



The FRP Retrofit Experts

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DIVISION 03 – CONCRETE

03 30 12 – CAST-IN-PLACE CEMENTITIOUS AND EPOXY GROUT AND CELLULAR CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. This section applies for all placement of concrete (grout) associated with QuakeWrap manufactured and patented systems, such as PileMedic[®], SPiRe[®] and StifPipe[®] systems AND other FRP encasement/jacketing systems. See specifications for these systems for additional information and requirements. Concrete and grout terminology are used throughout this specification and are interchangeable as they apply to standards, testing, use and requirements. See Contract Documents for additional information and requirements.
- B. The work covered in this section includes the following materials:
 - 1. Cementitious flowable grout
 - 2. Epoxy grout
 - 3. Cellular concrete
- C. The work covered in this specification includes, but is not limited to, grout placement, non-shrink pressure grouting, surface preparation, and grout curing.

1.2 REFERENCES

- A. The latest edition and addenda of the following publications in effect on the date of Contract Award are part of this Specification and, where referred to by title or basic designation only, are applicable to the extent indicated by the specific reference:
 - 1. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
 - AASHTO R80 Reactivity of Concrete Aggregates and Selecting Appropriate Preventing Deleterious Expansion in New Concrete Construction
 - AASHTO T259 Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration

AASHTO T358	Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration
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2. AMERICAN CONCRETE INSTITUTE (ACI)

ACI 121	Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 117	Specifications for Tolerances for Concrete Construction Materials
ACI 201.2R	Guide to Durable Concrete
ACI 211.1	Standard Practice for Selecting Proportions of Normal, Heavyweight and Mass Concrete
ACI 214	Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 304.2R	Placing Concrete by Pumping Methods
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 309	Guide for Consolidation of Concrete
ACI 311.4	Guide for Concrete Inspection
ACI 318	Building Code Requirements for Structural Concrete
ACI 347R	Guide to Formwork for Concrete
ACI 563	Specification for Repair of Concrete in Buildings
ACI SP-66-04	ACI Detailing Manual

3. AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Hardware
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A884	Standard Specification for Epoxy Coated Steel Wire and Welded Wire Fabric for Reinforcement
ASTM A1064	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Ready-Mixed Concrete
ASTM C138	Test Method for Density, Yield, and Air Content of Concrete
ASTM C143	Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C172	Practice for Sampling Freshly Mixed Concrete
ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C233	Standard Test Method for Air-Entraining Admixtures for Concrete

ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C289	Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C294	Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C307	Standard Test Methods for Tensile Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing
ASTM C441	Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494	Chemical Admixtures for Concrete
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM C566	Standard Test Method for Total Moisture Content of Aggregate by Drying
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C796	Standard Specification for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C869	Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete

ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM C1157	Performance Specification for Hydraulic Cement
ASTM C1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM D25	Standard Specification for Round Timber Piles
ASTM D512	Standard Test Methods for Chloride Ion in Water
ASTM D516	Standard Test Method for Sulfate Ion in Water
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D1179	Standard Test Methods for Fluoride Ion in Water
ASTM D1339	Methods of Test for Sulfate Ion in Water
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D3867	Standard Test Methods for Nitrite-Nitrate in Water
ASTM D4791	Standard Test Method for Flat or Elongated Particles in Coarse Aggregate
ASTM E329	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

4. CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	Manual of Standard Practice
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5. U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C39	Test Method for Coefficient of Linear Thermal Expansion of Concrete
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COE CRD-C61

Test Method for Determining the
Resistance of Freshly Mixed Concrete to Washing Out in Water

6. SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SP WJ-2

Surface Preparation and Cleaning of Metals by Water Jetting

7. AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

UC5A

Salt or Brackish Water and Adjacent Mud Zone (Northern
Waters)

1.3 SUBMITTALS

A. Comply with pertinent provisions of the Project Master Specification and Submittal requirements.

B. Cementitious Grout (Ready-mix or pre-mixed bagged grout):

1. Product Data

- i. Description of proposed admixtures including anti-washout and corrosion inhibitors
- ii. Spacers for placement of reinforcing steel
- iii. Anchoring system for securing reinforcing dowels into existing concrete extensions or encasements
- iv. Quick connection adapter for end of pump hose and pumping ports
- v. Cementitious dry pack (repair/patching material)
- vi. Cementitious repair mortar
- vii. Material test reports for aggregates from a qualified testing agency, including service record data indicating absence of deleterious expansion of concrete due to alkali aggregate and support from formwork.

