Design Guidelines for the use of Full Depth Precast Deck Slabs used for new construction or for replacement of existing decks on bridges. This guideline has been reviewed and approved by the New England Technical committee. Several projects have already used these details and specification. If a State Standard exists it will take precedence.

Number of Pages: 18

PCI cannot accept responsibility for any errors or oversights in the use of this material. The user must recognize that no guidelines or regulations can substitute for experienced judgment. This guideline is intended for use by personnel competent to evaluate the significance and limitations of its contents and able to accept responsibility for the application of the material it contains.
FULL DEPTH PRECAST CONCRETE DECK SLABS

GENERAL

Full Depth Precast Concrete Deck Slabs may be used for new construction or for replacement of existing deck slabs. Continuity for live load design in existing multi-single-span bridges may be achieved by making use of the longitudinal post tensioning in the precast deck slab system.

MATERIALS

Material Designations

Concrete
Concrete for prestressed concrete deck slabs shall conform to the requirements of the State standard specifications for prestressed concrete members.

Reinforcement
All mild reinforcement shall conform to the requirements of ASTM A615 (A615M) and shall be epoxy coated in accordance with ASTM D3963 (D3963M).

Strands for Pre-tensioning
The seven wire strands for pre-tensioning shall conform to the requirements of ASTM A416, Grade 270, Low relaxation and shall be tensioned to the allowable stresses outlined in the AASHTO Specifications.

GENERAL DESIGN REQUIREMENTS

Framing Geometry and Layout
Members should be laid out perpendicular to the main supporting members. The main reinforcement (herein referred to as transverse reinforcement) should run along the length of the panel, generally transverse to the main supporting members. Distribution reinforcement shall consist of post tensioning strand running the length of the deck, generally parallel to the main supporting members.

Deck slabs should be set to match the cross slope of the finished roadway. For crowned roadways, a small closure pour should be incorporated into the design at the crown. For narrow roadways, it may be possible to install the slabs level and crown the wearing surface.
**Concrete Design Strength**
The design of pre-tensioned members should be based on a minimum concrete compressive strength (f'c) of not less than 5 ksi (35 Mpa). The recommended concrete compressive strength is 6 ksi (42 Mpa).

The compressive strength of the concrete at the time of transfer (f'ci) should not be less than 4 ksi (28 Mpa).

**Strand Patterns**
Typical strand patterns are laid out with no eccentricity in order to resist the positive and negative moments in bridge decks.

**Allowable Concrete Stresses**
The allowable stresses in the deck slabs shall conform to the AASHTO Specifications.

**Transverse Flexure**
Deck Slabs may be designed with mild reinforcement, prestressing strand, bonded post-tensioning strand, or combinations of each. Prestressed design is the preferred method, however mild reinforcement will most likely be required in the deck overhangs (see text below). Moments for design shall be based on the AASHTO specifications for concrete deck slabs.

**Prestressing for Handling**
Deck Slabs shall have a sufficient amount of transverse prestress to avoid cracking during handling of the units. The design of the prestress will be the responsibility of the Contractor, since methods of handling are determined by the Contractor.

**Longitudinal Distribution Design**
Reinforcement for distribution shall be comprised of mild reinforcement. The design of distribution reinforcement shall be according to the AASHTO Specifications based on a slab with mild reinforcement. The top reinforcement shall be #5 (#16) bars at 8" (203 mm). The mild reinforcement does not pass through the joints between the deck slabs.

Additional longitudinal post tensioning shall be used to provide continuity between deck slabs. This post tensioning shall be located at mid-depth in the units and shall run the entire length of the bridge or between closure pours. The post-tensioning shall transmit a prestress of 200 psi (1.4 Mpa) minimum after all losses and after all dead loads have been applied to the structure (i.e. the Engineer may take advantage of the stress due to positive composite dead load moments). For continuous spans, the Engineer must design for additional prestress to overcome the tensile stress due to negative composite dead load moments)
The minimum final post-tensioning force per duct shall be shown on the plans, as well as a sequence for stressing the ducts (generally starting at the center and working to the outside).

**Slab Overhang**
Special attention should be given to the design of the slab overhang with regard to the development of prestressing strand. If the strand cannot be developed within the slab overhang, a design using mild reinforcement or post tensioning in conjunction with prestressing may be necessary in order to accommodate the overhang moments.

