



Iowa Department of Transportation

SPECIAL PROVISIONS FOR PRECAST CONCRETE SUBSTRUCTURE ELEMENTS

Pottawattamie County
BRF-006-1(114)--38-78

Effective Date
February 15, 2011

THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

090110.01 DESCRIPTION.

- A. Furnish, erect, and install precast concrete substructure elements including abutment stem and abutment wingwalls, pier columns and pier cap. This work includes all necessary materials and equipment to complete the work as shown on the plans. The use of cast-in-place concrete will not be considered for substitution.
 - 1. **Abutment Stem.**
Includes precast abutment stem, wingwall extensions, extension footings, epoxy-coated reinforcing, self consolidating concrete at steel piles, galvanized metal PT ducts for anchor bolts, lifting anchors, preformed closed cell foam, subdrain, floodable backfill, porous backfill, geotextile fabric, water flooding, and subdrain outlet.
 - 2. **Abutment Wingwall.**
Includes precast wingwalls and footings, epoxy-coated reinforcing, barriers, barrier end section, self-consolidating concrete closure pours, self consolidating concrete at steel piles, and lifting anchors.
 - 3. **Pier Column.**
Includes precast concrete columns, epoxy-coated reinforcing, non-shrink grout, grouted splice couplers, steel shims, and lifting anchors.
 - 4. **Pier Cap.**
Includes precast concrete cap beam, Styrofoam blockouts, epoxy-coated reinforcing, sponge rubber, non-shrink grout, grouted splice couplers, galvanized metal PT ducts for anchor bolts, steel shims, and lifting anchors.
- B. Apply Sections 2403, 2404, 2407, and Divisions 11 and 41 of the Standard Specifications with the following modifications.
- C. **Submittals**
The submittals requiring written approval from the Engineer are as follows:

1. Assembly Plan.

Prepare the assembly plan under the seal of a Professional Engineer licensed in the State of Iowa. Place the title block with project information (similar to plans title block) in the lower right-hand corner of each sheet. Submit 7 sets of half-size, 11 inch by 17 inch sheets with a 1 1/2 inch blank margin on the left-hand edge, for approval 28 days before fabrication.

Sequence of construction shall be as shown in the plans. Deviations shall be submitted to the engineer for approval prior to assembly in the field.

The assembly plan shall include, but not necessarily be limited to, the following:

- A work area plan, depicting utilities overhead and below the work area, drainage inlet structures, protective measures, etc.
- Details of all equipment that will be employed for the assembly of the substructure.
- Details of all equipment to be used to lift precast elements including cranes, excavators, lifting slings, sling hooks, jacks, etc. Include crane locations, operation radii, lifting calculations, etc.
- Detailed sequence of construction and a CPM schedule for all operations. Account for setting and cure time for grouts, grouted splice couplers, closure pours and pile pocket pours.
- Methods of providing temporary support of the precast elements. Include methods of adjusting and securing the element after placement.
- Procedures for controlling tolerance limits both horizontal and vertical. Include details of any alignment jigs including bi-level templates for reinforcing anchor dowels.
- A detailed installation procedure for connecting the grouted splice couplers including pre-grout and post-grout applications.
- Methods for curing grout, closure pour concrete and pile pocket concrete.
- Proposed methods for installing non-shrink grout and the sequence and equipment for the grouting operation.
- Methods of forming closure pours including the use of backer rods. Do not assume that the backer rods will restrain the pressure from the grout in vertical grout joints. Provide additional forming to retain the backer rod.
- A list of personnel that will be responsible for the grouting of the reinforcing splice couplers. Include proof of completion of two successful installations within the last two years. Training of new personnel within three months of installation by a manufacturer's technical representative is an acceptable substitution for this experience. In this case, provide proof of training.

2. Shop Drawings for Precast Elements.

Prepare shop drawings under the seal of a Professional Engineer licensed in the State of Iowa. Place the title block with project information (similar to plans title block) in the lower right-hand corner of each sheet. Submit 7 sets of half-size, 11 inch by 17 inch sheets with a 1 1/2 inch blank margin on the left-hand edge, for approval 28 days before fabrication.

