

## Handling of Self Compacting Concrete

### Objective:

Self Compacting Concrete (SCC) is fast becoming a regular concrete in Indian Construction Industry. Professionals have recognised that SCC is not only a concrete product but contributes to the application part as well.

SCC is getting acceptance by various sectors in the construction Industry due to its unique effectiveness in building the structures stronger and durable.

However, the unique design and properties of SCC makes it very sensitive product as well.

Therefore during the entire sequence of choice of raw materials, design, supply, casting, finishing and curing of this concrete product, all the concerned engineers, from both manufacturer side and user side, shall exercise utmost control to reap the maximum benefit out of this product.

- This manual is prepared to provide minimum guidelines in Handling SCC.
- It is assumed that Viscosity Modifying Agent (VMA) is considered and used in order to optimize both binder and fine aggregate content as higher amount of binder content would result in shrinkage and cracking.
- Also, addition of VMA could help make SCC more robust.

### SCC shall have the following attributes:

- Fresh condition - it should be self-compacting maintaining its uniformity and cohesiveness.
- Early age – it should avoid initial defects such as in-homogeneity in the concrete mass.
- Hardened state - protection against external factors such as organic/inorganic salt attacks due to very high homogeneity and impermeability.

### Test requirements & criteria of SCC (Based on European Guide Lines 2005)

Specific requirements for SCC in the fresh state depend on the type of application and especially on;

- Confinement conditions related to the concrete element geometry and the quantity / type and location of reinforcement, inserts, cover and recesses etc.,
- Placing equipment (e.g. pump, direct from truck-mixer, skip, tremie)
- Placing methods (e.g. number and position of delivery points)
- Finishing method

The classifying system allows for an appropriate specification of SCC to cover these requirements, which are characterized as;

- |  |                             |
|--|-----------------------------|
| • Flowability                              | slump-flow (SF)             |
| • Viscosity (measure of the speed of flow) | viscosity (VS or VF)        |
| • Passing ability (flow without blocking)  | passing ability (PA)        |
| • Segregation resistance                   | Segregation resistance (SR) |

### Note:

- SCC requirements in fresh state that are appropriate for a given application should be selected from one or more of these four characteristics and then by the class or target value given in the following tables.
- Unless it is designed for higher percentage of air entrainment, the entrapped air content in SCC shall not be more than 2%

## Handling of Self Compacting Concrete

### **Fresh concrete characteristics/properties – Based on European Guidelines for SCC 2005 and ASTM C -1621:**

#### **1. Flow Clause – Slump Flow**

Class	Slump – Flow in mm	Conformity criteria
SF 1	550 - 650	>520 & <700 mm
SF 2	660 - 750	>640 & <800 mm
SF 3	760 - 850	>740 & <900 mm

*SF 660mm and above shall be considered only for structures with heavily congested reinforcement or critical dimension / shape*

#### **2. Passing Ability Clause - J-Ring Test (alternate to L-Box)**

ASTM C-1621	Passing ability
	Slump Flow difference Not more than 50mm

#### **3. Viscosity Clause - V-Funnel Test**

Class	V-Funnel Time in seconds	Conformity criteria
VF 1	$\leq 8$	+/- 3
VF 2	9 to 25	+/- 3

*VF2 is suitable for structures like slab, retaining wall where reinforcement is nominal*

#### **4. Segregation Resistance – $V_{5min}$ Flow class**

Class	V-Funnel Time in seconds	Conformity criteria
$V_{5min}$	$V_{5min} + 3$	+/- 2

- Both the slump flow and J-Ring flow tests could be carried out both @ site and @ plant
- V-Funnel test could be carried out in laboratory during development of SCC and during implementation in plant. It could be used to verify the viscosity at plant as and when required during supply

#### **1. Mix Designs & Trials**

1. Analyse the properties of aggregates through tests.
2. Keep the binder content optimum based on the flow, strength and durability requirements. Though higher binder content will give better flow properties that will lead to higher degree of shrinkage and cracking.
3. Select suitable Super-plasticizer and VMA for the binders chosen and the required flow retention.
4. Consider travel and placing duration.
5. Develop the mix design for the given grade, flow characteristics and any other requirements through laboratory & plant trials.

## Handling of Self Compacting Concrete

---

### **2. Inspection & Scheduling**

1. Make site inspection to ensure sturdier support to formwork (to withstand concrete pressure) and sealing of gaps to prevent leakage.
2. As SCC pour requires continuous batching, required numbers of transit mixers (vehicles) and placing equipments (pumps, Crane & bucket) are made available.
3. Schedule the concreting in such a manner that there shall be no delay in delivery.
4. Plan the sequence of casting in such a manner that there will not be cold joint formation either vertically or horizontally.

