For more information, contact ***Master Builders Solutions;*** 23700 Chagrin Blvd., Beachwood, OH 44122; Phone: (800) 628-9990; Website: <https://www.master-builders-solutions.com/en-us.>

Note: this document contains specific guidance (in green) that enables the user to select the appropriate solution for the required application. This three-part guide specification is representative of a specification meeting the CSI section code and containing multiple product options. For an individual product specifi­cation, visit: https://master-builders-solutions.com/en-us/specifications/

**SECTION 03 31 26**

**SELF-CONSOLIDATING CONCRETE (SCC)**

*This section is based on the products of BASF Corporation – Admixture Systems which is located at:*

 *23700 Chagrin Blvd.*

 *Cleveland, OH, USA, 44122*

 *Telephone: (800) 628-9990*

 *Fax: (216) 839-8821*

 *Email: admixtures@basf.com*

 *Internet: http://www.master-builders-solutions.basf.us*

**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

**1.3 REFERENCES**

A. Standards referenced shall be the most current versions.

B. ASTM International (ASTM):

1. C 31/C 31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. C 33/C 33M - Standard Specification for Concrete Aggregates
3. C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C 70 - Standard Test Method for Surface Moisture in Fine Aggregate
5. C 94/C 94M - Standard Specification for Ready-Mixed Concrete
6. C 138/C 138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
7. C 150/C 150M - Standard Specification for Portland Cement
8. C 172/C 172M - Standard Practice for Sampling Freshly Mixed Concrete
9. C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
10. C 231/C 231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
11. C 260/C 260M - Standard Specification for Air-Entraining Admixtures for Concrete
12. C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete
13. C 566 - Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
14. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
15. C 989/C 989M - Standard Specification for Slag Cement for Use in Concrete and Mortars
16. C 1017/C 1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
17. C 1064/C 1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
18. C 1116/C 1116M - Standard Specification for Fiber-Reinforced Concrete
19. C 1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
20. C 1550 - Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)
21. C 1579 - Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)
22. C 1602/C 1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
23. C 1609/C 1609M - Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)
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. C 1712 - Standard Test Method for Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test
28. C 1758/C 1758M - Standard Practice for Fabricating Test Specimens with Self-Consolidating Concrete
29. E 329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

C. American Concrete Institute (ACI):

1. ACI SPEC-301 - Specifications for Structural Concrete
2. ACI SPEC-301M - Specifications for Structural Concrete (Metric)
3. ACI SPEC-305.1 - Specification for Hot Weather Concreting
4. ACI SPEC-306.1 - Standard Specification for Cold Weather Concreting
5. ACI SPEC-308.1 - Standard Specification for Curing Concrete
6. ACI CODE-318 - Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary
7. ACI CODE-318M - Building Code Requirements for Structural Concrete (ACI 318M-14) and Commentary (Metric)

D. NSF International (NSF):

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

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

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

F. Corps of Engineers:

1. CRD-C 48 Standard Test Method for Water Permeability of Concrete

G. International Organization for Standardization (ISO):

1. ISO 14040: 2006 Environmental management – Life cycle assessment – Principles and framework

2. ISO 14044: 2006 Environmental management – Life cycle assessment – Requirements and guidelines

H. American National Standards Institute/ Steel Deck Institute (ANSI/SDI):

 1. C - 2017 Standard for Composite Steel Floor Deck-Slabs

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

H. 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.

I. Static Segregation Resistance: Resistance of a concrete mixture to segregation of the mortar component from the coarse aggregate while the concrete is at rest and before initial setting.

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.

K. [Green Sense® Concrete](http://www.master-builders-solutions.basf.us/en-us/functions-and-applications/producing-concrete/green-sense-concrete): Green Sense Concrete is an environmentally preferable, cost-effective concrete that is proportioned to meet or exceed performance targets using an optimization procedure from Master Builders Solutions, and materials that include supplementary cementitious materials, non-cementitious inert fillers, or both, Master Builders Solutions MasterGlenium® (Glenium) high-range water-reducing admixtures and MasterSure® Z 60 (RheoTEC Z-60) workability-retaining admixture.

All concrete mixtures can be proportioned using the BASF procedure to optimize the quantities of supplementary cementitious materials and non-cementitious inert fillers to reduce their environmental impact and promote sustainable construction.

**1.5 SUBMITTALS**

A. In accordance with 01 33 00.

 1. Mixture proportions.

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

 3. Product Data.

 4. Ready-mixed concrete delivery tickets.

1. Green Sense Concrete as proportioned by Master Builders Solutions Phone: (800) 626-6260.

In addition, an environmental assessment report for the concrete mixture shall be submitted. The environmental assessment shall compare the submitted concrete mixture to a conventional/typical reference concrete mixture that would otherwise be used to achieve the specified performance. The assessment at a minimum shall include information in the following environmental impact areas: air emissions (climate change, acidification, photochemical ozone formation, ozone depletion), water emissions (aquatic eutrophication), consumption of raw materials (resource depletion - mineral, fossil) and human toxicity potential. The methodology used to conduct the analysis and assessment shall be in accordance with ISO 14040 and ISO 14044 (ecological part) and shall be third-party-verified by NSF International, or other accredited agency that provides third-party assessment services.

