**CEMENT ADMIXTURES ASSOCIATION**

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the Sign of Quality

# Admixture Sheet – ATS 17
# Underwater concrete / Anti-washout admixtures

## 1 Function

Underwater concrete Anti-washout admixtures are water soluble organic polymers which increase the cohesion of the concrete in a way that significantly reduces the washout of the finer particles i.e. the cementitious material and sand from fresh concrete when it is placed underwater.
Anti-washout admixtures are often used in conjunction with superplasticisers to produce flowing self-levelling concrete to aid placing and compaction underwater.

Anti-washout admixtures were developed to improve the integrity of concrete placed underwater and to reduce the impact that the washed out cementitious material can have on the marine environment.
They are suitable for use in deep underwater placement, in inter-tidal zones and in the splash zone and other situations where water movement may result in the cement and other fine material being washed out.

## 2 Materials

The principal chemicals are:
Organic viscosity control polymers
Associated polymers
Superplasticisers

## 3 Mechanism

In contact with water, the anti-washout admixtures produce a branched polymer network which controls the movement of water and reduces the tendency for dilution with external water during and after placing. The viscosity and cohesion of the mix is increased, reducing workability and flow. As underwater concrete needs to have high flow and be self-compacting so superplasticisers may be needed to recover the lost workability.

## 4 Use

### 4.1 Dose

The majority of anti-washout admixtures are powder based products, which makes them difficult to dispense. The dosage ranges from about 0.3 to 1.0 % depending on manufacturer and on the degree of washout resistance required. It is generally preferable to use the lowest dose that is consistent with the degree of washout resistance needed.
Liquid versions based on non-aqueous dispersions of polymer are available, but these can be difficult to dispense, as they must avoid any contact with water. Liquid dispersions of silica are also available, but because of their high dosage, their inclusion needs to be made as part of the mix design, which can then take account of the added water. These materials may be less effective in more demanding situations.

### 4.2 Mix design

Anti-washout admixtures control the movement of water, but are more effective if the base mix is cohesive. Cement contents should be at least 400 kg/m3 but this can include blended cement and the use of additions. The increased cohesion provided by very fine binders such as silica fume have been found particularly effective in some applications.
Sand contents are also high, typically 45% or higher and the sand needs to have a uniform grading.

### 4.3 Overdosing
Overdosing of the anti-washout admixture can result in an increase in air-entrainment that will tend to lower the compressive strength. Cohesion and anti-washout properties will be increased which may lead to reduced workability of the concrete. There may also be an increase in set time.

### 4.4 Placing
The concrete can be placed by skip, pump or tremie and at higher admixture dosages may tolerate some free-fall. However, care is needed not to allow the concrete to free-fall through a water filled pump line or tremie pipe as the turbulent flow produced will cause the mix to segregate. Pumping will normally produce the best results and minimise washout as only the top surface is usually exposed to the full effects of the water movement.

## 5 Effects on properties of concrete

### 5.1 Strength
The compressive strength of the concrete may be slightly reduced by the inclusion of an anti-washout admixture but this is often negated by the addition of a superplasticiser into the concrete. Some admixture types can interfere with the hydration and strength development of some binders other than Portland cement and this needs to be checked prior to use.

### 5.2 Workability
Underwater concrete needs to have high workability in order to flow and compact in a situation where vibrators cannot easily be used and where the water buoyancy reduces the gravitational compaction. Anti-washout admixtures combined with superplasticisers require a long, slower mixing action to achieve a high workability.

Because the mix is very sticky and cohesive, a slow flowing collapse of the slump is common. Workability retention of these mixes is usually much longer than an equivalent mix without admixture and may look stiffer due to its viscosity and appearance.

### 5.3 Setting Time
The setting time of the concrete will be increased when anti-washout admixtures are used. This extra time to set is often beneficial to the concreting operation as underwater concrete pours generally take longer to complete than conventional land based pours.

### 5.4 Air entrainment
The air-content of the concrete may be increased slightly due to the viscous nature of the mortar matrix preventing all entrapped air being released.

### 5.5 Anti-washout properties
There is now a British Standard to measure the performance of anti-washout admixtures, BS 8443. Performance is assessed, based on plunge tests where a known mass of concrete is dropped through water a number of times in a wire cage, and the degree of washout determined as a percentage loss in mass. The American CRD-C 61 test is suitable for assessing washout of grout and some mortar mixes but has not been found to be sufficiently aggressive to give an effective indication of washout in concrete used in demanding situations.

In most underwater placing situations some washout should be expected and top surfaces may have several centimetres of low strength material which must be removed before further construction. The extent of the washout will depend on the water flow, but in rivers and most tidal areas around the UK, significant water movement should be assumed even where there is good shuttering.