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Self-consolidating concrete adds to the versatility of products offered at concrete pipe plants

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Concrete pipe and precast box producers work with suppliers to advance the technology of their products to maintain a competitive edge, while supplying rigid products for drainage systems and culverts considered to be critical infrastructure. One of the many advances in precast box and manhole production is self-consolidating concrete (SCC). Introduced to America in 2000, the concrete mix is finding its way into applications that are in demand. Structures for implementing disaster plans and other strategies for ensuring sustained economic growth in the face of anticipated floods, coastal surges, firestorms, and extreme winter weather may be supplied with boxes produced with SCC.

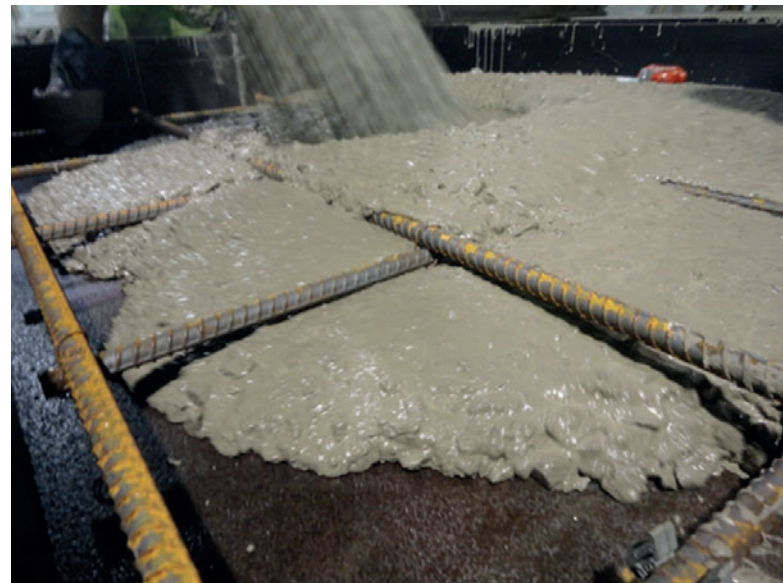
ACI 237 defines SCC as a highly flowable, non-segregating concrete that can flow into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation. It is a highly engineered fluid with unique rheological properties. Rheology is the science dealing with the flow of 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)

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. A common example is toothpaste, which will not be extruded until a certain pressure is applied to the tube. It then is pushed out as a solid plug. (Wikipedia) The addition of superplasticizers and viscosity modifier are added to the mix, reducing viscosity and segregation. Concrete that segregates loses strength and results in honeycombed areas next to the formwork. A well-designed SCC mix does not segregate, has high deformability and excellent stability characteristics. For these reasons, precast box producers



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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.



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CONCRETE PIPES AND MANHOLES

The Precast/Prestressed Concrete Institute (PCI) published "Guidelines for the use of SCC in August 2003. The publication "Guidelines for The Use of Self-Consolidating Concrete in Precast/Prestressed Concrete is now a 2nd Edition (TR-6-15). The guidelines have been updated to incorporate developments that have taken place since 2003. 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. Construction site use of SCC is not addressed in these guidelines. The goal of this publication is to present recommendations for best practices for use of SCC as applicable to current North American practice.

The precast advantage using SCC - Precast vs. CIP

Compared to cast-in-place (CIP) construction with SCC, the advantages of precast construction are many.

- The quality and aesthetics of SCC-produced precast is greater because precast elements are produced in a controlled environment without weather constraints
- Speed of construction using precast products is well documented giving it an advantage over CIP, whether SCC or non-SCC
- Contractors and owners benefit from savings in construction time due to speed of installation of precast products
- If SCC is an option for production, there are savings in production time with much less labor input compared to CIP
- Workers are not exposed to the elements, traffic, construction site activity, and the noise of vibration, since SCC can be used in a controlled plant environment. A production plant is much safer and quieter than a CIP project



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Test Methods to Evaluate SCC in Fresh State

- Workability: ASTM C-1611: "Standard Test Method for Slump Flow of Self-Consolidating Concrete"
- Stability: ASTM C-1610 Column Segregation Test
- ASTM C-1712 Rapid Assessment Test for SCC Segregation
- Passing Ability: ASTM C-1621 J-Ring



Several ASTM standards for test methods of SCC are available.

- The need for accelerated precast construction is increasing, and the method better understood for replacing failed drainage systems, culverts, and small bridges. Add SCC into the process and it is likely that products can be delivered to construction sites more quickly, especially if large box culverts or storm sewers are specified.

Since SCC does not require vibration, producers may choose to change the production process, if the advantages of SCC for the producer, contractor and owner continue to be positive. There are environmental advantages to SCC products through noise reduction, and fast construction schedules result in lower environmental impact. Production of complex box designs without vibration for a variety of applications including stormwater detention systems, culverts and bridges using the accelerated precast construction method are likely to see greater market share. And there is the apparent advantage of healthier and safer working environments that are likely to trigger specifications of precast products where SCC may be an advantage. As the 21st century construction industry continues to be defined, and demand for precast products not dreamed of at the turn of the century become standardized, we can only expect the science of SCC to open new markets for precast concrete boxes, manholes, and concrete pipe. ■

Photos: courtesy of the ACPA and its members.

References:

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January 2018, SCC for Precast Box Culverts, Joseph A Daczko, FACI, BASF Construction Chemicals, joseph.daczko@basf.com

An Introduction to Self-Consolidating Concrete (SCC), Technical Bulletin

https://gcpat.com/sites/gcpat.com/files/2017-06/Technical-Bulletin-TB-1500_v2%20%281%29.pdf

Self-Compacting Concrete Applications and Advantages

<https://www.thebalance.com/self-compacting-concrete-844767>

FURTHER INFORMATION



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