**Composite Design**
Deck slabs shall be made composite with the supporting members. Compose action is achieved with shear connectors placed in blockouts in the slab. Shear connectors shall consist of welded studs on steel girders, and hooked reinforcing dowels on concrete girders. Spacing of shear connector blockouts shall be kept at 2’ (610 mm) on center where possible. The design for variable horizontal shear can be accommodated by varying the number of shear connectors per blockout.

**Deck Grades**
The plans should include the elevations of each slab (generally each corner of each slab) based on the required elevation of the slabs after all slabs are placed on a span. The following equation can be used to determine the deck grades.

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A = B - W + C
\]

A....Deck Grade shown on plans  
B....Finished Grade of Deck  
W..Thickness of Wearing Surface  
C....Deflection due to Composite Loads

**Curved Structures**
The use of precast deck slabs on curved structures is acceptable. The units should be cast in a trapezoidal shape, and the longitudinal post-tensioning should run along the curve. The design of the longitudinal post-tensioning should take into account the losses due to friction in the post-tensioning ducts.

**Closure Pours**
A 2’ (610 mm) minimum cast-in-place concrete closure pour should be used at the end of the bridge deck to account for construction tolerances and varying field conditions, and to accommodate the composite end diaphragms. Closure pours should also be used to accommodate cross slope changes in the deck.
Simple Spans Made Continuous
Joints over piers should be eliminated wherever possible. Beams can be designed as continuous for live load by using the longitudinal post tensioning as negative moment tension reinforcement. The sequence of construction may need to be modified in order to transfer the post tensioning forces into the beams in the negative moment regions. This will generally consist of grouting the haunches and shear connector blockouts before post tensioning.

CONSTRUCTION REQUIREMENTS

Construction Sequence
In order to avoid inducing unusual stresses in the girders, the sequence of construction for precast concrete deck slabs shall be such that the longitudinal post-tensioning is accomplished after the transverse slab joints have been grouted and before the slab has been made composite with the girders. See detail sheet number 16 for a typical sequence of construction.

Casting Tolerances
Tolerances for casting slabs shall be shown on the plans, or in the specifications. Special attention should be given to the location of the longitudinal post-tensioning ducts. The ducts should be oversized in order to accommodate the specified tolerances. For recommended tolerances for precast deck slabs, see detail sheet number 17.

Vertical Adjustment
Leveling bolts should be used to adjust the grade of the deck slabs after placement. The plans should note that each bolt should be torqued to insure that there is approximately equal bearing on each leveling bolt providing proper dead load distribution to each girder. For this reason, there should be the same number of leveling bolts over each girder. The amount of torque on each bolt should be within 20% of an average torque that is determined in the field.

Horizontal Adjustment
The transverse joints between deck slabs should have a nominal width of ¼" (6 mm). The width of this joint may be adjusted in the field by ±1/4" (6 mm) to account for casting tolerances. Provisions for dimensional growth of the slabs is not necessary. Any minor dimensional growth can be accounted for in the closure pours at the ends of the spans.
Note A: Slabs shall be placed to the nominal spacing shown. Actual width of slabs shall be 7'-11 3/4" (2432 mm) wide.

Note B: Cast-in-place closure pours shall be used to provide attachment to end bearing diaphragms. See Page Number 14.
Note A: Deck slabs shall be placed to a nominal spacing of 8' (2438 mm) on center. The reduced width of slab is to accommodate a 10 mm wide (nominal) joint. For details of transverse joints, see Page Number 7.

Note B: Blockouts for shear connectors shall generally be spaced at 2' (610 mm) on center. For special designs, this dimension may be changed.

Note C: At least two leveling devices shall be used at each girder in order to achieve proper dead load distribution. For details, see Page Number 8.
NOTE A: The variation indicated is due to fabrication tolerances for sweep and camber of the slabs.

The designer shall add the following note to the plans:

"The slab shall be placed at the nominal spacing shown on the plans with a 1/4" (6 mm) wide gap between the slabs. The width of this gap can vary due to tolerances of the slabs."

NOTE B: The designer shall add the following note to the plan:

"Grout for shear keys shall be rodded or vibrated to ensure that all voids in the shear keys are filled."
TYPICAL SECTION
LEVELING DEVICE

NOTES:

The contractor is responsible for the design of the leveling device based on the weight of the slabs and the number of devices.