### **3. Communication and Awareness**

1. Conduct awareness programme at project site involving all the personnel to make sure all the points related to manufacturing, supply, sampling, testing, casting, finishing and curing are discussed and finalized with the responsibilities of each section of personnel are defined.
2. If SCC is being used for the first time in a project site, it is advisable to do a mockup trial which will give clear idea about SCC, required fresh concrete tests, sampling for hardened concrete test, placing arrangement, etc.

### **4. Production Process control**

1. Ensure uniformity in wetting the coarse aggregates through sprinkling and also ensure that aggregates from middle height of the stock piles are drawn for batching by JCB/Wheel loader operator.
2. Ensure that materials are accepted within the parameters stipulated and uniformity is maintained throughout the pour. It is advisable to stock the required quantity of raw materials prior to pour.
3. Any difference in limits of silt content, dust content and aggregate grading of higher magnitude shall be informed and discussed for suitable control measures.
4. Produce the SCC for the designed initial flow using appropriate moisture/absorption values for aggregates found through lab tests.
5. Check for SF, JF and VF<sub>1</sub>/VF<sub>5</sub>.
6. Adjust the admixtures dosage (SP & VMA) suitably to arrive at the required flow. The adjustment shall not deviate by more than +/-0.1% from the prescribed dosage.
7. Make required / specified number of cubes in plant.
8. Ensure each load is batched within the planned interval.
9. Sampling of SCC shall be done only with wheel barrow both @ plant as the sample in the wheel barrow can be a representative one and the mix can also be observed for segregation/settlement of coarse aggregates.

### **5. Transportation**

1. Ensure Transit mixer (TM) drivers are aware of the pouring location and interval between successive loads is maintained as planned.
2. Personnel in the plant and at site shall record batch details, fresh concrete properties verified physically or visually for all the batch loads in a format.

## Handling of Self Compacting Concrete

---

### **6 Inspection on Receipt of load @ site**

1. Allow the TM to mix the concrete load thoroughly by rotating TM drum in full rpm for not less than 100 seconds.
2. Take concrete sample in the wheel borrow (not less than 3/4<sup>th</sup> of the wheel barrow capacity) from the TM.
3. Check for SF and JF. (VF test could be limited to plant to avoid delay).
4. If flow is less, add admixture of required dose into the TM to arrive at the required flow.
5. Verify whether concrete is not segregating in the form of coarse aggregate settling down when kept in a wheel barrow, not bleeding in the form of bleed water around flow ring, and difference between J-Ring flow and Slump flow is not more than 50mm.
6. If segregation is noticed, add VMA of required dose into the TM to improve the cohesiveness of the mix
7. Mix full load of concrete thoroughly during every re-dosing process by rotating TM drum @ full rpm for not less than 100 seconds.
8. Take concrete sample again to verify the flow properties.
9. If flow properties are satisfactory, mix the concrete in TM again thoroughly for not less than 60 seconds and then allow the concrete to be poured for pumping.  
(This is essential as concrete in TM will be almost at rest while flow tests are being carried out.)
10. If flow properties are not satisfactory repeat the Steps from 4 to 9.
11. If segregation is very high and beyond adjustment with VMA @ site due to very high flow the TM load shall be rejected.
12. Also it is very important not to use SCC beyond a certain time limit after batching. The time limit shall be agreed and fixed based on the predetermined requirements.

### **6 Pumping and Placing**

The flow distance of SCC with same flow class varies with amount and pattern of reinforcement and dimension of the structure.

1. SCC shall be, poured directly into the beam-column junctions / beam-beam junctions / column-wall junctions and poured at the optimum interval by which concrete-spreads overlap with each other in slabs and beams.
2. SCC has the ability to remain homogeneous even when poured from a height of 4 feet, especially in column, wall structures and thick slabs. It is also advisable to pour from a height of 4 feet (the end of the pipe or hose can be lifted up when concrete conveying pipe lines are laid horizontal) as that will provide additional momentum for SCC to flow. Such a momentum will aid SCC to flow and fill the formwork very effectively.
3. Pumping of full load of SCC shall be done at one go and SCC shall not be kept in the TM drum for the purpose of slow pumping while expecting the delayed successive load as this will cause drop of flow.
4. Ensure that the consumption of SCC load is made within stipulated time to prevent SCC from losing its flow properties.
5. Ensure smooth supply, laying and finishing of SCC to avoid delay.
6. The interval between successive loads shall not be allowed by more than the stipulated interval, because such a delay will result in development of cold joint.
7. At no point of time pump shall keep cement mortar or slurry or water in receiving hopper and pipeline in order to keep these inner portions in liquid state.
8. It has been experienced that SCC can be pumped directly without priming slurry.

