mortar industry association

Data sheet 17

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Pigments for mortar

General Information

Mortars can be pigmented to highlight, enhance or tone in with the masonry used. The colour of the mortar joint can totally change the appearance of the finished masonry and a comprehensive range of colours and shades are available from suppliers of factory-produced mortars.

Both lime: sand and ready-to-use mortars can be coloured by the use of pigments and the controlled manufacturing conditions employed by the factory producers will ensure that a consistent colour is obtained.

Composition, Properties and Durability

The pigments should conform to the requirements of BS EN 12878: Pigments for building materials based on cement and/or lime.

The majority of the pigments used to colour mortar are based upon synthetic and/or naturally-occurring iron oxide reds, iron oxide yellows and iron oxide blacks, which have been blended by the pigment manufacturers to give a wide range of attractive shades including browns, marigolds and olive green. These pigments physically bind to grains of cementitious material, changing the overall colour of the mixture. Iron oxide pigments are inorganic, lime-proof, light fast, weather-resistant, inert to atmospheric conditions, stable, and have tightly controlled levels of water-soluble matter.

Other equally stable mineral pigments extend the range of colours but are expensive; chromium oxide yields greens and cobalt based mixed metal oxides produce blues. Titanium dioxide can be used to whiten a mix or produce pastel shades, but the same effect is usually accomplished more economically by using white Portland cement.

While carbon black is an economical alternative to iron oxide for producing black and grey mortar, the mortar containing carbon black must be protected from water penetration. While the carbon black pigment itself does not fade, some grades of carbon black can slowly leach out of the mortar, resulting in a faded appearance. Mortars used in exposed locations should normally be coloured with black iron oxide. Other pigments that are subject to similar limitations as carbon black include organic pigments such as the phthalocyanine blues and greens. Ultramarine blue is a relatively inexpensive pigment but untreated grades will rapidly lose their colour in mortar due to a reaction with the calcium in the cement. The pigment manufacturers can provide further information on the suitability of these pigments for the intended application.

The tinting strength of pigments depends upon the particle size, surface area and purity. The more discrete particles per unit weight of pigment, the greater the covering power and hence the depth of shade of the mortar, assuming complete dispersion. However, with some fine particle pigments it is advantageous to incorporate a coarser product to facilitate easier dispersion.

Water absorption of pigment falls within the range 20 to 100% of the pigment weight. For example 100 parts of red iron oxide will absorb 25 parts of water before coagulating and 50 parts of water to transform it into a flowable paste, whereas yellow iron oxide will require 2 to 3 times these amounts. It may, therefore, be necessary to make adjustments to the water/cement ratio of the mortar to allow for the pigment's water demand. In general relative density, bulk density and particle size increase as water demand decreases. It is essential that pigments be batched by weight, not volume, because of bulk density variations, so as to ensure consistency of colour in the final product.

Liquid colours are produced by mixing powdered or semi-dried pigment with 40 to 60% water, surfactants and stabilizers to form a 'suspension'. Granules are manufactured by mixing a binder and dispersant with the liquid colour and spray-drying the mixture. Compact grades are made by blending a

powder pigment with an appropriate binder/dispersant and compacting the mixture.

Even though the pigments used in mortars are chemically stable and do not significantly change their hue under normal environmental exposures, all cement-based materials can change appearance over time. Some changes that go virtually unnoticed in natural mortar may be more conspicuous in coloured mortars. For instance, efflorescence, a white powdery deposit, may form on the surface of mortar and can obscure the colour. It occurs when moisture dissolves salts in the mortar and carries them via capillary action to the surface. Further information on the prevention and treatment of efflorescence can be found in MIA data sheet No 8 'Efflorescence and Bloom on Masonry'.

Colour Consistency

The first variable to control when producing consistently coloured mortars is the elimination of any significant variation in the colour pigment itself whether a powder, liquid, compact or granulated form is used.

Utilizing different base pigments or increasing or decreasing the quantity of pigment in the batch can create a wide spectrum of colour tones and shades. The quantity of pigment added is usually expressed as a percentage (by weight) of the batch cement content. Cement, pigment and admixtures must be measured into the mix accurately. Water must be batched accurately as the water-cement ratio will significantly affect the final colour of the mortar.

Every pigment has a saturation point, where increasing the dosage rate fails to make an appreciable difference to the final colour intensity of the mortar. Pigments with high tint strength reach saturation at a lower dosage rate. Black iron oxide has the highest tint strength, generally achieving saturation at 6% dosage. Brown has slightly lower tint strength, levelling-off at approximately 7% dosage, followed by 8% for red and 9% for yellow. However these figures will vary significantly for different shades of each type of pigment. Dosage rates up to 10% are permitted at which point strength can be affected due to the displacement of cement. Quality control practice within the pigment industry is to classify as standard batches that may vary by ± 5 % in colour strength from the manufacturer's reference standard using spectrophotometric measurements. A 5% colour variation is less than would be seen in natural cut limestone.

Cement colour is the second most important variable impacting on final product appearance. The colouring effect of cement is especially important for mortars made with low pigment dosage rates, such as light buff shades. A cement from the same source should always be used.

While not as critical as cement, a substantial change in aggregate colour can make a noticeable difference to the final colour of the mortar. Also variations in aggregate water content can affect the mix water-cement ratio. Mortars made with aggregates with a higher content of fines will be lighter coloured due to the increased surface area of fine particles and their associated light-scattering characteristics. Again consistent aggregate from the same source should be used.

All commonly used mortar mixes may be coloured by the addition of pigment in appropriate quantities, subject only to the dosage limitations outlined previously.

The specification of factory-produced mortars ensures that account is taken of the possible variations in constituent materials properties thus minimising colour variations in the finished mortar.

Site Workmanship

Having ensured the quality of all the constituent materials and the accuracy of batching it is essential to ensure that workmanship is of high standard.

On delivery to the site the responsibility for obtaining consistent results with both ready-to-use and lime:sand mortar then rests with the contractor and requires careful control. The following factors are significant:

- Bricks and blocks should be stored on a clean and level surface and protected from rain and site activities by being adequately covered.
- Deliveries of mortar should also be protected from the elements.
- All constituent materials should be weighed accurately.
- Cement from the same source should always be used.
- A standard mixing time should be adopted.
- Water content should be accurately controlled.
- All equipment should be carefully cleaned before changing to a new colour.
- Mortar should not be 'knocked up'. This practice significantly changes the final colour of the mortar.
- Finished masonry should be protected from the elements until the mortar has fully cured.
- Tool the mortar joints in a consistent manner and at the same degree of hardness and moisture content (wetter mortar will tool lighter than drier mortar).
- Masonry units from different packs should be mixed to minimise colour variations.

Masonry cleaners should be used with great care and only after careful testing on a trial area. Follow the cleaner manufacturers instructions precisely.

A well-designed and proficiently constructed coloured masonry structure should not require any maintenance throughout its life.

References	
BS EN 12878	Pigments for the colouring of building materials based on cement and/or lime. Specification and methods of test

For a full list of British and European Standards see the MIA data sheet of technical references.

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The Mortar Industry Association is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries

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There is a real danger of contact dermatitis or serious burns if skin comes into contact with wet mortar. Wear suitable protective clothing and eye protection. Where skin contact occurs either directly or through saturated clothing wash immediately with soap and water. For eye contact immediately wash out eyes thoroughly with clean water. If swallowed wash out mouth and drink plenty of water.

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