2. Design Data

- i. Grout mix proportions: indicating strength, brand and type of Portland cement, amounts of any admixtures and proportions and size of aggregates
- ii. Pumping Plan: indicate equipment and methods that will be used to place concrete within forms, including maximum time between mixing and placement of concrete.

3. Quality Assurance Documents

- i. Resumes or other supporting documents of installation company and personnel experience.
- ii. Proposed method of sealing and resealing of grout hose and pump ports
- iii. Cold and/or hot weather concreting procedures
- iv. Name and address of all testing companies
- v. All concrete testing reports
- vi. All on-site concrete batching reports

4. Closeout Submittals

- i. Submit as-built drawings showing locations and details of all repairs, modifications to details, etc.

C. Epoxy Grout

1. Product Data
 - i. Description, proportioning, and catalog cuts of proposed epoxy grout
 - ii. Manufacturer's instructions for proposed epoxy grout
 - iii. Epoxy paste for sealing the tops of the encasements and the forms
 - iv. Formwork spacers
 - v. Quick connection adapter for end of pump hose and pumping ports
2. Quality Assurance Documents
 - i. Resumes or other supporting documents of installation company and personnel experience.
 - ii. Proposed method of sealing and resealing of grout hose and pump ports
 - iii. Cold and/or hot weather concreting procedures
 - iv. Name and address of all testing companies
 - v. All concrete testing reports
 - vi. All on-site concrete batching reports

D. Cellular Concrete (Low Density Cellular Concrete (LDCC))

1. Product Data
 - i. Mix design for Non-Pervious LDCC, including materials to be used along with material sourcing records.
 - ii. Spacers for placement of reinforcing steel.
 - iii. Anchoring system for securing reinforcing dowels into existing concrete extensions or encasements.
 - iv. Quick connection adapter for end of pump hose and pumping ports.
2. Design Data
 - i. Grout mix proportions: indicating strength, brand and type of Portland cement, amounts of any admixtures and proportions.
 - ii. Pumping Plan: indicate equipment and methods that will be used to place concrete within forms, including maximum time between mixing and placement of concrete.
3. Quality Assurance Documents
 - i. Resumes or other supporting documents of installation company and personnel experience.
 - ii. Proposed method of sealing and resealing of grouting hose and pump ports
 - iii. Cold and/or hot weather concreting procedures
 - iv. Name and address of all testing companies
 - v. All concrete testing reports
 - vi. All on-site concrete batching reports
4. Closeout Submittals
 - i. Submit as-built drawings showing locations and details of all repairs, modifications to details, etc.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installation company shall have a minimum of three (3) years of experience with placing underwater grout, epoxy grout and/or cellular concrete per

manufacturers requirements and fifteen (15) successfully completed projects.

The installation company shall provide a project manager or superintendent with a minimum of three (3) years of experience with placing underwater grout, epoxy grout and/or cellular concrete.

- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready-Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing
 - 3. Technician, Grade II.

1.5 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. Unacceptable Grout Placement
 - 1. The Engineer of Record (EOR) reserves the right to reject, at contractor's expense, any portion of the work which is known to contain deficient grout.
 - 2. It shall be the contractor's responsibility to evaluate the acceptability for placement of all grout contemplated for use on the project. Field testing information shall be promptly made available to the EOR. In no way shall the delivery of or the field interpretation of this information by the EOR be construed so as to relieve the contractor of the responsibility of determining the acceptability of the grout for placement.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Premixed and bagged grout: Deliver, store, and handle premixed and bagged grout to prevent breakage, contact with moisture and damage.
- B. Containers, bags, totes, etc. of components of any system shall be stored per product data sheet requirements and protected from exposure to environmental conditions, damage and spoilage.

