

## SECTION 03700 CONCRETE REBUILD

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes:
1. Removal of unsound and, as necessary, sound concrete and surface preparation, including full-depth, partial-depth, and shallow-depth concrete rebuilds.
  2. Surface preparation of reinforcing steel and installation of supplemental reinforcement.
  3. Installation of adhesive-grouted dowels.
  4. Cast-in-place concrete for rebuild applications, including but not limited to formwork; proprietary rebuild materials; batching, mixing, and placement procedures; finishing; and curing.
  5. Rebuild Materials and Placement Procedures:
    - a. Full depth rebuilds cast-in-place from top surface.
    - b. Formed-and-poured partial depth concrete rebuilds on horizontal, vertical and overhead surfaces.
    - c. Dry packed vertical and overhead partial depth rebuilds.
    - d. Trowel-applied shallow-depth rebuilds at vertical and overhead surfaces.
    - e. Core hole rebuilds.

#### 1.2 RELATED SECTIONS

- A. Following Work items are related to Work in this Specification, but are specified in other Specifications:
1. Section 03800: Embedded Galvanic Anodes for Concrete Rebuilds *{Engineer to verify applicability}*
  2. Section 07900: Joint Sealant and Expansion Joint Systems *{Engineer to verify applicability}*
- B. This section does not include all requirements related to shoring that may be necessary prior to performing concrete demolition and rebuild. The ENGINEER should review the proposed rebuild location and structure to determine the structural impact of any concrete demolition and repair and provide additional shoring requirements, if necessary.

#### 1.3 DEFINITIONS

- A. Abrasive – Any hard, strong substance, such as rocks, sand, water, or minerals, that will cut, scour, pit, erode, or polish another substance.
- B. Adhesion – The bonding of two surfaces through internal effects such as molecular (valence) forces or interlocking action, or both.
- C. Admixture – A material other than water, aggregates, hydraulic cement, or fiber reinforcement, added to concrete, mortar, or grout, during batching or mixing to enhance plastic or hardened material properties, or both.
- D. Aggregate – Granular materials, such as sand, gravel, and crushed stone, commonly used in concrete, mortar, or grout.
- E. Bond – Adhesion and grip of a material to other surfaces against which it is placed.
- F. Cathodic Protection – A form of corrosion protection for reinforced concrete wherein a sacrificial metal is caused to corrode in preference to the reinforcement, thereby protecting the reinforcement from corrosion.
- G. Cofferdam – A temporary structure enclosing all or part on a construction area so that construction or repair can proceed in the dry.

- H. Cohesion - The state in which the constituents of a mass of material are held together by chemical and physical forces.
- I. Consolidation – The process whereby the volume of freshly placed mortar or concrete is reduced to the minimum practical space, usually by vibration, rodding, tamping, or some combination of these actions.
- J. Corrosion – Degradation of concrete or steel reinforcement caused by electrochemical or chemical attack.
- K. Cure – The process by which a compound attains its intended performance properties by means of evaporation, chemical reaction, heat, radiation, or combinations thereof.
- L. Degradation – A detrimental change in the physical and/or chemical properties of a material.
- M. Delamination – A separation along a plane parallel to a surface.
- N. Deterioration – Physical manifestation of failure of a material (e.g., cracking, delamination, flaking, pitting, scaling, spalling, staining) caused by service conditions or internal autogenous influences.
- O. Erosion – Progressive disintegration of a solid by the abrasive or cavitation action of gases, fluids or solids in motion.
- P. Form – A temporary structure, or mold, to support a material while it is curing and gaining sufficient strength to be self-supporting.
- Q. Grout – A mixture of cementitious material and water, with or without aggregate, proportioned to produce a pourable consistency without segregation of the constituents.
- R. Keyway – A recess or groove in a concrete substrate which is filled with material to provide increased shear strength along the interface.
- S. Proprietary – Made and marketed by one having the exclusive right to manufacture and distribute.
- T. Reinforcement – Bars, wires, strands, fibers, or other slender members which are embedded in concrete primarily to improve tensile strength.
- U. Reinforcement Continuity – A condition in reinforced concrete in which the reinforcing steel is sufficiently interconnected to provide a path for electrical current.
- V. Sacrificial Anodes – Chemically active metals such as zinc, aluminum, and magnesium which, when electrically connected to the reinforcing bar, will provide the energy needed to cathodically protect the reinforcing bar.
- W. Saturated Surface-Dry – Condition of an aggregate particle or other porous solid when the permeable voids are filled with water and no water is on the exposed surfaces.
- X. Segregation – The differential concentration of the components of mixed concrete, aggregate, or the like, resulting in nonuniform proportions in the mass.
- Y. Shrinkage – A decrease in one or more dimensions of an object or material.
- Z. Slump – A measure of consistency of freshly mixed concrete.

#### **1.4 REFERENCE STANDARDS**

- A. Reference Standards: Latest edition.
  - 1. American Concrete Institute (ACI):
    - a. ACI 117: Specification for Tolerances for Concrete Construction and Materials and Commentary
    - b. ACI 207.1R: Guide to Mass Concrete
    - c. ACI 222R: Protection of Metals in Concrete Against Corrosion

- d. ACI 301: Specifications for Concrete Construction
  - e. ACI 305R: Guide to Hot Weather Concreting
  - f. ACI 306R: Guide to Cold Weather Concreting
  - g. ACI 309: Guide for Consolidation of Concrete
  - h. ACI 315: Guide to Presenting Reinforcing Steel Design Details
  - i. ACI 318: Building Code Requirements for Structural Concrete and Commentary
  - j. ACI 347: Guide to Formwork for Concrete
  - k. ACI 355.4: Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary
2. ASTM International (ASTM):
- a. ASTM A276: Standard Specification for Stainless Steel Bars and Shapes
  - b. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - c. ASTM A706: Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
  - d. ASTM C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
  - e. ASTM C33: Standard Specification for Concrete Aggregates
  - f. ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - g. ASTM C42: Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  - h. ASTM C94: Standard Specification for Ready-Mixed Concrete
  - i. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50 mm Cube Specimens)
  - j. ASTM C114: Standard Test Methods for Chemical Analysis of Hydraulic Cement
  - k. ASTM C138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
  - l. ASTM C143: Standard Test Method for Slump of Hydraulic-Cement Concrete
  - m. ASTM C150: Standard Specification for Portland Cement
  - n. ASTM C157: Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
  - o. ASTM C171: Standard Specification for Sheet Materials for Curing Concrete
  - p. ASTM C172: Standard Practice for Sampling Freshly Mixed Concrete
  - q. ASTM C185: Standard Test Method for Air Content of Hydraulic Cement Mortar
  - r. ASTM C191: Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
  - s. ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
  - t. ASTM C260: Standard Specification for Air-Entraining Admixtures for Concrete
  - u. ASTM C266: Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
  - v. ASTM C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
  - w. ASTM C403: Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
  - x. ASTM C469: Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
  - y. ASTM C494: Standard Specification for Chemical Admixtures for Concrete
  - z. ASTM C496: Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
  - aa. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  - bb. ASTM C856: Standard Practice for Petrographic Examination of Hardened Concrete

- cc. ASTM C1012: Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
- dd. ASTM C1064: Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- ee. ASTM C1152: Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete
- ff. ASTM C1171: Standard Test Method for Quantitatively Measuring the Effect of Thermal Shock and Thermal Cycling on Refractories
- gg. ASTM C1202: Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
- hh. ASTM C1218: Standard Test Method for Water Soluble Chloride in Mortar and Concrete
- ii. ASTM C1260: Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
- jj. ASTM C1293: Standard Test Method for Determination of Length Change of Concrete Due to Alkali Silica Reaction
- kk. ASTM C1315: Standard Specifications for Liquid Membrane Forming Curing Compounds and Curing and Sealing Compounds.
- ll. ASTM C1439: Standard Test Methods for Evaluating Latex and Powder for use in Hydraulic Cement Concrete and Mortar.
- mm. ASTM C1524: Standard Test Method for Water Extractable Chloride in Aggregate (Soxhlet Method)
- nn. ASTM C1602: Standard Specification For Mixing Water in Hydraulic Cement Concrete
- oo. ASTM C1611: Standard Test Method for Slump Flow of Self-Consolidating Concrete
- pp. ASTM C1621: Standard Test Method for Passing Ability of Self Consolidating Concrete by JRing
- 3. American Welding Society (AWS):
  - a. AWS D1.1/1.1M: Structural Welding Code-Reinforcing Steel (latest edition)
- 4. Concrete Reinforcing Steel Institute (CRSI):
  - a. Manual of Standard Practice
- 5. ICC Evaluation Service (ICC-ES):
  - a. AC308: Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
- 6. International Concrete Repair Institute (ICRI):
  - a. Technical Guideline No. 310.1R Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
  - b. Technical Guideline No. 310.2 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- 7. The Society for Protective Coatings (SSPC):
  - a. SSPC Painting Manual, Volume 2, Systems and Specifications.
- 8. United States Army Corps of Engineers (USACE):
  - CRD-C 39: Test Method for Coefficient of Linear Thermal Expansion of Concrete.

## 1.5 DEFINITIONS

- A. Abrasive Blast Cleaning: Surface preparation of substrates by abrasive propelled at high speed.
- B. Concrete Rebuild: Repairing or restoring deteriorated, damaged, or otherwise unsound concrete.
- C. Corrosion: The oxidation or eating away of a metal or other material by exposure to chemical or electrochemical action.
- D. Feather Edging: Reducing the thickness along the edge of a material.
- E. Full-Depth Concrete Rebuild: Reinforced concrete repair that encompasses the full section of an existing concrete element.

