Additional General SCC Infomration

The Following Information was Compiled From Articles By:

The European Guidelines for Self-Compacting Concrete
Specification, Production and Use
These Guidelines and specifications were prepared by a project group comprising five European Federations dedicated to the promotion of advanced materials, and systems for the supply and use of concrete. The Self-Compacting Concrete European Project Group was founded in January 2004 with representatives from:
BIBM The European Precast Concrete Organization.
CEMBUREAU The European Cement Association.
ERMCO The European Ready-mix Concrete Organization.
EFCA The European Federation of Concrete Admixture Associations.
EFNARC The European Federation of Specialist Construction Chemicals and Concrete Systems.

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THE CONCRETE PRODUCER
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Appearance

The appearance of an element cast with SCC mainly depends on:

- The type of cement and addition used
- The mix composition of the SCC
- The quality of the mold and release agent
- The placing procedure

The appearance is usually better than for normal concrete:

- The color is generally more uniform
- It is easier to avoid defects due to leakage spots at the location of mold joints and around strand or wires exit points
- The edges may be sharp if the mold is well designed and maintained

• Bugholes can still arise, but should be limited in number and size
• Air voids under horizontal parts of the mold can be limited in size and number, when the mold is filled properly.

The following list of defects can be found in all types of concrete but with care, SCC can give an improved finish compared to traditional concrete:

• Bugholes
• Honeycombing
• Vertical stripes and other color variations
• Plastic or drying shrinkage cracking.

Additional information on some defects is given in the following clauses.

Bugholes

Air is introduced into concrete during the mixing process but also during the transportation and casting. The extent to which air is either stabilized within SCC or is lost during placing depends on the cohesion of the mix. A high slump-flow SF3 and low plastic viscosity VS/VF1 are beneficial in helping to achieve perfect surfaces as they make it easier for the air to leave the concrete. A mix that is close to segregation will usually give the best surface.
Blowholes are formed when small air bubbles become trapped or adhere on the formwork surface. In addition to the factors detailed above, blowholes can also be due to the surface quality of the formwork and the type and/or quantity of release agent used. Advice should be sought from both the release agent supplier and the concrete producer.
Air will be released more easily if the rate of rise of the concrete in the formwork is limited and also if it has to move sideways in the mold for several yards.
Pumping from the bottom of the formwork generally produces better surface finish. If this is not possible the casting hose should be kept below the concrete surface at all times. If the concrete is allowed to free-fall, this may increase the number of larger entrapped air voids both on the surface and within the body of the concrete.

Honeycombing

Honeycombing may be due to leakage in the formwork but is more usually caused by poor passing ability resulting in aggregate bridging and voids behind reinforcement.

SCC with poor passing ability is usually due to:

• Slump-flow class too low
• Viscosity too high
• Maximum aggregate size too large
• Insufficient paste or too much coarse aggregate.

If honeycombing occurs and is not due to formwork leakage, the concrete should be checked against the specification. If conformity to the specification is confirmed, consideration should be given to revising the specification.

Color consistency and surface aberrations

Vertical stripes at the SCC surface are rare and usually caused by bleed water. Any bleed water tends to accumulate at the vertical mold surface and flow upwards leaving visible stripes on the hardened concrete surface due to washout and or floatation of the mold oil.
There are several reasons why bleeding may occur:

- High water to powder ratio
- Viscosity too low
- Low temperature
- Retarded set.

Other reasons for color variations are:

- Uneven drying of surface (for example caused by new or dry timber molds or plastic sheet that touch part of the concrete during the curing period)
- Over application or poor choice of release agent
- Differences in material source between batches of concrete.

Minimizing surface cracking

SCC is designed to be stable and resistant to segregation but, like traditional vibrated concrete, it may suffer from plastic settlement cracking above reinforcing bars if aggregate settlement does occur. Some SCC mix designs, especially those where a very high quality finish is required, can be very close to the aggregate segregation point so extra control may be required.

Because SCC has little or no bleed it can lose surface water, resulting in drying shrinkage cracks if curing is not started at an early age

Forms

Wood forms and metal forms will show significant differences in surface defects. Wood forms tend to produce fewer bug holes than metal because wood forms soak up excess release agent that has been hastily applied. Any small amount of extra oil on a steel form will react with the concrete mix and create small bug holes, perhaps better termed "pinholes." Therefore, proper application is absolutely necessary. Steel forms require more attention to ensure a clean, smooth surface. Any defect on the form will create a blemish on the concrete surface.

