JOINT BASE LEWIS-McCHORD

DIVISION 03 - CONCRETE

SECTION 03 01 00

REHABILITATION OF CONCRETE

07/20

PART 1 GENERAL

1.1 SCOPE

This specification governs the rehabilitation of structural concrete.

1.2 DEFINITIONS

1.2.1 Bracing

Temporary supplemental members used to avoid local or global instability during construction, evaluation, or repair that are intended to be removed after completion of construction.

1.2.2 Delamination

A planar separation in a material that is roughly parallel to the surface of the material.

1.2.3 Rehabilitation

Repairing or modifying an existing structure to a desired useful condition.

1.2.4 Repair

The reconstruction or renewal of concrete parts of an existing structure for its maintenance or to correct deterioration, damage, or faulty construction of members or systems of a structure.

1.2.5 Shoring

Props or posts of timber or other material in compression used for the temporary support of excavations, formwork, or unsafe structures; the process of erecting shores.

1.2.6 Termination Joint

The interface where a placement of repair material meets existing concrete, the edge of an expansion joint, or other existing surfaces.

1.2.7 Unsound Concrete

Concrete that is fractured, delaminated, spalled, deteriorated, defective, contaminated or otherwise damaged.

1.3 REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 288 | (2017) Standard Specification for Geosynthetic Specification for Highway Applications |

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 117 | (2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary |
| ACI 440.5 | (2008) Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars |
| ACI 440.6 | (2008) Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement |
| ACI 440.8 | (2013) Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures |
| ACI 503.2-503.4 | (2010, R 2003) Three Epoxy Specifications |
| ACI 503.3 | (2010) Specification for Producing a Skid-Resistant Surface on Concrete by the Use of Epoxy and Aggregate |
| ACI 503.7 | (2007) Specification for Crack Repair by Epoxy Injection |
| ACI 548.10 | (2010) Specification for Type MMS (Methyl Methacrylate Slurry) Polymer Overlays for Bridge and Parking Garage Decks |
| ACI 548.12 | (2012) Specification for Bonding Hardened Concrete and Steel to Hardened Concrete with an Epoxy Adhesive |
| ACI 548.4 | (2011) Standard Specification for Latex-Modified Concrete (LMC) Overlays |
| ACI 548.8 | (2007) Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks |
| ACI 548.9 | (2008) Specification for Type ES (Epoxy Slurry) Polymer Overlay for Bridge and Parking Garage Decks |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE/SEI 37 | (2015) Design Loads on Structures During Construction |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A775/A775M | (2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A934/A934M | (2016) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars |
| ASTM C1059/C1059M | (2013) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete |
| ASTM C1077 | (2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM C1438 | (2013; R 2017) Standard Specification for Latex and Powder Polymer Modifiers for use in Hydraulic Cement Concrete and Mortar |
| ASTM C1583/C1583M | (2013) Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method) |
| ASTM C1600/C1600M | (2017) Standard Specification for Rapid Hardening Hydraulic Cement |
| ASTM C1602/C1602M | (2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete |
| ASTM C33/C33M | (2016) Standard Specification for Concrete Aggregates |
| ASTM C387/C387M | (2017) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar |
| ASTM C42/C42M | (2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C496/C496M | (2017) Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens |
| ASTM C881/C881M | (2015) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |

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| ASTM C882/C882M | (2013a) Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear |
| ASTM C928/C928M | (2013) Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs |
| ASTM D1078 | (2011) Standard Test Method for Distillation Range of Volatile Organic Liquids |
| ASTM D2103 | (2015) Standard Specification for Polyethylene Film and Sheeting |
| ASTM D226/D226M | (2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing |
| ASTM D2822/D2822M | (2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing |
| ASTM D323 | (2015a) Vapor Pressure of Petroleum Products (Reid Method) |
| ASTM D3418 | (2015) Transition Temperatures of Polymers by Differential Scanning Calorimetry |
| ASTM D4016 | (2014) Viscosity of Chemical Grouts by Brook field Viscometer (Laboratory Method) |
| ASTM D450/D450M | (2007; E 2013; R 2013) Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing |
| ASTM D4580/D4580M | (2012) Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding |
| ASTM D4869/D4869M | (2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing |
| ASTM D542 | (2014) Index of Refraction of Transparent Organic Plastics |
| ASTM D93 | (2016) Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester |
| ASTM E329 | (2018) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction |

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

| | |
|---|---|
| ICRI 310.2R | (2013) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair |

1.4 SUBMITTALS

**********
NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20.
**********
Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval or information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the government. Submittals with an "S" are for inclusion in the [Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING][Environmental Records Binder, in conformance to Section 01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS]. Submit the following in accordance with Section 01 33 00 SUBMITTAL ROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G

Work Plan; G

Quality Control Plan; G

Form Release Agents (Biobased Content); S

Concrete (Recycled Content); S

Concrete Curing Agents (Biobased Content); S

Concrete Leveling or Patching Materials (Biobased Content); S

Blast Media (Recycled or Biobased Content); S

Two-Component Epoxies (Biobased Content); S

SD-03 Product Data

Conventional Concrete

Polymers

Miscellaneous Materials And Equipment.SD-04 Samples

Reinforcement And Reinforcement Supports

SD-05 Design Data

Formwork And Shoring; G

Repair Procedures; G

Mixture Proportioning; G

SD-06 Test Reports

Mixture Proportioning

Quality Control

SD-07 Certificates

Qualifications

Reinforcement And Reinforcement Supports

SD-11 Closeout Submittals

Form Release Agents (Biobased Content); S

Concrete (Recycled Content); S

Concrete Curing Agents (Biobased Content); S

Concrete Leveling or Patching Materials (Biobased Content); S

Blast Media (Recycled or Biobased Content); S
Two-Component Epoxies (Biobased Content); S

## 1.5 QUALITY ASSURANCE

### 1.5.1 General Requirements

a. Follow the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE for Work involving portland cement concrete.

b. To protect personnel from overexposure to toxic materials, conform to the applicable manufacturer's Safety Data Sheets (SDS) or local regulations. Submit manufacturer's SDS for all polymers as well as other potentially hazardous materials.

c. Submit the repair procedures for executing the work as well as the test data and documentation on materials used for repair. Submittal must include component materials, mixture proportions, and supplier's quality control program.

d. Inspection and testing of surface preparation as well as placement of reinforcing steel must be in accordance with provisions included herein and the Contract Document.

e. Sampling and testing of materials, as well as inspection and testing of work, must be in accordance with established procedures, manufacturer's instructions, specific instructions from the Contracting Officer if given, or recommended practices as referenced herein and the Contract Documents.

f. Trial batches and testing requirements for various repair materials specified are the responsibility of the Contractor.

g. The testing agency must inspect, sample, and test repair materials and concrete production as required. When it appears that material

furnished or work performed by Contractor fails to conform to Contract Documents the testing agency will immediately report such deficiency.

