SPEC NOTE: DYNAMax HPC is an alternative to conventional concrete in challenging structural projects making the overall design of structures more efficient and sustainable in reducing their carbon footprint. DYNAMax HPC is also a value adding substitution of conventional concrete, making the overall design of structures more efficient and sustainable through resource reduction and prolonged life cycles

Part 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 DYNAMax – The Ultimate Performance Concrete (HPC) for use in various structural applications.

SPEC NOTE: Edit the following to suit project. For text in red color, select the relevant option from the square bracket list, or edit the requirements.

1.2 RELATED REQUIREMENTS

.1 Section 01 45 00 – Quality Control: Testing

.2 Section 03 10 00 – Concrete Falsework, Formwork and Accessories

.3 Section 03 20 00 – Concrete Reinforcing

.4 Section 03 21 23 – Stainless Steel Reinforcing

.5 Section 03 24 13 – Glass Fibre Reinforced Polymer Reinforcing

.6 Section 03 31 00 – Structural Concrete

.7 Section 03 33 00 – Architectural Concrete

.8 Section 03 35 00 – Concrete Finishing

.9 Section 03 38 00 – Post Tensioned Concrete

.10 Section 03 40 00 – Precast Structural Concrete

.11 Section 03 45 00 – Precast Architectural Concrete

.12 Section 05 50 00 – Metal Fabrications

1.3 DEFINITIONS

.1 **Compressive Strength**: The measure of the concrete's ability to resist loads which tend to compress it. It is measured by crushing cylindrical concrete specimens in compression testing machine.

.2 **Durability:** The ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties.

.3 **Rigidity:** Modulus of elasticity (MOE) is defined as the measurement of resistance a concrete structure has to deform or sway.

.4 **Quality Assurance Services**: Activities, actions, and procedures performed before and during execution by third party of the Work by the Contractor to guard against defects and deficiencies and ensure proposed construction complies with requirements of the owner.

.5 **Quality Control**: Quality control plan designed by the concrete supplier to demonstrate achievement of the specified concrete properties.

.6 **Testing Agency**: Entity engaged to perform specific tests, inspections, or both. Testing laboratory to mean same as testing agency.

.7 **Pumpability:** The capacity of a concrete under pressure to be moved by a concrete pump while maintaining its initial properties.

1.4 REFERENCES

.1 American Concrete Institute (ACI):

.1 ACI 301: Specifications for Structural Concrete for Buildings.

.2 ACI 305: Guide to Hot Weather Concreting.

.3 ACI 306: Guide to Cold Weather Concreting.

.4 ACI 308: Guide to External Curing of Concrete

.5 ACI 318: Building Code Requirements for Structural Concrete and Commentary.

.2 American Society of Concrete Contractors (ASCC):

.1 Guide for Surface Finish of Formed Concrete.

.3 American Society for Testing and Materials (ASTM):

.1 ASTM C39/C39M-05e1, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

.2 ASTM C78: Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

.3 ASTM C171: Waterproof paper, polyethylene film or burlap.

.4 ASTM C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

.5 ASTM C309: Standard Specifications for Liquid Membrane Forming Curing Compounds and Curing and Sealing Compounds.

.6 ASTM C469/ ASTM C469M-14e1, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.

.7 ASTM C494: Standard Specification for Chemical Admixtures for Concrete.

.8 ASTM C1202: Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

.9 ASTM C1074-19e1: Standard Practice for Estimating Concrete Strength by the Maturity Method.

1.5 SUBMITTALS

.1 Comply with Section 01 30 00, unless otherwise indicated.

.2 Product Data:

.1 Manufacturer's specifications and technical data including:

.1 Test reports from producer indicating compliance with performance requirements specified.

.2 Laboratory reports: 3 copies of tests and reports specified.

.3 Shop Drawings: Indicate dimensions, general construction, specific modifications, plus following specific requirements.

.4 Concrete Design Mix: Submit performance parameters for each concrete type for review and return prior to placing concrete.

.1 Include available supporting backup data.

.2 Include manufacturer's data sheets.

.5 Delivery Tickets: 1 copy indicating quantity, mix identification, design strength, design slump-flow, and time of batching for each load delivered.