The Shop Drawings shall include, but not necessarily be limited to, the following:

- Show all lifting inserts, hardware, or devices and locations on the shop drawings for Engineer's approval.
- Show locations and details of the lifting devices, including supporting calculations, type, and amount of any additional reinforcing required for lifting.
- Show minimum compressive strength attained prior to handling the precast elements.
- Show details of vertical adjusting hardware.
- Show dead load camber of precast per project plans.

Do not order materials or begin work until receiving final approval of the shop drawings. The Contracting Authority will reject any precast element fabricated before receiving written approval, or any precast elements that deviate from the approved drawings. The Contractor shall be responsible for costs incurred due to faulty detailing or fabrication.

3. Grouted Splice Couplers

Submit 7 copies of an independent test report confirming the compliance of the coupler, for each supplied coupler size, with the following requirements:

- Develop 100 percent of the specified minimum tensile strength of the attached Grade 60 reinforcing bar. This equates to 90 ksi bar stress for an ASTM A 615 bar.
- The time to achieve a minimum of 100 percent of the specified yield strength of the attached reinforcing bars which corresponds to the expected ambient temperature at installation. This value shall be used to develop the assembly plan timing. This data shall be the result of lab testing as performed by an approved testing laboratory.

Submit the specification requirements for the grout including required strength gain to develop the specified minimum yield strength of the connected reinforcing bar.

4. Structural Non-Shrink Grout

Submit a Certificate of Compliance to Engineer.

Submit a proposed method for forming grout voids and installing the structural non-shrink grout, sequence, and equipment for grouting operation to Engineer for review for a minimum of 28 days. Obtain approval before placing grout.

5. Concrete Requirements

For alternate concrete mix, self-consolidating concrete shall comply with Material I.M. 445, Appendix D. Alternate mix designs will be approved by the District Materials Engineer.

Submit a high early strength self-consolidating concrete mix design for closure pour concrete and pocket concrete to the engineer for approval. Self-consolidating concrete shall comply with Material I.M. 445, Appendix D. Develop a mix that can attain a 6-hour compressive strength of 2500 psi, and a 7-day compressive strength of 4000 psi.

6. Defects and Breakage of Precast Elements

Submit proposed written repair procedures for approval.

090110.02 MATERIALS.

A. Concrete.

1. Precast elements: High performance concrete shall conform to Section 2407 in the Standard Specifications and as required in the plans. Site casting shall conform to the Alternate Site Casting provisions listed in the plans and materials must be approved by the District Materials Engineer prior to any concrete casting.
2. Precast Abutment Closure Pours and Pockets: High early strength self-consolidating concrete mix designs shall be approved by the engineer. Self-consolidating concrete shall comply with Material I.M. 445, Appendix D.

A high early strength self consolidating concrete shall include the following properties:

- Develop a mix that can attain a 6-hour compressive strength of 2500 psi, and a 7-day compressive strength of 4000 psi.
- Additionally, develop a mix that contains shrinkage compensating additives such that there will be no separation of the closure pour concrete from the adjacent elements.

- Use a shrinkage-compensating additive that produces expansion in the high early strength concrete of no more than 3 percent.

B. Reinforcing Steel.

1. Conform to Section 2404 of the Standard Specifications.
2. Use epoxy coated reinforcing steel in all precast elements.
3. Use reinforcing conforming to ASTM A 615 for all precast elements.

C. Non-Shrink Grout.

Use structural, gray, non-shrink grout for joints between drilled shaft and pier column, and for joints between pier column and pier cap, as shown on the plans. Non-shrink grout shall be quick-setting, rapid strength gain, high-bond strength grout. Grout shall not contain calcium chloride or admixture containing calcium chloride or other ingredient in sufficient quantity to cause corrosion to steel reinforcement. Mix grout just prior to use according to the manufacturer's instructions. Follow manufacturer's recommendation for dosage of corrosion inhibitor admixture.