**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. Testing shall be conducted by an ACI Self-Consolidating Concrete Testing Technician, or equivalent.

* 1. **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/C 150M, Type [I] [II] [I/II] [III] [V].

B. 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/C 989M.

4. Silica Fume: Shall conform to ASTM C 1240.

a. Products and Manufacturers:

“MasterLife SF 100” (Rheomac SF 100) by Master Builders Solutions.

5. Metakaolin: Shall conform to ASTM C 618, Class N.

a. Products and Manufacturers:

MasterLife MK 828 by Master Builders Solutions.

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

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

E. 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/C 260M.

b. Products and Manufacturers:

MasterAirAE 90, MasterAir AE 400, or MasterAir AE 200 by Master Builders Solutions.

3. Water-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type A.

b. Products and Manufacturers:

MasterPozzolith Series by Master Builders Solutions.

1. Mid-Range Water-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type A.

b. Products and Manufacturers:

MasterPolyheed Series by Master Builders Solutions.

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:

MasterGlenium Series by Master Builders Solutions.

6. Accelerating Admixture:

a. Shall conform to ASTM C 494/C 494M Type C or E.

b. Products and Manufacturers:

MasterSet AC 534 or MasterSet FP 20 by Master Builders Solutions.

7. Retarding Admixture:

a. Shall conform to ASTM C 494/C 494M Type B or D.

b. Products and Manufacturers:

MasterSet R Series or MasterSet DELVO® Series by Master Builders Solutions.

8. Hydration Controlling Admixture:

a. Shall conform to ASTM C 494/C 494M Type B or D.

b. Products and Manufacturers:

MasterSet DELVO Series by Master Builders Solutions.

1. 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:

MasterSure Z 60 by Master Builders Solutions.

10. Permeability-Reducing Admixture:

* + 1. Shall be a portland cement-based crystalline capillary waterproofing admixture that reacts in concrete to form non-soluble crystalline hydration products in the capillary pores of the concrete.
		2. Shall conform to ASTM C 494/C 494 M, Type S.
		3. Shall show a reduction in permeability of concrete compared to an identical concrete mixture without the admixture, when tested in accordance with CRD-C 48 at a pressure of 200 psi (1.4 MPa) [equivalent to 460 ft (140 m) of head].
		4. Shall reduce or have no penetration of water compared to an identical concrete mixture without the admixture, when tested in accordance with DIN 1048 for a duration of 96 hours.
		5. Shall be certified to NSF/ANSI 61.

*NSF Certification may be required for potable water tanks. Delete if it is not required for the project*

* + 1. Product:

MasterLife300 Series by Master Builders Solotions.

11. Viscosity-Modifying Admixture:

a. Shall conform to ASTM C 494/C 494M Type S.

b. Products and Manufacturers:

MasterMatrix VMA Series by Master Builders Solutions.

12. Corrosion-Inhibiting Admixture:

a. Shall be a nominal 30 percent solution of calcium nitrite or an amine/ester-based organic corrosion-inhibiting admixture.

b. Products and Manufacturers:

MasterLife CI 30 or MasterLife CI 222 by Master Builders Solutions.

13. Shrinkage-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type S.

b. Products and Manufacturers:

MasterLife SRA Series or MasterLife CRA 007 by Master Builders Solutions.

*MasterLife CRA 007 is also classified as a crack-reducing admixture, because it provides better performance under restrained shrinkage resulting in smaller crack widths.*

14. Alkali-Silica Reaction Inhibiting Admixture:

* 1. Shall contain a nominal lithium nitrate content of 30 percent.
	2. Shall conform to ASTM C 494/C 494M Type S.
	3. Products and Manufacturers:

MasterLife ASR 30 by Master Builders Solutions.

15. Coloring Admixture:

a. Products and Manufacturers:

MasterColor Series by Master Builders Solutions.

16. Other admixtures shall be approved by the Architect/Engineer.

BASF Kaolin was formerly known as Engelhard Corporation

F. Fiber Reinforcement:

* 1. Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of 1.5 inches long, with a minimum aspect ratio of 45 <Insert ratio>, for use in producing Type I Steel Fiber-Reinforced Concrete

meeting the requirements of ASTM C1116/C1116M.