- F. Overlay: A layer of non-structural construction material, such as cementitious mortar, placed over an existing structural element or substrate to improve aesthetics, provide function and/or add protection.
- G. Partial-Depth Concrete Rebuild: Reinforced concrete repair that extends past, at least, the first later of reinforcing of an existing concrete element.
- H. Quality Assurance Inspector: Certified and/or qualified individual(s) responsible for inspecting and/or testing Work such as conditions, materials, installations, applications, etc. to verify Work is performed in accordance with applicable specifications and requirements.
- I. Shallow-Depth Concrete Rebuild: Concrete repair that is less than 2 inches deep with no reinforcing bars exposed.
- J. Welding Specialist: A Certified Welding Inspector (CWI) as per the AWS D1.1/D1.1M:(latest edition) .

## 1.6 SUBMITTALS

- A. Pre-Award Submittals: Submitted with Bid
  - 1. CONTRACTOR and Subcontractor Qualifications
  - 2. Ready-Mix Concrete Supplier Qualifications
  - 3. Qualifications for Installer of Adhesive-Grouted Dowels
  - 4. Intent to Warrant Documentation
- B. Pre-Construction Submittals: Submitted prior to performing Work.
  - 1. Quality Control Plan / Work Plan
    - a. To be submitted as part of Quality Control System.
  - 2. Product Data / Safety Data
    - a. List of proposed materials, including aggregates for extension, and additives.
    - b. Technical data sheets for each type of manufactured material and product indicated, including but not limited to:
      - 1) Rebuild materials.
      - 2) Reinforcing bar mechanical splices.
      - 3) Reinforcement supports.
      - 4) Corrosion-inhibiting coating.
      - 5) Adhesive for grouted dowels.
      - 6) Curing blanket.
      - 7) Curing compound.
    - c. Safety Data Sheets.
    - d. Written verification from proprietary rebuild material manufacturer of aggregate extension requirements.
  - 3. Shop Drawings:
    - a. Steel Reinforcement: Details of fabrication, bending, and placement, prepared in accordance with ACI 315. Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
    - b. Welding: Description of reinforcing bar weld locations, welding procedure specifications and AWS welder certification when welding is permitted.
    - c. Structural Formwork: Detailing of fabrication, assembly, and support of formwork prepared by, or under supervision by a professional engineer licensed in State of Virginia.
  - 4. Material Manufacturer Written Certification for Proprietary Rebuild Material Indicating:
    - a. Lot numbers of materials for Project have been tested and meet or exceed material properties published in product data sheets, including compressive strength, slump during lot testing, and amount of water used during mixing.
    - b. CONTRACTOR's foremen and laborers have been trained in use of rebuild products.

- c. Proposed alternate proprietary rebuild materials, include supplemental pre-qualification information and test reports. Include notice if tests indicate concrete or mortar is not in conformance with product data sheets
- 5. Design Mixes for each Ready-Mix Concrete:
  - a. Indicate amount of mix water to be withheld for later addition at Site without adversely affecting hardened concrete.
  - b. Indicate dosage range for all admixtures, including retarding, accelerating, and water reducing admixtures that may potentially be added on site or at the batch plant, and the anticipated effects on mix set time, slump retention, and air content.
  - c. For proposed alternate mix designs, include supplemental pre-qualification information and test reports.
- 6. Concrete Placement Plan, including control measures for ensuring SSD prior to placement and limiting effects due to temperature and humidity during placement, finishing, and curing.
- 7. Batch Tickets for all Ready-Mix Concrete.
- 8. Weld Procedure Specification (WPS) for Welding Reinforcing Bars:
  - a. AWS D1.1/D1.1M:(latest edition); including but not limited to:
    - 1) If chemical analysis and carbon equivalent of reinforcing bars is not known, use pre-heat temperature of 300 to 500 degrees F and E7018 electrodes.
    - 2) Minimum preheat, welding process, and filler metal.
      - a) If oxyacetylene torch is used to achieve preheat, clean steel surface with grinder or wire brush before welding.
    - 3) Tension and macroetch test results for welds other than fillet welds, using maximum reinforcing bar size approved by ENGINEER; unless specifically waived by ENGINEER.
- C. Closeout Submittals: Submitted upon completion of Work prior to final payment.
  - 1. Record documentation of Work performed such as:
    - a. Red-line Drawings, Specifications and/or Sketches.
    - b. Construction Photos.
    - c. Quality Assurance Inspection and Quality Control Reports.
- D. Executed Warranty(s)

## 1.7 QUALITY ASSURANCE AND QUALITY CONTROL

- A. CONTRACTOR Qualifications:
  - 1. Experienced with successful installations of specified materials in similar environments and on similar structures in use for minimum of 5 years.
  - 2. Foremen with minimum of 5 years of experience as foremen on similar projects, who are fluent in English, to be on site at all times during Work. Do not change foremen during course of Project except for reasons beyond control of CONTRACTOR; inform OWNER in advance of any changes.
  - 3. Foremen and at least 50 percent of laborers shall be trained by material manufacturers in use of specific products to be used.
- B. Qualifications for Installer of Adhesive-Grouted Dowels:
  - 1. ACI-CRSI certified Adhesive Anchor Installer and/or installers who are qualified by the product manufacturer.
  - 2. Foreman or laborer with minimum 5 years of experience performing similar Work to be on site at all times during Work. Do not change foreman or laborer during course of Project except for reasons beyond control of dowel Installer; inform OWNER in advance of any changes.
- C. Ready-Mix Concrete Supplier Qualifications:
  - 1. ASTM C94; Certification of Production Facilities and Delivery Vehicles by National Ready Mixed Concrete Association.

- D. Adhesive for Adhesive-Grouted Dowels:
1. Provide samples of adhesive to OWNER and/or Quality Assurance Inspector for observation of set and compression testing.
  2. Provide minimum of 3 samples per shift during first 4 shifts of adhesive use on project.
  3. Make samples by placing adhesive in 3/8-inch-diameter test tubes to height of approximately 1 inch so that after trimming cylinder of 3/8-inch diameter and 3/4-inch length can be obtained.
- E. Pre-Construction Meeting:
1. Review requirements for concrete rebuild Work, including but not limited to:
    - a. Schedule.
    - b. Availability of materials and CONTRACTOR's personnel, equipment, and facilities needed to make progress and avoid delays.
    - c. Site use, access, staging, and set-up location limitations, including on-site testing laboratory and sample storage.
    - d. Limitations due to OWNER's use of facility.
    - e. Procedures for concrete rebuild Work, including but not limited to:
      - 1) Removal of unsound and sound concrete.
      - 2) Surface preparation.
      - 3) Coating of exposed reinforcing steel.
      - 4) Installation of supplemental reinforcement.
      - 5) Installation of adhesive-grouted dowels.
      - 6) Rebuild material placement: including but not limited to formwork; proprietary rebuild materials; batching, mixing, and placement procedures; finishing; and curing.
    - f. Approved mockup requirements and procedures.
    - g. Testing and inspection requirements.
    - h. Site protection measures and protection of adjacent surfaces.
    - i. Governing regulations.
  2. CONTRACTOR's site superintendent / foremen, CONTRACTOR's quality control representative, OWNER, ENGINEER, representatives of other trades directly affected by Work and/or other stakeholders shall attend.
- F. Pre-Placement Meeting:
1. Conduct meeting at Project site before concrete placements.
  2. Review requirements for specific concrete rebuild placement, including but not limited to:
    - a. Materials and CONTRACTOR's personnel, equipment, and facilities that will be used for placement.
    - b. Site use, access, and staging.
    - c. Coordination with OWNER's use of facility.
    - d. Procedures for concrete rebuild placement, including but not limited to:
      - 1) Prewetting concrete substrate.
      - 2) Batching, mixing, and placement procedures.
      - 3) Finishing.
      - 4) Curing.
      - 5) Special procedures related to temperature and humidity during placement, finishing, and curing, and thermal/mass concrete effects.
    - e. Testing and inspection requirements.
    - f. Site safety and protection measures, including but not limited to protection of adjacent surfaces.
    - g. Criteria for formwork stripping and shoring removal.
  3. CONTRACTOR's site superintendent / foremen, ENGINEER, OWNER, Quality Assurance Testing and Inspection Representative(s) and representatives of other trades directly affected by Work shall attend.
- G. CONTRACTOR's Quality Control System:



