time requirement for the removal of forms commences after all the concrete for the placement is in place and finished. If high early strength concrete is used, the specified time limits may be decreased as determined by the Engineer, and agreed upon before placing the concrete.



17

710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
g. Removal of Forms and Falsework

700-47

g. Removal of Forms and Falsework. Do not remove forms and falsework without the Engineer's approval. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **TABLE 710-1**.

If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**. Remove forms on handrails, ornamental work and other vertical surfaces that require a rubbed finish as soon as the concrete has hardened sufficiently that it shall not be damaged.

Under normal conditions, the Engineer will allow removal of forms and falsework according to **TABLE 710-3**. The determination of the time requirement for the removal of forms commences after all the concrete for the placement is in place and finished. If high early strength concrete is used, the specified time limits may be decreased as determined by the Engineer, and agreed upon before placing the concrete.



18

Say there was a question about minimum production rate for a concrete bridge overlay: where would one look?

717	BRIDGE OVERLAYS	700-91
717.1	DESCRIPTION	700-91
717.2	MATERIALS	700-91
717.3	CONSTRUCTION REQUIREMENTS	700-91
a.	Equipment	700-91
b.	Preparation of Surface	700-92
c.	Placing Concrete	700-92
d.	Finishing	700-92
e.	Curing and Protection	700-93
f.	Weather Limitations	700-93
g.	Limitations of Operations	700-93
h.	Construction Joints	700-93
i.	Sealing Vertical Faces of the Overlay	700-93
j.	Correction of Unbonded Areas	700-93
717.4	METHOD OF MEASUREMENT AND BASIS OF PAYMENT	700-93



19

717 BRIDGE OVERLAYS

717.3 CONSTRUCTION REQUIREMENTS

a. Equipment

700-91

717.3 CONSTRUCTION REQUIREMENTS

a. Equipment. Use a finishing machine consisting of a mechanical strike-off capable of providing a uniform thickness of concrete slightly above finish grade in front of an oscillating screed or screeds. The finishing machine will be inspected and approved by the Engineer before work is started on each project.

Use a minimum of 1 oscillating screed capable of consolidating the concrete by vibration to 100% of the vibrated unit weight with the following features:

- Install identical vibrators so a minimum of 1 vibrator is provided for each 5 feet of screed length;
- Bottom face a minimum of 5 inches wide with a turned up or rounded leading edge;
- Effective weight a minimum of 75 pounds for each square foot bottom face area;
- Positive control of vertical position, the angle of tilt and the shape of the crown;
- Design together with appurtenant equipment to obtain positive machine screeding of the plastic concrete as close as practical to the face of the existing curb line;
- Length sufficient to uniformly strike-off and consolidate the width of the lane to be paved;
- Forward and reverse motion under positive control;
- Supporting rails which are fully adjustable (not shimmed) to obtain the correct profile, unless otherwise approved by the Engineer. Provide supports which are sufficiently rigid and do not deflect under the weight of the machine. Anchor the supporting rails to provide horizontal and vertical stability; and
- Equip to travel on the completed lane when placing concrete in a lane abutting a previously completed lane.

Manufacturer's specifications or certification may be used as verification of the oscillating screed requirements.

A drum roller equipped to perform all functions outlined for the oscillating screed above, may be used for finishing the overlay concrete in lieu of an oscillating screed. Equip the drum roller to vibrate by either a factory or



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717 BRIDGE OVERLAYS

717.3 CONSTRUCTION REQUIREMENTS

a. Equipment

700-92

717 - BRIDGE OVERLAYS

field adaptation. The drum roller must be able to compact the concrete to a minimum of 100% of the consolidated unit weight.

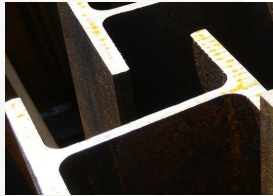
Provide an overall combination of labor and equipment with the capability for proportioning, mixing, placing and finishing new concrete at the following minimum rates shown in TABLE 717-1.

