Definitions of Terms Relating to Self-Consolidating Concrete (SCC)

This technical bulletin provides definitions to certain terms related to Self-Consolidating Concrete (SCC). Various sources, including ACI 116 and PCI's "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants," were used in the compilation of this information. There are many terms covering similar aspects of performance being applied to SCC. We have tried to emphasize the more commonly agreed on terms by referring the reader to them when defining other terms. There is ongoing activity both in ACI and ASTM to develop consensus guides and standards; this technical bulletin will be revised as appropriate to reflect any consensus changes in terminology.

Aggregate aspect ratio—The ratio of length to width of individual pieces of coarse aggregate. This ratio sometimes affects the characteristics of SCC. Aggregates characterized as "harsher" tend to have higher aspect ratios.

Aggregate blocking—see **Blocking**

Air-migration—The undesirable condition in which entrapped air in fresh SCC migrates to the top surface causing a bubbling or boiling appearance. This is an indication of unstable air and a low viscosity mortar. Air-popping is another term used for this occurrence.

Binder—see **Powder**

Bingham fluid—A material that exhibits the behavior of having a yield stress. Thus a force (y axis) versus shear rate curve will have y intercept, known as the yield stress, and a slope, known as the plastic viscosity. Concrete tends to behave as a Bingham fluid, or near to it (pseudoplastic).

Bleed water—The water that appears to rise to the surface of concrete subsequent to placement. ACI defines bleeding as "the autogenous flow of mixing water within, or its emergence from, newly placed concrete or mortar; caused by settlement of solid materials within the (concrete) mass."

Blocking—The condition in which coarse aggregate particles combine to form elements large enough to obstruct flow of the fresh concrete between reinforcing steel or other obstructions in the concrete formwork. This property is of increased importance in SCC because of the absence of vibration energy to dislodge these blockages.

Blocking resistance—see **Passing ability**

Cohesiveness—The tendency of SCC to stick together, resulting in resistance to segregation, aggregate settlement, and bleeding.

Compactability—see **Filling ability**

Dynamic stability—The characteristic of a fresh SCC mix that ensures uniform distribution of all solid particles and air voids as the SCC is transported and placed.

Filling ability—The ability of SCC to flow under its own weight (without vibration) into and fill completely all spaces within formwork containing obstacles such as reinforcement.

Fines—All dry materials in SCC passing the 2.36 mm (No. 8) sieve.

Finishability—The ease with which SCC can be finished to achieve the desired surface flatness and smoothness on that portion of an element that must be finished. Finishability does not refer to formed surface finish quality.

Flowability—A property of fresh SCC indicating the ease of flowing without manual or mechanical effort. This is a component of filling ability, but a concrete can have high flowability without high filling ability, if the passing ability is poor.

Fluidity—see **Flowability**

J-Ring test—A test used to determine the passing ability of SCC, in which a ring containing vertical reinforcing bars surrounds the slump cone during the slump flow test. The degree to which the passage of concrete through the bars of the J-Ring apparatus is restricted indicates passing ability. Quantitatively, this is indicated by the ratio of the slump flow without the J-Ring to the slump flow with the J-Ring. Qualitatively, this is indicated by visual inspection of blocking behind the J-Ring bars.

L-Box test—A test used to determine both the filling and passing ability of SCC. A vertical column of concrete is allowed to flow through a reinforcing bar barrier to fill a trough. The flatness of the resulting concrete indicates filling ability, while any blockage at the bars indicates a lower passing ability.

Moisture control of aggregates—A critical factor in production of SCC, in that variations in moisture content accounted for in normal concrete by plant or site adjustment can cause SCC to vary in filling ability and segregation resistance by more than acceptable amounts. Thus tests or measurements for moisture control are required to be done more precisely and more frequently while producing SCC.

Mortar fraction—The volume percentage of all materials in the mixture (powder, aggregate, water, air) that pass the 2.36 mm (No. 8) sieve.

Mortar halo—A concentration of mortar that can form at the perimeter of the slump flow patty. The width of this halo is one of the parameters evaluated in the Visual Stability Index (VSI) test used to judge the stability of plastic SCC.

O-funnel—Circular device similar to a V-funnel.

Passing ability—The ability of SCC to flow through openings approaching the size of the mix's nominal maximum-size aggregate, such as the space between steel reinforcing, without segregation or aggregate blocking.

Paste—The volume percentage of the SCC mix comprising powder (cement + supplementary cementitious materials + unreactive powders), water, admixtures and air.

Placeability—The ability to place SCC in the time span required such that the material remains homogenous while exhibiting all the required SCC fresh concrete properties. A general term, encompassing elements of filling and passing ability, as well as time-dependent change.

Plastic viscosity—The rheologist's term for measurement of a material's resistance to increase in its rate of flow with increasing application of force. In a plot of the force versus the flow rate, the higher the slope, the higher is the plastic viscosity. SCC mixes tend to have moderate to high plastic viscosity.

Powder—Materials in SCC with particle sizes passing the 150 mm (No. 100) sieve. These include cement, supplementary cementitious materials and unreactive fillers.

Powder additions—Finely divided inorganic material used in SCC in order to improve certain properties or to achieve special properties. There are two types of inorganic powder additions: 1) nearly inert powder additions such as ground limestone or aggregate fines, and 2) pozzolanic or latent hydraulic powder additions such as fly ash, metakaolin, silica fume or blast furnace slag.