1. CONTRACTOR's quality control system is the means of assurance that construction complies with the requirements of the ENGINEER and/or specification. Controls shall be adequate to cover all construction operations.
  2. Establish a quality control system and perform sufficient inspection and tests of all items of Work, including that of subcontractors, to ensure conformance to the specification for materials, workmanship, construction, finish, functional performance, and identification.
  3. Maintain records of all inspections and tests performed, instructions received from OWNER, ENGINEER or Quality Assurance Inspector(s), and actions taken as a result of those instructions. These records shall include evidence that the required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.), proposed or directed remedial action, and corrective action taken. CONTRACTOR shall document inspections and tests as required by this section.
  4. Testing and Inspection: Include a comprehensive schedule of Work requiring testing or inspection, including the following:
    - a. CONTRACTOR-performed tests and inspections including subcontractor performed tests and inspections. Include required tests and inspections and CONTRACTOR-elected tests and inspections.
    - b. OWNER-performed tests and inspections.
  5. Materials and fabrication procedures are subject to inspection. Tests in the mill, shop, or field shall be conducted by a qualified Inspection Agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
  6. CONTRACTOR shall promptly remove and replace materials or fabricated components that do not comply with the specified requirements.
- H. Field Quality Control and Quality Assurance Testing:
1. Quality Assurance Testing Agency: OWNER or CONTRACTOR (at the request of OWNER) will provide qualified third-party Quality Assurance Testing and Inspection to perform inspections and tests and submit reports during Work. Reports will be provided to OWNER and CONTRACTOR.
    - a. Quality Assurance Testing and Inspection shall be performed, supervised and/or reviewed by a professional engineer licensed in State of Virginia unless otherwise permitted by OWNER.
  2. Sampling of materials shall be in accordance with ASTM C172 and will be performed on grade. Sampling shall generally comply with the following requirements:
    - a. When pumping, the rebuild material will be directed to a wheelbarrow or other suitable means for testing agency to acquire sufficient materials for testing and casting all specimens (approximately 2-1/2 cubic feet).
    - b. Collect first test sample at beginning of placement, and subsequent samples at frequency noted in Table 1 of this Specification.
    - c. Samples from proprietary rebuild material shall be taken from the second batch prepared. If two or more mixers are used, ensure that samples are obtained from mixers in an alternating fashion.
  3. Test Sample Set:
    - a. Six 3-inch diameter by 6-inch long cylinders, or Six 4-inch diameter by 8-inch long cylinders should the coarse aggregate size exceed 3/4 inches will be made and cured in accordance with ASTM C31. The number of required sets shall be in accordance with the Table 1 of this Specification.
    - b. Slump in accordance with ASTM C143.
    - c. For Self-Consolidating Concrete: Slump flow in accordance with ASTM C1611.
    - d. Air content in accordance with ASTM C231
    - e. Concrete and air temperature in accordance with ASTM C1064.
  4. Cylinders will be cured under field conditions for 1 day; then transported to testing laboratory and cured for remaining period until testing.



5. For each test sample set, 2 cylinders will be tested in compression at 3 days, 2 cylinders at 7 days and 2 cylinders at 28 days. Compression tests will be performed in accordance with ASTM C39 and shall be an average of 2 samples at a given age. OWNER may adjust required number of sample test sets and/or frequency of testing upon CONTRACTOR request and/or based on schedule and need.
6. For proprietary rebuild materials, CONTRACTOR shall record material bag weights for minimum of 10 percent of planned bags per lot of material. The average bag weight shall be used to determine amount of water to be used, proportional to manufacturer's product data based on the measured bag weight.
7. Test reports for each test sample will include following information:
  - a. Specimen number.
  - b. Portion of structure represented by material tested.
  - c. Date cast.
  - d. Date tested.
  - e. Slump or slump flow and visual stability index.
  - f. Air content.
  - g. Concrete and air temperature.
  - h. Individual cylinder strength and type of failure.
  - i. Rebuild material strength on product data sheet.
  - j. Notice if test indicates rebuild material does not conform with following criteria:
    - 1) Rebuild material strength will be considered satisfactory if average of two 28-day test results meets or exceeds the specified 28-day strength and neither 28-day test results is below 90% of the specified 28-day strength.
    - 2) Proprietary rebuild materials shall be within 1 inch of the manufacturer's specified slump or slump flow. Rebuild material may be rejected if slump or slump flow not within specified limits or if segregation is visible at leading edge of spread. Manufacturer shall provide slump or slump flow if not reported on typical product data sheet.
  - k. Non-Conforming Rebuild Material:
    - 1) If tests indicate that rebuild material is not in conformance with criteria above, remove and replace non-conforming rebuild material or perform additional testing, acceptable to OWNER and/or ENGINEER, to verify conformance with Specification, at no cost to OWNER.
    - 2) For Additional CONTRACTOR Performed testing:
      - a) Procure core samples in accordance with ASTM C42.
      - b) If tests indicate that slump, air entrainment, or other requirements have not been met, examine core samples petrographically, according to ASTM C856, to evaluate hardened concrete characteristics.
      - c) If compressive-strength tests do not meet acceptance requirements, procure 3 core samples from each portion of structure represented by unsatisfactory tests, and test in compression. Strength of rebuild material in area represented by core tests is satisfactory if average of 3 compressive strength tests equals or exceeds 85 percent of specified 28-day compressive strength and no compressive-strength test value is less than 75 percent of specified 28-day compressive strength. If strength acceptance criteria are not met, remove and replace non-conforming rebuild material areas at no cost to OWNER.
    - 3) Perform additional inspection and testing and inspecting, at no cost to OWNER, to determine compliance of replaced or additional Work with specified requirements.
    - 4) CONTRACTOR is responsible for any schedule delays, costs and related items resulting from non-conforming materials or additional testing of suspected non-conforming materials.
8. Cast additional cylinders to verify rebuild material strength to determine when shoring or formwork may be removed as required. Cast cylinders with final placement of day and field cure adjacent to rebuild location until tested. CONTRACTOR to pay for cost of sampling and testing.

9. CONTRACTOR Responsibilities:
  - a. CONTRACTOR shall Coordinate Work schedule to allow inspections and testing.
  - b. Provide access to Work in timely manner for inspections and testing.
  - c. Record lot numbers, expiration dates, and use dates of materials.
  - d. Maintain record of locations and quantities of Work installed.
10. Inspections:
  - a. Inspections are to be performed at critical steps throughout the rebuild process. Unless indicated otherwise, a qualified Quality Assurance Inspector and/or ENGINEER shall perform inspections.
  - b. CONTRACTOR's Quality Control representative shall perform initial inspections and correct any items not in conformance with specification prior to requesting inspection. Subsequent inspections will be performed if required by the OWNER and/or ENGINEER.
  - c. Do not proceed with Work that may make hold point inspections difficult or impossible to perform until inspection has been completed and deficiencies corrected, unless ENGINEER and/or OWNER waives specific inspection requirements.

### **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and structure.
- B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or which have been exposed to moisture.
- C. Deliver materials to Project site in original, unopened containers, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.
- D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight.
- E. Store aggregate stockpile in manner to avoid segregation or contamination with foreign matter. Store away from normal drainage paths and cover with canvas or plastic if necessary to keep dry.
- F. If containers become torn or otherwise damaged prior to use, dispose of affected materials.
- G. Limit stored materials on structures to safe loading of structure at time materials are stored and to avoid permanent deck deflection.
- H. Conspicuously mark unlabeled, damaged, or opened containers or containers with contaminated materials and remove from site as soon as possible.
- I. Remove and replace materials that cannot be applied within stated shelf life.

### **1.9 SAFETY**

- A. Adhere to requirements herein and applicable requirements within the Contract Documents.
- B. The CONTRACTOR shall ensure OWNER and CONTRACTOR personnel are aware of any hazards peculiar to the jobsite.
  1. Identify location(s) of supplied and/or existing first aid stations, eye wash stations and pertinent safety equipment
  2. Provide contact information of responsible personnel and emergency phone numbers.
  3. Obtain contact information for OWNER stakeholders and pertinent OWNER site personnel.
  4. Determine and communicate evacuation routes.
- C. Keep all work areas clean and safe.

- D. Obey all plant rules and regulations.
- E. Barricade and/or establish appropriate labeled boundaries to prevent entry to Work location by individuals who do not have a business need to enter.
  - 1. Establish appropriate sound and/or material exposure/hazard boundaries *(as required)*.
  - 2. Hang appropriate hazard labels and/or communicate applicable hazards to appropriate OWNER personnel.
  - 3. Ensure appropriate contact information is clearly displayed and/or communicated such that individuals may contact responsible personnel to communicate hazards and/or permit access.
- F. The CONTRACTOR shall conduct all work covered by this section in accordance with all pertinent OSHA regulations.

## 1.10 CHANGES IN WORK

- A. It shall be the responsibility of the CONTRACTOR to notify OWNER of any conflicts, obstructions, discrepancies, damage, deterioration and similar items at variance with the Contract Document content, specifications, instructions, field conditions, weather, etc. that could jeopardize integrity or performance of coating systems promptly upon discovery by means of a formally submitted Request for Information (RFI).
- B. CONTRACTOR shall submit proposed changes relating to Work including but not limited to scope, execution, materials, schedule, etc. to OWNER by means of a formally submitted RFI.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Ready-Mix Concrete Materials:
  - 1. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mixes or field-test data, according to ACI 301.
  - 2. Aggregate and Paste Materials:
    - a. Source Limitations: Obtain each type or class of cementitious material of same brand from same manufacturer's plant, each aggregate from single source.
    - b. Cement: ASTM C150, Type II or V.
    - c. Fly Ash: ASTM C618, Type F. Include 20 to 30 percent by mass of total cementitious materials, as cement replacement, unless otherwise approved.
    - d. Aggregates: ASTM C33, including Table 3; from single source with documented record of at least 10 years of satisfactory service using similar aggregates and cementitious materials in similar applications and service conditions.
      - 1) Coarse Aggregates: Uniformly graded; Maximum size of coarse aggregate per ACI 318 unless noted otherwise; Class 4S.
    - e. Water: ASTM C1602; potable; free from substances known to be harmful to Portland cement; and with less than 0.05 percent chloride ions.
    - f. Maximum Water-Cementitious Materials Ratio, by weight: 0.45.
  - 3. Admixtures:
    - a. General:
      - 1) No more than 0.05 percent chloride ions.
      - 2) Admixture manufacturer shall certify that admixtures meet requirements and are compatible with other concrete mixture components.
      - 3) Use admixtures according to manufacturer's written instructions.
      - 4) No chlorides shall be intentionally introduced into concrete mix.
      - 5) Obtain admixtures from single manufacturer.