Use structural non-shrink grout that meets a minimum compressive strength of 4,000 psi within 24 hours when tested as specified in AASHTO T 106. Meet all the requirements of AASHTO T 160 with the exception that the Contractor-supplied cube molds will remain intact with a top firmly attached throughout the curing period. Use structural non-shrink grout with no expansion after seven days. Refer to Table 1 for structural non-shrink grout requirements.

Table 1

Structural Non-Shrink Grout			
*Properties	Requirements	ASTM	AASHTO
Accelerated Weathering	As Specified in ASTM or AASHTO	C 666	T 260
Compressive Strength	>5,000 psi @ 28 days		T 106
Accepted Bond Strengths	>1,000 psi @ 24 Hours	C 882	
Test Medium	<3% White Utah Road Salt		T 161
Accepted Weight Loss	<15% @ 300 Cycles		T 161
Length Change	No expansion after 7 days		T 160

*Certified test results from a private AASHTO accredited testing laboratory will suffice for acceptance.

D. Grouted Splice Couplers.

Use grouted splice couplers to join precast elements as shown on the plans.

Provide couplers that use cementitious grout placed inside a steel casting.

Threaded connections may be used for the portions of the coupler that are placed within the precast element if the strength of the coupler meets or exceeds the requirements of this specification.

The following reinforcing splice couplers are acceptable for use provided that the requirements of this specification are met.

NMB Splice Sleeve
Splice Sleeve North America, Inc.
192 Technology Drive, Suite J,
Irvine, California 92618-2409

Dayton Superior Sleeve-Lock Grout Sleeve
Dayton Superior
Corporate Headquarters
7777 Washington Village Dr., Ste. 130
Dayton, OH 45459

Erico Lenton Interlok
ERICO United States
34600 Solon Road
Solon, Ohio 44139

Use grouted splice couplers that are epoxy coated and can join epoxy coated reinforcing steel without removal of the epoxy coating on the spliced bar.

Use grouted splice couplers that can provide 100 percent of the specified minimum tensile strength of the connecting Grade 60 reinforcing bar. This equates to 90 ksi for reinforcing conforming to ASTM A 615.

Supply grout for the inside the couplers from the manufacturer of the coupler that is matched to the certified test report for the coupler. Do not substitute any other grout in the couplers unless additional certified test reports are submitted for the grout/coupler system.

E. Corrugated Metal Pipe.

Use corrugated metal pipe to form precast abutment pockets of diameter and length required by the plans. Conform to AASHTO Standard Specifications for Highway Bridges and AASHTO M 36 or AASHTO M 245

F. Leveling Devices.

If the plans show the use of fabricated steel leveling devices, alternate devices may be used provided they can support the anticipated loads.

G. Preformed Closed Cell Foam Seals.

Conform to Section 4136.03, B, of the Standard Specifications.

H. Vertical Joint Seals.

Use natural rubber or neoprene sheet with a durometer of 50-60, meeting the requirements of ASTM D 2240.

I. Galvanized Metal PT Ducts.

Galvanized Metal PT ducts shall be approved by the District Materials Engineer.

J. Lifting Anchors.

Lifting anchors shall be in accordance with Chapter 5 of the PCI Design Handbook and shall be approved by the District Materials Engineer.

090110.03 CONSTRUCTION.

A. Quality Assurance.

1. Precast Elements.

The following requirements for precast elements shall be met:

