BASF
The Chemical Company

Note to Specifier:

The **Admixture Systems** business of **BASF's Construction Chemicals Division** previously conducted business as **Degussa Admixtures, Inc.** and **Master Builders, Inc.**

The Master Builders brand of innovative chemical admixtures and solutions that have been used in concrete for over a century are now offered by **BASF – The Chemical Company**, the largest chemical company in the world.

Please update your Master Specifications to reflect the company name change.

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Options and notes are provided in square brackets. Delete those that are not necessary.

SECTION 03 31 26

SELF-CONSOLIDATING CONCRETE (SCC)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for producing Self-Consolidating Concrete.

1.2 RELATED SECTIONS

A. Related Sections:

1. Section 01 10 00 - Summary
2. Section 01 33 00 - Submittal Procedures
3. Section 01 45 00 - Quality Control
4. Section 01 60 00 - Product Requirements
5. Section 03 01 30 - Maintenance of Cast-in-Place Concrete
6. Section 03 01 40 - Maintenance of Precast Concrete
7. Section 03 10 00 - Concrete Forming and Accessories
8. Section 03 20 00 - Concrete Reinforcing
9. Section 03 30 00 - Cast-in-Place Concrete
10. Section 03 35 00 - Concrete Finishing
11. Section 03 39 00 - Concrete Curing
12. Section 03 40 00 - Precast Concrete
13. Section 07 92 00 - Joint Sealants

Master Builders

1.3 REFERENCES

A. ASTM International (ASTM):

1. A 820/A 820M - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
2. C 31/C 31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field
3. C 33 - Standard Specification for Concrete Aggregates
4. C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
5. C 70 - Standard Test Method for Surface Moisture in Fine Aggregate
6. C 94/C 94M - Standard Specification for Ready-Mixed Concrete
7. C 138/C 138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
8. C 150 - Standard Specification for Portland Cement
9. C 172 - Standard Practice for Sampling Freshly Mixed Concrete
10. C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
11. C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
12. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete
13. C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete
14. C 566 - Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
15. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
16. C 989 - Standard Specification for Slag Cement for Use in Concrete and Mortars
17. C 1017/C 1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
18. C 1064/C 1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
19. C 1116/C 1116M - Standard Specification for Fiber-Reinforced Concrete
20. C 1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
21. C 1582/C 1582M - Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete
22. ASTM C 1585 - Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes
23. C 1602/C 1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

24. C 1610/C 1610M - Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique
25. C 1611/C 1611M - Standard Test method for Slump Flow of Self-Consolidating Concrete
26. C 1621/C 1621M - Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring
27. E 329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing
28. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

B. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete
2. ACI 301M - Specifications for Structural Concrete (Metric)
3. ACI 305.1 - Specification for Hot Weather Concreting
4. ACI 306.1 - Standard Specification for Cold Weather Concreting
5. ACI 308.1 - Standard Specification for Curing Concrete
6. 318 - Building Code Requirements for Structural Concrete (ACI 318-08) and Commentary
7. 318M - Building Code Requirements for Structural Concrete (ACI 318M-08) and Commentary (metric)

C. NSF International (NSF):

1. NSF/ANSI Standard 61 - Drinking Water System Components

D. DIN (Deutsches Institut Fur Normung, Germany):

1. DIN 1048 Part 5 “Testing Concrete - Testing of hardened concrete (specimens prepared in mould)”

1.4 SUBMITTALS

A. In accordance with 01 33 00.

B. Mixture proportions.

C. Certification: Manufacturer’s certification stating that the products delivered meet or exceed Project Specifications.

D. Product Data.

E. Ready-mixed concrete delivery tickets.

1.5 DEFINITIONS

A. Self-Consolidating Concrete (SCC): A highly flowable, non-segregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation.

B. Passing Ability: The ability of SCC to flow under its own weight (without vibration) and fill completely all spaces within intricate formwork, containing obstacles, such as reinforcement.

C. J-Ring Test: Test used to determine the passing ability of SCC, or the degree to which the passage of concrete through the bars of the J-Ring apparatus is restricted.

