Prepackaged SCC for Repairs & Case Studies

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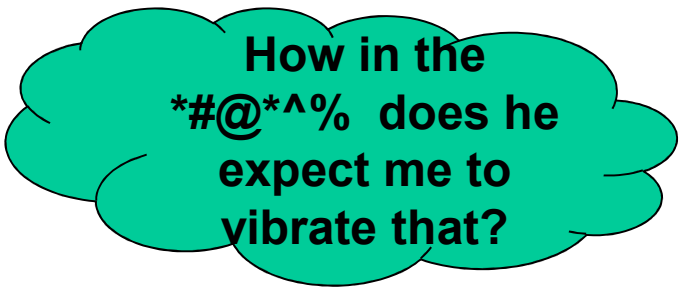
What is SCC?....

A new solution to an old problem…



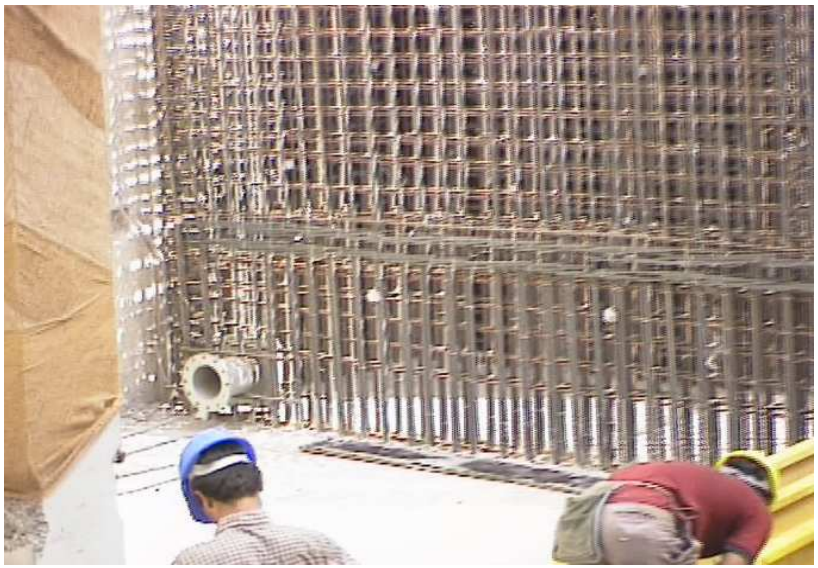
Contents

SCC - Definition

Self consolidating concrete (SCC) is highly flowable, non segregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation (ACI 237).

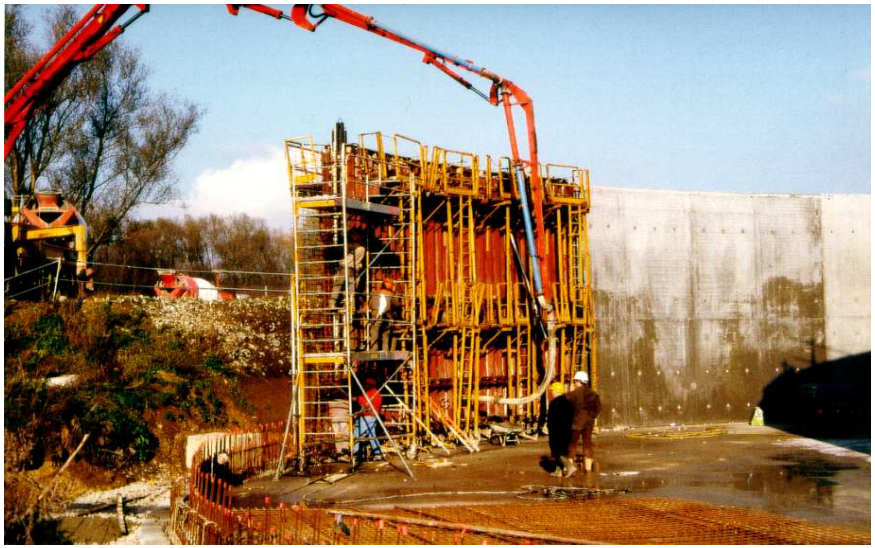
Need for SCC Today

- Slender sections
- Congested reinforcement
- High productivity
- Better surface finish
- These applications are not limited to new construction



