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Admixtures for mortar

DATA SHEET 15

MORTAR INDUSTRY ASSOCIATION

General Information

Admixtures have been incorporated into mortars since ancient times. The practice of Roman engineers to add ox blood to building mortars, to enhance their physical properties, is a good example of this custom.

The use of hydrated lime and coloured pigments, as additions to mortar, has also been well documented throughout the ages and these materials are covered in other data sheets in this series.

Modern brick and block layers face exactly the same technical problems as their predecessors. Just as the Romans used ox blood to improve the properties of mortar, modern producers achieve beneficial results by incorporating proprietary admixtures.

The use of admixtures in modern cementitious mortars has become universal as the technology describing the benefits of plasticizers, retarders, water repellents, fibres and other types of admixtures has been better understood.

The drafting of British Standard BS 4721 (Specification for Ready-mixed building mortars) also led to the drafting of BS 4887 (Mortar admixtures) the corresponding standard for admixtures. These will shortly be replaced by British/European standards BS EN 998 (Specification for mortar for masonry) and BS EN 934-3 (Admixtures for masonry mortar).

The various categories of admixtures used in the production of mortar are discussed in the following sections.

Air entraining/plasticizing admixture

This is defined in BS EN 934-3 as ‘Admixture which increases workability, or allows water reduction, by incorporating during mixing a controlled quantity of small, uniformly distributed air bubbles which remain after hardening’. It should be noted that within mortar technology the reduction in water content is unlikely to be relevant except in increasing the resistance to the effects of freeze thaw action.

Air entraining/plasticizing admixtures improve the cohesion of fresh mortar by entraining significant volumes of air into the mortar. The air bubbles act like minute ball bearings and lubricate the mortar making it easier to work. The effects are so pronounced that air entrained mortars are commonly referred to as ‘alive’, whereas those that do not have any air incorporated in them are referred to as ‘dead’. The air bubbles are so small (typically 0.02-1.0mm) that they have the effect of improving the overall grading of most fine aggregates (sands) and they are commonly used to improve the ‘feel’ of mortars produced from sands which are not ideal or are too coarse. The plasticizing properties of the admixture result in decreased mix water demand, subsequent reduction in shrinkage and enhanced resistance of the mortar to the destructive effects of exposure to freeze thaw conditions.

Air entraining/plasticizing admixtures are therefore included in mortar mixes to improve the durability of hardened masonry mortars particularly in cold wet climates.

As well as enhancing the fresh properties, the use of hydrated lime in traditional mortars also achieves a cohesive effect, consequently, mortar plasticizers are often promoted as a replacement for lime in mortars. Nowadays, the benefits of both lime and mortar plasticizers are recognised and the best quality building mortars may well contain both.

Set retarding admixture

This is defined in the Standard as 'Admixture which extends the time to commencement of transition of the mix from the plastic to the rigid state, but specifically intended for use in long term retarded mortar incorporating entrained air'.

Set retarding admixtures are used to delay, for a controlled period of time, the hydration (setting) of cement and cement: lime mortars. This allows the transport, storage on site and use of mortars for periods of up to 72 hours from the time of manufacture.

This category of admixtures is typically based on gluconates, which act by inhibiting the reaction between cement and water. Dosage rates vary with many factors; amongst which are the individual types of cement, lime and fine aggregate (sand) used and their respective properties. Guidance will be given by the admixture supplier. A number of the commercially available set retarding admixtures have a dual function and also possess plasticizing properties.

While the cement set is retarded the mortar remains fully workable allowing it to be used at up to the stated workable life of the mortar. During storage on site care should be taken to minimise water loss by evaporation (e.g. by covering, especially in warm and/or windy conditions). Workability that has been lost by evaporation of water may be restored by the addition of small amounts of water and thorough hand mixing on the spot board or in the storage skip, but mortars should not be retempered after the commencement of the initial set.

When the retarded mortar is used to lay bricks or blocks, the mortar stiffens initially due to water loss by absorption into the masonry units before hydration of the cementitious component of the mortar continues in the normal manner. The extended workability of the mortar is of benefit not only in the flexibility it provides in site operations, but is also of assistance when tooling up joints, permitting larger areas to be tooled in one operation thereby enhancing visual conformity.

Water repellents

Water repellent admixtures are also known as permeability reducers or, incorrectly, as waterproofers. They are added integrally to the mortar to reduce absorption and to make the hardened mortar less porous and less permeable to water. The two main types of water repellent admixture are:

a Materials which act by producing a hydrophobic lining in the pores of the cement matrix, thereby reducing capillary forces and reducing the rate of passage of water through the hardened mortar.

b Materials which act by filling and blocking the pores of the cement matrix.