D. J-Ring Flow: The distance of lateral flow of concrete using the J-Ring in combination with a slump cone.

E. Slump Flow: Test method used to measure the unconfined flow and stability of SCC using a slump cone (upright or inverted).

F. Slump Flow Spread: The numerical value in inches (mm) of flow determined as the average diameter of the circular deposit of SCC at the conclusion of the slump flow test.

G. T_{50} Value: Time (in seconds) the edge of the concrete mass takes to reach 50 cm (500 mm, 20-inch) diameter from the time the mold is first raised in the slump flow test.

H. Stability: The ability of a concrete mixture to resist segregation of the paste from the aggregates.

I. Static Segregation (Segregation Factor): Segregation of the mortar from the coarse aggregate that occurs after placement while the concrete is still in a plastic state.

J. Visual Stability Index (VSI) Rating: An assessment of the homogeneity of concrete based on the visual inspection of the concrete sample at the end of the slump flow test.

1.6 QUALITY ASSURANCE

A. In accordance with ACI 301 (ACI 301M) for mixing, transportation and placing of concrete

B. In accordance with ACI 305.1 for hot weather concrete placement and protection.

C. In accordance with ACI 306.1 for cold weather concrete placement and protection.

D. In accordance with ACI 308.1 for curing.

E. In accordance with ACI 301 (ACI 301M) for concrete consolidation.

F. Testing and Inspection Agency Qualifications: Independent agency conforming to the requirements of ASTM E 329.

1.7 DELIVERY, STORAGE AND HANDLING

A. Ready-mixed concrete truck driver shall provide batch ticket to the Architect/Engineer or his [her] representative at the time of concrete delivery. Contents of the batch ticket shall be as specified in ASTM C 94/C 94M.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cement: Shall conform to ASTM C 150, Type I or Type II.

B. Aggregates: Fine and coarse aggregates shall conform to ASTM C 33.

C. Water: Shall conform to ASTM C 1602/C 1602M.

D. Admixtures: Furnish from one manufacturer.

1. Characteristics: Compatible with each other and free of intentionally-added chlorides.

2. Air-Entraining Admixture:
   a. Shall conform to ASTM C 260.
   b. Products and Manufacturers:
      "MB-AE™ 90", "MB-VR™" or "Micro Air®" by BASF Corporation - Admixture Systems.

3. Water-Reducing Admixture:
   a. Shall conform to ASTM C 494/C 494M Type A.
   b. Products and Manufacturers:
      "Pozzolith®" Series by BASF Corporation - Admixture Systems.

4. Mid-Range Water-Reducing Admixture:
   a. Shall conform to ASTM C 494/C 494M Type A.
   b. Products and Manufacturers:
      "PolyHeed®" Series by BASF Corporation - Admixture Systems.

5. High-Range Water-Reducing Admixture:
   a. Shall conform to ASTM C 494/C 494M Type F [or ASTM C 1017/C 1017M Type I].
   b. Products and Manufacturers:
      "Glenium®" Series or PS 1466 by BASF Corporation - Admixture Systems.

6. Accelerating Admixture:
   a. Shall conform to ASTM C 494/C 494M Type C or E.
   b. Products and Manufacturers:
      "Pozzolith NC 534" or "Pozzutec® 20+" by BASF Corporation - Admixture Systems.

7. Retarding Admixture:
   a. Shall conform to ASTM C 494/C 494M Type B or D.
   b. Products and Manufacturers:
      "Pozzolith" Series or "DELVO®" Series by BASF Corporation - Admixture Systems.

8. Hydration Control Admixture:
   a. Shall conform to ASTM C 494/C 494M Type B or D.
   b. Products and Manufacturers:
      "DELVO" Series by BASF Corporation - Admixture Systems.

9. Workability-Retaining Admixture:
   a. Shall retain concrete workability without affecting time of setting or early-age strength development.
   b. Shall conform to ASTM C 494/C 494M Type S.
   c. Products and Manufacturers:
      "RheoTEC™ Z-60" by BASF Corporation - Admixture Systems.

