Section 2405. Foundations and Substructures

2405.01 DESCRIPTION.

A. Bases or supports upon which a superstructure rests and they may consist of abutments and piers with or without piling or drilled shafts.

B. Do not apply the requirements of this section to culverts.

2405.02 MATERIALS.

Refer to the materials requirements for Sections 2401, 2402, 2403, 2404, 2408, 2414, and 2501.

2405.03 CONSTRUCTION.

Construct foundations and substructures complying with the contract documents and with requirements of this section and various sections applying to the type of construction designated. Apply the provisions of Sections 2401, 2402, 2403, 2404, 2408, 2414, and 2501 as well as the provisions of this section.

A. Construction of Cofferdams.

1. Construct the cofferdams used for construction of foundations and substructures in a manner capable of resisting earth and water pressure without appreciable displacement.

2. If submittal for review is designated in the contract documents or requested by the Engineer, furnish details to show the cofferdams will meet these requirements. Submit cofferdam plans, including the computations and drawings, according to Article 1105.03. Do not start work prior to receiving the agreed upon plans. This review does not relieve the Contractor of responsibility for satisfactory results and safety of the workers on the project.

3. For cofferdams use steel sheeting of such length that it may be driven to a depth to prevent unstable material from flowing into the excavation. Ensure the sheeting will form a safe and adequate cofferdam. Strongly brace cofferdams, but place the bracing so it will not be encased in the concrete of the structure, except as provided in the following paragraphs and with the Engineer's approval:

a. If the bracing is at elevations that it will not be exposed in the finished structure, cut the bracing off flush with the surface of the concrete. If the bracing is at elevations that it will be exposed in the finished structure, recess it and cut off at least 4 inches (100 mm) inside the face of the concrete.

b. Form pockets around the bracing. Neatly fill these pockets with concrete after the bracing is cut off. Small openings may be left in diaphragm walls and other thin sections to provide for cofferdam bracing, provided these openings are not located to interfere with the structural integrity of the structure and are located in places where they can be filled later in a satisfactory manner.

c. Do not place cofferdam bracing to bear against heavy concrete sections less than 3 calendar days old. In the case of thin sections

or unfavorable weather conditions, this time may be increased at the Engineer's discretion.

4. Provide a clear space of at least 36 inches (1 m) on all sides between the footing and the cofferdam. Except for seal courses, do not use the cofferdam as a form for the concrete footing. Build an independent form for the footing. Use sheeting for the cofferdam of such a type, and drive the sheeting, to prevent as nearly as possible water entering through the walls of the cofferdam. Provide pumps of sufficient capacity to keep the excavation free from water, according to Article 2403.03, J, until the concrete has reached initial set.

5. After the foundation is in place, place backfill material in all excavated areas in and around cofferdams to the original ground surface or streambed with materials meeting the provisions for the appropriate required regulatory permits. If additional material has been added adjacent to the pier sites, remove this material to the ground line or streambed.

B. Seal Courses.

1. The Engineer may require the Contractor to seal the cofferdam with concrete if:

- The material encountered at the designed elevation of the bottom of the footing is so porous that water enters at a rate that it is impractical to lower the water level to this elevation by pumping, or
- The material cannot be prevented from flowing into the excavation by driving sheeting to reasonable depths.

2. Place the seal course below the elevation of the bottom of the footing in the manner prescribed in Article 2403.03, J. The cost of this work will be paid for according to Article 1109.03. After placement of the seal course, do not dewater the cofferdam until test beams show a flexural strength of no less than 500 psi (3.5 MPa).

C. Footings.

1. Construct footings as shown in the contract documents or as the Engineer orders in writing. Anchor footings resting upon solid rock by extending the footing at least 6 inches (150 mm) into the solid rock. Adjustment in quantities will not be made for extending the dimensions horizontally beyond the neat lines shown in the contract documents. Remove all loose boulders and fragments of rock before the footing is placed.

2. Do not place concrete in a footing until the Engineer has inspected and approved the depth of excavation and integrity of the foundation materials, and has given permission to proceed.

3. When the contract includes an item for Excavate and Dewater, construct the footings for piers in the dry using either:

- Steel sheet pile cofferdams and tremie concrete seal courses, or

- Other means of maintaining a dry excavation, as may be developed by the Contractor and approved by the Engineer.

4. Prevent water from seeping through the bottom of the excavation during placement of the footing concrete. Prevent unbalanced water pressure from acting on the bottom of the footing during curing of the footing concrete.

5. Approval of the Contractor's recommended procedure does not relieve the Contractor from responsibility to place the footing and pier concrete in the dry. The Engineer reserves the right to require the Contractor to provide cofferdams and tremie concrete seal courses if, during construction, the Engineer determines that the excavation cannot be satisfactorily dewatered by the Contractor's recommended procedure.

D. Class of Concrete.

1. Construct foundations and substructures using Class C concrete unless specified otherwise in the contract documents.

2. For concrete in seal courses use Class X concrete (not air entrained) mixed with sufficient water to provide a satisfactory mix having a slump of no more than 8 inches (200 mm).

E. Placing Concrete.

1. Apply the provisions of Section 2403 to concrete placed in foundations and substructures.

2. In reinforced concrete substructures, securely fasten in position reinforcement extending into footings.

3. Request the Engineer inspect before any concrete is placed.

4. Use suitable wood or metal forms to enclose footing concrete, except for extension into rock as provided in Article 2405.03, C.