- b. Air-Entraining Admixture: ASTM C260. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content recommended by ACI 318 for moderate exposure, unless otherwise indicated. Use one of following:
  - 1) Air Mix, Eucon Air 40; Euclid Chemical Company.
  - 2) Darex AEA ED, Daravair 1000; W. R. Grace & Co.
  - 3) MasterAir AE 200; BASF Corporation.
  - 4) Sika Air; Sika Corporation.
  - 5) Approved Equal
- c. Water-Reducing Admixture: ASTM C494, Type A. Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Eucon WR 75; Euclid Chemical Company.
  - 2) WRDA 20; W. R. Grace & Co.
  - 3) MasterPolyheed 1020; BASF Corporation.
  - 4) Sikament 686; Sika Corporation.
  - 5) Approved Equal
- d. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or Type G. Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Eucon 37; Euclid Chemical Company.
  - 2) Daracem 19; W. R. Grace & Co.
  - 3) MasterRheobuild 1000; BASF Corporation.
  - 4) Sika ViscoCrete 2100; Sika Corporation.
  - 5) Approved Equal
- e. Water-Reducing, Non-Corrosive, Non-Chloride Accelerating Admixture: ASTM C494, Type C or E. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least 1 year duration) using an acceptable accelerated corrosion test method, such as electrical potential measures. Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Eucon AcN 200; Euclid Chemical Company.
  - 2) PolarSet; W. R. Grace & Co.
  - 3) MasterSet FP 20; BASF Corporation.
  - 4) SikaSet NC; Sika Corporation.
  - 5) Approved Equal
- f. Water-Reducing, Retarding Admixture: Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Eucon Retarder 75; Euclid Chemical Company.
  - 2) Daratard 17; W. R. Grace & Co.
  - 3) MasterSet R 100; BASF Corporation.
  - 4) Plastiment ES; Sika Corporation.
  - 5) Approved Equal
- g. Anti-Microbial Admixture: For use in H<sub>2</sub>S and microbial-induced corrosion environments. Shall has documented performance of 10 (min) applications in service for 5 years (min) with minimal-to-no deterioration in H<sub>2</sub>S environments averaging 50ppm (min). Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Con<sup>mic</sup>Shield® HD.
  - 2) Approved Equal.
- h. Crystalline Waterproofing Admixture: Chloride content shall be no greater than 0.1%. Shall be capable of sealing cracks up to 0.4mm. Shall have a minimum 50% reduction in concrete permeability per CRD-C 48. Products that may be incorporated in the work include, but are not limited to, the following:
  - 1) Xypex Admix C-500/C-500 NF; Xypex Chemical Corporation.
  - 2) Crystal-X AdMix; ConShield Technologies Inc.
  - 3) Approved Equal.

- i. Hardening Admixture: Products that may be incorporated in the work include, but are not limited to, the following:
        - 1) Hard-Cem; Kryton International Inc.
        - 2) Approved Equal.
- B. Proprietary Concrete Rebuild Materials:
  - 1. Shall contain no calcium chloride or added gypsum.
  - 2. Water-Cementitious Materials Ratio: 0.45 maximum.
  - 3. Aggregate Materials:
    - a. Aggregates: Use the + No. 170 mesh fraction obtained by wet sieving according to ASTM C1171 for the tests specified in the section titled “Methods of Sampling and Testing” of ASTM C33. If aggregate(s) is added to product as an extender, each additional aggregate is to be tested per ASTM C33 requirements. Pea gravel or other coarse aggregate added as an extension shall meet requirements of Table 3, Class 3S. ASTM C1260 test results for the + No. 170 mesh fraction, as well as each additional aggregate shall be reported to OWNER and/or ENGINEER for approval.
    - b. Obtained from single source with documented record of at least 10 years of satisfactory service using similar aggregates and cementitious materials in similar applications and service conditions; acceptable to proprietary concrete manufacturer.
    - c. Extension of products with aggregate:
      - 1) Pre-packaged material may only be extended in strict accordance with the manufacturer’s guidance.
      - 2) Obtain written verification of product extension requirements from the manufacturer. Submit written verification to OWNER and ENGINEER for approval.
      - 3) Aggregate used for extension shall be clean, rounded, 3/8-inch pea gravel, or as approved by product manufacturer. Aggregate shall be thoroughly washed and/or saturated surface dry as recommended by manufacturer. Aggregates for extension shall meet ASTM C33 requirements including deleterious materials as described below.
      - 4) Maximum aggregate extension shall be in keeping with manufacturer’s recommendations. In no case shall total coarse aggregate content exceed 50 percent of the total rebuild product weight including the aggregate extension.
- C. Compressive Strength:
  - 1. Compressive Strength: 4,000 psi (min).
- D. Concrete Rebuild Mixes:
  - 1. General:
    - a. For applications exposed to H<sub>2</sub>S and microbial-induced corrosion, at least one of the following shall be incorporated into the Work:
      - 1) Incorporate anti-microbial admixture into the concrete rebuild material.
      - 2) Utilize surface applied coatings and/or materials designed to protect concrete surfaces from exposure to H<sub>2</sub>S.
  - 2. Full-depth Rebuilds Cast-in-Place from Top Surface:
    - a. HRSD Mix 1: Ready-mix concrete with low electrical resistivity (less than 15,000 ohm-cm) for use with galvanic anodes.
      - 1) Provide required data and mix design for evaluation.
      - 2) Provide required testing data including electrical resistivity testing data for evaluation.
  - 3. Formed-and-poured partial-depth concrete rebuilds on horizontal, vertical and overhead surfaces:
    - a. HRSD Mix 2: Proprietary silica-fume or polymer-modified concrete or cementitious mortar with 3/8-inch aggregate added, per manufacturer’s recommendations, with high electrical resistivity (greater than 15,000 ohm-cm).
      - 1) Sikacrete 211 SCC Plus; Sika Corporation.

- 2) Eucocrete; Euclid Chemical Company.
  - 3) SikaTop 111 Plus; Sika Corporation.
  - 4) Approved Equal
4. Trowel-applied (drypacked) vertical and overhead partial and shallow-depth rebuilds with lift thickness not to exceed 1-1/2 inches (vertical) / 1-inch (overhead), unless otherwise specified by manufacturer:
    - a. HRSD Mix 3: Proprietary silica-fume- or polymer-modified cementitious, non-sag mortar with high electrical resistivity (greater than 15,000 ohm-cm).
      - 1) SikaTop 123 Plus; Sika Corporation.
      - 2) Verticoat Supreme; Euclid Chemical Company.
      - 3) EucoRepair V100; Euclid Chemical Company.
      - 4) DuralTop Gel; Euclid Chemical Company.
      - 5) Approved Equal
  5. Horizontal shallow-depth rebuilds:
    - a. HRSD Mix 4: Proprietary silica-fume- or polymer-modified cementitious, mortar with low electrical resistivity (less than 15,000 ohm-cm).
      - 1) Concrete-Top Supreme; Euclid Chemical Company.
      - 2) Approved Equal
    - b. HRSD Mix 5: Proprietary silica-fume- or polymer-modified cementitious, mortar with high electrical resistivity (greater than 15,000 ohm-cm).
      - 1) Concrete-Top Supreme; Euclid Chemical Company.
      - 2) Sikacrete 211 SCC Plus; Sika Corporation.
      - 3) Eucocrete; Euclid Chemical Company.
      - 4) SikaTop 111 Plus; Sika Corporation.
      - 5) Approved Equal.
  6. Vertical, overhead and horizontal rebuilds with thickness not to exceed 3/8-inch. For waterproofing and resurfacing.
    - a. HRSD Mix 6: Proprietary crystalline modified Portland cement waterproofing parge coat.
      - 1) Krystol Bari-Cote; Kryton International Inc.
      - 2) Xypex Magamix I; Xypex Chemical Corporation.
      - 3) Vandex Unimortar ZSL; Euclid Chemical Company.
      - 4) Approved Equal.
  7. Vertical, overhead and horizontal rebuilds with thickness between 3/8-inch and 2-inch. For waterproofing and resurfacing.
    - a. HRSD Mix 7: Proprietary crystalline modified Portland cement waterproofing.
      - 1) Xypex Magamix II; Xypex Chemical Corporation.
      - 2) Vandex Unimortar ZSL; Euclid Chemical Company.
      - 3) Approved Equal.
    - b. HRSD Mix 8: Proprietary crystalline modified Portland cement waterproofing for surfaces with exposure to H<sub>2</sub>S and microbial-induced corrosion.
      - 1) Xypex Magamix II with Bio-San; Xypex Chemical Corporation.
      - 2) Approved Equal.
  8. Other Materials and Products:
    - a. Hydraulic Cement: Rapid-setting crystalline hydraulic cement for plugging and sealing active leaks.
      - 1) Krystol Plug; Kryton International Inc.
      - 2) Xypex Patch'N Plug; Xypex Chemical Corporation.
      - 3) Vandex Plug; Euclid Chemical Company.
      - 4) Approved Equal.
    - b. Reinforcing Bars: Grade of reinforcing bars shall be Grade 60 minimum and based on the original design with sizes to match existing unless otherwise shown in Contract Documents.
      - 1) Use ASTM A706 reinforcement where reinforcing bars are welded.