Vertical Applications

- Can be poured from the top or pumped from bottom to top
- Can be poured from a single point
- Similar geometries for repair



Horizontal Applications

- Faster placing time
- No Vibration required
- Smaller scale for repairs
- Less labor


Traditional
Double Ts


Photo from Fredericksburg, VA
Guess which one was made using SCC!
Same quality is achievable in repair work!

Contents

- SCC – General
- SCC – Repair & New Construction
- Case studies - SCC applications in repair

SCC – Properties

Quality SCC must possess:

- ***Filling ability*** :

  Ability to flow into all spaces within the form-work under self weight

- ***Passing ability*** :

  Ability to flow through tight openings such as spaces between steel reinforcing bars, under self weight

- ***Resistance to segregation*** :

  Its composition at any stage must be uniform through the process of transportation and placement

	Pre-Cast	Cast in Place	Formed Repairs
Filling Ability	✓	✓	✓
Passing Ability	✓	✓	✓
Segregation Resistance	✓	✓	✓

SCC – Fluid Properties

Tests to evaluate typical fluid properties:

Characteristic	Test Method	New Construction/ Ready Mix	Restoration/ Repair
Flowability	Slump Flow Test	✓	✓
Viscosity (Rate of Flow)	T50 of Slump Flow Test V-Funnel Test Rheometer	✓	✓
Passing Ability	L-Box Test J-Ring Test U- Box Test	✓	✓
Segregation	Column Segregation Test Segregation Resistance (Sieve Test) Visual Stability Index	✓	✓

ASTM C-1611

- Covers flowability (slump flow), viscosity and Visual Stability Index (VSI)

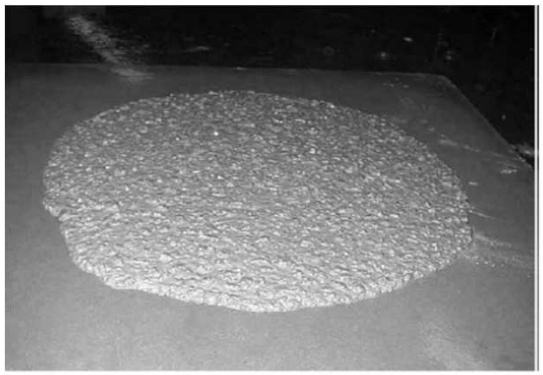


FIG. X1.1 VSI = 0 – Concrete Mass Is Homogeneous and No Evidence of Bleeding.

FIG. X1.2 VSI = 1 – Concrete Shows Slight Bleeding Observed as a Sheen on the Surface.

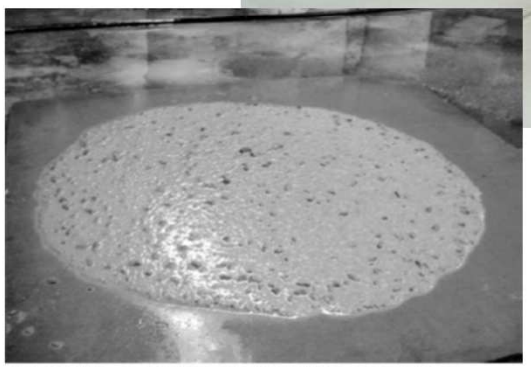


FIG. X1.3 VSI = 2 – Evidence of a Mortar Halo and Water Sheen.

