CEMENT ADMIXTURES ASSOCIATION

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the Sign of Quality

Admixture Sheet – ATS 13
Self-compacting concrete & VMA admixtures

1 Function

Self compacting concrete (SCC) is a concrete which is fully flowing and self compacting and which can be placed with minimal or no vibration. VMA admixtures are specifically designed for use in SCC and work with the superplasticiser to control the bleed and segregation that would normally occur at these very high levels of workability.
Self-Compacting Concrete offers the following benefits:

SCC lends itself to situations where access to vibrators is difficult or impossible but full compaction is essential for durability or strength reasons.

SCC allows concrete to be flowed into confined spaces or complicated formwork, facilitating innovate design or placing methods.

Elimination of vibration enables lighter, less-costly formwork to be used.

Because vibration is unnecessary, noise is eliminated from the concrete placing. This has benefits in populated areas, night working and in internal placement or precast where noise is confined.

SCC does not normally trap or retain air, and so surfaces are more defect free and require less remedial work. Edges and detailing are also sharper.

SCC is quick to place by skip, pump and because it does not need vibration, a reduced work force is required.

2 Materials

The high fluidity may be achieved from high dosages of traditional superplasticisers, but is preferably achieved from admixtures based on polycarboxylated-ether copolymers (PCE). The latter are particularly effective as they give very fluid but cohesive concrete with good retention of high flow. (See ATS sheet 2)

The lack of bleed and segregation results mainly from careful mix design which often includes the use of fine fillers or additions. However, the mix may also require the inclusion of a rheology or segregation-control admixture (VMA) which can be added separately, or form part of a dual function admixture in combination with a superplasticiser. Two of the VMA chemicals that have been found most effective for this application are:

Nanometric colloidal silica sols
Polysaccaride biopolymers

3 Mechanism

Self-compacting concrete admixtures combine two normally mutually exclusive properties.

Firstly they use very efficient cement dispersion agents which function by a combination of electrostatic repulsion and steric hindrance. Superplasticising admixtures are used to achieve this but at the high levels of fluidity needed for self-compaction, the concrete has a very low yield and this may then induce bleed and segregation of the mix.

To prevent this segregation, the rheology of the mix may need to be modified in a way that does not reduce the fluidity and self compactability but does increase the plastic viscosity. Viscosity modifying admixtures (VMA) are used for this purpose. These are based on shear-sensitive thickening polymers which produce a low viscosity at the high shear rates which occur during mixing, but a high viscosity at low shear rates when the concrete has been poured and is at rest. The speed at which the viscosity reduces under shear but then rebuilds when shearing stops is critical to effective performance.

4 Use

4.1 Dosage

Dosage varies depending on the system being used.
The SCC superplasticiser will typically be 1 to 2% on cement weight.
In addition, there may then be a VMA, viscosity control admixture.
Water based, liquid VMA types based on colloidal silica sols, can have higher dosages, and the mix design will need to be adjusted to take account of the water contributed by the admixture.
Powder based VMA's have a much lower dosage.

4.2 Mix design

The mix design for self-compacting concrete is critical to its success. There needs to be a high proportion of fine material, typically around 450 to 500 kg/m3 which includes the cement, but this can be augmented with other fine materials such as slag or PFA additions, but also limestone powder. Sand content is normally in the range 50 to 60% of the total aggregate content.

4.3 Compaction

No compaction is necessary with this type of concrete and the use of vibrators can result in segregation of the mix.

4.4 Overdosing

Overdosing of the SCC superplasticiser is likely to result in segregation of the mix. Overdosing of the VMA, segregation control admixture, could result in some thickening of the mix and a loss of self-compacting properties.

5 Effects on properties of concrete

5.1 Strength

The strength of self compacting concrete depends on the end application. The mix materials and proportions used, can be designed to give low or high strength and any other properties required. However, due to the good compaction achieved, in-situ strengths tend to exceed those predicted from the mix design.

5.2 Workability

Self-compacting concrete has a very high workability. Using a slump flow test SCC typically requires a spread diameter of 700 mm with no indication of segregation or bleed. In fast precast operations, this level of workability may well only be transient, but in civil works, this level of workability may need to be retained for longer than is normal for superplasticised concrete. The correct choice of SCC admixture is, therefore, very important. Self-compacting concrete can be pumped but care should be taken to avoid a significant free-fall down the last length of pump line as turbulence may introduce unwanted air and unexpected blow holes in the surface.

5.3 Setting time

There is usually some extension of setting time, the amount dependent on admixtures used.

5.4 Air entrainment

The self-compacting concrete admixtures do not normally result in air entrainment.

5.5 Bleeding

The mix is designed to produce homogenous concrete, essentially free of bleed and segregation.

5.6 Durability

The low water: cement ratio and high degree of compaction result in a highly durable mix.