- c. Reinforcing Bar Mechanical Splices: Mechanical butt splices utilizing lock-shear bolts and internal serrated grip rails within the coupling sleeve capable of developing twice the tensile capacity of reinforcing bars. Use one of the following:
  - 1) Standard Reinforcement:
    - a) Lenton Lock B-Series; Erico International Corporation.
    - b) Approved Equal.
  - 2) Epoxy-Coated Reinforcement:
    - a) Lenton Lock B-Series (Epoxy Coated); Erico International Corporation.
    - b) Approved Equal.
- d. Stainless Steel Wire: For shallow-depth rebuild.
  - 1) 16 Gauge Stainless Steel Type 316 for shallow depth concrete rebuild.
- e. Tie Wire: Wire used to secure reinforcing bars during concrete placement.
  - 1) Standard (uncoated) Reinforcing: 16 gauge black annealed wire reinforcing.
  - 2) Epoxy-Coated Reinforcing: 16 gauge PVC coated wire.
- f. Corrosion-Inhibiting Coating Materials: Use material specifically intended for reinforcing steel embedded in concrete; use one of following:
  - 1) Cementitious Coating: Sika Armatec 110 EpoCem; Sika Corporation.
  - 2) Cementitious Coating: Duralprep A.C.; Euclid Chemical Company.
  - 3) Epoxy: Sikadur 32 Hi-Mod; Sika Corporation.
  - 4) Approved Equal.
- g. Adhesive-Grouted Dowels:
  - 1) Dowels:
    - a) ASTM A615, Grade 60, uncoated steel bars, cut true to length with ends square and free of burrs.
    - b) ASTM A276, Type 316 stainless steel threaded rods.
  - 2) Adhesive Grout for Dowels: Tested and evaluated for cracked concrete according to ACI 355.4 or ICC-ES AC308; use one of the following
    - a) HIT-RE 500 V3 Epoxy Adhesive; Hilti, Inc.
    - b) HIT-HY 200 Epoxy Adhesive; Hilti, Inc.
    - c) Approved Equal
- h. Helical Concrete Anchors for shallow depth rebuild:
  - 1) 3/8-inch diameter Heli-Tie Helical Wall Ties; Simpson Strong-Tie Company, Inc.
  - 2) Approved Equal.
- i. Helical Concrete Anchors for core hole rebuild:
  - 1) 1/4-inch diameter Heli-Tie Helical Wall Ties; Simpson Strong-Tie Company, Inc.
  - 2) Approved Equal.
- j. Concrete screws for shallow depth rebuild:
  - 1) 1/4-inch (min) diameter Stainless Steel Type 316.
- 9. Forms:
  - a. Forms for surfaces exposed to view shall be constructed of a new 1-inch, Plyform Grade B-B EXT-APA Class 1 exterior plywood of concrete-form grade or equal. Plywood may be reused for formed surfaces exposed to view as long as it is in good condition. Plywood may be 3/4-inch or less provided it can maintain position and shape and meet the deflection criteria in ACI 347 during placement of the concrete. Steel forms are acceptable for curved surfaces.
  - b. Forms are to provide finish-to-match finish and profile of existing finish of adjacent material.
  - c. The use of form release or form oil is not permitted unless approved by OWNER and/or ENGINEER.
- 10. Curing Materials:
  - a. Moisture-Retaining Cover: ASTM C171, white burlap-polyethylene sheet:
    - 1) Sika UltraCure; Sika Corporation.
    - 2) Approved Equal.
  - b. Water: Potable.



- c. Dissipating Membrane-Forming Curing Compound: ASTM C309, Type 1, 1-D, or 2; VOCs less than 2.9 lbs/gal (350 g/L):
  - 1) Kurez DR VOX; Euclid Chemical Company.
  - 2) Cure R; L&M Construction Chemicals, Inc.
  - 3) 1100-Clear; W.R. Meadows, Inc.
  - 4) Approved Equal.
- d. Solvent-Based Membrane-Forming Curing Compound: ASTM C309, Type 1, Class A & B; ASTM C1315, Type 1, Class A; VOCs less than 2.9 lbs/gal (350 g/L):
  - 1) Super Diamond Clear 350; Euclid Chemical Company.
  - 2) Approved Equal.

## **PART 3 - EXECUTION**

### **3.1 PROJECT CONDITIONS**

- A. Verify existing dimensions and details prior to concrete rebuild Work. Notify OWNER and/or ENGINEER of conditions found to be different than those indicated in the Contract Documents. OWNER and/or ENGINEER will review condition and inform CONTRACTOR of required changes or resolutions.
- B. Environmental Limitations: Install materials at temperatures, humidity, and other environmental conditions recommended by material manufacturer.
- C. Handle and install materials in strict accordance with safety requirements of material manufacturers, Safety Data sheets, and local, state, federal and regulatory requirements.
- D. Maintain adequate ventilation during surface preparation, mixing and placement of materials.

### **3.2 EXAMINATION**

- A. Examine substrates and conditions with representatives of proprietary concrete rebuild manufacturers for compliance with requirements and other conditions affecting performance of concrete rebuild Work.
- B. Ensure that Work done by other trades is complete and ready to receive concrete rebuild material.
- C. Verify that areas and conditions under which concrete rebuild Work is to be performed permit proper and timely completion of concrete rebuild Work.
- D. Notify OWNER and/or ENGINEER in writing of conditions which may adversely affect concrete placement or performance. Do not proceed with concrete placement until these conditions have been corrected and reviewed by OWNER and/or ENGINEER.

### **3.3 PROTECTION**

- A. Protect adjacent surfaces, equipment, utilities, and surrounding site from staining, damage, or debris from concrete rebuild Work.
- B. Restore surfaces and site to condition prior to concrete rebuild Work, to satisfaction of OWNER.

### **3.4 COORDINATION**

- A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate with:
  - 1. OWNER and/or OWNER's designated representative.
  - 2. Other trades with Work in progress to ensure proper sequencing and satisfactory completed construction.
  - 3. Other trades to avoid or minimize Work on, or in immediate vicinity of, concrete rebuild Work in progress. Ensure that Work from other operations will not adversely affect quality of completed installation.

### 3.5 CONCRETE REMOVAL AND SURFACE PREPARATION

- A. Prior to Concrete Removal Work:
  - 1. Develop plan for confining and disposing of broken concrete and other debris from removal Work.
  - 2. Coordinate with OWNER and remove or temporarily shore existing plumbing, mechanical, and/or electrical lines and associated fixtures that interfere with Work. Reattach removed items at completion of Work.
  - 3. Install structural shoring as required and/or specified by Contract Documents OWNER and/or ENGINEER.
- B. Equipment: Use following or approved equal.
  - 1. Pneumatic Chipping Hammers:
    - a. Nominal 30-lb class or less for removal of concrete at rebuild areas.
    - b. Nominal 15-lb class or less for detail work adjacent to and beneath reinforcing steel.
  - 2. Saws capable of cutting concrete to specified depth.
  - 3. Abrasive blasting equipment capable of removing and cleaning laitance, dirt, loose pieces of concrete, and surface contaminants from exposed concrete surfaces and rust, concrete, and surface contaminants from exposed steel surfaces.
  - 4. High-pressure, oil-free compressed air equipment capable of removing dust and dirt from exposed concrete removal areas.
- C. Sound concrete surfaces with hammer, chain, reinforcing bar, or similar metal object; and mark areas of unsound concrete.
- D. For partial depth rebuild, remove unsound concrete and, as necessary, sound concrete to create minimum removal depth of 1-inch behind all exposed reinforcing bars as shown in Drawing 00-30 *{Engineer to specify}* and Drawing 00-33 *{Engineer to specify}*. Refer to ICRI Technical Guideline No. 310.1R. Reinforcing bars shall be considered exposed if 25 percent of the surface area is visible along any given 1 foot length.
  - 1. Exercise care to avoid cracking underlying sound concrete, punching through member, or damaging embedments such as utilities or conduit.
  - 2. Limit chipping hammer size and impact angle to minimize damage to sound concrete. Impact angle shall be no more than 60 degrees to surface.
- E. Concrete Removal Geometry:
  - 1. Slope removal of substrate to avoid abrupt changes in removal thickness.
  - 2. Where possible, make removal area rectangular in shape in plan (for top- and overhead-surface rebuilds) and elevation (for vertical-surface rebuilds).
  - 3. Remove concrete at a 45-degree-angle to eliminate re-entrant corners.
  - 4. Extend concrete removal at least 4-inches beyond edge of unsound concrete.
  - 5. Create rounded or square edges at removal areas by core-drill or sawcut. Provide 1-inch minimum depth at top surface removal areas. Adjust depth of sawcut to avoid sawing into reinforcing steel, embedded electrical conduits, or other embedments.
- F. Notify OWNER and/or ENGINEER of embedded electrical conduit, utilities or similar encountered in removal areas. Proceed as directed by OWNER and/or ENGINEER. Unless otherwise directed, remove abandoned embedded materials in removal area.
- G. Inspect and sound concrete surfaces in and around removal areas. Remove additional unsound concrete and concrete contaminated with oil or other materials. Sawcut, or core-drill, and chip removal area perimeter and corners as necessary to provide square configuration. Limit abrupt changes in geometry to prevent re-entrant corners.
- H. Abrasive blast clean surfaces of removal area, including vertical edges, to remove surface contaminants, loose pieces of concrete, and concrete that is bruised or micro-fractured and to roughen surfaces. Clean removal area surfaces with dry, oil-free compressed-air jet.