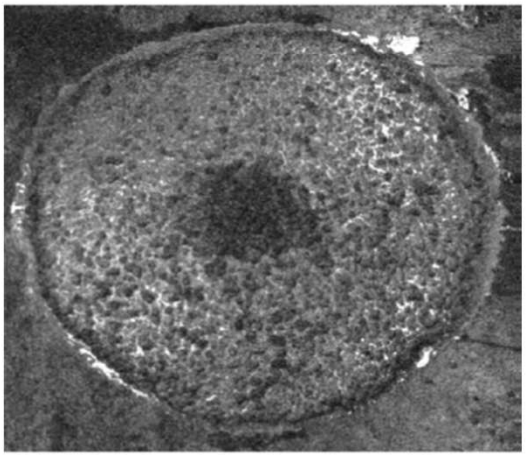


FIG. X1.4 VSI = 3 – Concentration of Coarse Aggregate at Center of Concrete Mass and Presence of a Mortar Halo.

ASTM C-1621

- Covers passing ability with the J-Ring Test

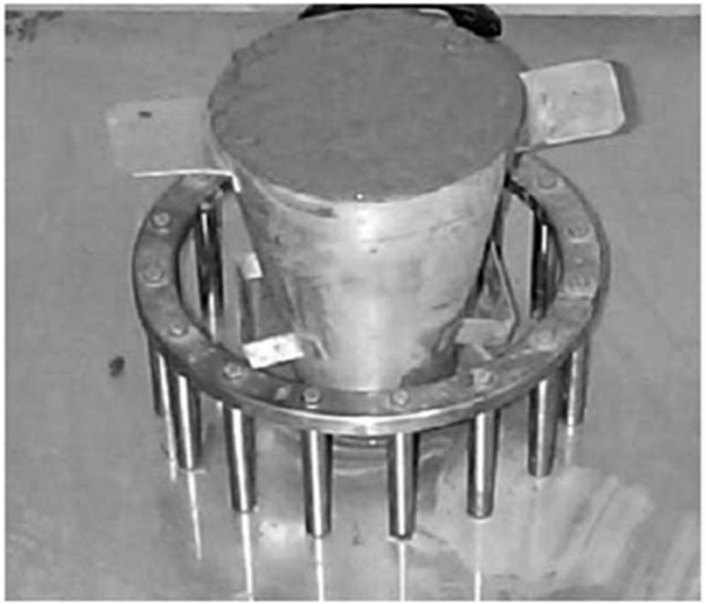


FIG. 2 J-Ring Setup with Inverted Mold Filled with Concrete

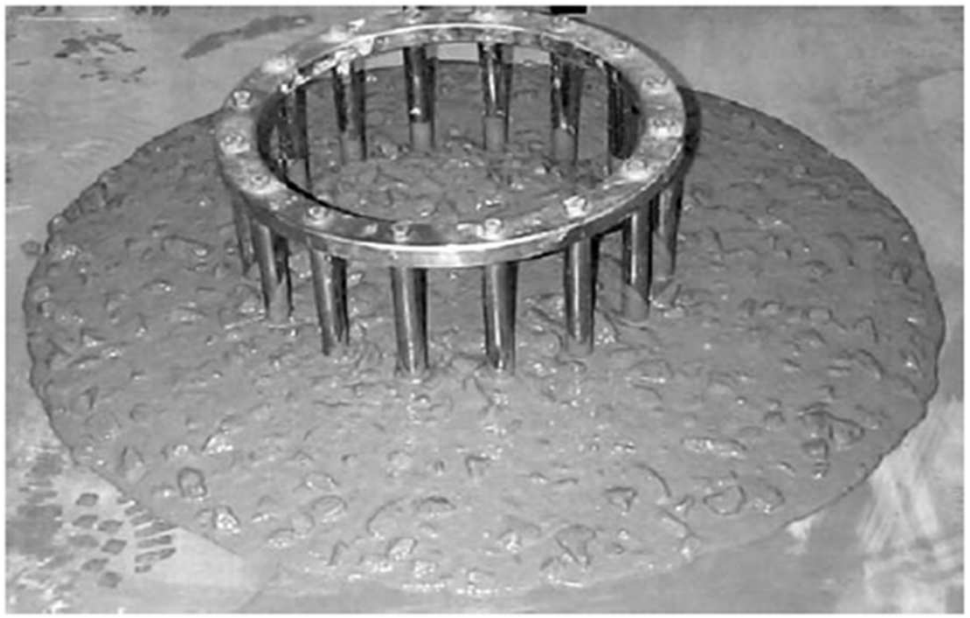
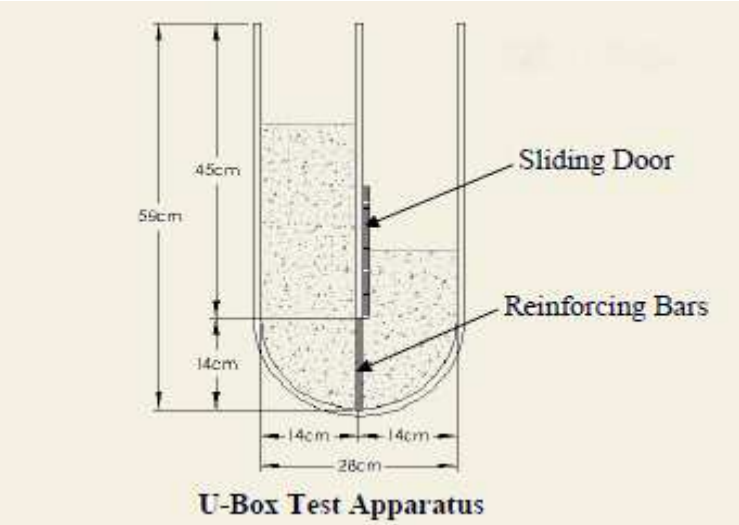