Alternate devices may be substituted with approval from the Engineer.

SECTION A-A

TYPICAL SECTION
SHEAR STUD BLOCKOUTS

Note: Shear connector blockouts may be either rectangular or oval.
NOTES: Horizontal shear reinforcement shall be placed along the skew of the blockouts.

Additional horizontal shear capacity may be provided by adding a ¼" (3 mm) amplitude corrugated form liner between the blockouts on the underside of the slab along the centerline of the beams.

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Precast Concrete Bulb Tee Beam Attachment Detail

Full Depth Precast Concrete Decks for Bridge Construction

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TYPICAL SECTION – AASHTO TYPE III AND LARGER BEAMS

DECK REPLACEMENT
TYPICAL SECTION - AASHTO TYPE I AND II BEAMS

DECK REPLACEMENT

Deck Replacement Attachment Detail on AASHTO TYPE I and II Beams
Full Depth Precast Concrete Decks for Bridge Construction
Report Number PCINER-02-FDPCDS
TYPICAL SECTION - DECK OVERHANG AND PARAPET DETAILS

NOTES: Cast parapet over and beyond the end of the precast deck slab in order to provide a smooth edge, and to protect end cut-off of posttensioning steel.

Refer to State standard for actual parapet reinforcing and layout.
Note A: Post-tensioning duct shown is for 4 - 1/2" (6 mm) dia. prestressing strand. Alternative ducts may be used. The connection of the duct shall be water tight.

Note B: Fill handholes with non-shrink grout simultaneously with the transverse shear keys.
CAST-IN-PLACE CLOSURE POUR (TYP)

#5 @ 12" (#16 @ 305) DOWEL BETWEEN
POST TENSIONING ANCHORAGE (TYP)

PRECAST DECK SLAB

EXPANSION JOINT SYSTEM

2'-0" (610 mm) (MIN) (TYP)

BRIDGE GIRDER

END DIAPHRAGM

TYPICAL SECTION - CLOSURE POURS AT DECK ENDS

NOTES:

Closure pours shown at a pier. Closure pours at abutments similar.

Closure pour details may vary based on design of bridge joint.

Reinforcement for closure pours shall be designed by the engineer.
TYPICAL SECTION - ROADWAY CROWN DETAILS
### SEQUENCE OF CONSTRUCTION

1. Place all precast deck slabs on girders in a span.

2. Adjust leveling devices on deck slabs to bring slabs to grade. All leveling bolts shall be torqued to approximately the same value (20 percent maximum deviation).

3. Install longitudinal post tensioning strand (un-tensioned) in ducts and seal joints in ducts between deck slabs.

4. Place a flowable non-shrink grout in all transverse joints. The grout shall be rodded or vibrated to ensure all voids are filled.

5. After the grout in the transverse joints has attained a strength of 1000 psi (7 MPa) (based on grout manufacturer's recommendations), the longitudinal post tensioning strands may be stressed. The Contractor shall determine the jacking force required to achieve the minimum final post tensioning force shown on the plans accounting for all losses.

6. Install shear connectors in all blockouts.

7. Form haunches between the top of the girders and the bottom of the deck slabs. Grout all haunches and shear connector blockouts with a flowable non-shrink grout.

8. Cast end closure pours and parapets.

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**NOTE A:** The designer shall include a sequence of construction on the plans.

**NOTE B:** Minor changes may be made to this sequence for special designs (i.e. transverse post-tensioning, stage construction, etc.)
a = Use PCI 6.4.5
b = Use PCI 6.4.5
c = Use PCI 6.4.5
dt = Not Applicable
db = Not Applicable
e = Not Applicable
f = Not Applicable
g = Use PCI 6.4.5
h = Use PCI 6.4.5
i = Use PCI except tolerance = ± 1/4" (6)
j = Use PCI 6.4.5
k = Not Applicable
l = Not Applicable
m = Use PCI 6.4.5
n = Not required

q = Spacing of post-tensioning ducts shall be ±1/2" (6) measured from centerline of the center post-tensioning sleeve to centerline of any other post-tensioning

Projection Steel:
The tolerance on the elevation of reinforcing steel projecting from the slabs shall be ±1" (25).

Horizontal Spacing of Reinforcing Steel:
Center to center of mild reinforcing ± 1/4" (25).

Note: PCI 6.4.5 refers to the "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products" (MNL-116).