- I. Test and record substrate pH using pH indicating papers. pH testing frequency should be performed once every 100 square feet of surface area to be coated.
  1. For dry substrate spray the surface lightly with distilled, de-ionized water from a commercially available spray bottle that has been properly rinsed to preclude any dissolved solids. The spray shall wet the surface to a "shiny" appearance and water shall not run down the wall. Wait 60 seconds to allow chemical equilibria to be established and then test the pH of the water on the surface.
    - a. The selected preparation and cleaning method must produce a concrete surface pH of 8.0 to 11.0. If after surface preparation, the surface pH remains below 8.0, perform additional waterblasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
- J. Achieve final surface profile of CSP 7 or higher according to ICRI Guideline No. 310.2.

### **3.6 REINFORCEMENT PREPARATION**

- A. Leave existing reinforcing in place unless otherwise directed by OWNER and/or ENGINEER.
- B. Notify OWNER and/or ENGINEER of reinforcing bars that are incorrectly located or have less than 2 inches of concrete cover; damaged; fractured; or have lost more than 10 percent of their original cross-sectional area at any point. OWNER and/or ENGINEER will determine if remedial action is required.
- C. Abrasive blast clean exposed steel surfaces, including but not limited to existing reinforcement and embedments, to SSPC-SP 6/NACE No. 3 (SSPC Painting Manual, Volume 2), Commercial Blast Cleaning, finish, with minimal rust or concrete debris. Clean steel surfaces with dry, oil-free compressed-air jet. Exercise care to clean undersides of reinforcing bars.
- D. Prior to placement, reinforcement shall be free of materials deleterious to bond.
- E. Place, support, and fasten reinforcement as indicated in Contract Documents and/or by OWNER and/or ENGINEER. Do not exceed tolerances specified in ACI 117.
- F. Unless otherwise specified, concrete cover for reinforcement shall conform to Table 2 of this Specification. Concrete cover tolerances shall comply with ACI 117. Position tie ends away from exposed surfaces. Build out concrete rebuild as needed to achieve minimum cover.
- G. Unless otherwise permitted, furnish and use templates for placement of column dowels.
- H. Field bending or straightening: When permitted, bend, or straighten reinforcing bars embedded in concrete (black steel only). Reinforcing bar sizes No. 3 through 5 may be bent cold the first time, provided bar temperature in above 32°F. For other bar sizes, preheat reinforcing bars before bending.
- I. Preheating: Apply heat by methods that do not harm reinforcing bar material or cause damage to concrete. Preheat length of reinforcing bar equal to at least five bar diameters in each direction from center of bend but do not extend preheating below concrete surface. Do not allow temperature of reinforcing bar at concrete interface to exceed 500°F. Preheat temperature of reinforcing bar shall be between 1100 and 1200°F. Maintain preheat temperature until bending or straightening is complete. Unless otherwise permitted, measure preheat temperature by temperature measurement crayons or contact pyrometer. Do not artificially cool heated reinforcing bars until bar temperature is less than 600°F.
- J. Field cutting reinforcement: Field cut reinforcement only when specifically permitted using cutting methods specified by or acceptable to OWNER and/or ENGINEER.
- K. Reinforcement through expansion joint: Do not continue reinforcement or other embedded metal items through expansion joints, unless permitted and/or specified by OWNER and/or ENGINEER.

- L. Apply 2 coats of corrosion-inhibiting material on exposed steel surfaces. Corrosion-inhibiting material not required for embedded steel items that are galvanized or otherwise coated with a corrosion-inhibiting coating. Protect existing galvanized and/or coated embedded items during abrasive blasting.
  - 1. Batch, mix, and apply material according to recommendations of material supplier.
    - a. Minimum dry film thickness: 10 to 12 mils.
  - 2. Exercise care to coat difficult-to-reach surfaces, such as undersides of reinforcing bars.
  - 3. Minimize spillage on concrete surfaces. Remove materials that will act as bond breaker by chipping or other means.
- M. Provide and install supplemental reinforcement as specified herein or as directed by Contract Documents and/or OWNER and/or ENGINEER.
  - 1. Where existing reinforcement has lost 10 percent or more of its original cross-sectional area, add supplement bars of same size as existing bars, unless smaller sized bars are approved by OWNER and/or ENGINEER. An engineering analysis may be performed to determine if repairs are needed.
    - a. Develop supplement reinforcement by lap splice with existing bars, as shown in Drawing 00-36 and 00-37 *{Engineer to specify}*. If lap splices are not feasible, develop with mechanical reinforcing bar splices, as shown in Drawing 00-38 and 00-39 *{Engineer to specify}*. If mechanical splices are not feasible, notify OWNER and/or ENGINEER and, if approved by OWNER and/or ENGINEER, develop by welding supplement bars to existing bars using approved WPS and as shown in Drawing 00-40, 00-41 and 00-42 *{Engineer to specify}*.
  - 2. Where existing reinforcement is located 3-inches or more below the concrete surface, or is spaced further apart than 12-inches, add supplemental No. 3 bars in both directions with 2 inches minimum of clear cover to result in maximum spacing between fully exposed bars of 12-inches, as shown in Drawing 00-43 *{Engineer to specify}*.
    - a. Secure outer layer of supplemental No. 3 bars with adhesive-grouted stainless steel threaded rods at 12-inches maximum on center, as shown in Drawing 00-43 and 00-44 *{Engineer to specify}*.
  - 3. Remove additional sound concrete to properly position bars with minimum concrete and full encasement by rebuild material; and to develop supplemental reinforcement beyond areas of deteriorated existing bars. At welded splices, expose full circumference of existing reinforcing bars for at least 3-inches beyond weld.
- N. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- O. Do not weld reinforcement unless specifically approved by OWNER and/or ENGINEER.
- P. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

### 3.7 EMBEDDED ITEMS

- A. Place and secure items to be embedded in concrete rebuild placement including, but not limited to, discrete galvanic anodes.
- B. For concrete rebuilds adjacent to existing embed plates, extend rebuild behind edge of embed plate as shown in Drawing 00-45 *{Engineer to specify}*. Clean and coat plate surfaces with corrosion inhibiting material. Do not extend demolition behind embed plate greater than 1-inch without approval of OWNER and/or ENGINEER.

### 3.8 INSTALLATION OF ADHESIVE-GROUTED STEEL DOWELS

- A. Equipment:
  - 1. Percussive or rotary drilling equipment for making holes in concrete substrate for dowel installation.

- B. Dowels:
  - 1. Install dowels at locations and in sizes specified in Contract Documents or as directed by OWNER and/or ENGINEER.
  - 2. Dowels to be installed in the adhesive shall be clean, oil-free, and free of loose rust, paint, or other coatings.
  - 3. Install in concrete removal areas on vertical and overhead surfaces that do not include exposed reinforcing bars, as shown in Contract Documents or as directed by OWNER and/or ENGINEER and shown in Drawing 00-44 *{Engineer to specify}*, to mechanically anchor rebuild material. Install dowels in 12-inch grid pattern.
- C. Remove unsound concrete and install dowels in sound concrete.
- D. Install dowels in accordance with adhesive manufacturer.
- E. Dry drill holes with rotary impact hammer drill or rock drill perpendicular to concrete surface.
  - 1. Locate existing reinforcement and embedded items with reinforcing bar locator and position holes to avoid existing reinforcement.
  - 2. Do not damage existing reinforcement.
  - 3. Make hole diameter at least 1/8-inch larger than dowel diameter, unless otherwise recommended by adhesive manufacturer.
- F. Clean holes with stiff brush and dry, oil-free compressed-air jet to remove loose concrete, dust, and debris.
- G. Inject adhesive with tube into back of hole and fill hole to front, withdrawing tube.
  - 1. Unless otherwise indicated by manufacturer, adhesive shall be dispensed through a tube or cartridge extension, beginning at the maximum depth of the hole and withdrawn as adhesive is injected, followed by insertion and rotating the dowel to the specified depth. Where necessary, spaces around anchors at the surface shall be sealed at horizontal to vertical overhead locations to prevent loss of the adhesive during curing.
  - 2. Carefully proportion and mix 2-part epoxies according to manufacturer's directions. Scrape out entire contents of both containers to assure accurate proportions.
  - 3. Mix adhesive for approximately 3 minutes with paint stirrer attached to low speed (400 to 600 rpm) electric or pneumatic drill, unless otherwise specified by manufacturer. Move stirrer up and down and around sides of mixing container until even, streak-free color is attained. Do not whip in air.
  - 4. Install sufficient material to completely fill annular space around dowel.
- H. Insert dowel to bottom of hole and secure in center of hole, perpendicular to surface, until adhesive has set. Provide 2-inch minimum clear cover from concrete surface.
- I. Promptly remove excess adhesive.
- J. Apply 2 coats of corrosion-inhibiting material on exposed steel surfaces. Corrosion inhibiting material not required for embedded steel items that are galvanized or otherwise coated with a corrosion-inhibiting coating.

### 3.9 SHALLOW DEPTH REBUILD PROCEDURE

- A. For rebuilds less than 2-inches deep with no exposed reinforcing steel, perform shallow depth concrete rebuild as shown in Drawing 00-46 and 00-47 *{Engineer to specify}*.
- B. Wet substrate thoroughly and then remove standing water.
- C. Place shallow-depth rebuild materials by troweling toward edges of rebuild area to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch.
- D. For vertical patching, place material in lifts of not more than 1-1/2 inches or less than 1/4 inch. Do not feather edge.

- E. For overhead patching, place material in lifts of not more than 1 inch or less than 1/8-inch. Do not feather edge.
- F. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
- G. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth surface with a wood or sponge float.
- H. If 25 percent or more of the surface area of the reinforcement is exposed along a 1-foot length, remove concrete to a depth of 1-inch behind reinforcing bar and perform partial depth rebuild.