.6 Submit final DYNAMax mix verification 2 weeks prior to placing concrete.. Include following information for each concrete mix design:

.1 Type of fine and coarse aggregates.

.2 Slump and Slump-Flow of Concrete: to ASTM C143 / C143M

.3 Air content: to ASTM C231/C231M, Air content of Plastic Concrete by Pressure Method or Air Content of Plastic Concrete by Volumetric Method to ASTM C173/C173M.

.4 Density and Yield of concrete: to ASTM C138/138M.

.5 Compressive Strength of Cylindrical Concrete Specimens: to ASTM C39/C39M-05e1.

.6 Modulus of elasticity and Poisson’s ratio to ASTM C469/ ASTM C469M-14e1.

.7 Rapid Chloride Permeability to ASTM C1202-19.

.7 Submit proposed curing techniques of test specimens for acceptance prior to beginning concrete work.

SPEC NOTE: Specifier to add desired LEED points and the required submittals for high performance concrete (HPC) under each of the LEED points to applicable for the project.

.8 Sustainable Design Submittals: Coordinate project sustainable design requirements with [Section 01 35 63 – Sustainability Project Requirements] [; in addition, provide information for following specific requirements of this Section:]:

SPEC NOTE: In challenging pumping situations, specifier to add mix pumpability verification requirements.

.9 Mix Pumpability Submittals: Validate concrete mix compatibility with pump model and pumping pressure, to ensure the pumpability to desired height and length.

a. Basis-of-Design Solution: Subject to compliance with requirements, use Holcim (US); iCONCrete Smartflow; pumpability testing and simulation tool, or equivalent

b. Submit proposed pump model and proposed pumping pressure for each concrete product
c. Submit iCONCrete Smartflow trials and simulation results, to validate pumping feasibility to required height and length

1.6 QUALITY ASSURANCE

.1 Qualifications:

.1 Manufacturer: experienced in production of high-performance concrete materials and has production facilities, raw materials, know how and equipment necessary to produce specified materials for this project.

.2 Testing Agency: Independent third-party testing agency qualified in accordance with ASTM C1077 and ASTM E329 and acceptable to the Structural Engineer or the Consultant to perform source quality control testing. Must be capable to end grind all cylinder specimens for compressive strength testing of DYNAMax HPC.

.2 Hold pre-job conference at jobsite to discuss site-related points in this Section. Include Holcim ready mix, the contractor, the engineer, the Consultant, and the Testing Agency. No concrete placements of the DYNAMax high-performance concrete (HPC) allowed prior to meeting.

.3 Field Testing Agency Qualifications: A certified testing agency, acceptable to authorities having jurisdiction and Consultant, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated

.4 All compressive strength cylinder tests are to be conducted on end grinded specimens.

Part 2 PRODUCTS

2.1 MANUFACTURERS

.1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- Holcim – ACM Management, Inc. and its subsidiaries

2.2 HIGH PERFORMANCE CONCRETE MATERIALS

SPEC NOTE: Select reinforcing materials for the project.

.1 DYNAMax High Performance Concrete: Proprietary formulation with [glass fibre reinforced polymer] [[stainless] [galvanized] steel] reinforcing and as follows:

SPEC NOTE: Select products required for the project.

.1 DYNAMax

.1 Strength: 8,000-17,000 psi in accordance with ASTM C39/C39M-05e1.

.2 DYNAMax^{XD}

.1 Strength: 8,000-17,000 psi in accordance with ASTM C39/C39M-05e1.

.2 Permeability: <750 Coulombs in accordance with ASTM C1202.

.3 DYNAMax^{XR}

.1 Strength: 8,000-17,000 psi in accordance with ASTM C39/C39M-05e1.

.2 Modulus of Elasticity: ≥5,800 ksi in accordance with ASTM C469/ ASTM C469M-14e1.

.4 DYNAMax^{XRD}

.1 Strength: 8,000-17,000 psi in accordance with ASTM C39/C39M-05e1.

.2 Permeability: <750 Coulombs in accordance with ASTM C1202.