TABLE 717-1: PORTLAND CEMENT CONCRETE OVERLAY PRODUCTION REQUIREMENTS	
Total Placed Surface Area per Bridge (Square Yards)	Minimum Cubic Yards per Hour
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5



CIT Structures

Pile Driving Review



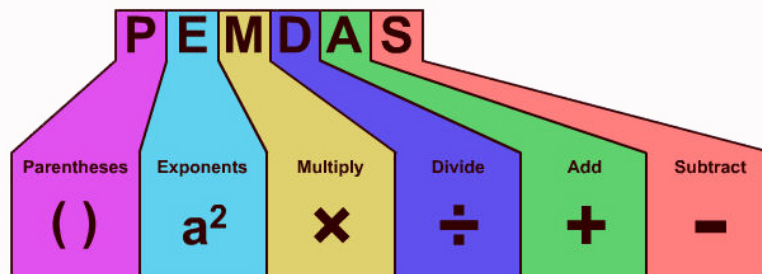
1

1. Mathematics Order of Operations

- Be sure to remember the rules of math while calculating pile bearing

- PEMDAS

- Parentheses
- Exponents
- Multiplication
- Division
- Addition
- Subtraction



2

2. Pile Driving Review

- P= safe bearing power in pounds
- W= weight in pound, of striking part of hammer
- H= height of fall in feet
- S= the average penetration in inches per blow
- X= weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving



3

3. Pile Driving Review

- Pile Designation
 - HP 12 X 53
 - "H" - pile
 - 12" in width and depth
 - Weighs 53 lbs. per foot



4

4. Pile Driving Review

- Drive distance
- S = Average penetration in inches per blow
- 5 blows for gravity hammer
- 20 blows for air/steam & diesel

5. Pile Driving Review

- Diesel Hammer



6. Pile Driving Review

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

*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



7

7. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

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



8

8. Pile Driving Review

- Pile Driving Review

- Pile is a 10 x 42 and 26 feet long
- Delmag Diesel D19-42 Hammer and the striking part of the hammer weighs 4,190 lbs
- Cap and Anvil weigh 1,200 lbs
- Height of fall 10 feet
- 2.0" total in 20 blows for an average penetration 0.10 inches



9

9. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{1.6 * 4190 * 10}{0.10 + 0.1(2292/4190^{**})}$$

(10 = FALL)

(S = 2.0/20)

(X = 1200 + (42 X 26))



10

10. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10 + 0.1(0.55^{**})}$$

**** Diesel quantity x/w shall not be < 1**



11

11. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10 + 0.1(1.00^{**})}$$

**** Diesel quantity x/w shall not be < 1**



12

12. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10+0.10}$$



13

13. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.20}$$



14

14. Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = 335200 \text{ lbs} / 2000$$

$$P = 168 \text{ tons}$$



15

15. Pile Driving Review

- Air/Steam Hammer
- Single Action



16

16. Pile Driving Review

TABLE 704-1: PILE FORMULAS		
Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2 W H}{S + 1.0}$
Gravity	Steel Shell Steel Sheet	$P = \frac{3 W H}{S + 0.33} \left(\frac{W}{(W + X)} \right)$
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



17

17. Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{2 W H}{S + 0.1}$$



18

18. Pile Driving Review

- Pile Driving Review
 - Pile is a 14 x 89 and 20 feet long
 - Conmaco E65 Air/Steam Hammer and the striking part of the hammer weighs 6,500 lbs
 - (For Air/Steam Hammer the weight of Pile, Cap and Anvil are not used in the calculations)
 - Height of fall 5 feet
 - 1.0" total in 20 blows for an average penetration 0.05 inches



19

19. Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{2 \quad 6500 \quad 5}{0.05 + 0.1}$$

(5 = fall)

(S = 1.0/20)



20

20. Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{65000}{0.05 + 0.1}$$

21. Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{65000}{0.15}$$

22. Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = 433333 \text{ lbs} / 2000$$

$$P = 217 \text{ tons}$$



23

23. Pile Driving Review

- Gravity Hammer
- Steel H-Pile



24

24. Pile Driving Review

TABLE 704-1: PILE FORMULAS		
Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2 W H}{S + 1.6}$
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

25. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3 W H}{S + (0.35)} \left(\frac{W}{(W + X)} \right)$$

26. Pile Driving Review

- Pile Driving Review
 - Pile is a 12 x 53 and 15 feet long
 - Gravity Hammer and the striking part of the hammer weighs 4,050 lbs
 - Cap and Anvil weighs 900 lbs
 - Height of fall 8 feet
 - 1.0" total in 5 blows for an average penetration 0.2 inches



27

27. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3 \ 4050 \ 8}{0.2 + (0.35)} \left(\frac{4050}{(4050 + 1695)} \right)$$

(8 = FALL)

(S = 1.0/5)

(X = 900 + (15 X 53))



28

28. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3 \ 4050 \ 8}{0.55} \left(\frac{4050}{5745} \right)$$

29. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{97200}{0.55} \left(\frac{4050}{5745} \right)$$

30. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = 176727 \left(0.705 \right)$$



31

31. Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = 124593 \text{ lbs} / 2000$$

$$P = 62 \text{ tons}$$



32

Pile Driving Review