Powder-type SCC—SCC mixes that rely on high amounts of powders in the mix to meet SCC performance requirements. The higher powder contents increase cohesiveness and segregation resistance at high filling abilities.

Preset time—The time required to reach a degree of stiffening of concrete equal to a strength of 3.45 MPa (500 psi) as measured by penetration resistance test or other means. Also referred to as initial set time.

Pumpability—The ability of an SCC mix to be pumped without significant degradation of its fresh SCC properties.

Rheology—The science of the deformation and flow of materials. Certain of the critical properties of fresh SCC can best be understood through the principles of rheology.

Rheometer—A device used to test the deformation and flow of materials. In studying SCC, the critical parameters measured are yield stress and plastic viscosity.

Segregation resistance—see **Stability**

Self-consolidating concrete (SCC)—Also known as self-compacting concrete, a highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation or excessive bleeding, and without the need for vibration.

Settlement—A form of segregation in which the aggregates in SCC tend to sink to the bottom of the form resulting in a non-homogenous concrete.

Settlement resistance—The ability of a concrete mixture to resist settlement.

Slump flow test—A test method using the standard Abram's slump cone (upright or inverted) on a flat surface to measure the unconfined flow and stability of SCC. The numerical value in mm (inches) of flow is determined as the average diameter of the circular deposit (patty) of SCC at the conclusion of the slump flow test.

Slump flow T_{500} (T_{20})—Measurement of the time it takes for the slump flow patty to reach a 500 mm (20 in.) diameter circle drawn on the slump flow plate, after starting to raise the slump cone. Most SCC will have a T_{500} (T_{20}) of 2-5 seconds. The longer the time (at the same slump flow), generally the greater the passing ability.

Stability—The ability of SCC to remain homogenous during mixing, transportation, handling, placement, finishing and curing.

Static stability—The characteristic of fresh SCC to maintain a uniform distribution of all solid particles and air voids once all placement operations are complete.

Stickiness—The property of concrete that relates to its propensity to adhere to finishing tools and other surfaces with which it comes in contact.

Stone powder addition—Finely crushed limestone, dolomite, or granite with particle sizes passing the 150 µm (No. 100) sieve that may be used to increase the amount of powder in SCC mixes.

Thixotropic behavior—The property of a material that it exhibits a low viscosity while being mechanically agitated and for a while after, but stiffens after a period of rest. This is different from the normal Bingham plastic behavior of concrete, in which it appears to exhibit lower viscosity while moving than at rest, in that a change over time while at rest is required for a material to be thixotropic.

U-Box test—A test involving a U-shaped filling apparatus composed of two separate chambers used to measure the filling and passing ability of SCC. The concrete is held in one side of the U, then a gate is opened allowing the SCC to pass through a reinforcing bar screen to the other side. The characteristics of SCC are assessed by comparing the height of the mixture on one side of the U (h_1) to the height on the opposite side of the U (h_2).

V-funnel—A device for testing the flowability of SCC by determining the time for a measured amount of concrete to flow through a funnel opening of a specific size. Due to possible aggregate blocking in the throat of the funnel the resulting time can be a complex measure of both flowability and passing ability, and may be difficult to interpret.

Viscosity—A rheological term defined as the magnitude of the change in the applied stress required for changing the unit flow velocity of a material – in other words, the slope of the stress-shear rate curve. In simpler terms viscosity is how "thick" a fluid behaves. Simple fluids like water or oil, which have no yield stress, appear to have the same "thickness" regardless of how fast they are moving, and are called "Newtonian." Concrete, which follows so-called Bingham behavior, will have different apparent viscosities, with the lowest apparent viscosity at highest speed of shear.

Visual Stability Index (VSI)—A rating of the visual appearance of the slump flow patty to evaluate several parameters as an indication of the stability of the SCC mix. The VSI ranges from 0 for excellent; 1 acceptable; 2 needs improvement; to 3 unacceptable. There are specific guidelines for each rating.

Viscosity modifying agent (VMA)—An admixture that, when added to concrete, increases the plastic viscosity and improves the stability of the mixture at a constant fluidity.

Water to cementitious ratio (w/cm)—The ratio of the weight of free water to the weight of all cement and reactive powders such as slag, fly ash, silica fume, and metakaolin.

Water to powder ratio—The ratio of the weight of free water to the weight of all solids comprising the paste (material passing the 150 µm (No. 100) sieve) in a concrete or mortar mix.

Water to powder volume—The ratio of the volume of free water to the volume of solids comprising the paste (material passing the 150 µm (No. 100) sieve) in a concrete or mortar mix.

Water sensitivity—The amount of free water variation within the mixture that causes the characteristics of an SCC mixture (primarily its stability) to change from an acceptable range to an unacceptable range.

Workability—That property of freshly mixed concrete or mortar that determines the ease with which it can be mixed, placed, consolidated, and finished. It is a complex combination of aspects of fluidity, cohesiveness, compactability, and stickiness, quantified in tests to determine filling ability, passing ability, and stability.

Yield stress—

One of the rheological parameters of fresh concrete, fresh mortar, and fresh paste. It is the minimum stress required to make the concrete flow. SCC requires a low-yield stress. Inversely related to slump or slump flow.

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