### 3.10 CORE HOLE REBUILD PROCEDURE

- A. For rebuild at concrete core holes, perform concrete rebuild as shown in Drawing 00-48 and 00-49 *{Engineer to specify}*.
- B. Surface preparation:
  - 1. Depth of core hole shall extend at least 2 inches from surface of concrete.
  - 2. Surface of core hole shall be cleaned of dust, dirt, oil, or other contaminants that may inhibit proper bonding of rebuild materials.
  - 3. Cleaning shall be by wire brushing followed by water flushing. Remove all excess water with compressed air free of suspended oils to provide a saturated surface-dry condition.
  - 4. The wire brushing shall be aggressive enough to roughen the surface of the core hole and provide an open pore structure.
- C. Supplemental mechanical anchorage:
  - 1. Install 2 helical concrete anchors, per anchor manufacturer's recommendations, at each core hole. If core hole is full depth through wall thickness 12-inches or greater, install 4 helical anchors, two from each face.
  - 2. Drill angled pilot hole through the core hole.
  - 3. Install anchor with hammer drill.
  - 4. Recess anchor to a 1/2-inch depth, seal surface penetration with an approved epoxy.
- D. Select rebuild material based on depth and orientation of core using concrete rebuild mixes specified herein.
- E. Place rebuild material in accordance with specifications herein and material manufacturer's instructions.

### 3.11 FORMWORK

- A. Formwork shall be in accordance with applicable provisions of ACI 347. Forms shall be of wood, metal, structural hardwood or other suitable material that will produce the required surface finish.
- B. Construct formwork so final appearance and shape of rebuild material matches adjacent existing concrete, and so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
  - 1. Limit abrupt or gradual concrete surface irregularities to ACI 347 Class C, 1/2-inch.
  - 2. Provide 3/4-inch chamfer at exterior corners and edges of permanently exposed concrete.
  - 3. Construct forms tight enough to prevent loss of concrete mortar.
- C. Notify OWNER and/or ENGINEER of rebuilds on overhead and vertical surfaces where reinforcement has less than 2 inches of clear cover. Form and build-out rebuild surface to provide 2 inches minimum of clear cover, as shown in Figure 3 *{Engineer to specify}*, unless otherwise directed by OWNER and/or ENGINEER. Chamfer edges of build-out.

- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Do not allow metal tools to come into contact with concrete surfaces. Kerf wood inserts for forming keyways, reglets, and recesses, for easy removal.
- E. Arrange form ties such that metal is at least 2 inch below concrete surfaces exposed to weather. Lugs, cones, washers, and other devices shall not leave depression or hole larger than 2 inches in diameter.
- F. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical (1.5:1).
- G. Do not use form-release oil unless approved by OWNER and/or ENGINEER.
- H. Provide temporary openings for cleanouts, air relief holes, and inspection ports as required. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations. Rebuild all cored air relief holes as specified herein.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris immediately before placing concrete.
- J. Retighten forms and bracing before placing concrete to prevent mortar leaks and maintain proper alignment.
- K. Removing and Reusing Forms: Formwork, for sides of beams, walls, columns, and similar parts of Work, that does not support weight of concrete, may be removed after cumulatively curing at not less than 50 degree F for 24 hours after placing concrete, provided concrete is hard enough not to be damaged by form-removal operations and provided curing and protection operations are maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of 28-day design compressive strength.
  - 2. Clean and repair surfaces of forms to be reused in Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material, or patched forms, for exposed surfaces.

### 3.12 MIXING AND PLACEMENT

- A. Concrete Mixing:
  - 1. Ready- Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94.
    - a. Deliver concrete to Site and discharge within 90 minutes or before 300 revolutions of mixer drum, whichever comes first, after introduction of mix water. Concrete that exceeds specified time limit will be rejected without prior approval from OWNER and/or ENGINEER. Alternate mixing or discharge times, may be approved by the OWNER and/or ENGINEER depending on the approved mix design and the environmental conditions during placement.
    - b. Temperature: If the measured concrete temperature at delivery is not within the limits specified below or as otherwise specified, a check test will be performed immediately at a new location in the sample. If the check test fails, the concrete is considered to have failed to meet the requirements of this Specification.
    - c. Concrete temperature: When the average of the highest and lowest ambient temperature from midnight to midnight is expected to be less than 40°F for more than three successive days, deliver concrete to meet the following minimum temperatures immediately after placement:
      - 55°F for sections less than 12 in. in the least dimension
      - 50°F for sections 12 to 36 in. in the least dimension
      - 45°F for sections 36 to 72 in. in the least dimension
      - 40°F for sections greater than 72 in. in the least dimension



The temperature of concrete as placed shall not exceed these values by more than 20°F. These minimum requirements may be terminated when temperatures above 50°F occur during more than half of any 24-hour duration. Unless otherwise specified or permitted by OWNER and/or ENGINEER, the temperature of concrete as delivered shall not exceed 95°F.

- d. Do not add water-reducing or high-range, water-reducing admixture indiscriminately to increase slump.
  - e. Introduce high-range, water-reducing admixture at Site with additional mixing per manufacturer's recommendations.
  - f. Reject concrete that arrives at Site with slump exceeding maximum specified slump.
2. Project-Site Mixing: Measure, batch, and mix concrete materials according to manufacturer's written instructions and ASTM C94.
- a. Develop batching and mixing operations so that quality control is assured.
  - b. Designate one or two individuals to batch and mix concrete. Fully instruct these individuals on batching and mixing procedures.
  - c. Maintain accurate mix proportions. Batch materials by weight on basis of whole bags of proprietary material. Maintain calibrated scale at site during concrete placement operations. Batching by volume is permitted if weight-volume relationship for each material is verified on daily basis, and aggregate moisture content is measured at least once daily and aggregate volume is adjusted for bulking.
  - d. Combine and mix ingredients to uniform consistency.
  - e. Mix concrete materials in appropriate paddle-type mortar/plaster mixer(s) in lieu of volumetric-type mixer(s), unless otherwise permitted by OWNER and/or ENGINEER.
    - 1) For mixer capacity of 1 cubic yard or smaller, mix at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer.
    - 2) For mixer capacity larger than 1 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
    - 3) Provide sufficient number of mixers, including reserve mixers, so that concrete placement operations will proceed uninterrupted, and each area is completely cast before material achieves initial set.
- B. Concrete and Mortar Placement, General:
1. Reference Drawing 00-31 *{Engineer to specify}* for typical section showing concrete rebuild placement.
  2. Use bonding procedure recommended by material manufacturer.
    - a. If saturated-surface-dry condition is required, soak concrete surface at least 4-hours prior to concrete or mortar placement.
  3. Convey concrete from mixer to place of deposit in manner such that no segregation or loss of materials occurs. If pumping, minimize length of pipeline.
  4. Place concrete continuously until rebuild section is completed, with no cold joints.
    - a. Do not allow concrete to disturb or displace reinforcing bars, floor drains, or other embedments.
    - b. Dispose of concrete that has partially set prior to placement or that has been contaminated by foreign material.
- C. Concrete Placement, Top- and Vertical-Surface Rebuilds:
1. Place concrete as near as possible to its final position to avoid segregation due to re-handling or flowing.
  2. Avoid or minimize vertical fall. Do not allow concrete to fall vertical distance greater than 4-feet from point of discharge to point of deposit.
  3. Place concrete at rate so that concrete is plastic and flows readily into corners of forms and into spaces around reinforcing bars.
  4. Consolidate concrete in accordance with requirements herein, except for self-consolidating concrete and unless otherwise specified by material manufacturer.

- a. Concrete shall be consolidated by mechanical vibrators. The vibrators shall be internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all concrete as specified in ACI 309. The frequency shall be not less than 8000 cycles per minute when the vibrator is submerged in concrete.
  - b. The duration of vibration shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation. In consolidating each layer of concrete, the vibrator shall be operated in a near vertical position, be inserted at uniformly spaced locations no farther apart than the visible effectiveness of vibrator and the vibrating head shall be allowed to penetrate under the action of its own weight.
  - c. Do not use vibrators to transport concrete.
  - d. If internal vibrators will not fit in formed rebuild void, external vibration of forms is permitted.
- D. Concrete Placement, Overhead Rebuilds:
1. Place concrete as near as possible to its final position.
  2. Consolidate concrete with metal rod, taking care to fill corners and around reinforcing bars and to avoid segregation.
- E. Mortar Placement, Trowel-Applied Rebuilds:
1. Apply mortar firmly with trowel.
  2. Place mortar in lifts if recommended by material manufacturer. Where multiple lifts are used, score surface of lift with trowel to roughen surface for application of subsequent lift. Allow lift to reach final set before placing subsequent lift.
  3. Allow surfaces to remain exposed to become firm and then finish to smooth surface with wood or sponge float.
- F. Cold-Weather Placement:
1. Protect concrete work from physical damage or reduced strength due to frost, freezing, or low temperatures. Comply with ACI 306R and as follows.
    - a. When air temperature has fallen or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement. Mix water and aggregates together before adding cement. Do not add cement if temperature of water/aggregate mixture exceeds 70 degrees F.
    - b. Do not use frozen materials or materials containing ice or snow.
    - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix design.
- G. High Evaporation Conditions:
1. When high evaporative conditions necessitate protection of concrete immediately after placing or finishing, make provisions in advance of concrete placement for windbreaks, shading, fogging, sprinkling, ponding, or wet covering.
- H. Hot-Weather Placement
1. Protect concrete work from physical damage or reduced strength due to rapid evaporation or overheating of concrete. Refer to ACI 305R for hot-weather conditions that may adversely affect concrete placement, finishing, and curing. Do not allow temperature of concrete at time of placement to exceed 95 degrees F. When hot-weather conditions exist, use 1 or more of following procedures:
    - a. Place concrete at night or early in morning.
    - b. Cool ingredients before mixing to maintain concrete temperature below 95 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature; include water equivalent of ice in mixing water quantity. Use liquid nitrogen to cool concrete at CONTRACTOR's option.
    - c. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

- d. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
  - e. Provide windbreaks or sunshades, or both.
  - f. Cool pump pipelines by shading, running cool water over, or other means as necessary.
- I. Mass Concreting
- 1. Protect concrete work from physical damage or reduced strength due to thermal effects of mass concreting, per ACI 207.1R.