- a. Provide precast elements produced in a plant for which equipment, procedures and quality of concrete have been approved by the Contracting Authority prior to letting per Materials I.M. 445. Site-casting shall conform to the Alternate Site Casting provisions listed in the plans and procedures must be approved by the District Materials Engineer prior to any concrete casting.
- b. Permanently mark each precast element with date of casting and supplier identification. Stamp markings in fresh concrete.
- c. Prevent cracking or damage of precast elements during handling and storage.
- d. Replace defects and breakage of precast elements according to the following:
 - Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review or rejection.
 - Obtain approval before performing repairs.
 - Repair work must reestablish the elements' structural integrity, durability, and aesthetics to the satisfaction of the Engineer.
 - Determine the cause when damage occurs and take corrective action.
 - Failure to take corrective action, leading to similar repetitive damage, can be cause for rejection of the damaged element.
 - Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive are subject to review and rejection.
 - Full depth cracking and breakage greater than one foot are cause for rejection.
- e. Construct precast elements to tolerances in conformance with Section 2407 of the Standard Specifications and as shown on the plans.
- f. The plant (or fabricator) will document all test results. The quality control file will contain at least the following information:
 - Element identification
 - Date and time of cast
 - Concrete cylinder test results
 - Quantity of used concrete and the batch printout
 - Form-stripping date and repairs if applicable
 - Location/number of blockouts and lifting inserts
 - Temperature and moisture of curing period
 - Document lifting device details, requirements, and inserts

2. Grouted Splice Couplers.

The performance of grouted splice couplers is related to the embedment length of the bars and the compressive strength of the grout. The following requirements for grouted splice couplers shall be met:

- a. Check the length of rebar anchor dowel to make sure they meet the minimum embedment specified in the manufacturer's manual.
- b. Monitor shim thickness between the precast elements to ensure that the reinforcing extensions are within the manufacturers recommended tolerance.
- c. Monitor the grout mixing, water to grout ratio, mixing time, and shelf life of the grout for conformance with the manufacturers written instructions.
- d. Monitor the grouting operation to verify that all sleeves have been filled.
- e. Make four sets of three - 2 inch cube molds in heavy brass molds with cover plates for testing according to AASHTO T 106.
- f. Ensure that all sleeves are protected from any vibration, shock, or other excessive movement until temporary bracing is removed.
- g. Check the temperature of the sleeve at the time of grouting (50°F minimum) and during curing.

B. Fabrication.

Precast elements shall conform to Section 2407 of the Standard Specifications. Site-casting shall conform to the Alternate Site Casting provisions listed in the plans and materials and procedures must be approved by the District Materials Engineer prior to any concrete casting.

Do not place concrete in the forms until the Engineer has inspected the form and has approved all materials in the precast elements and the placement of the materials in the form.

Provide the Engineer a tentative casting schedule at least two weeks in advance to make inspection and testing arrangements. A similar notification is required for the shipment of precast elements to the job site.

Removal of forms shall conform to Section 2407 of the Standard Specifications. Minimum compressive strength prior to moving unit shall be 4500 psi.

Continuously wet cure the precast elements for 7 days commencing immediately after final finishing with all exposed surfaces covered. The precast elements will have a minimum cure of 14 days prior to placement.

Supply test data such as slump, air voids, or unit weight for the fresh concrete and compressive strengths for the hardened concrete after 7, 14, and 28 days, if applicable.

Finish the precast elements according to Section 2407 of the Standard Specifications. Trowel finish the top surface of all precast elements.

C. Handling, Storing, and Transportation.**1. Handling and Storing.**

Follow Chapter 5 of the PCI Design Handbook for handling and erection bracing requirements.

Precast elements damaged during handling and storage will be repaired or replaced at the Contract Authority's direction at no cost to the Contract Authority.

Precast elements shall be lifted at the designated points by approved lifting devices embedded in the concrete and proper hoisting procedures. The Contractor is responsible for handling stresses in the precast elements and shall include all necessary precast element modifications to resist handling stresses on the shop drawings.

Storage areas shall be smooth and well compacted to prevent damage due to differential settlement.

Precast elements shall be protected from freezing temperatures (32°F) for 5 days or until attaining design compressive strength detailed on the plans, whichever comes first. Do not remove protection any time before the units attain the specified compressive strength when the surrounding air temperature is below 20°F.

Precast elements may be loaded on a trailer as described above. Shock-absorbing cushioning material shall be used at all bearing points during transportation of the precast elements. Tie-down straps shall be located at the lines of blocking only.

The precast elements shall not be subject to damaging torsional, dynamic, or impact stresses.