1.7 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect grout work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for

three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. All frost and ice shall be removed from formwork or any area that could come into contact with fresh grout during placement.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

PART 2 PRODUCTS

1.0 CEMENTITIOUS GROUT – UNDERWATER, FLOWABLE, NON-SHRINK

A. Ready Mix Grout or Pre-sacked (Premixed) Grout

1. ASTM C150, Type I or Type II Portland Cement
2. Water shall comply with the requirements of ASTM C94 and the chloride and sulfate limits in accordance with ASTM D512 and ASTM D516. Mixing water shall not contain more than 500 parts per million of chlorides as Cl and not more than 100 parts per million of sulfates as SO₄. Water shall be free from injurious amounts of oils, acids, alkalis, salts, and organic materials. Where water from reprocessed concrete is proposed for use in the work, submit results of tests to verify that the treatment has negated adverse effects of deleterious materials.
3. Coarse aggregate shall be ASTM C33 #8 (max 3/8 in. aggregate). Fine aggregate shall be in compliance with ASTM C33. Provide aggregates for exposed concrete from one source, ASTM C227. Do not provide aggregates that react deleteriously with alkalis in cement. Refer to appendix, paragraph entitled "Test Method C227" of ASTM C33 for expansion limits. Provide aggregate containing no deleterious material properties as identified by ASTM C295.
4. The grout shall meet the US Army Corps of Engineers CRD-C621 (ASTM-C1107) specifications for plastic/flowable conditions.
5. Grout Characteristics
 - a. "Wash-out" resistant thixotropic consistency for dependable underwater repairs (displaces water)
 - b. Free-flowing and/or pumpable consistency for each application
 - c. High early and ultimate strength for fast repair and turn around without chlorides
 - d. Positive expansion for maximum durability and adhesion
 - e. Appropriate properties for placement by ports and/or tremies

6. Minimum properties of the grout per the table below:

Grout Properties		
Property	Standard	Value
Flowability CRD C-227, %	- - -	124-145
Flexural Strength, psi (Flowable)	ASTM C190	1,200
Tensile Strength, psi (Plastic)	ASTM C190	550
Compressive Strength, psi	ASTM C190	5,000
Initial Set Time (flowable), hr	ASTM C191	3
Final Set Time (flowable), hr	ASTM C191	5
Entrained Air, %	ASTM C260	5-7
Maximum Aggregate Size, in	ASTM C33	3/8

7. Admixtures causing accelerated setting of concrete are not permitted. Where not shown or specified, admixtures may only be used upon specific prior written approval by the Engineer of Record. Admixtures used shall conform to ASTM C494.
8. Grout shall be proportioned, packaged, precision cement-based grout requiring only the addition of potable water. Measurement of grout volume shall be after additional of water per manufacturer's instructions.
9. The non-shrink grout shall not contain metallic aggregate, expansive cement, or gas generating additives such as aluminum powder. The grout shall contain an air release aggregate to generate positive expansion.

2.0 EPOXY GROUT

A. Epoxy Grout

1. The epoxy grout shall be a three-component 100% solids epoxy grout specifically designed for underwater concrete applications.
2. The epoxy grout resin must have a mixed viscosity of 100-500 cps at 77°F to ensure easy flowability.
3. Epoxy grout will require appropriate properties for placement by ports and/or tremies.
4. Minimum properties of the grout per the table below:

Epoxy Grout Properties		
Property	Standard	Value
Viscosity @ T=77° F, cps	ASTM D-1290	100-500
Tensile Strength, psi	ASTM D-638	2,500
Compressive Strength, psi	ASTM D-695	11,000
Gel Time, min (200g mass)	- - -	120
Tensile Bond Strength, psi	ASTM C-1583	>250
Final Set Time (flowable), hr	ASTM C-191	5