10. Waterproofing Admixture:
   a. Shall be an integral crystalline capillary waterproofing admixture for concrete.
   b. Shall satisfy the following requirements, when used at the manufacturer's recommended dosage:
      i. Reduction in capillary absorption: Not less than 40 percent relative to a companion untreated concrete mixture, when tested in accordance with ASTM C 1585.
      ii. Reduction in water penetration: Not less than 40 percent relative to a companion untreated concrete mixture, when tested in accordance with DIN 1048.
      iii. The admixture shall not affect the setting time, strength or durability properties of concrete.
   c. Shall be certified to NSF/ANSI 61.

      [Note: NSF Certification may be required for potable water tanks. Delete if it is not required for the project.]
   d. Product:

      "Rheomac 300D" by BASF Corporation - Admixture Systems.

11. Viscosity-Modifying Admixture:
   a. Shall conform to ASTM C 494/C 494M Type S.
   b. Products and Manufacturers:
      "Rheomac®" Series by BASF Corporation - Admixture Systems.

12. Corrosion-Inhibiting Admixture:
    a. Shall conform to ASTM C 1582/C 1582M.
    b. Products and Manufacturers:
       "Rheocrete® CNI" or "Rheocrete 222+" by BASF Corporation - Admixture Systems.

13. Shrinkage-Reducing Admixture:
    a. Products and Manufacturers:
       "Tetraguard® AS20" by BASF Corporation - Admixture Systems.

14. Alkali-Silica Reaction Inhibiting Admixture:
    a. Shall contain a nominal lithium nitrate content of 30 percent.
    b. Products and Manufacturers:
       "ASRx™ 30 LN" by BASF Corporation - Admixture Systems.

15. Coloring Admixture:
    a. Products and Manufacturers:
       "RHEOCOLOR® L" by BASF Corporation - Admixture Systems.

16. Other admixtures shall be approved by the Engineer.

E. Supplementary Cementitious Materials (SCM):
1. The substitution of supplementary cementitious materials for cement shall be made on the basis of mass.
2. Fly Ash: Shall conform to ASTM C 618.
3. Slag Cement: Shall conform to ASTM C 989.
4. Silica Fume: Shall conform to ASTM C 1240.
    a. Products and Manufacturers:
       "Rheomac SF 100" by BASF Corporation - Admixture Systems.

F. Fibers:
1. Microsynthetic Fibers:
    a. Shall conform to ASTM C 1116/C 1116M.
    b. Products and Manufacturers:
       "MasterFiber™ F or M" Series by BASF Corporation - Admixture Systems.

2. Macrosynthetic Fibers:
    a. Shall conform to ASTM C 1116/C 1116M.
    b. Products and Manufacturers:
       "MasterFiber MAC" Series by BASF Corporation - Admixture Systems.

3. Steel Fibers:
    a. Shall conform to ASTM A 820/A 820M.
    b. Products and Manufacturers:
       "MasterFiber FF or FS" Series by BASF Corporation - Admixture Systems.

G. Evaporation Reducer:

1. Shall be a monomolecular film-forming liquid for application to fresh concrete to prevent rapid drying of the surface.

   a. Products and Manufacturers:
   "Confilm®" by BASF Corporation - Admixture Systems.

2. Evaporation reducer shall not be used as a finishing aid.

H. Curing Materials: Shall be in accordance with Section 03 39 00.

2.2 CONCRETE MIXTURES

A. Mixture Specifications:

1. Water-to-cementitious materials ratio shall not exceed 0.45 [___] by mass.

2. Supplementary Cementitious Materials: The weight of SCM shall not exceed the percentages listed in the following table for concrete exposed to deicing chemicals:

Material	Maximum percent of SCM by mass of total cementitious materials
Fly ash or other pozzolans	25
Slag cement	50
Silica Fume	10
Total of Fly ash or other pozzolans, slag cement and silica fume	50*
Total of fly ash or other pozzolans and silica fume	35*

* Fly ash or other pozzolans and silica fume shall not constitute more than 25 and 10 percent, respectively, of the total mass of cementitious material

B. Slump Flow:

1. Slump flow shall be measured in accordance with ASTM C 1611/C 1611M.

2. Typical ranges of slump flow are outlined in the following table.

3. The design slump flow of the SCC mixture shall be established after consideration of the project requirements.

4. The slump flow of SCC used on the project shall be the design slump flow plus or minus 2 inches.

Type of Construction	Range of Slump Flow Values	
	inches	mm
Slabs	20-30	500-750
Architectural members	24-30	600-750
Wall, lightly reinforced	20-30	500-750
Column or wall, densely reinforced	24-30	600-750
Drilled Shafts	20-24	500-600

C. Visual Stability Index (VSI): VSI Rating (in accordance with ASTM C 1611/C 1611M) shall not exceed 1.

D. J-Ring Flow: Difference between slump flow and J-Ring flow (as measured by ASTM C 1621/C 1621M) shall not be more than 2 inches.

