

ARTICLE XIV – CONCRETE REPAIR WORK

14.1 GENERAL

- A. Work under this Article includes furnishing all labor, materials and equipment necessary to repair spalled concrete on the pier substructure.
- B. In general, the work includes, but is not necessarily limited to the following:
 - 1. Sounding concrete to determine extent of concrete spall repairs.
 - 2. Removal of concrete surrounding reinforcing steel in repair areas.
 - 3. Preparing concrete repair area.
 - 4. Replacing severely corroded reinforcing steel with replacement reinforcing steel at spall repairs.
 - 5. Installing new reinforcing steel.
 - 6. Cleaning reinforcing steel and applying reinforcing steel coating.
 - 7. Installing and removing formwork.
 - 8. Placing concrete or patching compound.
 - 9. Temporarily supporting existing utilities and related appurtenances under the pier as required.
- C. All work shall be in accordance with the following sections of the Standard Specifications except as modified or supplemented herein:

Section 503 Concrete Structures

Section 601 Structural Concrete

Section 602 Reinforcing Steel

Section 711 Concrete Curing Materials and Admixtures

Sections on Materials referenced in the above sections are hereby incorporated.

14.2 MATERIALS

- A. Concrete
 - 1. Concrete shall be Class $f'c = 5,000$ psi conforming to Section 601 “Structural Concrete” of the Standard Specifications.

2. Maximum aggregate size shall be 3/8 inches and shall be coordinated with concrete preparation procedures for spall repairs.

- B. Admixture - Admixture to be used in the concrete shall be approved by the Harbors Construction Engineer and shall conform to Section 711 of the Standard Specifications. Contractor shall strictly adhere to the manufacturer's recommendations regarding the use of admixtures including storage, transportation and method of mixing.

CORTEC MCI 2005NS migrating corrosion inhibiting admixture manufactured by Cortec Corporation or approved equal shall be added at the following rate and as recommended by the manufacturer.

CORTEC MCI 2005NS: 1.5 pints per cubic yard of concrete

To combat climate change and reduce the concrete carbon footprint, supplementary cementitious material(s) shall be used to reduce the cement content in the concrete for this project. The following supplementary cementitious material shall be substituted for cement by weight at the following rate and as recommended by the concrete supplier.

Silica Fume: 10% of cement by weight

The maximum water to cementitious materials ratio shall be 0.40 and the mix water shall be reduced as necessary to account for the admixture.

- C. Reinforcing Steel for Weld Splicing - Reinforcing for weld splicing shall be ASTM A706 Grade 60.
- D. Welds - Welding electrodes shall be low hydrogen E70.
- E. Reinforcing Steel Anti-Corrosion Coating – Anti-corrosion coating with a minimum 7 day open time for reinforcing steel shall be Sika Armatec 110 Epocem by Sika, or approved equal.
- F. Epoxy Grout - Epoxy for grouting of dowels shall be Set 3G by Simpson Strong-Tie, or approved equal.
- G. Patching Compound for form and pour repairs shall be Sikacrete 211 SCC Plus by Sika, or approved equal.
- H. Patching Compound for repairing vertical repairs in lifts shall be Sikaquick VOH with Later R by Sika, or approved equal.
- I. Curing Compound for concrete repairs shall be acceptable to the Harbors Construction Engineer.
- J. Forms shall conform to Section 503.03.C "Forms" of the Standard Specifications.

- K. Snap ties and inserts shall be plastic or stainless steel. All loose reinforcing steel shall be secured with ties at all intersections with adjacent reinforcing steel.

14.3 CONSTRUCTION METHODS

- A. Concrete construction shall conform to the American Concrete Institute (ACI) ACI 318R and ACI 546R-14.
- B. Surface preparation for spall repair work shall follow the International Concrete Repair Institute (ICRI) Guideline No. 310.1R-2008. The sizes, locations and types of repair work specified on the drawings are intended to be approximate only. The actual amount and type of repair work to be done shall be determined after completion of the removal work. Removal and surface preparation shall be performed in the order listed below.
1. All visible loose and deteriorated concrete shall be removed with suitable pneumatic or hand tools until only sound concrete remains.
 2. Such chipped areas and adjoining areas shall be further sounded by tapping with a light hammer. Areas emitting a hollow sound indicating unsound and delaminated concrete with voids shall be further chipped to sound concrete and beyond the extent of the corroded reinforcing.
 3. Partially exposed reinforcing steel or steel exposed during the concrete chipping process shall be fully exposed throughout their length within the repair area. There shall be a minimum of 3/4 inch of clear distance between the reinforcing steel and the chipped surface of the existing concrete for placing patching compound or concrete.
 4. The edges of the repair shall be saw-cut and chipped as necessary to attain a minimum repair material depth of 3/4 inch and to prevent featheredge conditions.
 5. The existing concrete in the repair areas shall be chipped to approximate rectangular dimensions to facilitate the repair work.
 6. The patch area shall be cleaned of all dust and debris just prior to patching with high pressure, oil-free compressed air with appropriate PPE's and containment.
- C. Live Load Limitation
1. Any element being repaired shall not be subjected to live loads during the period starting from the removal of existing concrete until the repair concrete has been allowed to cure for 7 days or obtained a minimum compressive strength of $f'_c = 4,000$ psi.