* + - * 1. Shall provide a minimum residual strength, *fD150*, (or a minimum average flexural strength, *fe,3*) of [ ] psi when tested in accordance with

ASTM C1609/C1609M, using the roller support system described in

ASTM C1812/C1812M. [Shall have a minimum toughness of [ ] Joules when tested in accordance with ASTM C1550]

* + - * 1. Dosage shall be as recommended by the manufacturer, but not less than 25 lb/yd3 for composite metal deck floor slabs.

c. Manufacturers: Subject to compliance with requirements, provide

 products by one of the following:

1. Master Builders Solutions; MasterFiber510 or 515.

2. <Insert manufacturer’s name>

* 1. Carbon-Steel Cut Sheet Fiber: ASTM A820/A820M, Type 2, cut sheet,

deformed, minimum of 1 inch long, with a minimum aspect ratio of 45 <Insert ratio>, for use in producing Type I Steel Fiber-Reinforced Concrete

meeting the requirements of ASTM C1116/C1116M.

* + - * 1. Shall provide a minimum residual strength, *fD150*, (or a minimum average flexural strength, *fe,3*) of [ ] psi when tested in accordance with

ASTM C1609/C1609M, using the roller support system described in

ASTM C1812/C1812M. [Shall have a minimum toughness of [ ] Joules

when tested in accordance with ASTM C1550

* + - * 1. Dosage shall be as recommended by the manufacturer, but not less than 25 lb/yd3 for composite metal deck floor slabs.
				2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Master Builders Solutions; MasterFiber 520 or 525

2. <Insert manufacturer’s name>

 3. Synthetic Monofilament Microfiber: ASTM D7508/D7508M, monofilament

 polypropylene microfibers engineered and designed for use in producing

 Type III Synthetic Fiber-Reinforced Concrete meeting the requirements of

 ASTM C1116/C1116M.

 a. Shall provide a minimum crack reduction ratio (CRR) of [40] [ ] percent

 when tested in accordance with ASTM C1579.

 b. Dosage shall be as recommended by the manufacturer.

 c. Manufacturers: Subject to compliance with requirements, provide

 products by one of the following:

 1. Master Builders Solutions; MasterFiber M Series.

 2. <Insert manufacturer’s name>

 4. Synthetic Fibrillated Microfiber: ASTM D7508/D7508M, fibrillated

 polypropylene microfibers engineered and designed for use in producing

 Type III Synthetic Fiber-Reinforced Concrete meeting the requirements of

 ASTM C1116/C1116M.

 a. Shall provide a minimum crack reduction ratio (CRR) of [40] [] percent

 when tested in accordance with ASTM C1579.

 b. Dosage shall be 1.5 lb/yd3.

 c. Manufacturers: Subject to compliance with requirements, provide

 products by one of the following:

 1. Master Builders Solutions; MasterFiber F Series.

 2. <Insert manufacturer’s name>

 5. Synthetic Macrofibers: ASTM D7508/D7508M, polypropylene macrofibers

 engineered and designed for use in producing Type III Synthetic Fiber-

 Reinforced Concrete meeting the requirements of ASTM C1116/C1116M.

 a. Shall provide a minimum residual strength, *fD150,* (or a minimum

 average flexural strength, *fe,3*) of [ ] psi when tested in accordance with

 ASTM C1609/C1609M, using the roller support system described in

 ASTM C1812/C1812M. [Shall have a minimum toughness of [ ] Joules

 when tested in accordance with ASTM C1550]

 b. Dosage shall be as recommended by the manufacturer, but not less

 than 4 lb/yd3 for composite metal deck floor slabs.

 c. Manufacturers: Subject to compliance with requirements, provide

 products by one of the following:

 1. Master Builders Solutions; MasterFiber MAC Series.

 2. <Insert manufacturer’s name>

*Specify either equivalent flexural strength ratio (RDT,150) or toughness based on the type of structural element and the type of analysis used in the design of fiber-reinforced concrete. Delete options that are not necessary. Contact BASF Corporation for guidance to calculate RDT,150 values. Toughness values based on ASTM C 1550 are typically specified for shotcrete.*

*Dosage of fibers for composite steel deck shall not be less than 4 lb/yd3 (2.4 kg/m3) for synthetic macrofibers as recommended in ANSI/SDI C - 2017*

 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:

MasterKureER 50 by Master Builders Solutions.

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 mass of SCM shall not exceed the percentages listed in the following table for concrete exposed to freezing and thawing and in continuous contact with moisture and exposed to deicing chemicals (ACI CODE-318 (ACI CODE-318M) Exposure Class F3).

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

\* Fly ash or other pozzolans and silica fume shall not constitute more than 25

and 10 percent, respectively, of the total mass of cementitious materials

B. Slump Flow:

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

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

3. The slump flow of SCC used on the project shall be the design slump flow plus or minus 2 inches (50 mm).

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

|  |  |
| --- | --- |
| 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 (50 mm).