1.5.2 Quality Control Plan

Submit a quality control plan as specified in Section 01 45 00.00 10 QUALITY CONTROL or 03 30 00 CAST-IN-PLACE CONCRETE, whichever is applicable.

1.5.3 Qualifications

The submittals must where applicable, identify agencies and individuals who will be working on this contract and their relevant experience. Do not make changes in approved agencies or personnel without prior approval of the Contracting Officer.

1.5.3.1 Testing Agencies

In addition to the requirements of Section 01 45 00.00 10 QUALITY CONTROL, agencies that test concrete materials must meet the requirements of ASTM C1077. Testing agencies that test or inspect placement of reinforcing steel must meet the requirement of ASTM E329. Submit data on qualifications of Contractor's proposed testing agency for acceptance.

1.5.3.2 Quality Control Personnel

Field tests of repair materials required must be made by an ICRI Concrete Surface Repair Technician Tier 2. Submit resumes, pertinent information, past experience, training and education of all operators of specialized demolition equipment if needed for this and the three paragraphs above.

1.5.3.3 Contractor Qualifications

The contractor performing the repair work must have been involved in a minimum of three concrete repair projects similar in size and scope to this project for at least five years. Submit information, including name, dollar value, date, and point-of-contact for similar projects which demonstrates the required experience and/or training.

1.5.3.4 Worker Qualifications

a. Each worker engaged in the use of specialized removal or application equipment, including saw operators and milling machine operators, must have satisfactorily completed an instruction program and three years of experience in the operation of the equipment. The worker must have active experience with the equipment within five years of the project.

b. Workers installing adhesive anchors must be ACI Adhesive Anchor Installer certified or equivalent.

1.5.3.5 Regulatory Requirements

Perform all work in accordance with applicable Federal, State, and local safety, health, and environmental requirements. The Contractor is responsible for obtaining all permits required by Federal, State, and local agencies for the performance of the work.

### 1.5.4 Pre-Construction Conference

Conduct a pre-construction conference to discuss repair materials performance requirements, control provisions, and roles and responsibilities for the Work to ensure that the Contractor's personnel understand all aspects of the repair material, its properties and application procedures. The conference must include the Contracting Officer or authorized representative, the Contractor's field superintendent and foreman, and a competent Technical Representative of the material manufacturer, and other involved trades or supplier representatives. The Technical Representative must be fully qualified to perform the work.

### 1.5.5 Work Plan

Prepare a work plan describing the methods of concrete removal and repair, including methods, equipment and materials to be used for each feature. Submit the work plan for approval at least 30 days prior to the start of the work. The plan must include, but not be limited to, repair materials to be used with specific information on products and/or constituents, and requirements for handling, storage, etc., equipment to be used, surface preparation, and requirements for placement, finishing, curing and protection specific to the materials used. Include a description of field demonstrations in the work plan. Do not commence work until the work plan and field demonstration representative of the type of work are approved.

## 1.6 ACCEPTANCE OF REHABILITATION WORK

### 1.6.1 General Requirements

a. Completed concrete rehabilitation work must conform to applicable requirements of Contract Document and this specification. The Contractor is responsible to bring Work into compliance with requirements of Contract Documents if the Concrete repair work fails to meet one or more requirements of Contract Documents.

b. Correct rejected repair work by removing and replacing or by strengthening with additional construction acceptable to the Contracting Officer. Use repair methods that meet applicable requirements for function, durability, dimensional tolerances, and appearance.

c. Submit proposed work plan, repair methods, materials, and modifications to the Work needed to correct rejected repair work to meet the requirements of Contract Documents.

### 1.6.2 Tolerances

a. Construction tolerances for repairs must conform to ACI 117. Where existing conditions do not allow tolerances to conform to ACI 117, use the details and materials for such conditions as indicated in the Contract Documents. For conditions not shown or that are different than indicated in the Contract Documents, notify the Contracting Officer before proceeding with the work at those locations. Provide a tolerance report as required by Section
03 30 00 CAST-IN-PLACE CONCRETE.

b. Inaccurately formed concrete surfaces resulting in concrete members with dimensions that exceed ACI 117 tolerances are subject to rejection.

1.6.3 Appearance

Concrete surfaces not meeting the requirements of the Contract Documents must be brought into compliance.

1.7 PROTECTION OF COMPLETED REHABILITATION WORK

a. Do not allow construction loads to exceed the loads that a structural member or structure is safely capable of supporting without damage. Provide supplemental support if construction loads are expected to exceed safe load capacity.

b. Protect repaired and adjacent areas from damage by construction traffic, equipment, and materials. During the curing period, protect repair materials from damage by mechanical disturbances, including load-induced stresses, shock, and vibration.

c. Protect repair materials from environmental damage by weather events during the length of the curing period.

PART 2 PRODUCTS

Products or materials used must conform to the requirements included herein as well as the Contract Documents. The usage of other products or materials not covered by this requirement or specified in the Contract Documents are permitted upon approval by the Contracting Officer. Additional information and submittals for products and materials not included in this document including product data, samples, design data, test reports, certificates, manufacturer's instructions, and field reports must be submitted as requested by the Contracting Officer.

2.1 MATERIALS FOR SHORING AND BRACING

2.1.1 Shoring and Bracing Systems

Use commercially manufactured and engineered shoring and bracing systems and components, except where custom built assemblies of lumber or other suitable materials are permitted by the Contracting Officer.

2.1.2 Design Requirements

The design of the bracing and shoring must be based on ASCE/SEI 37.

a. Non-manufactured shoring and bracing systems must have calculations signed and sealed by a Licensed Design Professional.
b. Members of non-manufactured shoring systems, must be designed in accordance with the provisions of the governing building code for the specific material of the member.
c. Members of manufactured shoring systems, consisting of pre-engineered components designed and produced specifically for structural shoring, must be used in accordance with the manufacturer's recommendations.

## 2.2 EQUIPMENT FOR CONCRETE PREPARATION

Means and methods used for concrete removal and surface preparation must be selected and used such as to minimize damage to the structure and to the concrete substrate that remains.

### 2.2.1 Equipment for Concrete Removal

Removal equipment and techniques must be suitable to produce concrete surface profiles and level of cleanliness in designated areas as required by this specification and the contract Documents.

#### 2.2.1.1 Cutting Equipment

a. The following cutting equipment are permitted: High-pressure water jet without abrasives, Saw cutting, and Stitch drilling.

b. Cutting, lifting, and transporting equipment must be adequate to cut, support, and transport concrete sections without incurring any damage to the existing structure.

#### 2.2.1.2 Concrete Breakers

a. Provide sharp tips on breaker equipment to minimize microcracking damage in partial depth removal.

b. The use of the following impact equipment and methods is permitted: Hand-held breakers and Needle scalers.

