Admixture Sheet – ATS 1

Normal Plasticising / Water reducing

1 Function

Water reducing admixtures (WRA) are water-soluble organic materials, which reduce the amount of water needed to achieve a given workability in plastic concrete without significantly affecting the air content or setting characteristics. The use of a WRA can also provide a more controlled action of cement deflocculation than using water. This effect can be utilised in three ways:

Increased strength and rate of strength gain
Economies in mix design and reduced carbon footprint
Increased workability

When water reducing admixtures are used to increase the workability or consistence of the concrete they are usually termed 'Plasticising admixtures '.

2. Standards

This class of admixture is covered by the requirements of BS EN 934 Part 2: Concrete admixtures – Definitions requirements, conformity, marking and labelling. The specific requirements are stipulated in Tables 2.

All CAA manufacturers CE mark their products to show they conform to this standard.

3 Materials

Water reducing admixtures are normally based on:

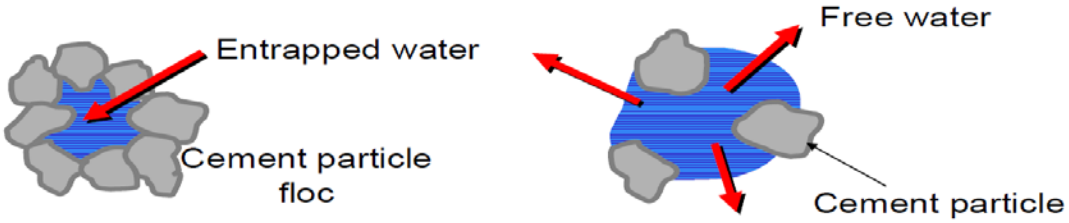
Salts of lignosulphonic acids.
These may be modified with low molecular weight polysaccharides (hydroxylated polymers) or small amounts of other cement dispersing polymers.
Salts of hydroxcarboxylic acids are also used but mainly for retarding water reducing admixtures.

Other modifiers are used to help control air content, setting time or enhance specific properties.

4 Mechanism

The water reducing admixture is adsorbed on to the cement particles and lowers the inter particular attraction so that flocs of cement break up. This produces a more uniform dispersion of cement grains reducing the amount of water needed to achieve a given paste viscosity. Providing the performance benefits below:

- Electrostatic inter particle repulsion
- Reduced surface tension
- Retarding the hydration process
- Entrapped water is liberated
- Workability is improved



5 Use

5.1 Dosage

Normal water reducing admixtures are typically used in the range 0.2 to 0.6% by weight of cement and give water reductions of 8 to 12%.

Mid range water reducing admixtures are used at 0.3 to 0.8% by weight of cement and typically give 10 to 15% water reduction.

Trials should always be undertaken to confirm the optimum dose and the effect on other properties of the concrete. In the case of supply from a readymix concrete company, the supplier will normally have done this for all his standard mixes.

5.2 Admixture Selection

Normal water reducing admixtures / plasticisers are available in a range of types optimised for particular cement blends, aggregate sources and other properties. For example, some types are particularly designed to enhance strength development in cement blended with Fly Ash (PFA) or Ground Granulated Blast Furnace Slag (GGBS) but may give a lower level of benefit with other cements.

Lignosulphonate types usually give some enhanced air entrainment (typically 1 to 2%), that improves cohesion and reduces bleed in many mixes.

Hydroxcarboxylic salts can reduce air entrainment / cohesion which may be useful in high cement content, sticky mixes.

Most normal water reducing admixtures give some retardation, which increases when they are used as plasticisers. Some types, especially those containing hydroxylated chemicals can give large increases in retardation as the dosage increases.

The admixture supplier should be able to give advice on the best product based on the other concreting materials to be used.

5.3 Cement Type

Water reducing admixtures can be used with all types of Portland cement including those covered by EN 197-1 and with GGBS, Fly Ash or other binders blended with CEM I cement.

Factors such as air entrainment, mix cohesion and stiffening time may be affected when water reducing admixtures are used with blended cements. Fly Ash typically reduces air entrainment but improves cohesion. GGBS may have the opposite effect. It should be noted that retardation is usually increased when admixtures are used with cement replacements such as GGBS or Fly Ash blends and this effect may be more pronounced at low temperatures.

5.4 Yield

Where water reduction is used, there may be a reduction in the volume of cement paste and hence in the yield. This must be taken into account in calculating mix yield and potential economies.

5.5 Overdosing

The amount of water reduction or gain in workability will increase with increasing dose. Any over dosing which is significantly in excess of that intended can, in certain circumstances, result in significant retardation and/or a degree of air entrainment. This effect may be more pronounced at low temperatures and or with GGBS or Fly Ash blends.
The higher the intended dosage within the manufacturers stated range, the more significant will be the effect of overdosing.

For normal water reducers, the retardation is unlikely to be more than 24 to 36 hours even at considerable overdose (3 to 5 times normal recommended). Extra curing is essential to prevent the surface drying out before setting and re-vibration is also advisable up to the time of initial set.
Where there is no air entrainment the gain in strength and the other properties will develop normally after the initial retardation period.

In the case of overdosing of more than twice the normal recommended level, manufacturer's advice should be sought.

6 Effects on properties of concrete

6.1 Strength

When water reducing admixtures are used to reduce the water content while maintaining consistence, the compressive strength of concrete is increased as a direct result of the lower water/cement ratio. BS EN 934-2 requires an increase in compressive strength over the equivalent plain concrete mix of at least 10% after 7 and 28 days.