The reduction in permeability gives different advantages depending on whether the mortar is for masonry or rendering use. In masonry mortars the reduction in permeability results in reduced efflorescence. This is achieved due to the reduction in the passage of water containing a cement hydration product (calcium hydroxide) which may carbonate on exposure to air to form calcium carbonate and subsequently dry on the surface as a fine white deposit. The reduction in permeability can also assist in maintaining the colour and appearance of mortar by resisting adhesion of air-borne and rain borne dirt; additionally it improves the weather resistance and increases the durability of the mortar.

In renders, the reduction in permeability is of benefit in backing coats where it results in reduced suction and improved adhesion of the following coats. Additionally, it can improve the resistance of the render to the penetration of rain and dampness. However, the permeability should not be reduced excessively as this can adversely affect the adhesion of subsequently applied decorative materials and finishes such as paint or ceramic tiles.

Polymers

There are a large number of chemical polymers that can be added to mortar in order to modify its properties and/or achieve specific properties.

However, there are two commonly used polymers; styrene butadiene rubber latex, normally referred to as SBR, and poly vinyl acetate, normally referred to as PVA.

SBR is normally added to mortar in the form of a dense white liquid. This is a rubber latex, which is a dispersion of microscopic rubber spheres in water. When the water evaporates, the rubber particles coalesce into a continuous film. If there is insufficient SBR to form a continuous film, then they do not function correctly. For this reason the dosage rate of SBR tends to be relatively high, at 20-30% by mass of the cement.

When used at this dosage rate the inclusion of SBR produces some very useful properties. For example, bonding to other cementitious products is very much enhanced. SBR mortars are, therefore, very useful for repairs or for bonding between render coats.

Additionally, the inclusion of SBR will produce a very low permeability mortar, ideal for the minimisation of water migration and for damp proofing. SBR mortars are also very resistant to sulfate attack. For these reasons they are beneficial for mortars used in below ground conditions.

PVA, which gives similar bonding benefits, is normally used for internal plasters and should never be used in external applications as the resin will react slowly with water (hydrolyse) and degrade. This problem does not occur with SBR and for this reason it is used for exterior applications.

Fibres

Fibres have been included in construction materials since biblical times. Straw was used by the ancient Egyptians in the making of crude clay or mud bricks to prevent them cracking when they dried out in the sun.

For the same reason polypropylene fibres are commonly used in cementitious renders. Because renders tend to be thin coatings, having a large surface area, they are susceptible to moisture loss and subsequent cracking.

Moisture loss caused by suction of the substrate tends to be reduced by the inclusion of a permeability reducer in the base coat. These materials are commonly, but incorrectly, referred to as waterproofers and are discussed in an earlier section of this data sheet. However, moisture can also be lost by evaporation into the air and if this occurs before the render has gained significant strength then this can lead to plastic shrinkage cracking. This cracking occurs at a very early age and may not be immediately obvious, but can be the root cause of subsequent failure of the render. The incorporation of polypropylene micro fibres into renders is an effective protection against plastic shrinkage cracking. Micro fibres are normally 6-12mm long, but are finer than a human hair. A typical dosage of micro fibre is 0.6-1.0kg/m^3.

Large polymer fibres, typically over 40mm long are called macro fibres. These are used at higher dosages than micro fibres, typically 3-8kg/m^3, and are primarily used to enhance the toughness of a render or screed. Any area subject to impact damage, such as a squash court would benefit from the inclusion of macro fibres. It should be noted however, that fibres are not required in the final coat, where their appearance would mar the finish, but only in the undercoats.

References

BS 4721	Specification for ready-mixed building mortars
BS 4887	Mortar admixtures
BS EN 998-1	Specification for mortar for masonry: Part 1 - Rendering and plastering mortar
BS EN 998-2	Specification for mortar for masonry: Part 2 - Masonry mortar
BS EN 934-3	Admixtures for masonry mortar

Note: British Standards are currently being revised in line with European requirements. The new standards are at varying stages of preparation and/or publication, for a full list of British and new European Standards see the MIA data sheet of technical references.

Cement burns (skin ulceration) can result from contact with fresh mortar. Prevent skin contact by wearing suitable protective clothing and eye protection where possibility of splashing exists. Where skin contact occurs either directly or through saturated clothing, wash the affected area without delay. Where eye contact occurs, the area must be immediately and thoroughly irrigated with clean water.

The relevant codes of practice, standards and statutory regulations must always be observed.

Mortar Industry Association

156 Buckingham Palace Road London SW1W 9TR Tel +44 (0)20 7730 8194 Fax +44 (0)20 7730 4355