#### 2.2.1.3 Hydromilling Equipment

a. Hydromilling equipment must include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The water tank and auxiliary re-supply equipment must be of sufficient capacity to permit continuous operations.

b. Use protective covers and barriers to protect adjacent surfaces not intended to be repaired from water blasting and over-spray.

c. Use equipment capable of delivering pressures of 35 MPa 5000 psi to 275 MPa 40,000 psi at 7.5 liters/min 2 gal/min to 190 liters/min 50 gal/min for concrete removal and surface preparation.

### 2.2.2 Surface preparation and cleaning equipment

#### 2.2.2.1 Abrasive Blasting

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NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20 and incorporate bracketed sustainable acquisition language within that section.
**********

a. Use dry or wet oil-free abrasive blasting capable of removing loose micro-fractured (bruised) or otherwise damaged or pulverized concrete surfaces, and rust from exposed steel reinforcement, and providing a surface profile in compliance with the Contract Documents.

b. Use the following abrasive blasting methods: Sandblasting.

c. Blast media must comply with recycled or biobased content requirements per Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS]. See https://sftool.gov/greenprocurement/green-products/8/miscellaneous/0 for more information. Use of coal ash is not permitted.

2.2.2.2 Low Pressure Water Cleaning

Use equipment capable of delivering 7 MPa 1000 psi to 35 MPa to 5000 psi at 7.5 liters/min 2 gal/min to 38 liters/min 10 gal/min for cleaning loose material from repair areas.

2.2.2.3 Other Cleaning Equipment

Use equipment that delivers oil free air capable of cleaning loose material and debris from repair areas. If necessary to dry the concrete surface, [gas-fired torches or] clean, dry, compressed air may be used. Also, use vacuums capable of removing loose material and debris.

2.3 MATERIALS FOR FORMWORK AND EMBEDDED ITEMS

**********
NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20.
**********

a. Formwork and embedded items must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE /03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, as applicable.

b. Install and remove formwork without damaging or staining the existing structure or repair material.

Forms used for polymer concrete/mortars must be tight enough to hold the material that is used without leaking. All surfaces where bond is not desired, but which are exposed to the monomer or resin, must be treated with a form release agent. Release agent must meet the biobased requirement per Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS] See also https://sftool.gov/greenprocurement/green-products/16/roadwayconstruction/61/concrete-asphalt-release-fluids/0 for more information.

2.4 REINFORCEMENT AND REINFORCEMENT SUPPORTS

2.4.1 Steel Bars, Wires, and Fiber-reinforced Concrete

a. Reinforcement and reinforcement support must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE or 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, as applicable.

b. Repair coating damage incurred during shipment, storage, handling, and placing of reinforcing bars in accordance with the appropriate ASTM standard practices for repair of damaged reinforcement ASTM A780/A780M; ASTM A775/A775M; ASTM A934/A934M. Damaged areas must not exceed 2 percent of surface area in each linear foot of each bar.

c. Mechanical splices for coated reinforcement must have compatible coatings, in accordance with manufacturer's instructions. Splices for galvanized reinforcement must be galvanized or coated with dielectric material. Splices used with epoxy-coated or dual-coated reinforcement must be coated with dielectric material.

d. Submit mill certificates and shop drawings as required by Section 03 30 00 CAST-IN-PLACE CONCRETE or 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, as applicable.

2.4.2 Fiber-Reinforced Polymers

a. Fiber-Reinforced Polymers (FRP) bars used as internal reinforcement in concrete and their supports must meet the product requirements of ACI 440.5 and conform to ACI 440.6.

b. Submit test reports and certificates for FRP bars as required by ACI 440.5 and the Contract Documents.

c. Fiber-Reinforced Polymer (FRP) laminate materials externally bonded to concrete made by wet layup must meet the requirements of ACI 440.8 and the Contract Documents. Submit product data sheets for materials used for FRP layup systems as described in ACI 440.8.

d. The use of externally bonded FRP systems other than wet layup systems are permitted upon approval by the Contracting Officer. Submit product and materials data, design data, test reports, certificates, manufacturer's instructions, and field reports for those systems as requested by the Contracting Officer and required by Contract Documents.

2.5 Conventional Concrete

**********
NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20 and incorporate bracketed sustainable acquisition language within that section.
**********

a. Portland cement concrete materials must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE or 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, as applicable.

b. Materials for shotcrete must meet the requirements of Section 03 37 13 SHOTCRETE.

c. For cement based bonding systems use neat portland cement or a blend of portland cement and an ASTM C33/C33M fine aggregate filler proportioned one to one by mass. The water-to-cement ratio of the bonding mixture must be equal to the water-to-cement ratio of concrete used as a repair

or overlay material. Water used must meet ASTM C1602/C1602M requirements.

d. Use cementitious materials indicated in the Contract Documents. Use cementitious materials of the same brand and type from the same manufacturing plant as the cementitious materials used in the concrete represented by the submitted field test records or used in trial mixtures.

e. Aggregates used in concrete must be obtained from the same sources, be of the same type, and have the same size range as aggregates used in the concrete represented by submitted historical data or used in trial mixtures.

f. Refer to Section [03 30 00 CAST-IN-PLACE CONCRETE 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, or 03 37 13 SHOTCRETE, as applicable for details on submittals involving conventional concrete.

g. Concrete must meet recycled content requirements per Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS]. See https://sftool.gov/greenprocurement/green-products/1/construction-materials/29/cement-concrete/0?addon=False for more information.

## 2.6 POLYMERS

a. The requirements for the properties of polymers and aggregates used in polymers must meet the requirements specified in this paragraph as well as the properties specified in the referenced specifications and the Contract Documents.

b. Polymers used must be compatible with other polymers and materials used on the project. Unless repair materials are specified in the contract documents, the Contractor is responsible for verifying material compatibilities.

c. Submit product data, manufacturer's SDS, samples, design data, test reports, certificates, manufacturer's instructions, and field reports for materials as required by this document as well as the referenced specifications and the Contract Documents.

### 2.6.1 Epoxies

**********
NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20 and incorporate bracketed sustainable acquisition language within that section.
**********

a. Epoxy mortars and epoxy compounds must conform to ASTM C881/C881M

b. Epoxy mortars used for repairing defects in hardened portland cement concrete must meet the requirements of ACI 503.2-503.4.

c. Epoxy used for crack repair must meet the requirements of ACI 503.7.

d. Epoxy used to produce a skid-resistant surface on hardened concrete must meet the requirements of ACI 503.3.

e. Epoxy used for overlays must meet the requirements of ACI 548.8/ ACI 548.9. ACI 548.8 covers Epoxy multi-layer overlays while ACI 548.9 covers epoxy slurry overlays (for Bridge and Parking Garage Decks.

f. Epoxy used for bonding freshly mixed concrete and hardened concrete must meet the requirements of ASTM C881/C881M, Type [II][V], Grade [2][3], Class [A][B][C]. (to be specified).

g. Epoxy used for bonding hardened concrete and steel to hardened concrete must meet the requirements of ACI 548.12.

h. Two-component epoxies must meet biobased content requirements per Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS]. See https://www.biopreferred.gov/BioPreferred/faces/pages/ProductCategories.xhtml for more information.