2. Transportation.

A precast element shall not be transported from the casting yard until the minimum 28 day compressive strength specified on project plans has been attained as shown by test cylinders cured in accordance with AASHTO T 23, and a minimum of 7 days has elapsed from casting of the precast elements.

Material, quality and condition after shipment will be inspected after delivery to the construction site, with this and any previous inspections constituting only partial acceptance.

D. General Procedure for Installation of Precast Elements.

1. Review the approved assembly plan. Sequence of construction shall be as shown in the plans, or as approved by the engineer. If changes are warranted due to varying site conditions, resubmit the plan for review and approval.
2. Dry fit adjacent precast elements in the shop if required by the Contract Documents. The fabricator may opt to dry fit precast elements in any case.
3. Establish working points, working lines, and benchmark elevations prior to placement of all precast elements.
4. Check the condition of the receiving bonding surface prior to connecting precast elements and take any necessary measures to remove dust, rust, debris, etc. to provide the satisfactory bonding required between the protruding reinforcing bars precast element and the grouted couplers.
5. Place precast elements in the sequence and according to the methods outlined in the assembly plan. Adjust the height of each precast element by means of leveling devices or shims.

E. General Procedure for Connection using Grouted Splice Couplers.

1. Use personnel that are familiar with installation and grouting of splice couplers that have completed at least two successful projects in the last two years. Training of new personnel within three months of installation by a manufacturer's technical representative is an acceptable substitution for this experience.
2. Remove and clean all debris from the joints prior to application of non-shrink grout.
3. Keep bonding surfaces free from laitance, dirt, dust, paint, grease oil, or any contaminants other than water.
4. Saturate Surface DRY (SSD) all joint surfaces prior to connecting the precast elements.
5. Use heaters in freezing temperatures to maintain a minimum temperature of 50°F. Monitor the temperature of the covered sleeves until the temporary bracing is removed.
6. Follow the recommendations of the manufacturer for the installation and grouting of the couplers. The general procedures are as follows:
 - a. Determine the thickness of shims to provide the specified elevation within tolerance.
 - b. Mix the non-shrink grout according to the supplier's recommendations including preparation and application.
 - c. Place non-shrink grout on the interface between the two precast elements being joined prior to setting the precast element. Crown the thickness of the grout toward the center of the joint so that the grout can be displaced outward as the precast element is lowered

onto the joint. Take precautions to prevent the non-shrink grout from entering the coupler above (e.g. grout dams or seals).

- d. Set the precast element in place. Engage all couplers in the joint. Allow the non-shrink grout to seep out of the joint.
- e. Trowel off excess non-shrink grout to form a neat joint once the precast element is set, plumbed, and aligned. Pack grout into any voids around the joint perimeter.
- f. Flush out the coupler with clean potable water.
- g. Mix the special coupler grout according to the manufacturer's recommendations for methods and proportions of mix and water.
- h. Make four sets of three 2-inch cube specimens for testing. Cure the specimens according to AASHTO T 106. Test one set of cubes for compressive strength at a minimum of 24 hours (or to determine when to release bracing) and 28-days. Store extra sets for longer term testing, if necessary.
- i. Pump the coupler grout into the coupler that is cast into the precast element. Start from the lower port. Pump until the grout is flowing freely from the upper port.
- j. Cap the upper port first and then remove the nozzle to cap the lower port. Proceed to the next coupler in a defined sequence.
- k. Cure the joint according to the non-shrink grout manufacturer's recommendations.

F. General Procedure for Pier Columns.

1. Lift column precast element as shown in the assembly plan using lifting devices as shown on the shop drawings.
2. Survey the elevation of the drilled shaft directly below the column. Provide shims to bring the bottom of the column to the required elevation.
3. Measure the elevation of the top of the shim stack and the top of the projecting dowels. Verify that the elevations and dowel extensions are within specified tolerances.
4. A dry fit of the column is recommended until work crews become more familiar with the process. Set column in the proper horizontal location. Check for proper horizontal and vertical alignment within specified tolerances. Remove and adjust the shims and reset the column if the column is not within tolerance.
5. Check the dowel spacing or grouted splice couplers between adjacent columns that will support common precast elements in future stages of construction. The use of bi-level templates and jigs is recommended. Slight tilting of the column within tolerances is permitted.
6. Set the column and install the couplers as described in this specification once the connection geometry is established and checked.
7. Install temporary bracing if specified in the assembly plan.
8. Allow the grout in the coupler to cure until the coupler can resist 100 percent of the specified minimum yield strength of the bar prior to removal of bracing and proceeding with installation of components above the pier column. The required strength of the grout for this is based on the certified test report. Verify the strength of the grout by testing cube samples according to AASHTO T 106.