F. Construction Joints.

1. In general, construct each footing as a monolith.

2. If construction joints are required, construct them as specified in Article 2403.03, H.

G. Ice Breakers.

1. Set ice breakers true to alignment and with correct batter.

2. Place the anchorage before placing concrete.

3. The ice breaker is considered part of the substructure.

H. Anchor Bolts for Bridge Bearings and Foundations.

1. General.

a. Use bolts, nuts and washers, galvanized according to ASTM A 153, Class C; or ASTM B 695, Class 50.

b. Use full-length galvanized anchor bolts that:

- Meet the requirements of ASTM F 1554, Grade 36.
- Are Unified Coarse Thread Series, and
- Have Class 2A tolerance.

c. Color code in blue the end of each anchor bolt intended to project from the concrete in order to identify the grade. Use galvanized washers that meet the requirements of ASTM F 436. Use heavy hex, galvanized nuts that meet the requirements of ASTM A 563, DH. Nuts may be over-tapped in accordance with the allowance requirements of ASTM A 563.

2. Bridge Bearings.

Unless otherwise specified in the contract documents, set anchor bolts to be embedded in concrete in drilled holes. Set them prior to the time the concrete is placed, when specified in the contract documents.

a. Anchor Bolts Set in Drilled Holes.

1) In clean, dry holes accurately set anchor bolts for bridge bearings perpendicular to the plane of the bridge seat. Vary the locations of anchor bolts in relation to slotted holes in expansion shoes to compensate for the temperature of the structure. Adjust the nuts on anchor bolts at the expansion bearings of spans to permit movement of the span with changes in temperature. Set anchor bolts with a hydraulic cement or polymer grout.

2) When hydraulic cement grout is used, use one that meets the requirements of Materials I.M. 491.13. Make the diameter of the hole 1/2 inch (13 mm) larger than the bolt diameter. Slightly overfill the annular space with grout.

3) When polymer grout is used, use one meeting the requirements of Materials I.M. 491.11. Make the diameter of the hole 1/8 inch (3 mm) larger than the bolt diameter. Fill the annular space with the grout according to the manufacturer's recommendations and limitations, as approved by the Engineer.

b. Preset Anchor Bolts.

1) When specified by the contract documents, set the anchor bolts for bridge bearings during the placing of concrete.

2) Per Article 2405.03, H, 3.

3. Foundations.

a. Hold the bolts firmly in a rigid template which spans the concrete with sufficient clearance to permit proper finishing of the surface of the concrete. Obtain a template from the manufacturer/fabricator for proper placement of the anchor bolts. Do not weld anchor bolts.

b. Leave the template in place until the concrete has hardened.

c. Accurately set anchor bolts, plumb to within 1/4 inch (6 mm) per 12 inches (300 mm), at points specified in the contract documents.

I. Finish.
Finish surfaces of concrete foundations and substructures as provided in Article 2403.03, P.

J. Placing Superstructure.
Apply the provisions of Article 2403.03, N, to placing superstructures on piers and abutments.

K. Reconstruction of Substructures.

1. When the work involves reconstruction of an existing substructure, submit to the Engineer detailed plans for supporting the superstructure according to Article 1105.03.

2. Securely shore or guy the superstructure at all times while it is raised off the substructure to prevent overturning or slipping from the temporary supports.

L. Pile Substructures.

1. When designated in the contract documents, construct the substructure by driving piling for abutments and piers. Drive piles according to Section 2501.

2. Support earth approaches laterally by sheet piling or by backing planks resting against the abutment piling.

3. Complete wood, steel, and concrete construction in connection with pile substructures according to Sections 2403, 2407, 2408, or 2409.

2405.04 METHOD OF MEASUREMENT.

A. Measurement for the quantities involved in foundations and substructures, will be as provided in the following sections:

1. Excavation for Structures: Section 2402.04 applies.

2. Structural Concrete: Section 2403.04 applies.

3. Reinforcement: Section 2404.04 applies.

4. Precast and Prestressed Concrete: Section 2407.04 applies.

5. Structural Steel: Section 2408.04 applies.

6. Timber and Lumber: Section 2409.04 applies.

7. Piles: Section 2501.04 applies.

B. No measurement will be made for Excavate and Dewater.

2405.05 BASIS OF PAYMENT.

A. Payment for the quantities involved in foundations and substructures will be as follows:

1. Excavation for Structures: Section 2402.05 applies.

2. Structural Concrete: Section 2403.05 applies.

3. Reinforcement: Section 2404.05 applies.

4. Precast and Prestressed Concrete: Section 2407.05 applies.

5. Structural Steel: Section 2408.05 applies.

6. Timber and Lumber: Section 2409.05 applies.

7. Piles: Section 2501.05 applies.

B. Payments are full compensation for furnishing materials, equipment, and labor and for performance of work necessary to complete the substructure in conformance with the contract documents.

C. When the contract documents do not provide a separate price for Class X concrete, payment for this concrete, when ordered by the Engineer, will be per Article 1109.03, B. The quantity paid for is limited to that concrete placed within 18 inches (0.5 m) of the footing, as shown in the contract documents.

D. When the contract includes an item for Excavate and Dewater, payment will be made at the contract lump sum price each for Excavate and Dewater. Payment is full compensation for:

- Class 20 and Class 21 excavation,
- Cofferdams and tremie concrete seals, if used,
- Costs of other procedures required to dewater the excavations,
- Pumping,
- Bailing and drainage, and
- Materials, work, labor, and equipment required to place the footings and piers in the dry, including the cost of furnishing design computations and drawings.

E. Additional compensation will not be allowed for any delays resulting from compliance with the above requirements.