FIG. 3 J-Ring Flow

Passing Ability: L-Box Test

Passing Ability: U-Box Test



U-Box Test Apparatus

- Similar to the L-Box Test
- Indicates ability to fill
- Suitable for laboratory and site use

Viscosity: V-Funnel Test

- Related to plastic viscosity
- Partially indicates filling ability and ability to move through blockages
- Suitable for laboratory and site use

ASTM C 1610

- Column Segregation Test
- Visually shows how a product segregates at multiple depth levels
- Indicates product stability

SCC Materials

Chemical admixtures:

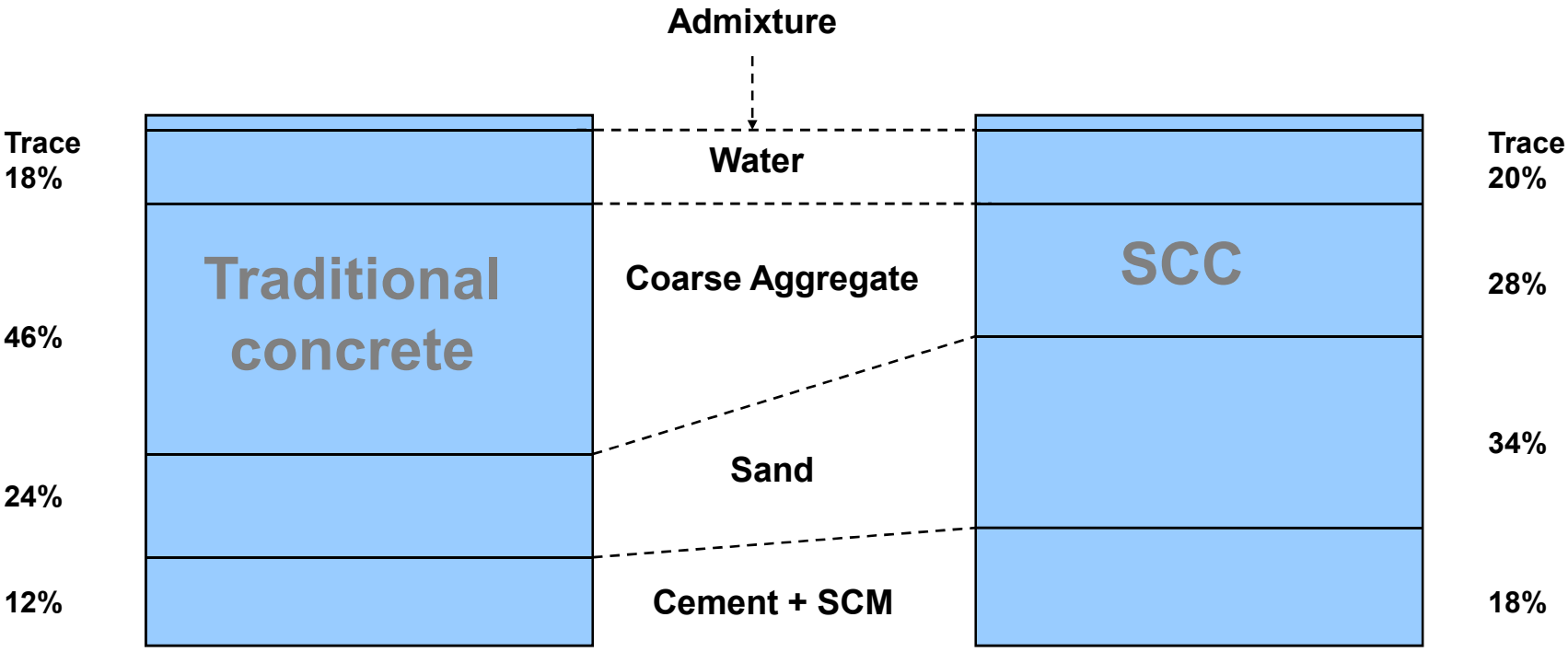
- High Range Water Reducers
  - Polycarboxylate based
  - Conventional admixtures can also be used
- Viscosity Modifying Admixtrues (VMA's)
- Other Admixtures
  - Retarders
  - Air Entrainers
  - Accelerators, etc.

SCC Materials

Aggregates:

- Normal concreting aggregates for structural concrete can be used.
- Nominal maximum size of aggregate to be used depends on reinforcement layout & minimum form dimension.
- Aggregates should be well graded.
- Blending natural and manufactured sand can improve SCC properties

Typical Mix Design Volume Percentage



Same for Ready Mix and Bagged Material

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Beams & Column Repair

Indiana Bridge

- IL Tollway Authority
- Approx 40 Year Old Bridge
- Extreme Repairs – Size and Volume