## Handling of Self Compacting Concrete

---

9. If delay is anticipated, ball passing shall be done to clear the pipe inner surface and receiving hopper shall be washed to get a fresh start.
10. In order to avoid cold joint formation, last laid layer of SCC (that is supposed to be over lapped with the load that follows) shall be compacted gently before and after delayed load is poured.
11. Sample taken in the wheel barrow or any spilled concrete shall be poured only inside the concrete pump hopper or crane bucket and not into the structure directly as this would create voids and cold joint formation.
12. Form work carpenter shall remain at site to inspect and ensure supports are kept intact and are not allowing deformation of the formwork.

### **7 Post Placing / laying**

1. SCC is not a self leveling concrete and hence leveling the surface with aluminium runner / bull float is necessary.
2. A good SCC will have evenly spread coarse aggregate at the surface and will not have laitance formation. This characteristic will help to limit the shrinkage of surface as well as cracking.
3. The surface shall not be overworked or disturbed due to which coarse aggregates are pushed inside from the surface or the laid concrete is segregated.
4. Presence of evenly spread coarse aggregates would form “key” for finish layer top.
5. SCC has the characteristic of nil-bleeding and hence the surface of SCC has to be treated with sprinkling or spraying of water immediately after finishing to avoid moisture loss from concrete surface. This is essential to avoid plastic shrinkage cracking (PSC). The sprinkling shall be done with the help of spray gun, without stepping onto the surface which would be fresh now.
6. Sprinkling of water shall be continued at regular interval at all locations until the concrete surface gets hardened to resist PSC.
7. When there is a requirement to cover the surface with plastic or tarpaulin sheets, especially during hot, windy and low humid climatic conditions, they shall not be laid directly onto the surface of the concrete as such a method would disturb the surface of concrete. Arrangements shall be made to tie them or hold them above the surface.
8. Site personnel shall inspect the slab surface during and after pouring and finishing for noticing plastic shrinkage cracks or settlement cracks. If such cracks are noticed the cracks shall be closed immediately, by tamping the cracks with wooden runner before the surface becomes stiff. Proper care shall be taken to avoid disturbing the access.

### **8 Data Collection & Analysis**

1. QA/QC shall collect all data, summarize and carryout analysis.
2. Based on the results obtained and raw materials' properties mix designs shall be maintained or fine tuned in order to sustain the required / specified performances for the further pours.

## Handling of Self Compacting Concrete

To make SCC application successful	
<p style="text-align: center;"><b><u>Avoid Cold Joint formation</u></b></p> <p><b>Reason:</b></p> <ul style="list-style-type: none"> <li>• mix is very viscous</li> <li>• drastic loss of slump-flow</li> <li>• delay in supplying successive loads</li> <li>• delay in casting successive layers</li> <li>• very high temperature making concrete to stiffen fast</li> </ul> <p><b>Remedy if delay occurs:</b> Compacting to merge the old and new layers</p>	
<p style="text-align: center;"><b><u>Avoid Plastic shrinkage cracking</u></b></p> <p><b>Reason:</b></p> <ul style="list-style-type: none"> <li>• SCC will have almost no bleeding effect</li> <li>• faster drying of surface before hardening at high ambient temperature and wind velocity</li> <li>• poor or nil early curing</li> <li>• poor re-bar cover</li> <li>• Failure in re-working the surface when cracks starting to develop</li> </ul> <p><b>Remedy :</b> All precautions required in normal concrete</p>	
<p style="text-align: center;"><b><u>Avoid Segregation</u></b></p> <p><b>Reason:</b></p> <ul style="list-style-type: none"> <li>• Improper Mix design or mix produced</li> <li>• High water content, less fines, lack of or no VMA, high Super-Plasticizer dosage</li> <li>• Super-plasticizer and cement incompatibility</li> <li>• Wrong (less) moisture used than the actual during production (saturated sand will have 10% moisture)</li> <li>• Tampering of concrete especially when there is delay</li> </ul> <p><b>Remedy:</b> Proper Design, Controlled production, product tested for V &amp; V5, timely consumption, rejection of failed load.</p>	
<p style="text-align: center;"><b><u>Limit Blow Holes (Air Trapped on to the form work surface) – appearance issue</u></b></p> <ul style="list-style-type: none"> <li>• mix is very viscous and or with high fines content</li> <li>• Quality of form work</li> <li>• Type and quantity of releasing agent applied</li> <li>• If pouring or rising rate of SCC is too fast or too slow</li> <li>• Side way flow is too long or too short</li> <li>• Height of free fall is more</li> </ul> <p><b>Remedy:</b> Surface coating with polymer modified cement mixer</p>	



## Handling of Self Compacting Concrete



*SCC fresh surface – with very little bleeding – Coarse aggregate appearing on top surface*



*SCC hardened surface – Coarse aggregate appearing on top surface*

## Handling of Self Compacting Concrete



*Cold Joint in SCC (Floor Slab element)*



*Blow holes on SCC surface – not a structural issue but an appearance concern*



*SCC fallen from a height of 8 feet due to inadequate support to form work – yet homogeneous*