E. Stability: The stability of the concrete shall be determined in the laboratory prior to approval of the SCC mixture using test method ASTM C 1610/C 1610M. Concrete mixtures shall have a maximum static segregation (segregation factor) of 15 percent.

F. Compressive strength: [4000 psi (27.5 MPa)] [5000 psi (35 MPa)] [___ psi (___ MPa)] at 28 days.

G. Air content shall be [less than 3%] [5-7%] [___ %].

H. Maximum nominal size of coarse aggregate:

1. Not larger than 1/5 the narrowest dimension between sides of forms.
2. Not larger than 1/3 the depth of slabs.
3. Not larger than 3/4 of the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, bundled tendons, or ducts..
4. [Maximum size of aggregate shall be [3/4-inch (19 mm)] [1-inch (25 mm)]]

I. Furnish to the Engineer a mixture proportion for the SCC to be used.

1. Proportion mixture according to project specific criteria (Compressive Strength, Air Content, Slump Flow, T_{50}, VSI, J-Ring Value and Segregation Factor).
2. Use the same components in the trial batches as that to be used in the project including coarse and fine aggregates, water, source and type of cement, supplementary cementitious materials and admixtures including any site-added admixtures intended to be used.

PART 3 EXECUTION

3.1 FORMWORK

A. Concrete formwork shall be in accordance with Section 03 10 00, Concrete Forming and Accessories. Additional measures shall be taken to seal the formwork to prevent leakage of cement paste or mortar.

3.2 BATCHING

A. Materials shall be batched in accordance with ASTM C 94/C 94M.

In addition to the use of a moisture probe, the moisture content of the aggregates shall be determined once a day prior to batching in accordance with ASTM C 70 or ASTM C 566. Aggregate samples shall be taken as close as possible to the area where moisture probe is located. Use of microwave oven or hot plate to dry the aggregates is permitted in addition to using an oven.

B. Volume of concrete batched shall be such that no spillage occurs during transport.

3.3 TRANSPORTING

A. Concrete shall be transported in accordance with ASTM C 94/C 94M.

3.4 COLD WEATHER CONCRETING

A. Concrete shall be placed and protected in accordance with ACI 306.1.

3.5 HOT WEATHER CONCRETING

A. Concrete shall be placed and protected in accordance with ACI 305.1.

3.6 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for the first 24 hours or for additional time as may be required before transporting samples to the test lab.
2. Provide concrete for testing of slump flow, air content, density (unit weight) and temperature and, for making cylinders.
3. Water shall not be added to the concrete at the job site.
4. Field addition of admixtures, if needed for logistics reasons, shall be approved by the Engineer.

B. Consult with the admixture manufacturer in developing quality control operations appropriate to the project.

C. Field testing and inspection shall be performed in accordance with ACI 301 (ACI 301M).

D. Concrete tests shall be conducted by an ACI Concrete Field Testing Technician Grade I, or equivalent, knowledgeable in testing self-consolidating concrete.