.3 Modulus of Elasticity: ≥5,800 ksi in accordance with ASTM C469/ ASTM C469M-14e1.

.2 Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride [in steel-reinforced concrete].

SPEC NOTE: Retain one or more chemical admixtures from "Water-Reducing Admixture," "Retarding Admixture," "Water-Reducing and -Retarding Admixture," "High-Range, Water-Reducing Admixture," "High-Range, Water-Reducing and -Retarding Admixture," and "Plasticizing and Retarding Admixture" subparagraphs below.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

SPEC NOTE: Retain "Set-Accelerating Corrosion-Inhibiting Admixture" Subparagraph below if set-accelerating corrosion inhibitors are required. Set-accelerating products are usually calcium nitrite-based admixtures and comply with ASTM C494/C494M, Type C.

7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

SPEC NOTE: Retain "Non-Set-Accelerating Corrosion-Inhibiting Admixture" Subparagraph below if corrosion inhibitors that do not affect concrete setting time are required.

8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor;

capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

SPEC NOTE: Retain "Permeability-Reducing Admixture" Subparagraph below if required. Consider actual need, budget, and expected results. If retained, insert specific requirement for permeability-reducing admixture in applicable paragraph under "Concrete Mixtures" Article. See the Evaluations.

9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

    a. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi (1.28 MPa) for 14 days.

.3 Cement and Supplementary Cementing Materials:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Holcim US ccementitious materials or comparable product.

2. Portland Cement: ASTM C150/C150M, [Type I] [Type II] [Type I/II] [Type III] [Type V], [gray] [white].

3. Blended Cement: ASTM C595/C595M, [Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type IL, portland-limestone] [Type IT, ternary blended] cements.
    a. Basis-of-Design Product: Subject to compliance with requirements, provide Holcim (US) [FortiCem] [MaxCem] [OneCem] [TerCem] blended cement or comparable product.

4. Performance Cement ASTM C1157/1157M, [Type GU, general use] [Type HE, high early strength] [Type MS, moderate sulfate resistance] [Type HS, high sulfate resistance] [Type MH, moderate heat of hydration] [Type LH, low heat of hydration].

5. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
    a. Basis-of-Design Product: Subject to compliance with requirements, provide Holcim (US) NewCem slag cement or comparable product.

6. Fly Ash: ASTM C618, Class C or F.

7. Silica Fume: ASTM C1240 amorphous silica.

.4 Water: ASTM C94/C94M, potable [or] [complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4]

.5 Aggregate: ASTM C33/C33M, [Class 3S] [Class 3M] [Class 1N] <Insert class> coarse aggregate or better, graded. Provide aggregates from a single source.

SPEC NOTE: Retain "Alkali-Silica Reaction" Subparagraph below if damage caused by concrete expansion from alkali silica or alkali carbonate reactions is anticipated.

1. Alkali-Silica Reaction: Comply with one of the following:

    1. Expansion result of aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
    2. Expansion results of aggregate and cementitious materials in combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
    3. Alkali content in concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).

2. Maximum Coarse-Aggregate Size: [1-1/2 inches (38 mm)] [1 inch (25 mm)] [3/4 inch (19 mm)] <Insert dimension> nominal.

3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

.6 Moisture-Retaining Cover/Curing Compound:

1. Moisture-retaining covers complying with ASTM C171.

2. Liquid-type membrane-forming curing compound complying with ASTM C309

.7 Forming Materials: In accordance with Section 03 10 00.

2.3 SUPPLIER QUALITY CONTROL

.1 Concrete supplier to submit a quality control plan designed to demonstrate achievement of the specified DYNAMax properties.

.2 Maturity Calibration: Determine relationship between maturity and strength for mix. Maturity calibration can be used to determine in-place strength of concrete and replaces the need for field-cured cylinders. Perform maturity calibration in accordance with ASTM C1074.

a. Basis-of-Design Solution: Subject to compliance with requirements, use Holcim (US) iCONCrete Smartcast maturity sensors and calibration, or equivalent

2.4 CONCRETE MIXTURES

.1 DESIGN & TESTING

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Holcim (US) [Dynamax] [DYNAMax^{XD}] [DYNAMax^{XR}] [DYNAMax^{XRD}] or comparable product.

2. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

.2 CONCRETE MIXES

1. [Class A i.e. pile caps, ground slab, etc.]: Basis of design product: Subject to compliance with requirements, provide Holcim (US) **DYNAMax** or comparable product. Proportion normal-weight concrete mixture as follows:
   - Minimum Compressive Strength (f'c): *[8,000-17,000]* psi at *[xx]* days.
   - Exposure class: *[xx xx xx]* - in accordance with ACI 318-14
   - Maximum Aggregate Size: *[xxx]* inch
   - Slump limit: to be selected by Contractor based on ASTM C143, as permitted under ACI 301

2. [Class B i.e. pile caps, ground slab, etc.]: Basis of design product: Subject to compliance with requirements, provide Holcim (US); **DYNAMax^{XD}** or comparable product. Proportion normal-weight concrete mixture as follows:
   - Minimum Compressive Strength (f'c): *[8,000-17,000]* psi at *[xx]* days.
   - Permeability: *[750 or less]* Coulombs
   - Exposure class: *[xx xx xx]* - in accordance with ACI 318-14
   - Maximum Aggregate Size: *[xxx]* inch
   - Slump limit: to be selected by Contractor based on ASTM C143, as permitted under ACI 301

SPEC NOTE: Specify modulus of elasticity with a number of days needed to achieve it. Up to 91 days might be needed for very high modulus of elasticity requirements.

3. [Class C i.e. pile caps, ground slab, etc.]: Basis of design product: Subject to compliance with requirements, provide Holcim (US); **DYNAMax^{XR}** or comparable product. Proportion normal-weight concrete mixture as follows:
   - Minimum Compressive Strength (f'c): *[8,000-17,000]* psi at *[xx]* days.
   - Modulus of Elasticity: *[5800 or more]* ksi at *[28] [56] [91]* days.
   - Exposure class: *[xx xx xx]* - in accordance with ACI 318-14

- Maximum Aggregate Size: *[xxx]* inch
- Slump limit: to be selected by Contractor based on ASTM C143, as permitted under ACI 301

4. [Class D i.e. pile caps, ground slab, etc.]: Basis of design product: Subject to compliance with requirements, provide Holcim (US); **DYNAMax^{XRD}** or comparable product. Proportion normal-weight concrete mixture as follows:
   - Minimum Compressive Strength (f'c): *[8,000-17,000]* psi at *[xx]* days.
   - Modulus of Elasticity: *[5800 or more]* ksi at *[28] [56] [91]* days.
   - Permeability: *[750 or less]* Coulombs
   - Exposure class: *[xx xx xx]* - in accordance with ACI 318-14
   - Maximum Aggregate Size: *[xxx]* inch
   - Slump limit: to be selected by Contractor based on ASTM C143, as permitted under ACI 301

Part 3 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.

.1 Do not proceed until unsatisfactory conditions corrected.

3.2 PREPARATION

.1 Coordination: Notify others involved, allowing installation and completion of their work prior to concrete placement.

.2 Surface Preparation: Immediately before concrete placement, thoroughly wet moisture-absorbing material that will be in contact with concrete, without developing standing water.

3.3 INSTALLATION

.1 Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

.1 Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.

.2 Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.

.3 Maintain moisture loss no more than 0.2 lb/sq. ft. x h (1 kg/sq. m x h), calculated in accordance with ACI 305.1, before and during finishing operations.

3.4 CONCRETE PLACEMENT AND CONSOLIDATION

.1 Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed prior to placing concrete.

.2 Place concrete within 1-1/2 hours after mix water has been added unless the Holcim representative makes adjustments to mix.

.3 Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

.4 Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.

3.5 FINISHING

.1 In accordance with Section 03 35 00.

3.6 CONCRETE CURING AND PROTECTION

.1 Start initial curing as soon as concrete finished. Keep continuously moist or sealed for minimum 5 days.

.2 Begin final curing procedures immediately after initial curing and before concrete has dried. Continue final curing for minimum 5 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

3.7 FIELD QUALITY CONTROL

.1 In accordance with Section 01 45 00.

END OF SECTION