2.6.2 Latexes

a. Latex used in polymer modified portland cement concrete/mortar must meet the requirements of ASTM C1438.

b. Latex used in polymer modified portland cement concrete overlays must meet the requirements of ACI 548.4.

c. Latex used for bonding freshly mixed concrete and hardened concrete must meet the requirements of ASTM C1059/C1059M, Type II.

2.6.3 Methacrylates

a. Methyl methacrylate slurry (MMS) used for overlays must meet the requirements of ACI 548.10.

b. High molecular weight methacrylate (HMWM) must be a 2-component, rapid curing, and solvent-free system.

c. HMWM monomers must be a high molecular weight or substituted methacrylate that conforms the following properties:

| Physical Properties of HMWM Monomer | | |
|---|---|---|
| Property | Test Method | Criteria |
| Vapor Pressure Flash Point Density | ASTM D323 ASTM D93 | Less than 133 Pa at 25 degrees C Greater than 93 degrees C Greater than 1.0 g per cubic cm at 25 degrees C Less than 0.02 psi at 77 degrees F Greater than 200 degrees F Greater than 8.4 lbs. per gal. at degrees 77 F |
| Viscosity Index of Refraction | ASTM D4016 ASTM D542 | 0.012 ± 0.004 Pas at 23 degrees C; 1.470 +_ 0.002 |

| | | |
|---|---|---|
| Boiling point @ 133 Pa 0.02 psi<br>Shrinkage on cure | ASTM D1078 | 70 degrees C<br>Less than 11 percent<br>12 + 4 cps at 73 degrees F<br>1.470 ± 0.002<br>158 degrees F<br>Less than 11 percent |
| Physical Properties of HMWM Monomer | | |
| Glass Transition Temperature (DSC) | ASTM D3418 | 57.2 degrees C<br>158 degrees F |
| Curing Time (100 g mass) | ASTM D3418 | Greater than 40 minutes at 25 degrees C, with 4 percent cuemene hydroperoxide<br>Greater than 40 minutes at 73 degrees F, with 4 percent cuemene hydroperoxide |
| Bond Strength | ASTM C882/C882M | Greater than 10.3 mPa Greater than 1,500 psi |

d. The initiator/promoter system for HMWM must be capable of providing a surface cure time of not less than 40 minutes nor more than 3 hours at the surface temperature of the concrete during application. The initiator/promoter system must be such that the gel time may be adjusted to compensate for changes in temperature that may occur throughout the treatment application.

d. The initiator/promoter system for HMWM must meet the following criteria:

| | |
|---|---|
| Initiator Cuemene Hydroperoxide | 78 percent |
| Promoter Cobalt Napthenate | 6 percent |

2.6.4 Other Polymers

The use of urethanes/silicones/acrylics is permitted.

Submit product data, samples, design data, test reports, certificates, manufacturer's instructions for acceptance by the Contracting Officer.

2.6.5 Aggregate

a. Unless otherwise specified or recommended by the polymer material manufacturer, aggregate used with polymers must meet ASTM C33/C33M requirements.

b. Aggregate properties and proportions used with polymers must meet the requirements of the polymer material manufacturer, the requirements of the referenced polymer standard, and the Contract Documents.

c. Aggregate used with polymers must be dry and free of dirt, asphalt, and other organic materials. Aggregate moisture content must be less than 0.2 percent by weight.

d. For patch repairs, the maximum-sized aggregate must not be greater than one third the depth of the patch area.

## 2.7 Miscellaneous Materials and Equipment

### 2.7.1 Packaged and Proprietary Materials

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NOTE: If 01 33 29 is incorporated in the specifications, select that option below. If not, select the option for 01 57 19.01 20 and incorporate bracketed sustainable acquisition language within that section.
**********

The required properties for the materials listed in this paragraph must meet the properties specified in the Contract Documents. Submit [Product data], [samples,] [design data,] [test reports,] [certificates,] [manufacturer's instructions], [and field reports] as required by the Contracting Officer and the Contract Documents.

a. Packaged, rapid hardening concrete repair materials must conform to ASTM C928/C928M. Leveling and patching materials must meet biobased requirements per Section [01 33 29 SUSTAINABILITY REPORTING][01 57 19.01 20 SUPPLEMENTAL TEMPORARY ENVIRONMENTAL CONTROLS]. See https://www.biopreferred.gov/BioPreferred/faces/pages/ProductCategories.xhtml for more information.

b. Packaged, mortar and concrete must conform ASTM C387/C387M.

c. Rapid hardening cement must conform to ASTM C1600/C1600M.Water used with packaged and proprietary materials must meet ASTM C1602/C1602M requirements. Aggregates must meet the repair material manufacturer's requirements if available and ASTM C33/C33M if such requirements are not specified.

### 2.7.2 Bond Breakers

a. Bond breaker materials must meet the requirements of ASTM D2822/D2822M, ASTM D4869/D4869M, ASTM D226/D226M, Type I, ASTM D2103, and must have a minimum thickness of 0.25 mm 0.010 in., [AASHTO M 288, Erosion Control, Class B, ASTM D450/D450M, Type II, as applicable.

b. Bond breaker materials used must not have detrimental effects on portland cement concrete and reinforcement.

### 2.7.3 Structural steel

Structural steel used for repairs must meet the requirements of 05 12 00 STRUCTURAL STEEL.

### 2.7.4 Concrete Accessories

All concrete accessories not included in this document must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and 03 30 53 MISCELLANEOUS CAST-INPLACE CONCRETE, as applicable.

2.7.5 Miscellaneous Equipment

a. Equipment designed specifically for the application of repair materials must be used as required by the repair material manufacturer and the referenced specification.

b. Equipment not listed in this specification but referenced or used for repairs must be clean and in good operating condition.

c. All supplies and equipment must be available in sufficient quantities to allow continuity in the installation project and quality assurance.

2.8 MIXTURE PROPORTIONING

a. Portland cement-based concrete mixtures must be in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE, Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, or 03 37 13 SHOTCRETE, as applicable.

b. Polymer concrete/mortar/resin/monomer proportioning, handling, and mixing procedures as well as equipment used for mixing these materials must conform to the requirements of the referenced material specifications and the repair material manufacturer's directions.

c. Polymer-modified portland cement concrete proportioning, handling, and mixing procedures as well as equipment used for mixing these materials must conform to the requirements provided by the repair material manufacturer as well as ACI 548.4 when such materials are used for overlays.

c. Proportioning and mixing materials not specified above must follow the requirements provided by the repair material manufacturer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Examination

Locate area of unsound concrete or delamination using hammer sounding or chain drag sound methods in accordance to ASTM D4580/D4580M. Denote and mark perimeter boundaries and notify the Contracting Officer to approve the unsound concrete layout boundaries.