3.0 CELLULAR CONCRETE

A. Cellular Concrete

1. ASTM C150, Type II or Type V Portland Cement
2. Water shall comply with the requirements of ASTM C94 and the chloride and sulfate limits in accordance with ASTM D512 and ASTM D516. Mixing water shall not contain more than 500 parts per million of chlorides as Cl and not more than 100 parts per million of sulfates as SO₄. Water shall be free from injurious amounts of oils, acids, alkalis, salts, and organic materials. Where water from reprocessed concrete is proposed for use in the work, submit results of tests to verify that the treatment has negated adverse effects of deleterious materials.
3. Fine aggregate shall be in compliance with ASTM C33. Provide aggregate containing no deleterious material properties as identified by ASTM C295. See Contract Documents for use or specification of fine aggregate or as required by manufacturer to achieve required compressive strength.
4. Foam Concentrate shall be provided by an approved manufacturer and conform to ASTM C869 when tested in accordance with ASTM C796.
5. Cellular foam shall be specified between twenty-five (25) to thirty-five (35) cast density for annular fill around pipes and seventy-five (75) cast density for underwater marine environments.
6. Minimum properties of the grout per the table below:

Cellular Concrete Properties		
Property	Standard	Value
Compressive Strength, psi (annular fill for pipes)	ASTM C190	200
Compressive Strength, psi (underwater marine fill)	ASTM C190	500
Flow Consistency, inch	ASTM D6103	7 or greater

7. Admixtures causing accelerated setting of concrete are not permitted. Where not shown or specified, admixtures may only be used upon specific prior written approval by the Engineer of Record. Admixtures used shall conform to ASTM C494.
8. The non-shrink grout shall not contain metallic aggregate, expansive cement, or gas generating additives such as aluminum powder. The grout shall contain an air release aggregate to generate positive expansion.

PART 3 EXECUTION

1.0 GENERAL

- A. Execution shall be in accordance with applicable portions of the referenced codes and standards.

- B. Provide safety, demolition, and protection of adjacent areas. Personnel shall wear ear, eye and head protection as required.
- C. Install all products furnished in strict accordance with the product manufacturer's recommendations for optimum results.

1.1 STORAGE AND HANDLING

- A. All grout components shall be stored in a dry place away from direct sunlight, flame, or other hazards and within the temperature ranges specified by the manufacturer.
- B. All epoxy grout components shall be at the manufacturers recommended temperature prior to utilizing for production.
- C. Contractor shall follow all Material Safety Data Sheet (MSDS) warnings and instructions. All materials shall be clearly labeled and properly sealed when they arrive on site. Ensure that all materials have not reached their shelf life prior to use.

1.2 CAST-IN-PLACE GROUT AND EPOXY GROUT

- A. Surfaces upon which grout is to be placed shall be clean, damp, and free from: visible organic matter, concrete demolition debris, dust, oil, frost, ice, and other bond inhibiting materials.
- B. Discharge of concrete shall be completed within 1.5 hours after water is first introduced into mix.
- C. Concrete Strength and Mix Design Confirmation: Prior to concrete placement, check transit mix delivery slip to confirm 28-day concrete strength and mix design and other information.
- D. Do not drop grout from heights exceeding two (2) feet without the use of tremies for mix designs containing aggregate and four (4) feet for grout mix designs with sand aggregate. Injection ports may be required. Reference Contract Documents for more information.