- Product was pumped in place
- 7500 X 65 # bags used.

Beam & Column Repair

Illinois Bridge – onsite testing

Spread =26-30-”

Parking Deck
Plymouth, MA

- Edge of joint between two slabs showed wear and tear
- Area was prepped and the SCC was poured

Dry Folk Power Station - WY

- Beams constructed in 2008.
- Anchor bolts sleeves collected water- resulting in freeze thaw damage in winter.
- Depth of the repair ranged from 2-12”.
- Form an pour application with a pre-bagged SCC mix.
- Approx. 300 cu.ft. in repair

Dry Folk Power Station - WY

- Material Spread over 24”

- Large Spalling to be Repaired

Dry Folk Power Station - WY

Column Enlargement

Houston, TX

- Columns suffered severe deterioration
- Corrosion was removed and reinforcement was added
- Forms were put up and clamped in place
- Material was poured from the top to enlarge columns

Column Enlargement

Houston, TX

Henley Bridge Project

Knoxville, TN

- Bridge built in 1931
- Demolished & replaced bridge deck & supports
- Added traffic lane
- Minor repairs to arches & piers
- Total $24.7 million

Henley Bridge Project
Knoxville, TN

Henley Bridge Project

Knoxville, TN

Henley Bridge Project

Knoxville, TN

Air Force Academy

Colorado Springs

- Two large bridge structures supports were in need of repair

- Some repair areas were as deep as 12”