3.1.2 Protection

Protect pedestrians, motorized traffic, mechanical, electrical, and plumbing equipment, surrounding construction, project site, landscaping, and surrounding buildings from damage or injury resulting from concrete rehabilitation work.

a. Construct dust and debris barriers surrounding repair work perimeter to control dust and to protect and control construction traffic.

b. Dispose of runoff from wet demolition or surface preparation operations in accordance with all local ordinances. Disposal methods must avoid soil erosion, avoid undermining pavements and foundations, damage to landscaping and vegetation, and minimize water penetration through other parts of buildings.

c. Collect and neutralize alkaline wastes and acid wastes and dispose in accordance with local, state, and federal regulations.

d. Comply with local noise ordinances during demolition operations.

e. Perform demolition work and surface preparation work in a manner that minimizes disturbances of operations. Coordinate work with the Contracting Officer.

f. Submit a proposed protection plan for approval by owner representative and Licensed Design Professional.

3.1.3 Formwork and Shoring

Execution of formwork and shoring must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, or 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, as applicable.

3.1.3.1 Formwork

a. Construct forms to sizes, shapes, lines, and dimensions to match existing adjacent surfaces and textures. Provide forms that match openings, offsets, chamfers, anchorages, inserts and other features as described on Contract Documents. Construct forms to accommodate installation of products by other trades. Provide forms for easy removal to minimize damage to concrete surfaces and adjacent surfaces. Apply form release coating over formwork surfaces prior to each concrete placement. Form release agents must not be applied to or come in contact with the repair area concrete substrate or reinforcement.

b. Do not damage repair material during removal of formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete or repair material. Perform needed repair and treatment required on vertical surfaces at once and follow immediately with specified curing. Remove all formwork anchors embedded in existing concrete. Fill anchor holes and repair all damage to existing concrete at anchor holes.

3.1.3.2 Shoring

a. Provide shoring in accordance with the shoring drawings prior to performing work to brace the substrate structure temporarily while repair work is proceeding. Shoring must be designed, documented, and stamped by a Licensed Design Professional. Shoring designs must be submitted to and approved by the Contracting Officer prior to work commencing.

b. Leave formwork and shoring in place to support existing loads, construction loads and weight of repair material in beams, slabs, and other structural members until in-place strength of repair material determined in accordance with the Contract Documents. For posttensioned construction, leave formwork and shoring in place until stressing is complete. When shores and other supports are arranged to allow removal of form-facing material without allowing structural slab or member to deflect, form-facing material and its horizontal supporting members may be removed at an earlier age.

3.1.4 Concrete preparation

a. Remove concrete as needed per the removal requirements of this section. Limits on removal equipment are specified in the paragraph titled EQUIPMENT FOR CONCRETE PREPARATION.

b. Remove foreign material, such as dirt, oil, grease, or other chemicals, from the cracks before injection using compressed air, low-pressure water, or vacuuming. Allow wet surfaces to dry at least 24 hours.

c. Immediately before placing the repair material or installing formwork, make the repair area available for inspection by the Contracting Officer. Obtain acceptance by the Contracting Officer of surface preparation before proceeding with Work. If the Work is rejected, perform additional operations to the satisfaction of Contracting Officer.

3.1.5 Quality Control

3.1.5.1 Quality control of surface preparation

Evaluation of prepared substrate must be continuously monitored to assure that the prepared substrate surface meets project requirements.

3.1.5.2 Quality control of repair overlays

All components of overlay PPCC materials must be certified by the material manufacturer or aggregate supplier to meet all project testing requirements. During the PPCC overlay, take mixed samples and check that the materials are mixed properly. Confirm that the right PC overlay thickness was applied by recording the volume of PC overlay materials and the substrate surface area covered by the overlay.

3.1.6 Curing

a. For portland cement concrete Work, follow the requirements indicated in 03 30 00 CAST-IN-PLACE CONCRETE.

b. For polymer concrete/mortar Work, follow manufacturer's requirements for curing.

c. For polymer modified portland cement concrete Work follow manufacturer's requirements for curing.

3.1.7 Clean up

a. Clean and remove all spills and leaks of injection adhesive and stains caused by the injection adhesives.

b. Dispose wastewater used for cutting and cleaning without staining or damaging the existing surfaces of the structure or the environment of the project area. The method of disposal must meet all the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS

3.1.8 Safety

a. Provide SDS for products on site, reviewing them before work begins.

b. Provide safety guards, maintenance, and warnings for all machinery and equipment.

c. Have personal protection equipment practice in place - eye protection and face guards.

d. Have all workers in contact with wet cementitious material wear protective gloves and clothing.

e. Provide eyewash facilities on-site with location signage.

f. Provide dust masks for workers operating mixers.

g. Have confined space procedures in place including adequate ventilation in closed spaces before operating equipment or using products that emit potentially dangerous or toxic exhaust, fumes, or dust.

h. Provide secured storage available for all hazardous or flammable materials.

i. Conduct safety meetings prior to beginning repair operations.

3.2 CRACK REPAIR

3.2.1 Preparation

3.2.1.1 General Requirements

a. Clean all cracks in accordance with the paragraph titled Concrete Preparation.

b. Do not repair cracks when the temperature of the concrete is below freezing and moisture conditions indicate the possibility of ice on the internal surfaces of the crack.

c. Do not apply adhesive if the temperature of the concrete is not within the range of application temperatures recommended by the manufacturer of the adhesive.

3.2.1.2 Crack routing

Inspect surfaces adjacent to crack to receive repair material. If deteriorated, route a V-groove section at the crack face until sound concrete is reached.

3.2.1.3 Sealing

a. For epoxy injection, apply a surface seal over all exterior faces of the crack that can be reached to contain the injection adhesive in the crack.

b. For gravity fill repairs, apply a surface seal along the bottom surface of the element that can be reached to contain the repair material in the crack.

3.2.2 Application

3.2.2.1 Epoxy injection

a. Install the injection entry and venting ports using flush mounted or drilled fittings per proprietary manufacturer's instructions.

b. Space the ports at a distance equal to the thickness of the member.

c. Inject the epoxy using material manufacturer's recommended equipment.

d. Apply recommended manufacturer's injection pressure.

e. For vertical or inclined cracks, apply injection by pumping epoxy into entry ports at the lowest elevation, cap, and move upward.

f. For horizontal cracks, apply injection by proceeding from one end of the crack to the other until the crack is fully sealed.

g. After 10 min., repeat injection procedure until all ports refuse injection.

h. Remove ports and remove the surface seal by heat, chipping, or grinding or other acceptable means after the injected epoxy has cured.

