



Concrete Plant International
North America Edition

 JUNE | 3
2018
www.cpi-worldwide.com

REPRINT | CONCRETE PIPES AND MANHOLES

Building the Case for Self-Consolidating Concrete



REPRINT
CPI 03/18



Building the Case for Self-Consolidating Concrete

■ Russell Tripp, P.E., President, American Concrete Pipe Association, USA
 Cliff Ohlwiler, P.E., Cliff Ohlwiler Concrete Consulting, Inc., USA

One of the many advances in the reinforced concrete precast box and manhole production industry is self-consolidating concrete (SCC). SCC is a highly flowable, non-segregating concrete that can flow into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation. It is a highly engineered fluid with unique rheological properties. Rheology is the science dealing with the flow of materials, including studies of deformation of hardened concrete, the handling and placing of freshly mixed concrete, and the behavior of slurries and pastes. (Cement and Concrete Terminology, ACI Publication SP-19). The concrete mix is finding its way into many buried precast infrastructure applications. Those who recognize opportunities for SCC-based products have learned a new way of mixing concrete to increase market share in a very competitive storm sewer, sanitary sewer and stormwater management market space.

Many U.S. states are cautious about the use of SCC, and most do not have fully developed specifications to produce the mix, mainly due to lack of familiarity or promotion by our Industry. State DOTs, however, are becoming more interested in SCC and are beginning to work with reinforced concrete producers to develop specifications that have been adopted by municipal public works officials. Some of the state DOTs already accepting SCC in specifications are CA, MN, IA NE, ND, SD, MT, WY, KS, MO, WI, VA, NY, NJ, PA, and MD. California, Iowa and South Dakota have published specifications for SCC.

Caltrans 2015 Standard Specification section 90-5 allows SCC in precast concrete, providing the mix design has been pre-qualified per section 90-5.01D(2)(c) Prequalification of Mix Design. All other types of construction require approval in the special provisions, or special approval must be requested for a project.

The SCC Basics - 101

Concrete is typically considered a Bingham fluid, which is described in terms of yield stress and plastic viscosity. The yield stress is the shear stress to initiate or maintain flow and the plastic viscosity is the resistance to flow once the yield stress is exceeded. SCC should have a very low yield stress, but the plastic viscosity can vary. (Wikipedia)

The addition of superplasticizers and viscosity modifiers supplied by admixtures companies reduce viscosity and segregation. Concrete that segregates loses strength and results in lower durability and honeycombed areas next to the formwork. Admixtures companies and vendors supply increasingly complex and specialized raw materials that yield products tailored to specific construction environments and concrete production capacity. A well-designed SCC mix does not segregate and has high deformability and excellent stability characteristics. For these reasons, reinforced concrete producers



Finishing to provide a quality finish



Slump flow test

enjoy the benefits of increased potential for reduced vibration and automation in precast facilities, increased worker productivity, and reduced health and safety issues related to vibration. Because the production process is improved, higher quality products are the outcome.

SCC requires concrete movement to provide consolidation. It is important to limit the number of placement locations on a form to allow concrete to flow and consolidate. Normal concrete mixes typically require placement from many closely-spaced locations to minimize concrete movement and segregation. SCC is more efficient for placement in forms containing intricate details and congested reinforcement. The timing for finishing steps will be affected. Finishers must become familiar with the SCC mix setting characteristics to time the finishing steps and provide a quality concrete finish. Overall set time can be controlled like any other concrete with accelerators or retarders.

Quality Control

- Aggregate gradations must be closely monitored and consistent to produce SCC
- Forms must be level
- Visual Stability Index (VSI) is an easy and valuable test for monitoring mix stability but can be a subjective test
- PCI Guidelines
 - i. Guidelines for The Use of Self-Consolidating Concrete in Precast/Prestressed Concrete 2nd Edition (TR-6-15-PCI): The guidelines represent current recommended practice of using SCC in the precast/prestressed concrete industry. These guidelines address the use of SCC in precast, prestressed concrete manufacturing plants and reference PCI plant quality manuals MNL-116-99 and MNL-117-13.
- ASTM standard test methods specifically for SCC
 - i. C1758 / C1758M - 15: Standard Practice for Fabricating Test Specimens with Self-Consolidating Concrete. This practice covers procedures for fabricating test specimens in the laboratory or field using a representative sample of fresh self-consolidating concrete.

- ii. ASTM C1610 / C1610M - 17: Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique provides users with a procedure to determine the potential static segregation of self-consolidating concrete. This test method is used to develop self-consolidating concrete mixtures with segregation not exceeding specified limits.
- iii. ASTM C1611 / C1611M - 14: Standard Test Method for Slump Flow of Self-Consolidating Concrete provides a procedure to determine the slump flow of self-consolidating concrete in the laboratory or the field. The test method is used to monitor the consistency of fresh, unhardened self-consolidating concrete and its unconfined flow potential.
- iv. ASTM C1712 - 17: Standard Test Method for Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test is for the rapid assessment of the static segregation resistance of self-consolidating concrete. The method is useful for rapid assessment of the static segregation resistance of self-consolidating concrete during mixture development in the laboratory as well as prior to placement of the mixture in the field. The test does not measure static segregation resistance directly but provides an assessment of whether static segregation is likely to occur. Test Method C1610/C1610M for static segregation of SCC is not sufficiently rapid, and the non-mandatory Visual Stability Index as determined through the procedure described in Appendix X1 of Test Method C1611/C1611M is highly subjective and qualitative.
- v. ASTM C1621 / C1621M - 17: Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring provides a procedure to determine the passing ability of self-consolidating concrete. This test method is applicable for laboratory use in comparing the passing ability of different concrete mixtures. It is also applicable in the field as a quality control test.

Daily plant quality control testing similar to Caltrans requirements is a suggested minimum. This would include Slump Flow, Visual Stability Index (C1611) and Compressive Test Specimens (C1758). Combinations of the other tests can be used to evaluate characteristics of mix designs.

Safety improvements with SCC

- Plant noise reduction (no vibrators)
- No airlines or extension cords on the floors to power the vibrators
- Personnel are not needed on the forms to handle internal vibrators
- Reduced need for personnel to guide the concrete bucket during placement
- Remote control buckets are common with SCC concrete pouring



SCC Placement



Production cost savings with SCC

- Savings from reduced wear and tear on forms from vibration
- Savings from reduced placement labor costs and speed of placement
- Reduced costs for air hoses, vibrators and electrical extension cords
- Early stripping strengths can be obtained without the use of steam curing

Production cost increases with SCC

- Typically, higher cementitious material contents are used to increase paste volume to improve mix flow and mix stability
- SCC mixes may also have higher admixture costs

In increasingly competitive markets for precast concrete drainage systems, precasters are building the case for SCC with new applications for existing standard products. The introduction of new SCC products for sustainable drainage systems, low impact development for stormwater management, and resilient critical buried infrastructure are increasing each year. An additional option that holds opportunity for increasing market share lies in the use of self-consolidating concrete.

The mix is accepted in many states, and it appears that many more are now moving to work with local producers to develop and revise specifications to include SCC. Many producers have taken advantage of the SCC mix to realized cost savings in production for improving plant safety while supplying more products to infrastructure projects.

Photos: courtesy of the ACPA and its members. ■

FURTHER INFORMATION



American **Concrete Pipe** Association

American Concrete Pipe Association
8445 Freeport Parkway
Suite 350, Irving, Texas 75063-2595, USA
T +1 972 5067216, F +1 972 5067682
info@concretepipe.org, rtripp@concretepipe.org
www.concretepipe.org

Cliff Ohlwiler, P.E.
Cliff Ohlwiler Concrete Consulting, Inc.
cliff.ohlwiler@gmail.com