E. Stability: The stability of the concrete mixture shall be determined in the laboratory prior to approval of the SCC mixture using test method ASTM C 1610/C 1610M or ASTM C 1712. Concrete mixtures shall have a maximum static segregation (segregation factor) of 15 percent, based on ASTM C 1610/C 1610M or a maximum penetration depth of 15 mm, based on ASTM C 1712.

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

*ACI 318 (ACI 318M) provides the following guidance:*

*Because it is difficult to verify accurately the w/cm of concrete, the selected value of fc′ should be consistent with the maximum w/cm required for durability. Selection of an fc′ that is consistent with the maximum permitted w/cm required for durability will permit results of strength tests to be used as a surrogate for w/cm, and thus help ensure that the maximum w/cm is not exceeded in the field. (See Section R19.2 of ACI 318-14 (ACI 318M-14) for details)*

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 Architect/Engineer a mixture proportion for the SCC to be used.

1. Proportion SCC mixture according to project specific criteria (Compressive Strength, Air Content, Slump Flow, T50, VSI, J-Ring Value and Segregation Factor or Static Segregation Resistance (Penetration depth)).

2. Green Sense Concrete shall be proportioned in accordance with the Master Builders Solutions procedure.

3. Use the same components in the trial batches as that to be used in the project, including coarse and fine aggregates, inert non-cementitious fillers, water, source and type of cement, supplementary cementitious materials and admixtures including any site-added admixtures intended to be used.

**PART 3 EXECUTION**

* 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 [ASTM C 1116/C 1116M].

 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 [ASTM C 1116/C 1116M].

**3.4 COLD WEATHER CONCRETING**

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

**3.5 HOT WEATHER CONCRETING**

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

**3.6 FIELD QUALITY CONTROL**

A. General:

1. Water shall not be added to the concrete at the job site.

2. Field addition of admixtures, if needed for logistics reasons, shall be approved by the Architect/Engineer.

3. Provide concrete for testing of slump flow, air content, density (unit weight) and temperature and, for making cylinders.

4. 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.

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

1. Field testing and inspection shall be performed in accordance with ACI SPEC-301

(ACI SPEC-301M)

D. Concrete tests shall be conducted by an ACI Self-Consolidating Concrete Testing Technician, or equivalent.

E. Tests shall be conducted on the first batch of the day and for each 150 yd3 (110 m3) or fraction thereof, for each concrete mixture placed in any one day**.**

F. The testing and inspection agency shall provide the following services:

1. Inspect concrete placement.

2. Sample the concrete in accordance with ASTM C 172/C 172M.

3. Fabricate test specimens in accordance with ASTM C 1758/C 1758M.

4. 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.

5. Record the Visual Stability Index (VSI).

6. Determine the static segregation resistance in accordance with ASTM C 1712. (Optional)

7. Test passing ability in accordance with ASTM C 1621/C 1621M. Cone shall be used in the same way as in slump flow test.

8. Determine the density (unit weight) of concrete sample for each strength test in accordance with ASTM C 138/C 138M. Fill the mold with SCC following the procedure in ASTM C 1758/C 1758M.

9. Determine the air content of concrete sample for each strength test in accordance with ASTM C 231/C 231M or ASTM C 173/C 173M. Fill the mold with SCC following the procedure in ASTM C 1758/C 1758M.

10. Record the temperature of concrete for each strength test in accordance with ASTM C 1064/C 1064M.

11. 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. Fill the mold with SCC following the procedure in ASTM C 1758/C 1758M.

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

12. Record the fresh concrete data for each set. The data shall include the following:

* 1. Mixture number
	2. Specified 28-day strength
	3. Date and time of batching
	4. Time of testing
	5. Location of placement
	6. Truck number
	7. Ticket number
	8. Slump flow, VSI, passing ability, penetration depth (optional), air content, density (unit weight) and temperature of concrete
	9. Ambient temperature
	10. Names and quantities of admixtures added on site, and, name and title of the person who authorized the addition
	11. Set number, if more than one set of cylinders is cast on a single day
	12. Name of the testing agency
	13. Name and signature of the inspector who conducted the test, and
	14. Any additional observations or comments.

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

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

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

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

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

1. 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.
2. 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.

*Tests at other ages may be specified as necessary*

18. 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.

19. Test report shall include all the information in Item 12 above and compressive strength data and, shall be signed by the laboratory manager.

20. Strength of concrete shall be deemed satisfactory if both of the following requirements are met (ACI CODE-318 [ACI CODE-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.

* 1. **CONSOLIDATION**

Consolidation is typically not necessary for SCC. However, the contractor shall have internal vibrators as recommended in ACI SPEC-301 (ACI SPEC-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.

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 SPEC-308.1 [Section 03 39 00].

END OF SECTION