3.2.2.2 Gravity fill

a. Mix resin or monomer per material manufacturer's instructions.

b. Pre-fill cracks at least 3 mm 0.125 in. wide with aggregate.

c. Pour resin or monomer onto the surface, over the cracks and spread with brooms, rollers, or squeegees.

d. Work material back and forth over the cracks to maximize fill in crack.

e. Allow at least 20 minutes for material to penetrate cracks.

f. Remove excess material once cracks have been filled to refusal.

g. Broadcast 0.5 to 1.0 kg per square meter 1 to 2 lbs per square yard of sand.]

h. Allow material to cure per material manufacturer's recommendations.

3.2.3 Quality Control

a. Conduct quality and control tests for metering accuracy and mixing effectiveness of the continuous mixing pump in accordance with ACI 503.7.

b. Qualify the test injection procedures in accordance with ACI 503.7.

3.2.4 Acceptance Criteria

3.2.4.1 Core Sampling

a. Obtain core samples in accordance with ASTM C42/C42M.

b. Allow 24 hours after injection before coring.

c. Obtain cores in a manner that includes as much of the bond line of the repaired concrete as possible. Replace cores that do not intersect the crack for at least 75 percent of the length of the core.

d. Obtain three diameter core from first 30 m 100 ft. and one core for each 30 m 100 ft. thereafter.

e. If cores would sever reinforcing steel or other embedded items, do not core, and notify the Contracting Officer so that an alternative location can be chosen.

f. Obtain cores at least 50 mm 2 in. in diameter for visual inspections and at least 100 mm 4 in. in diameter for the splitting tensile test. Perform a splitting tensile test on one core from the first 30 m 100 ft. and one core for each 75 m 250 ft. thereafter.

g. Fill core holes with [non-shrink grout.

3.2.4.2 Core Testing

a. Test a portion of the core samples for the splitting tensile strength in accordance with ASTM C496/C496M.

b. Allow 72 hours after injection before beginning splitting tensile tests

c. Prepare core sample per ASTM C42/C42M.

d. Align the core so that the crack is in a plane as close to vertical as possible.

3.2.4.3 Acceptance

Work is acceptable if at least 90 percent of the depth of the crack in each core is filled with adhesive.

a. The splitting tensile strength of the core is at least 90 percent of the splitting tensile strength of a core taken from an uncracked area within 300 mm 12 in. of the repaired crack.

b. A splitting tensile test of the core indicates that no more than 10 percent of the bonded area of the crack in each core exhibits combined areas of separation of the adhesive from the concrete or cohesive failure within the adhesive.

3.3 CORROSION AND SURFACE REPAIR

3.3.1 Preparation

3.3.1.1 Identification of Extent of Concrete Removal

a. Configure geometry of removal area to maximize the use of right-angle geometry, avoiding reentrant corners, and to obtain uniformity of depth. Determine the depth, location, and size of reinforcing bars prior to removal of concrete.

b. Perform visual inspection and hammer tapping, chain drag sounding, or other methods acceptable by the Contracting Officer to identify cracked, delaminated, spalled, disintegrated, and otherwise unsound concrete for removal. Mark boundaries of repair area before concrete removal.

c. Inspect the marked boundaries with the Contracting Officer prior to commencing with the concrete removal. Revise the repair area boundaries as instructed by the Contracting Officer.

3.3.1.2 Shoring and Formwork

a. Provide shoring and formwork per the paragraph titled Formwork and Shoring.

b. For post-tensioned concrete, detension strands and wires as required by Contract Documents prior to repair.

3.3.1.3 Concrete Removal

a. Remove concrete from repair areas to indicated depth and profile. Notify Contracting Officer if additional delaminated, fractured, or unsound concrete is present.

b. Do not damage embedded reinforcing and adjacent concrete. The removal methods must produce minimal microcracking (bruising) of the prepared substrate surfaces. Avoid directly striking reinforcing steel with impact tools used for concrete removal.

c. Provide perpendicular edges at perimeter of repair area. The perimeter of the repair areas must be saw cut to a depth of 0.50 to 0.75 in. 15 to 20 mm. [For vertical or overhead surfaces, provide 45-degree slope at repair boundaries to facilitate air and rebound escape.] Do not cut or damage embedded reinforcement or other embedded items. If embedded

reinforcing steel or other embedded items are too close to the surface to provide the perpendicular edge cut, notify the Contracting Officer for direction before proceeding.

d. Extend concrete removal along the corroded reinforcing steel to a point where there is no further delamination, concrete cracking, or reinforcing steel corrosion, and where the reinforcement is bonded to the surrounding concrete.

e. Remove concrete around the exposed layer of reinforcement to a uniform depth beyond within the repair areas to provide a minimum clearance between exposed reinforcing steel and surrounding concrete of 0.75 in. 20 mm, or at least 0.25 in. 5 mm larger than the maximum nominal size of the coarse aggregate in the repair material.

f. Do not remove concrete behind vertical reinforcing bars in columns.

3.3.1.4 Preparation of Concrete Substrate Surface

a. Confirm perpendicular edges at repair area perimeter, and reinstate if damaged by concrete removal process. Remove loosely bonded concrete, bruised or fractured concrete, and bond-inhibiting materials such as dirt, concrete slurry, or any other detrimental materials from the concrete substrate using approved methods. Where concrete has been removed by impact methods, abrasive blasting must be used to prepare the surface and remove bruised concrete.

b. Provide substrate surface profiles as specified in the Contract Documents.

c. Visually inspect and sound substrate surface to confirm that no further delaminations or otherwise unsound concrete remains. If encountered, notify the Contracting Officer.

d. Clean the substrate per the paragraph titled Concrete preparation.

3.3.2 Application

3.3.2.1 Existing Reinforcement Preparation

a. Clean existing reinforcement that will remain. Remove corrosion and/or other laitance and notify the Contracting Officer if section loss is greater than 20%.

b. Replace coating on reinforcement per ASTM A780/A780M.
Exposed areas must not exceed 2 percent of surface area in each linear foot of each bar.

c. Permit evaluation of existing reinforcement and placement of new reinforcement by the Contracting Officer.

3.3.2.2 Placement of New Reinforcement

Placement of new reinforcement

a. Placement of new reinforcement to replace or strengthen existing reinforcement is like new construction. Placement, splicing, and handling of new reinforcement must meet the requirements specified in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE, 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS, 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, 03 20 00.00 10 CONCRETE REINFORCING, as applicable.

b. Reinforcement must be free of materials deleterious to bond. New reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wirebrushed test specimen are not less than applicable ASTM specification requirements.