When water reducing admixtures are used to increase consistence at equal water content, the compressive strength is generally similar to that of the equivalent plain concrete mix.

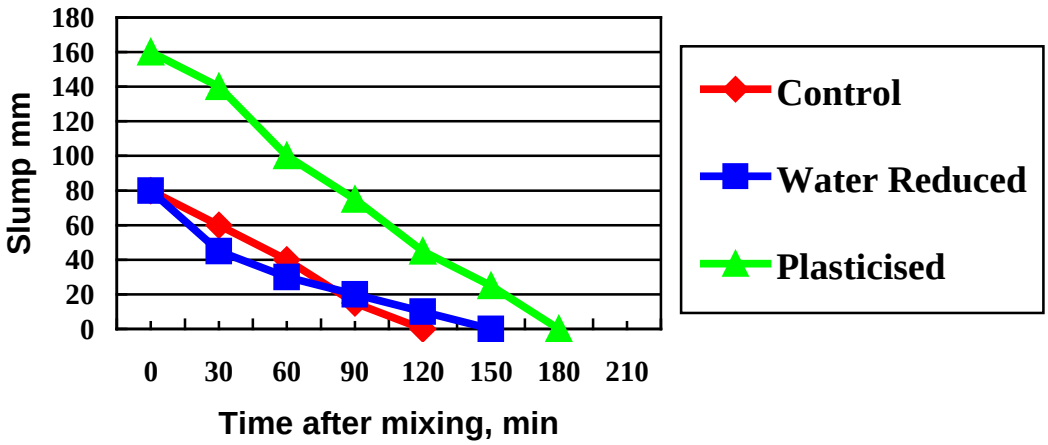
Early strength will depend on water reduction, dose and retardation. For a water reduced mix at normal dosage, 24 hour strength will typically be 15 to 20% higher. For a plasticised mix the 24 hour strenght may only be 80% of control but will then quickly reach the control strength.

6.2 Consistence

Where no change is made to the water cement ratio, water reducing / plasticising admixtures increase consistence. Typically the slump will be 60-100 mm higher the value for a plain concrete of equal water content. The use of a slightly higher admixture dosage will allow some water reduction as well as an increase in consistence. This can be the most effective way of using a water reducing admixture.

6.3 Slump loss

The rate of slump loss of concrete containing a normal water reducing admixture is generally similar to or greater than that of the equivalent plain concrete mix of the same initial consistence.
Where slump retention is required over a longer period, the water-reducing admixture can be used to increase initial consistence. The concrete will then maintain a high level of consistence for longer after mixing and will still have the structural properties of the plain concrete of equal water content.



6.4 Setting time
The setting time of the concrete containing normal water reducing admixtures is typically within 90 minutes of the equivalent plain mix at equal consistence and normal temperatures (15 to 30^0C). At lower temperatures setting times may be extended, especially where alternative binders such as GGBS or Fly Ash are being used to partially replace CEM I cement. Even at normal temperatures, high replacement levels of slag may result in longer setting times.

6.5 Air entrainment
Lignosulphonate based materials tend to increase the air entrainment but BS EN 934-2 requires that any increase in air content shall not be more than 2% by volume.
The higher the level of air in the control mix, the higher the level of additional air that will be entrained by an admixture.

Salts of hydroxycarboxylic acids and the low molecular weight polysaccharides do not entrain additional air and often result in reduced air contents.

Air entraining agents may be used in conjunction with water reducing admixtures either as an integral admixture or separately. Where used separately compatibility must be assured by reference to the manufacturer.

6.6 Bleeding
Salts of hydroxycarboxylic acids and low molecular weight polysaccharides can cause an increase in bleeding of those concrete mixes that exhibit a tendency to water movement.
Lignosulphonates normally result in decreased bleeding due to the slightly enhanced level of air entrainment resulting in improved cohesion of the concrete.

6.7 Heat of hydration
The maximum rise in temperature of concrete is unaffected by the presence of a normal water reducing admixture when no other mix design changes are made. If the cement content is reduced the maximum temperature rise is reduced in direct relation to the cement reduction made.

6.8 Volume deformation
Creep and drying shrinkage are not significantly altered from that of concrete without admixture, designed to have the same workability and 28 day strength. If the admixture is used as a plasticiser to increase consistence, a small increased drying shrinkage and creep may be observed.

6.10 Durability
When used to reduce the water content of the concrete, water reducing admixtures enhance the durability of the concrete by improving both the density and impermeability.
Lignosulphonate based water reducers have been in commercial use since the mid 1930s without any reported adverse effects on the long-term durability.

6.11 Sustainability
Admixtures can reduce the embodied carbon content (ECO_2) of concrete. Because admixtures are used in such small dosages compared to most other ingredients, they typically contribute less than 1% to the total ECO_2 of concrete while allowing the overall cement content which is the main contributor of ECO_2 to be reduced. Under BS EN ISO 14044, constituents like admixtures that contributing less than 1% of the total impact can be ignored in the environmental calculation. When using admixtures, this reduction in the total ECO_2 of concrete can be achieved whilst maintaining and, in most cases, further enhancing the properties of the concrete.

7 Health and Safety of Admixtures
Most admixtures are non hazardous and pose no abnormal health and safety risk but as with all forms of chemical it is essential that the material safety data sheets are read and understood before use. Risk assessments should be conducted to ensure all users are provided with a safe means of use and relevant PPE.

8 Other information
Other CAA information sheets are available including Environmental Product Declarations and sustainability information. These are available at www.admixtures.org.uk under the ‘Publications’ tab.