- Difficult access to repair areas, needed lift for material and personel

Air Force Academy
Colorado Springs

Air Force Academy
Colorado Springs

Air Force Academy

Colorado Springs

Romano Vineyard Way Bridge

- Concrete was poured at 105°F!
- Concrete not recommended for high temps
- Concrete set too quickly within forms creating voids and rock pockets
- Used SCC to repair mistake

Romano Vineyard Way Bridge

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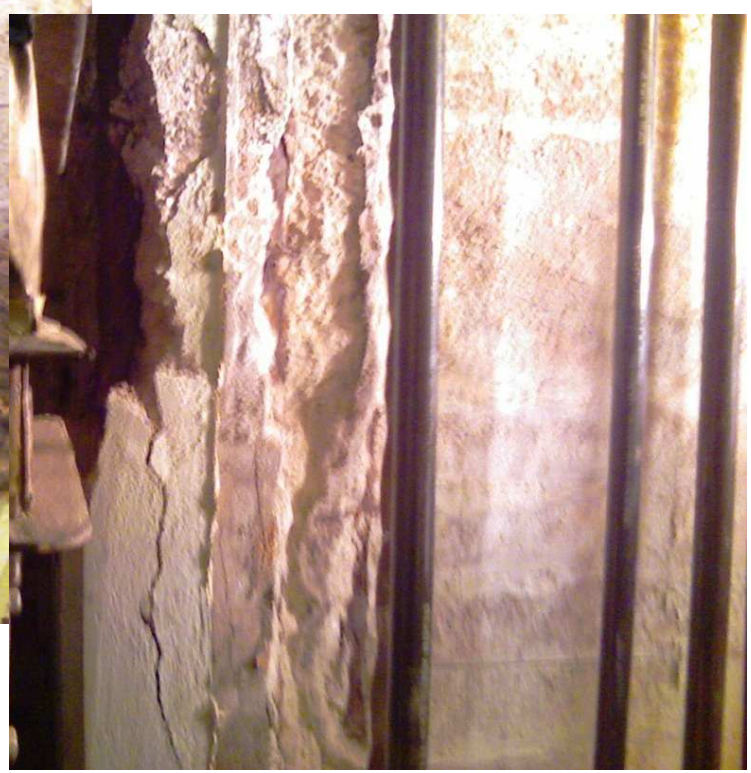
Jewelers Exchange
San Diego, CA

- Cast-in-place concrete from ~1910
- Significant cracking, corrosion and spalling caused by water intrusion for many years
- Walls, columns, stairs and shoring were all effected

Jewelers Exchange
San Diego, CA

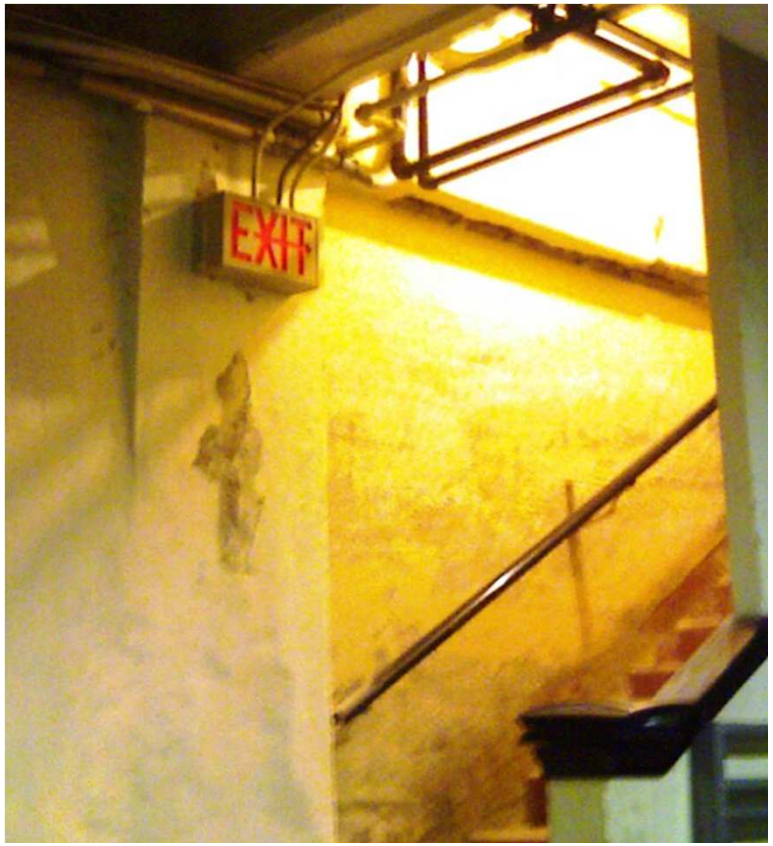


Column with major spalling into structural core. Blue line shows how wide column used to be.
Column is roughly 18” x 20” and is 33% “gone”.

Jewelers Exchange
San Diego, CA

Completed column repair after SCC formwork and pour

Jewelers Exchange
San Diego, CA



The deterioration of the concrete wall, peeling paint, and efflorescence are indicative of past water infiltration at this section of wall.

Stair Wall after SCC repair

Hobart Bridge
Lake County, Indiana

- Hobert Bridge, on Tollroad I-90, was repaired in 2007-2008
- ~15,000 bags of SCC was used
- Mainly substructure repair – piers & caps

Hobart Bridge
Lake County, Indiana

- Spalls are cut out to geometric shapes
- Concrete around rebar is removed

Hobart Bridge

Lake County, Indiana

- Formwork placed around repair areas
- SCC is pumped into place from above

Hobart Bridge
Lake County, Indiana

- Completed repairs

Wilson St. Parking Garage

Indiana

- Full depth and shallow repairs
- One product fits all!

Wilson St. Parking Garage
Indiana

- Forms were stripped within 24 hours!
- Pictures show during repair and after

NY Balcony Project

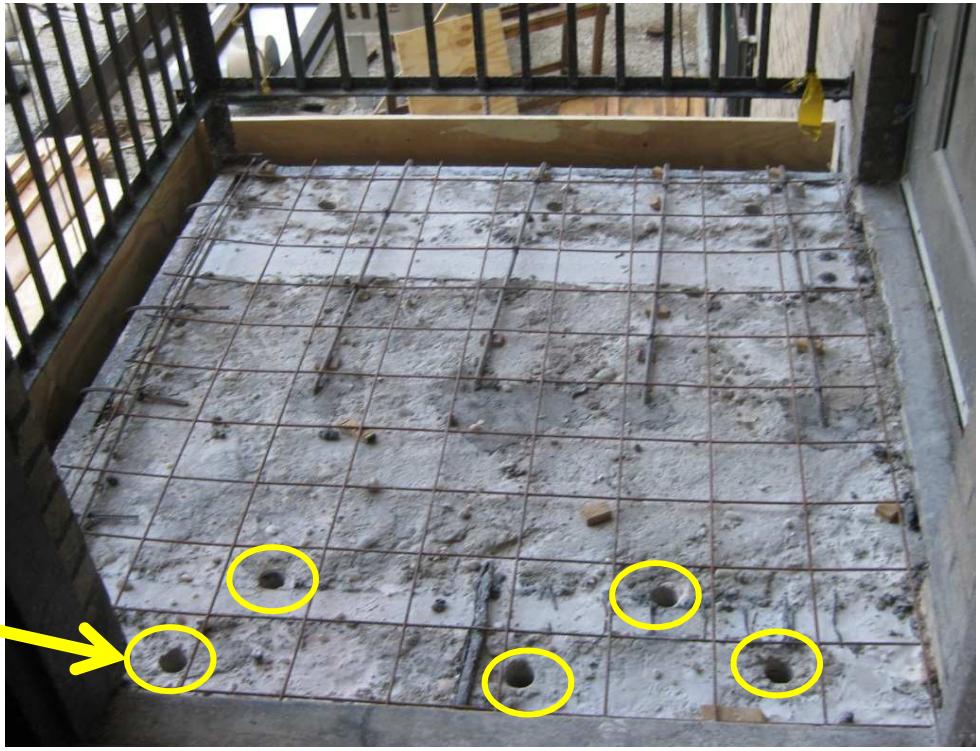
- Balconies in NYC
- Major spalling on top and undersides
- Pre Packaged SCC was used

- Underside of balcor after surface prep

NY Balcony Project

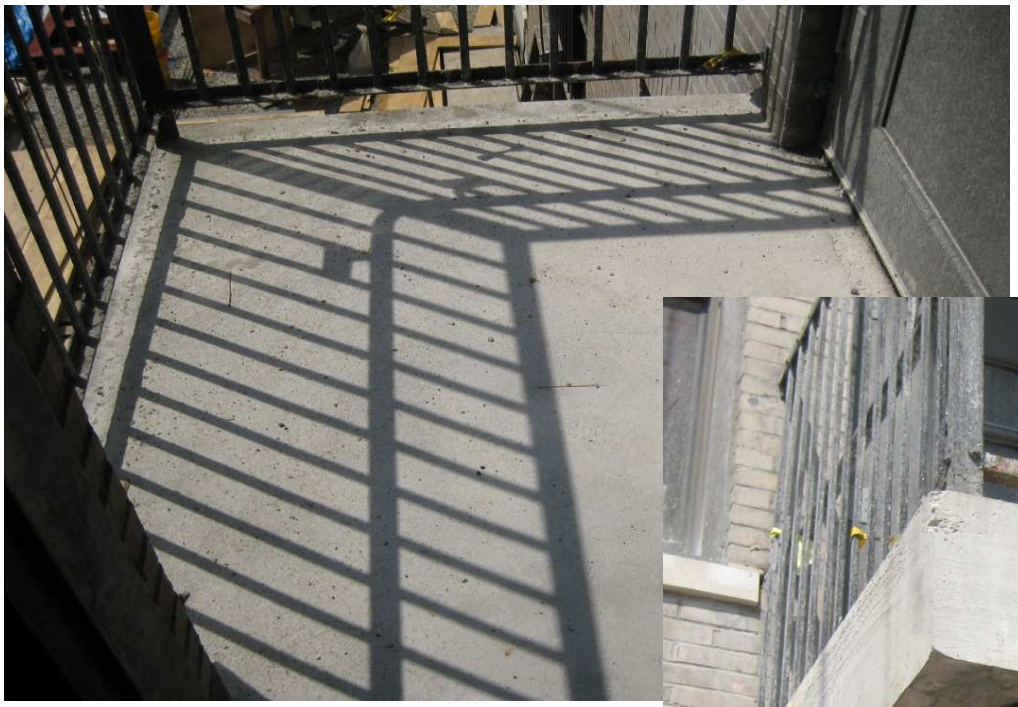
- Topside of balcony, after surface prep
- Notice core holes drilled through slab
- SCC was poured from the top and flowed through the holes to fill the underside formwork

Core Holes



NY Balcony Project

- Top and Bottom sides after repairs:



Quality of Production

Quality of Production

Production Challenges - Pre-Bagged SCC	
Challenges	**Margin of Error**
Very High Level/Potent Admixtures	Zero
Difference in Cement Characteristic	Low (need to adjust on a batch basis)
Bag Weight	Very Low
Variation in Aggregate	Medium
Quality Control Monitoring	Low

- If any one of these challenges is incorrect, the material will be **TOO FLUID**, and lead to segregation, or **TOO STIFF**, and lead to difficulties handling and placing.

- While all of these challenges are very important, without a high level of quality control, errors will be overlooked.

Conclusion

- Pre Packaged SCC technology is being used successfully in new construction as well as restoration and repair.
- Pre Packaged SCC in repair applications is helping solve many problems of the repair industry.
- Pre Packaged SCC has very specific production requirements and must be produced to a higher standard.

Thank You!

Any Questions?