3.3.2.3 Placement of Concrete

a. If portland cement concrete is used as the repair material, follow the requirements indicated in 03 30 00 CAST-IN-PLACE CONCRETE as well the Contract Document for proportioning, mixing, and placing concrete. For all other materials, follow material manufacturer's recommendations.

b. For vertical and overhead applications of portland cement concrete, use shotcrete. Follow the requirements indicated in 03 37 13 SHOTCRETE.

c. A bonding agent must be used.

d. Apply corrosion inhibitors as designated by the Contract Documents.

e. Bristle broom a thin coat of the repair material into the saturated surface dry substrate filling roughened surface pores before placing the repair material in the repair area. Do not allow thin coat to dry before placing repair material. This requirement only applies when bonding agents are not used.

f. Consolidate the repair material after placement with a vibrating screed or internal vibrator.

g. Finish the surface to match surface finish and texture requirements indicated in the Contract Document. Screed, float and trowel the repair material or broom the surface for non-slip texture. Follow the requirements of 03 30 00 CAST-IN-PLACE CONCRETE. For shotcrete, apply finishing techniques and requirements indicated in 03 37 13 SHOTCRETE.

3.3.2.4 Placement of Other Repair Materials

a. Equilibrate repair material(s) and substrate to the temperature, cleanliness of substrate and reinforcement, and moisture requirements of the repair material manufacturer's requirements.

b. Comply with the repair material manufacturer's requirements for batching, mixing, placing and curing repair materials.

c. Review consistency of the mixed repair material(s) relative to the parameters documented in the repair material manufacturer product data sheet. If non-conforming, adjust consistency in compliance with the repair material manufacturer's requirements.

d. Apply or install repair material(s) within the application time frame (pot life) requirements of the repair material manufacturer's requirements, and place and consolidate to provide well-compacted repair.

e. Finish and tool repair materials, finished in accordance with the repair material manufacturer's written instructions and as indicated in Contract Documents.

f. Protect installed repair material(s) from damage, exposure to environmental conditions that are detrimental to the uncured or cured properties of the material. Cure in accordance with the requirements of the repair material manufacturer's requirements.

3.3.3 Quality Control

a. Protect concrete surfaces, beyond limits of surfaces receiving bonding agent adhesive, against spillage. Immediately remove any bonding agent adhesive that has spilled beyond desired area. Perform cleanup with material designated by bonding agent adhesive manufacturer. Avoid contamination of work area.

b. The bond strength between the existing concrete and the repair material must be a minimum of 1.7 MPa 250 psi per ASTM C1583/C1583M

3.4.1 Preparation

Overlays must be properly designed and constructed for their application. Overlays are typically bonded or unbonded. If the surface is not properly designed or prepared, it can result in a partially bonded overlay. Partially bonded overlays can exhibit unanticipated random cracking and higher than expected curling/warping due to unplanned bonded and unbonded areas. For this reason, it is important for the Contracting Officer to verify that a surface was properly prepared before an overlay is placed.

3.4.1.1 Bonded Overlays

Bonded overlays are generally used to strengthen existing concrete surfaces or improve surface abrasion or impact resistance. The thickness of a bonded overlay as well as the type of material used should be accounted for in the design of the overlay. Materials used for bonded overlays include portland cement concrete, polymer modified concrete, and polymer concrete/mortars. In general, surface preparation requirements for bonded overlays are the same regardless of the type of material used for the overlay. Proper surface preparation is essential for the success of bonded overlays.

a. Provide surface preparation as required in this Section. Choose one or more mechanical abrasion method to prepare the surface of the existing slab. The surface preparation technique used should not be so aggressive that it damages the underlying pavement. An aggressive preparation technique will create a weak layer in the existing slab

immediately below the bond interface that might cause the overlay to fail. For additional guidance on surface preparation, refer to ACI 546R. If the slab being prepared for an overlay is supported, loads from equipment should have been considered as part of the design; shoring should be provided as needed.

b. Repair cracks and patch deteriorated concrete prior to final surface preparation

c. Apply additional preparation requirements specified by the overlay material manufacturer

3.4.1.2 Unbonded Overlays

Unbonded overlays surface preparation mainly consists of installing a bond breaker (Separation Layer) over the existing concrete slab before the overlay is placed. Per ACI 224R and ACI 302.1R, unbonded overlays are used where severe cracking is present in the base, where cracking can later develop, or when contamination of the existing slab prevents complete bond with the overlay. Unbonded overlays are not used to strengthen existing slabs and must be sufficiently thick to resist loads on their own. Per ACI 302.1R, unbonded overlays should have a minimum thickness of 3 in. (75 mm) for foot-traffic, and a minimum thickness of 4 in. (100 mm) if the surface is to be subjected to vehicular traffic. Because of the thickness requirements, unbonded overlays are usually portland cement concrete based and include a type of reinforcement.

a. Repair distresses that cause a major loss of structural integrity when present.

b. In the blank above add any observed distress that needs to be repaired prior to the installation of the overlay. Unbonded concrete overlays generally require minimal pre-overlay repairs; repairs are only done for severe distresses. For example, shattered slabs are usually replaced and full depth repairs are performed for punchouts, highseverity transverse cracks with ruptured steel, and unstable slabs or pieces of slabs with large deflections or pumping.

c. Clean the existing slab and remove any loose materials.

d. Install the separator layer as required by the Contract Documents and recommended by the material manufacturer.

3.4.2 Application

3.4.2.1 Portland Cement Concrete

a. Apply the specified bonding agent. Follow the requirements of 3.4.2.4.

b. Follow the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE] and the Contract Documents for installing forms, placing reinforcement, placing and consolidating concrete, and finishing concrete.

3.4.2.2 Polymer-modified Portland Cement Concrete
For polymer modified portland cement concrete

overlays follow ACI 548.4 requirements for placing and finishing the overlay.

3.4.2.3 Polymer Concrete/Mortar

For polymer concrete overlays, follow ACI 548.8 requirements for placing and finishing the overlay.

3.4.2.4 Bonding Agents

A bonding agent is a material used to improve the bonding between the overlay and the underlying material (concrete). A bonding agent can be used, but success has been seen without its use.

Use bonding agents with caution. Bonding agents should not be allowed to dry too early and form a skin that can act like a bond breaker that reduces the bond strength rather than increase it.

a. Use a cement slurry or epoxy bonding agent to improve the bonding between the overlay and the existing concrete.

b. Follow material manufacturer's instructions for mixing, preparing, and applying bonding agent. Do not exceed the manufacturer’s thickness recommendations.

c. Condition materials and the existing concrete surface to a temperature consistent with manufacturer’s recommendations at the time of installation.

d. Do not allow bond agents to dry before placement of repair material.

3.4.3 Quality Control

a. Concrete overlays must meet all the strength and durability requirements of 03 30 00 CAST-IN-PLACE CONCRETE.

b. The bond strength between the existing concrete and the overlay must be a minimum of 1.8 MPa 250 psi per [ASTM C1583/C1583M
.