A form's cleanliness and smoothness greatly affect the appearance of the concrete surface. This simple, logical truth cannot be overstated when dealing with SCC.

Forms should be as smooth as possible to allow entrapped air to move easily upward along the form system; they must be kept free of paste buildup and laitance, which prevent air and water pockets from traveling to the concrete surface. In our study, as paste built up on each form with subsequent castings, the concrete surface appeared worse. Scratches or gouges will hold air against the surface of the concrete. Any steel forms pitted with rust will cause blemishes, which at times produce more bug holes than are noticeable with vibrated conventional concrete. We also noticed that when the form skin had a lower temperature than the SCC, air voids smaller than usual were present. That occurred at approximately a *25*° F temperature difference.

Whenever you grind a "seasoned" steel form, you remove the protective barrier previously produced by the reactive form release agent. Rusted forms have negated the barrier that was in place. Once the form is ground, raw metal is exposed. The reactive portion of the form release agent, typically a fatty acid, has a natural affinity for metal. The fatty acid attacks the raw metal and forms metallic oleate, which acts as a protective coating. Subsequent applications of reactive form release agents are prevented from getting to the metal by the protective layer of metallic oleate, allowing the reactive portion of the form release to be available to react with the free lime on the surface of the concrete. This reaction forms a chemically inert metallic soap, which gives good release and allows free air to rise more easily to the surface on vertical walls. Until the form is seasoned, or the protective barrier is formed, the reactive portion combines with the metal, leaving nothing to react with the free lime. The steel forms used in this study were seasoned after cleaning and before further castings took place. That aided the finish somewhat but the pits left in the forming material by the rusting process trapped air voids, creating bug holes.

Release Agents

Five agents were analyzed in this study. Release agents fall into two primary types, barrier and reactive. Barrier release agents create a physical barrier between the form and the concrete. The barrier agent used here was a plain, low viscosity petroleum oil containing paraffin that acted like a wax, aiding the release of form materials. Reactive release agents contain weak acids derived from vegetable oils or animal fats. They may also include lignosulfates and tall oils (liquid rosin) byproducts from paper manufacture. Reactive agents fall into two primary categories: vegetable oils and petroleum-based. Most reactive release agents on the market today have petroleum-based carrying agents. In this study one vegetable-based and three petroleum- based oils were considered. Vegetable-oil-based agents had two disadvantages. After five to eight castings on a form, a buildup of flaky residue from the agent was noticed. Repeated form cleaning was necessary to maintain a good finish. Also, vegetable oils normally turn rancid when exposed to air and heat. The limited temperature range for product storage poses a problem. The vegetable-and petroleum-based reactive agents were applied to the www.concreteconstruction.net form in a thin mist, as prescribed by the manufacturers. The barrier type agent allowed the forming material to release from the concrete only when applied heavily. Heavy applications increased the presence of bugholes. The barrier agent also required five times more clean-up time to return the form surface to an acceptable casting condition after each pour. The vegetable-based agent provided the best results when used on new plywood, though only a minor improvement over two other reactive agents in the study. The petroleum based reactive agents produced the best average product appearance when used with steel forms. Not all of the reactive agents gave an acceptable appearance; even in certain reactive form oils various carrying agents can cause flaws in the concrete appearance. The barrier type agent consistently produced a poor finish, even when more labor than usual was put into release agent application.

Conclusion

Any defect in a forming system will become extremely visible in well-developed SCC. An overall smooth surface will exaggerate the appearance of marks left on the concrete from scratches in formwork, rust pits, concrete paste buildup, or other defects.

Barrier type release agents should not be used with SCC when the appearance of the formed finish is important. When barrier agents are applied thinly, the concrete does not release well from the form, and the surface of the concrete "peels." When applied heavily, the barrier agent traps large numbers of air pockets.

When a reactive release agent has been chosen, test specimens should be cast to ensure that the material performs well with the SCC being used. Not all reactive agents perform equally well with any concrete, though they generally do give a better finish than barrier agents. Reactive agents should always be applied in a thin layer, as prescribed by the manufacturer.