E. Tests shall be conducted on the first batch of the day and for each 100 yd^3 (76 m^3) or fraction thereof, for each concrete mixture placed in any one day**.**

F. The testing agency shall provide the following services:

1. Inspect concrete placement.
2. Sample the concrete in accordance with ASTM C 172.
3. Test concrete slump flow in accordance with ASTM C 1611/C 1611M. Cone can either be used upright or inverted. Same procedure shall be followed throughout the project.
4. Record the Visual Stability Index (VSI).
5. Test passing ability in accordance with ASTM C 1621/C 1621M. Cone shall be used in the same way as in slump flow test.
6. Determine the air content of concrete sample for each strength test in accordance with ASTM C 231 or ASTM C 173/C 173M, except that the concrete shall be filled in one lift and not consolidated. Light tamping of the sides of the air-meter is permitted.
7. Determine the density (unit weight) of concrete sample for each strength test in accordance with ASTM C 138/C 138M, except that the concrete shall be filled in one lift and not consolidated.
8. Record the temperature of concrete for each strength test in accordance with ASTM C 1064/C 1064M.
9. Cast concrete specimens for compressive strength test as follows:

   Cast and cure at least three 6-inch by 12-inch (150 mm by 300 mm) cylinders or four 4-inch by 8-inch (100 mm by 200 mm) cylinders in accordance with ASTM C 31/C 31M, except that the concrete shall be placed in one lift and not consolidated. However, light tapping of the sides of the cylinders with an open hand is permitted.

   [*Note: Adjust number of cylinders to be cast if strength tests at other than standard ages are required*]

10. Record the fresh concrete data for each set. The datasheet shall include the following:
    a. Mixture number
    b. Specified 28-day strength
    c. Date and time of batching
    d. Time of testing
    e. Location of placement
    f. Truck number
    g. Ticket number

h. Slump flow, VSI, passing ability, air content, density (unit weight) and temperature of concrete

i. Ambient temperature

j. Names and quantities of admixtures added on site, and, name and title of the person who authorized the addition

k. Set number, if more than one set of cylinders are cast on a single day

l. Name of the testing agency

m. Name and signature of the inspector who conducted the test, and

n. Any additional observations or comments.

11. Mark the cylinders and write the date of casting on each cylinder.

12. Store and protect the cylinders at the job site immediately after casting in accordance with ASTM C 31/C 31M.

13. Transport the cylinders from job site to the laboratory in accordance with ASTM C 31/C 31M after the cylinders have attained acceptable strength.

14. Cure the cylinders in the laboratory in accordance with ASTM C 31/C 31M.

15. Test cylinders for compressive strength in accordance with ASTM C 39/C 39M.

    a. Test one cylinder at 7 days for information and at least two cylinders at 28 days for acceptance when testing 6-inch by 12-inch (150 mm by 300 mm) cylinders unless otherwise specified.

    b. Test one cylinder at 7 days for information and at least three cylinders at 28 days for acceptance when testing 4-inch by 8-inch (100 mm by 200 mm) cylinders unless otherwise specified.

    [Note: Tests at other ages may be specified as necessary]

16. Base strength value on the average of at least two 6-inch by 12-inch (150 mm by 300 mm) cylinders or three 4-inch by 8-inch (100 mm by 200 mm) cylinders tested at 28 days.

17. Test report shall include all the information in Item 10 above and compressive strength data, and shall be signed by the laboratory manager.

18. Strength of concrete shall be deemed satisfactory if both of the following requirements are met (ACI 318 [ACI 318M]):

    a. Every arithmetic average of any three consecutive compressive strength tests equals or exceeds the specified compressive strength, and

    b. No compressive strength test falls below the specified compressive strength by more than 500 psi (3.5 MPa) when the specified strength is 5000 psi (35 MPa) or less; or by more than 10 percent of specified strength, when the specified strength is above 5000 psi (35 MPa).

If any strength test of laboratory-cured cylinders falls below the specified compressive strength by more than the values specified above, remedial measures shall be taken as recommended by the Architect/Engineer.

3.7 CONSOLIDATION

A. Consolidation is typically not necessary for SCC. However, the contractor shall have internal vibrators as recommended in ACI 301 (ACI 301M) on site in case internal vibration is needed due to delays in placement or the concrete has a lower than expected slump flow and has to be placed to prevent the formation of a cold joint.

B. Prior approval by the Architect/Engineer shall be obtained if minimal vibration (external or internal) is required for proper consolidation due to congested reinforcement or space restrictions.

3.8 FINISHING

A. Concrete finishing shall be in accordance with Section 03 35 00.

3.9 CURING AND PROTECTION

A. Curing and protection of concrete shall be in accordance with ACI 308.1 [Section 03 39 00].

END OF SECTION