3.4.4 Joints

a. For unbonded concrete overlays only, place joints as indicated in 03 30 00 CAST-IN-PLACE CONCRETE or 03 15 00.00 10 CONCRETE ACCESSORIES, and as shown on the drawings.

For both Bonded and Unbonded overlays, use the following:

b. Construct expansion and contraction joints in concrete overlay at the locations shown. Maintain alignment of control joints within 6 mm 1/4 in., to either side, of the required joint alignment.

c. Construct expansion and contraction joints at the locations shown and in accordance with Section 03 15 00.00 10 CONCRETE ACCESSORIES.

d. Construct expansion joints in the overlay at existing joint locations in the base slab while maintaining joint width and type.

e. Construct control joints by tooling the plastic concrete, then sawcutting at the appropriate time. Saw control joints to a minimum of 25 percent of the thickness of the slab. Maintain an ample supply of saw blades on the job before concrete placement is started, and have at least one standby sawing unit in good working order available at the jobsite at all times during the sawing operations. Begin sawcutting as soon as it is possible to saw the concrete without damaging adjacent concrete.

f. Inspect the faces of joints during sawcutting for undercutting or washing of the concrete due to early sawing. Complete sawcutting within 16 hours of concrete placement. Continue sawcutting regardless of weather conditions. Delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint or chipping, tearing, or spalling of the concrete occurs at the surface. Discontinue sawing when a crack develops ahead of the saw cut.]

g. Immediately after the joint is sawed, flush the saw cut and adjacent concrete surface thoroughly with water until all residue from sawing is removed from the joint. Control and dispose of waste water from sawcutting and cleanup in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

3.5 CONCRETE STRENGTHENING

a. For enlargement of slabs using overlays see the paragraph titled OVERLAYS.

b. For all other types of strengthening follow the requirements contained in this paragraph.

3.5.1 Preparation

a. Use equipment and methods specified in the paragraph titled EQUIPMENT FOR CONCRETE PREPARATION and the Contract Documents to produce a sound, rough, open-pore surface at locations where bonding between existing and new concrete is required.

b. Round members of existing concrete with corners to minimum 13 mm ½ in. radius. Roughened corners must be smoothed with putty.

c. Clean all surfaces from contaminant and remove unsound concrete using the prescribed cleaning equipment and methods in the paragraphs titled PRODUCTS. All laitance, dust, dirt, oil, curing compound, existing coatings, and any other matter that could interfere with bonding concrete to the repair material must be removed.

d. Follow the procedures of the paragraphs titled CRACK REPAIR and CORROSION AND SURFACE REPAIR. The concrete surface must be in good condition and all cracking, surface repair, and corrosion related

problems must be adequately addressed prior to proceeding with concrete strengthening procedures.

e. Insure that materials used for repairs are compatible with materials used for strengthening. Consult with the repair material manufacturers for information concerning material compatibility.

f. Surfaces not intended to be strengthened must be covered as needed to protect against contamination and spills.

g. Surfaces intended to be strengthened must be protected before application so that no materials that can interfere with bond are redeposited on the surface.

3.5.2 Application

3.5.2.1 Section enlargement

a. Install dowel reinforcement as required by the Contract Documents. Follow the adhesive or mechanical anchor manufacturer's procedures for installing dowels.

b. Install formwork and shoring following the requirements of this section.

c. Install reinforcement and reinforcement supports. Follow the requirements specified in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE, 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS, 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, 03 20 00.00 10 CONCRETE REINFORCING, as applicable.

d. Follow the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE or 03 37 13 SHOTCRETE to place, consolidate, and finish concrete.

3.5.2.2 Externally bonded systems

3.5.2.2.1 Steel Plates

a. Bond steel plates to concrete using the methods and materials specified in the Contract Documents.

b. For bonding steel plates to concrete using an epoxy resin follow the requirements and procedures of ACI 548.12.

c. For bonding steel plates to concrete using mechanical or adhesive anchors, follow the procedures provided by the material manufacturer.

3.5.2.2.2 Fiber-reinforced Polymer Laminates

The following procedures are general procedures used for the installation of FRP laminates. If the FRP system used requires conflicting procedures, consult with the Contracting Officer before proceeding.

a. Insure that all surfaces that will receive FRP are clean, dry, and free of contaminants.

b. Insure that the workplace is well ventilated and that the repair material is applied at a time when the air temperature, concrete surface temperature, and the relative humidity are as required by the repair material manufacturer.

c. Temporary protection of the Work area is required during installation and until the resins have cured. If temporary shoring is required, the FRP system must be fully cured before removing the shoring and allowing the structural member to carry the design loads.

d. If a primer is required, the primer must be applied uniformly to all areas on the concrete surface where the FRP system is to be placed at the manufacturer’s specified rate of coverage. Protect the primer from dust, moisture, and other contaminants before applying the FRP system.

e. Putty must be used in an appropriate thickness and sequence with the primer as recommended by the FRP manufacturer. The system-compatible putty must be used only to fill voids and smooth surface discontinuities before the application of other materials. Rough edges or trowel lines of cured putty must be ground smooth before continuing the installation. Allow the putty to cure as specified by the FRP system manufacturer before proceeding.

f. Proportion, mix, and apply resins components in accordance with the FRP system manufacturer’s recommended procedures.

g. Install and cure the FRP system per the manufacturer's recommendations.

h. During installation of wet layup FRP systems, entrapped air between layers must be released or rolled out before the resin sets. Sufficient saturating resin must be applied to achieve full saturation of the fibers. Furthermore, successive layers of saturating resin and fiber materials must be placed before the complete cure of the previous layer of resin. If previous layers are cured, interlayer surface preparation, such as light sanding or solvent application as recommended by the system manufacturer, is required.

i. Follow the FRP material manufacturer's recommendations for the application of protective coatings. Do not clean the installed FRP with a solvent before a protective coating is installed.

3.5.3 Quality Control

The cured FRP system must be evaluated for delaminations or air voids between multiple plies or between the FRP system and the concrete. Methods such as acoustic sounding (hammer sounding), ultrasonics, and thermography can be used to detect delaminations. The following requirements apply to wet layup systems:

a. Small delaminations less than 2 square inch 1300 square millimeter each are permissible as long as the delaminated area is less than 5 percent of the total laminate area and there are no more than 10 such delaminations per 10 square feet square meter.

b. Large delaminations, greater than 25 square inch 16,000 square millimeter, can affect the performance of the installed FRP and must be repaired by selectively cutting away the affected sheet and applying an overlapping sheet patch of equivalent plies.

c. Delaminations less than 25 square inch 16,000 square millimeter must be repaired by resin injection or ply replacement.

For other FRP systems, delamination must be evaluated and repaired in accordance with the material manufacturer direction. Upon completion of the Work, the laminate must be reinspected to verify that the repair was properly accomplished.

-- End of Section --