1.3 CELLULAR CONCRETE

- A. Surfaces upon which cellular concrete is to be placed shall be clean, damp, and free from: visible organic matter, standing water, concrete demolition debris, dust, oil, frost, ice, and other bond inhibiting materials.
- B. Concrete Strength and Mix Design Confirmation: Prior to concrete placement, check transit mix delivery slip to confirm 28-day concrete strength and mix design and other information.
- C. Do not drop grout from heights exceeding two (2) feet without the use of tremies for mix designs containing aggregate and four (4) feet for grout mix designs with sand aggregate. Injection ports may be required. Reference Contract Documents for more information.
- D. Foam generating equipment shall be used to produce a predetermined quantity of pre-formed foam which shall be mixed and blended with cementitious slurry. Equipment shall be calibrated to produce consistent foam. That foam shall retain its stability until the cement sets to form a uniform cellular structure.

- E. When producing neat cellular concrete (no sand or other aggregates), pre-formed foam shall not be added or blended with cementitious slurry in a transit mixer.
- F. Cellular concrete shall be produced utilizing specialized automated proportioning, mixing and foam producing equipment, capable of meeting the specified properties.
- G. Avoid excessive handling of the material. After sufficiently mixing the foam with slurry, the cellular concrete be conveyed promptly in its final location.
- H. All equipment used to furnish the cellular concrete must be approved by the manufacturer.
- I. Cellular concrete shall not be vibrated or disturbed. Vehicles, equipment, backfills or other loadings on the fill material shall not be permitted until the material has attained an adequate compressive strength.

1.4 CURING NEW GROUT

- A. Protect all new grout against injury from the elements and construction operations.
- B. Maintain surface of grout at 50 degrees Fahrenheit or more for at least 48-hours. Do not allow new grout to freeze.

1.5 FIELD QUALITY ASSURANCE/CONTROL

- A. The work to be provided in accordance with this section of the specification shall be subject to inspection by Owner at any time(s) during the progress of the work. Contractor shall provide access and any labor, materials, tools, and equipment required by Owner to complete inspection of the Work as specified herein.
- B. Completed installations shall be visually inspected to confirm the integrity of the laminate encasement, fiber reinforced polymer (FRP) and finished surfaces. Any deficiencies shall be corrected at the Contractor's expense. The Contractor shall propose a repair method and submit it to the Engineer for approval prior to implementing said repair.
- C. Acceptance of structure shall be contingent on the Work meeting all of the requirements of the Contract Documents as indicated by the results of all testing, inspection, and other quality assurance procedures required by Owner.
- D. Special Inspections: Owner may wish to engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- E. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- F. Inspections:
 - 1. Verification of use of required mix design.
 - 2. Concrete placement, including conveying and depositing.
 - 3. Curing procedures and maintenance of curing temperature.

G. Testing:

1. Cementitious Grout - For each mix design and/or each mix batch provided, according to ASTM C39.

- a. Testing Frequency: Obtain three or more composite samples for each day's pour of each grout mixture. Samples per ASTM C39 and shall be four inch by eight inch (4x8) cylinders.
- b. Grout Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

2. Epoxy Grout - For each mix design and/or each mix batch provided, according to ASTM C579.

- a. Testing Frequency: Obtain three or more composite samples for each day's pour of each epoxy grout mixture. Samples per ASTM C579 and shall be two inch by two inch (2x2) cubes.
- b. Grout Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

3. Cellular Concrete - For each mix design and/or each mix batch provided, according to ASTM C495.

- a. Testing Frequency: Obtain three or more composite samples for each day's pour of each concrete mixture and for each 300 cubic yards of material placed. Samples per ASTM C495 and shall be three inch by six inch (3x6) cylinders.
- b. Measure flow consistency and unit weight (wet density) at the point of placement from the first batch mixed, every hour during the pour, and from each batch from which compression test cylinders are made. Mix shall be adjusted as required to obtain the specified cast density at the point of placement.
- c. Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

H. Strength of each concrete mixture will be satisfactory if the average of any three-consecutive compressive-strength tests equals or exceeds the specified compressive strength and no compressive-strength test value falls below the specified compressive strength by more than 500 psi (3.4 MPa).

I. Test results shall be reported in writing to the Engineer of Record, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

- J. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION