SELF COMPACTING CONCRETE

Setting A New Standard For Cast In Place Concrete
Definition

“Self compacting concrete, Self placing concrete, or Self leveling concrete. These concretes are highly flowable concretes that can spread into place under their own weight and achieve good consolidation without internal or external vibration and without exhibiting defects due to segregation and bleeding.”

- Kamal Khayat
History

• SCC was first developed in Japan in the 1980’s
• First SCC mixes were hybrids of underwater concretes (tremie mixes).
• The Technology was transferred to Europe in the 1990’s with the development of polycarboxylate generation of superplasticizers.
• SCC Technology transferred to North America in the Late 1990’s via primarily University Research.

• Producing a SCC mix in a Ready Mix Plant is more challenging than producing one in the Laboratory.
SCC Mix Design Process

- Cementitious materials require selection on blaine and reactivity.
- Aggregates - Attention to Maximum size, particle shape, gradations and sand / stone ratios
- Admixtures - Superplasticizers and viscosity modifiers
- Proportioning - A SCC mixture is much more scientific than that of conventional concrete mixes.
• Conventional concretes start to segregate at approximately 8 in. - 10 in. slump.

• A well designed SCC mix does not segregate. It has high deformability and excellent stability characteristics.
Cut Cylinders showing segregation
Consolidation of Conventional Concrete

- Labor Intensive
- Labor Dependent
- Quality Control?
- Safety Concerns
Consolidation of Conventional Concrete
Applications of Self-Consolidating Concrete
Cinque Terre
Vancouver, Canada

5 story luxury condominium project

The labor to place and finish each suspended slabs was reduced over 90% from 35-man-hours to 3-man-hours.
Chinatown Millenium Gate
Vancouver, BC

Traditional Chinese gate to welcome visitors
Douglas County Justice Center Expansion
Castle Rock, CO
Application: Block fill
Block fill Flows Horizontally Without Vibration
SCC test at National Concrete Masonry Assn.
Robert Moses Dam
New York Power Authority

SCC placed from a crane bucket through a 4” PVC pipe 10’ vertically down over a parapet wall on the dam face and 4’ horizontally into a form.
Auger-Cast Piles
Rockville, MD

CONSTRUCTION STAGES

Augering
Concrete casting and auger extraction
Casting completion
Steel cage insertion

Auger schematic
One Wall Center
Vancouver, BC

Consolidation in heavily reinforced sections 50MPa, Heat generation, Shrinkage. Required surface finish, Exposed outrigger columns
Contractor
Saw the mix flow into heavily reinforced sections without vibration with excellent surface finishes

Engineer
Observed the product’s moderate heat, early strength development, with favorable shrinkage and modulus of elasticity results.
Kidd Mine
Timmins, Ontario
*Application: Mass concrete*

- Conversion of abandoned shaft into main shaft
  - Placement location 5000 ft underground
  - Unstable ground with a large traversing fault
  - Critical step on construction schedule
- Contractor: Cementation Skanska Canada Inc.
- Specified Performance
  - 3500 psi in 28 Days
  - Low Heat of Hydration – minimize temperature peak
  - Fluid to self-leveling consistency – no ability to properly consolidate
- Placement Techniques
  - Borehole from surface to 4800 level
  - Pump 500 ft. to top of shaft
  - Freefall maximum of 400 ft.
Step #1 - slash to 6m below 48
Pour sub collar & collar

Temp plug

Void to be filled

FST. SLOUGHAGE

goat fault zone

ELEV 1800
Calgary, Alberta
Visual Barrier Walls
City of Arvada, Colorado

303 precast concrete panels
8.5’ x 18.5’ x 6” with formliner

“By eliminating the vibration step in the casting process, it was sort of like an insurance policy, reducing the risk of variation in the labor efforts.” Xernie Meritt, partner Concrete Express

“The fast rate of strength gain of the Agilia mix enabled us to pour the panels in the afternoon, and lift them the next morning. That was a big help to our schedule.” Joe O’Dea, partner Concrete Express
Why does it flow?
Particle Size - Void Packing.
Workability

- Fluid material
- Input of energy
- Movement of particles
- Overcome internal friction
Cement-HRWR interaction.
Robustness is a key element
# Standard Class A Structural Mix vs Self Consolidating Mix

## Copyrighted Information

### CLASS A w/ SUPER SELF CONSOLIDATING

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<tr>
<td>CEMENT</td>
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**TOTAL VOLUME**

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7.35 CF

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9.74 CF
Rainbow Bridge Rehabilitation Project-2005

Niagara Falls Bridge Commission
Rainbow Bridge

• Crane access only on north side of bridge
• Repair work was needed on the south side
• Contractor ran a 4” PVC pipe 30’ at a 30 degree angle
• SCC was bucketed down to the pipe
• SCC ran down the pipe into the form
MTO
Madawaska River Bridge
SCC—MTO

- SCC for soffit repairs beneath the deck in the archways on this Bridge.
- The thickness of patches was between 1.5 and 4 inches.
The contractor worked from a barge to form the underside of the archways.
Formwork in place
SCC was poured into a trough that was drained by a 4 inch core hole in the deck. Most of the repair was under the paved portion of the bridge so the SCC had to travel approximately 15-20 ft, some of this distance through chipped out channels that had a cross sectional area of 2X4 inches.
The SCC completely filled the space and tensile-bond tests failed in the underlying concrete beneath the SCC-Concrete interface.
Slump Flow Test

- Concrete is poured into cone in one lift
- No rodding or vibration
- Slump Flow is the average of two measured diameters
- Assesses the deformability capacity of the concrete under a low shear rate regime (self weight)
- Slump Flow: 18 in. to 25 in. max. 30 in.
Slump flow measurement
Concrete Properties:

- Creep and Modulus of Elasticity
  - Similar to standard concrete

- In air entrained concretes. Air void systems equal to or better than conventional mixes

- Chloride permeability <1000 coulombs

- Shrinkage as per ASTM C 157 Values are similar to conventional concretes using the same materials
Concrete Properties

• **Durability:**
  Freeze Thaw testing ASTM C 666
  Dependent upon mix designs and materials used 95%- 100%

• **Setting Time:**
  Typical setting times as determined by ASTM C 403 will be similar to conventional concretes
Structural Engineer

- Ability to design with higher reinforcement density
- Bond to reinforcing steel
- Improved structural Integrity
Architect

- Improved Aesthetics
- Design creativity enhancement
- Consistency of Finish appearance
- Sharp Lines
Reid Agilia Job - Showing Door and Vent Openings