### 3.13 FINISHING AND CURING

- A. Finishing Top Surfaces:
- 1. Float and broom finish:
    - a. Float finish: Consolidate surface with power-driven float or by hand floating if area is small or inaccessible to power driven float. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with uniform, smooth, granular texture.
    - b. Medium-Broom Finish: Apply medium-broom finish, perpendicular to traffic flow, on top surfaces subjected to vehicular or pedestrian traffic.
    - c. Do not wet concrete surfaces or add cement.
  - 2. Tined Finish:
    - a. Texture and tine freshly placed pavement as soon as possible after floating.
    - b. Use a rake with individual 1/8-inch wide tines spaced uniformly 5/8-inches on center. For machine work, use a 10-foot rake drawn transversely across the full pavement width without overlapping passes.
  - 3. Float and trowel finish:
    - a. Float finish: Consolidate surface with power-driven float or by hand floating if area is small or inaccessible to power driven float. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with uniform, smooth, granular texture.
    - b. Trowel finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
    - c. Do not wet concrete surfaces or add cement.
  - 4. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
  - 5. Hot-Weather Conditions: Fog surface with water if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour, as estimated by Figure 4.2 in ACI 305R, before or during finishing operations.
- B. Finishing Formed Surfaces:
- 1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas addressed. All fins, runs, drips or projections shall be removed from surfaces which remain exposed. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing. Remove fins and other projections exceeding 1/2-inch.
- C. Concrete Curing:
- 1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete above 55-degree F and in moist condition for at least 7 days after placing.
    - a. For polymer-modified and silica-fume-modified materials, follow curing regimen recommended by manufacturer or developed in preconstruction testing.
    - b. Protect concrete from falling below 55 degrees F with insulating blankets or heated enclosures.

2. Unformed Top Surface: Begin curing immediately after finishing concrete. Use water-saturated, moisture-retaining cover, or other approved procedures.
    - a. Place cover in widest practicable width, with sides and ends lapped at least 12-inches.
    - b. Seal sides and ends of cover by holding down with soil, concrete pieces, or some other weight, or by using waterproof tape or adhesive.
    - c. Immediately repair holes or tears in cover during curing period using cover material and waterproof tape.
    - d. Re-wet concrete surface at least twice daily as necessary to ensure that surface remains moist.
  3. Unformed Vertical and Overhead Surfaces: Apply 2 coats of curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions and recommended coverage rate. Recoat areas subjected to heavy rainfall within 3-hours after initial application. Maintain continuity of coating and repair damage during curing period.
  4. Formed Surfaces:
    - a. Maintain form surfaces in moist condition.
    - b. Moist cure concrete after forms are stripped to achieve 7-day total cure period.
- D. Stripping of Forms and Removal of Shoring:
1. Strip forms 24-hours minimum after concrete is placed unless otherwise directed by Contract Documents, OWNER and/or ENGINEER.
  2. Remove shoring 24-hours minimum after concrete is placed and after rebuild concrete has achieved minimum compressive strength of 75 percent of the specified 28-day compressive strength, unless otherwise directed by Contract Documents, OWNER and/or ENGINEER.

### **3.14 DEFECTIVE CONCRETE REBUILD**

- A. Rebuild defective areas designated by OWNER and/or ENGINEER. Remove and replace concrete that cannot be repaired to satisfaction of OWNER and/or ENGINEER.
- B. Surface defects on exposed surfaces include:
  1. Voids, such as spalls, air bubbles, honeycomb, rock pockets, and form-tie voids, more than 1/2-inch in any dimension in solid concrete but not less than 1 inch deep.
  2. Cracks at least 1/8 inch wide. Notify OWNER and/or ENGINEER of cracks that penetrate through section.
  3. Fins and other projections exceeding 1/2-inch.
  4. High or low spots in repaired areas that create areas of standing water that are at least 1/2-inch deep and at least 9 square feet in area.
- C. Rebuild defects on concealed surfaces that affect concrete's durability and structural performance as determined by OWNER and/or ENGINEER.
- D. As soon as possible, cut out spalls, air bubbles, honeycombs, rock pockets, and voids. Make edges of cuts perpendicular to concrete surface. Clean voids and fill with rebuild mortar according to manufacturer's recommendations. Use polymer- or silica fume-modified, cementitious, non-sag mortar that is specifically intended for this application. Use one of following:
  1. SikaTop 123 Plus; Sika Corporation.
  2. Verticoat Supreme; Euclid Chemical Company.
  3. Approved Equal.
- E. Fill cracks with high-molecular-weight methacrylate or low-viscosity methyl methacrylate. Use one of following:
  1. SikaPronto 19 TF; Sika Corporation.
  2. Approved Equal.
- F. After concrete has gained sufficient strength to be unaffected by grinding, grind off fins, other projections, and high areas.

### **3.15 CLEANING**

- A. Remove and legally dispose of concrete and steel debris, abrasive blast materials, and excess materials.

3.16 TABLES

**TABLE 1: QUALITY CONTROL TESTING**

Rebuild Material	Quality Assurance Testing	Quality Control Material Testing				
	Compression Strength (ASTM C39)	Slump (ASTM C143) or Slump flow (ASTM C1611)	Unit Weight (ASTM C138)	Air Content (ASTM C231)	Concrete and Air Temp (ASTM C1064)	Additional Items (1/placement or material type)
Proprietary Rebuild Material	1 set / 75 cu. ft. 1 set = 6 cylinders (2 - 3 days, 2 - 7 days, 2 - 28 days)	1 test / placement 1 test / material	1 test / placement 1 test / material	1/placement 1/material	1 test /placement 1 test / material	Lot number Powder/water temp Weight of product bag Weight of water Mix time
Ready-Mix Rebuild Material	1 set / 20 cu. yd. min* 1 set = 6 cylinders (2 - 3 day, 2 - 7 days, 2 - 28 days)	1 test / truck*	1test / truck	1 test / truck	1 test / truck	Mix number Batch number Water added*

\* 1 additional set/test for each time water is added to mix on-site

**Table 2: Concrete Cover for Reinforcement**

<b>Reinforcement Type</b>	<b>Min. Cover (inches)</b>
A. Floor slabs and walls not exposed to weather and not in contact with the ground, and not at surfaces exposed to water.	
1.) No. 11 bars or smaller	3/4
2.) No. 14 and No. 18 bars	1-1/2
B. Beams, girders and columns principal reinforcement, ties, stirrups or spirals not exposed to weather or water	1-1/2
C. Formed concrete exposed to weather or at surfaces exposed to water	
1.) No. 5 bars and smaller	1-1/2
2.) No. 6 bars and larger	2
D. Unformed concrete in contact with soil above water table	3
E. Formed concrete in contact with soil above water table	2
F. Unformed concrete in contact with soil below water table	4
G. Formed concrete in contact with soil below water table	3



### 3.17 DRAWINGS

A. The following figures represent typical or representative conditions and may not be indicative of in-situ conditions. The ENGINEER should review the conditions as necessary for applicability.

*{Engineer to review Series 600 of Standard Details in Section 34 of HRSD Design and Construction Standards for applicability and inclusion}*

1. Standard Detail 626: Removal of Unsound Concrete – Typical Section
2. Standard Detail 627: Concrete Rebuild – Typical Section
3. Standard Detail 628: Concrete Rebuild to Provide Minimum Cover – Typical Section
4. Standard Detail 629: Removal of Unsound Concrete – Typical Corner Section
5. Standard Detail 630: Concrete Rebuild – Typical Corner Section
6. Standard Detail 631: Reinforcing Section Loss Table
7. Standard Detail 632: Lap Splice Plan – Option 1
8. Standard Detail 633: Lap Splice Lengths – Option 1
9. Standard Detail 634: Mechanical Splice – Option 2 (Typical Removal Section)
10. Standard Detail 635: Mechanical Splice – Option 2 (Typical Rebuild Section)
11. Standard Detail 636: Weld Splice – Option 3
12. Standard Detail 637: Weld Splice Details – Option 3
13. Standard Detail 638: Weld Splice Details – Option 3
14. Standard Detail 639: Supplemental Reinforcement Requirements
15. Standard Detail 640: Adhesive-Grouted Dowel Layout
16. Standard Detail 641: Typical Concrete Rebuild Section at Embed Plate
17. Standard Detail 642: Shallow Depth (2" Max.) Concrete Rebuild – Horizontal
18. Standard Detail 643: Shallow Depth (2" Max.) Concrete Rebuild – Vertical
19. Standard Detail 644: Partial-Depth Core Hole Concrete Rebuild
20. Standard Detail 645: Full-Depth Core Hole Concrete Rebuild

END OF SECTION