G. General Procedure for Pier Cap.

1. Lift pier cap precast element as shown in the assembly plan using lifting devices as shown on the shop drawings.

2. Survey the elevation of the column directly below the cap. Provide shims to bring the bottom of the cap to the required elevation. Measure the elevation of the top of the shim stack and the top of the projecting dowels. Verify that the elevations and dowel extensions are within specified tolerances.
3. A dry fit of the cap is recommended until work crews become more familiar with the process. Set cap in the proper horizontal location. Check for proper horizontal and vertical alignment within specified tolerances. Remove and adjust the shims and reset the cap if the cap is not within tolerance.
4. Set the cap and install the couplers as described in this specification once the connection geometry is established and checked.
5. Install temporary bracing if specified in the assembly plan.
6. Allow the grout in the coupler to cure until the coupler can resist 100 percent of the specified minimum yield strength of the bar prior to removal of bracing and proceeding with installation of components above the pier cap. The required strength of the grout for this is based on the certified test report. Verify the strength of the grout by testing cube samples according to AASHTO T 106.

H. General Procedure for Abutment Stem and Wingwalls (supported on piles).

1. Lift abutment stem precast element or wingwall precast element as shown in the assembly plan using lifting devices as shown on the shop drawings.
2. Set the precast element in the proper horizontal location. Check for proper alignment within specified tolerances.
3. Erect temporary supports for precast if required in assembly plan.
4. Adjust the devices prior to full release from the crane if vertical leveling devices are used. This will reduce the amount of torque required to turn the bolts in the leveling devices. Check for proper grade within specified tolerances.
5. Place high early strength self consolidating concrete around pile tops as shown on the plans. Allow concrete to flow partially under the precast element. The entire underside of the precast element need not be filled with concrete.
6. Do not remove the installation bolts (if used) or proceed with the installation of additional precast elements above until the compressive test result of the cylinders for the pile connection concrete has reached the specified minimum values.

090110.04 METHOD OF MEASUREMENT.

A. Abutment Stem.

The Engineer will determine the number of abutment stems from actual count (Each).

B. Abutment Wingwall.

The Engineer will determine the number of abutment wingwalls from actual count (Each).

C. Pier Column.

The Engineer will determine the number of pier columns from actual count (Each).

D. Pier Cap.

The Engineer will determine the number of pier caps from actual count (Each).

090110.05 BASIS OF PAYMENT.

A. Abutment Stem.

Payment will be full compensation for the manufacturing, furnishing, and placement of each abutment stem. All items required to assemble each abutment stem into a precast concrete abutment per the plans, including labor, materials and equipment, shall be considered incidental to this item and will not be paid for separately.

B. Abutment Wingwall.

Payment will be full compensation for the manufacturing, furnishing, and placement of each abutment wingwall. All items required to assemble each abutment wingwall into a precast concrete abutment per the plans, including labor, materials and equipment, shall be considered incidental to this item and will not be paid for separately.

C. Pier Column.

Payment will be full compensation for the manufacturing, furnishing, and placement of each pier column. All items required to assemble each pier column into a precast concrete pier per the plans, including labor, materials and equipment, shall be considered incidental to this item and will not be paid for separately.

D. Pier Cap.

Payment will be full compensation for the manufacturing, furnishing, and placement of each pier cap. All items required to assemble each pier cap into a precast concrete pier per the plans, including labor, materials and equipment, shall be considered incidental to this item and will not be paid for separately.