2. Mooring bollards shall be shut down when spall repair work is performed in the vicinity of the bollards. See Article X for additional information.
 3. The repair area shall remain barricaded with barriers visible at night from traffic during this period. The Contractor shall provide shoring for severely spalled areas as necessary to prevent damage or collapse.
- D. Cleaning Reinforcing Steel - All exposed concrete and reinforcing steel in the repair area shall be needle gunned to remove all scale, loose rust, debris and other bond-inhibiting materials. Any areas not patched more than 48 hours after cleaning shall be recleaned.
- E. Replacing Reinforcing Steel - All existing reinforcing bars with less than 80% of their cross-section remaining after cleaning shall be supplemented with welded reinforcing as shown on the plans. Replacement reinforcing steel will be measured by the pound, complete in place. The theoretical unit weight of each size of reinforcing bar used will be based upon Table 602.04-1 of the Standard Specifications.
- F. Welding Reinforcing Steel - All welding shall conform to AWS D1.4. All existing bars to be welded with a carbon equivalent (C.E.) above 0.55 percent shall be preheated according to the requirements set forth in AWS D1.4. If the C.E. is unknown, maximum preheat requirements for an assumed C.E. greater than 0.75 percent shall be used.
- The Contractor shall survey the entire area around the project site to ensure that no hazardous vapors are present. The Contractor shall certify in writing that the project site shall be safe for hot work and free of hazardous vapor. No open flame, hot cutting, welding or other hot work will be permitted without the certification.
- G. Reinforcing Steel Coating - All exposed steel shall be liberally coated with anti-corrosion coating per manufacturer's recommendations.
- H. Epoxy Grouting - Blow holes completely clean of all concrete debris to allow for adequate bonding of the epoxy. The holes shall be filled with epoxy gel before inserting and turning the supplemental reinforcement to displace the grout.
- I. Photographs – The Contractor shall provide digital photographs of substructure spall repairs to the Harbors Construction Engineer for their review. Photos shall be in color and taken with a digital camera having a 6.0 mega pixel resolution or higher. Each photo shall be identified with the time, date, and location referenced to the plans.

The Contractor shall provide one set of photos per 25 square feet of spall repairs. A set of photos shall contain at least two photos for each of the procedures listed below.

1. Existing condition of concrete repair.
2. After all removal of existing concrete has been completed, including spalled and delaminated concrete, concrete surrounding reinforcing steel in repair areas, and sawcut and chipped out concrete at the perimeter of the repair.
3. After cleaning of the reinforcing steel.
4. After replacing severely corroded steel with weld spliced reinforcing steel.
5. After installing replacement reinforcing steel.
6. After applying reinforcing steel coating.
7. After formwork has been installed.
8. After forms have been removed, or concrete has cured for at least 3 days.

The photos shall be taken on the same day that the procedure has been completed and shall clearly represent typical details of the completed procedure. The photos shall also be emailed to the Harbors Construction Engineer on the same day that the photos were taken. Additionally, one set of 4" x 6" sized prints shall be delivered to the Harbors Construction Engineer at the completion of the project.

- J. Formwork - Formwork shall be installed in accordance with Section 503.03.C - "Forms" of the Standard Specifications. The exact method of formwork requires the Harbors Construction Engineer's approval. Forms shall be designed to provide a minimum of three (3) inches of concrete cover over all reinforcing steel, unless noted otherwise. All edges of concrete repairs shall be chamfered and existing joints shall be maintained.
- K. Placing Concrete - Concrete shall be placed in accordance with Section 503.03 - "Construction" of the Standard Specifications. All repair surfaces including forms shall be thoroughly washed with clean water and remain in a saturated surface dry condition prior to placing concrete. Surfaces shall be clean and free of loose and other bond-inhibiting materials. The repair concrete shall be vibrated, rodded or tamped during placement to consolidate the pour and fill all corners of the patch or form and beneath the reinforcing. As an alternate self-consolidating concrete maybe used. There shall be no cold joints in the field of the repair.
- L. Patching Compound - Patching compound shall be used only to fill minor spalls and voids and to fill minor depressions such as those caused by the installation of expansion anchors used for formwork support. The Contractor shall follow the manufacturer's recommendations for mixing and placing patching compound, including application of a slurry coat to prime the substrate and application of the repair material in lifts.

- M. Finish - Concrete finish shall be Class I - Ordinary Surface Finish as specified in Section 503.03.M.1 of the Standard Specifications. Provide smooth finish on pier decks for all holes patched. Cementitious compound used to patch holes shall be finished to the level of the concrete surface. Remaining void in asphalt topping pavement shall be filled with asphalt to match existing elevation and composition.
- N. Formwork Removal - Formwork for all repairs shall not be removed for a minimum of 24 hours and until concrete has obtained a minimum compressive strength of $f'c = 4,000$ psi.
- O. Concrete Curing - Concrete repairs on the underside of the pier shall be cured a minimum 7 days by leaving the forms in place or covering the surface with a curing compound approved by and acceptable to the Harbors Division Construction Engineer.
- P. Identifying Repairs - Identify all repair work with paint unless visible from the pier exterior. The color and marking for identification shall be a minimum 6 inch in height and black stenciling unless otherwise directed by the Harbors Construction Engineer.
- Q. Defective Work - After forms have been removed, the repaired area shall be tested by tapping with a hammer. Any "hollow" sound emitted shall indicate the presence of voids and shall be sufficient cause for removal of repair work and reconstruction. The method of repairing defects shall be subject to the approval of the Harbors Construction Engineer. All defects shall be corrected by the Contractor at no additional cost to the State.

14.4 PAYMENT - Payment for concrete repair work shall be made as described in Article X of these Specifications.