Technical Information on the colouring of mineral-bound plasters with inorganic pigments

This Technical Information provides a guideline for factory production of coloured, mineral-bound dry plastering mortar.

Principles

By adding synthetic inorganic black, white or coloured pigments (Titanium Dioxide, Bayferrox® iron oxide pigments, Chromium Oxide Green, HEUCODUR® mixed metal oxide pigments) it is possible to achieve a permanent colouring of mineral-bound plasters in various colour shades. The mentioned pigments are resistant to alkali, light and weathering and therefore they excellently qualify for the colouring of cement and lime-bound plasters. Consequently, they are also listed under DIN EN 12878 "pigments for the colouring of building materials based on cement and/or lime". The properties of the plasters and the effects of the additives commonly used in plaster systems such as thickening agent, hydrophobing agent, air-entraining agent, dispersing agent, etc. are not affected negatively when using inorganic pigments for colouring.

The colouring of plasters provides advantages compared to the subsequent application of a coat of paint on a colour-neutral plaster surface. The colour pigments are permanently fixed in the binder matrix. Any damaging or weathering of the surface do not alter the visual appearance and the colour shade of the plaster, thus eliminating the costs for a new coat of paint. Ideally, it is recommended to use coloured plasters – for reasons that will be explained in sections below – in combination with a colour levelling coat of the same shade.

The most frequently used pigments for the colouring of mineral-bound plasters are Bayferrox® iron oxide pigments in the base colours yellow, red, black and in various mixed colours, Chromium Oxide for the colouring of green as well as Heucodur® mixed metal oxide pigments for green, yellow and blue shades. It is, in principle, possible to use ultramarine blue pigments, however, a colour stability might not be ensured in some cases. Titanium Dioxide allows additional brightening of grey and white plasters. In recent times, nanostructured Titanium Dioxides are also applied which, however, do no longer feature the character of a pigment but should permit the degradation of pollutants and organic contamination owing to the photocatalytic effects. All above-mentioned pigments can be mixed with each other providing an almost unlimited variety of options for the colouring of plaster surfaces (examples shown in Fig. 1).
In mere physical terms, colouring of plaster means colouring of binder. For this reason, the addition of pigments is always calculated on the weight of the binder content. The following pigmentation levels are to be understood as guideline values for colouring:

- pastel shades: up to 1 weight percent of pigment
- medium shades: 1 - 3 weight percent of pigment
- deep shades: 3 - 6 weight percent of pigment

in each case calculated on the binder content of the dry plaster. A higher addition of the pigment, in general, does not result in any additional benefit because the limit of saturation, above which no further changes in shade can be observed, is mostly below 10 weight percent. Fig. 2 shows examples referring to this.
The colour of the plaster is not only determined by the pigments used for colouring. The natural colour of the binders (cement, hydrated lime) and the aggregates used have an as important impact on the colouring as the water content of the plaster in the production process and in the phase of setting. As a rule, light grey or white binders are used in particular for brilliant and pastel shades. The darker the binder used is the more pigment is needed for obtaining the shade required. In many cases, it is not possible to obtain pastel shades or especially brilliant colours, for instance, when using grey cement. Fig. 3 demonstrates examples of the different effects of pigments in white cement and grey cement respectively. The "Scholz Shade Card" provides a selection of pigments suitable for the colouring of mineral plasters. In order to guarantee as constant colours and brightness in the manufacturing of coloured plasters as possible, special attention has to be paid to a constant quality of the raw materials used and consistency during the mixing process.

Fig. 2: Different pigment concentrations in white cement

Fig. 3: Effect of various pigments in grey cement (left) and white cement (right)
As to work out formulations for coloured dry plastering mortars, it has to be made sure that the binders, aggregates and additives used in this process will also be used later in the factory production process. Furthermore, when working out the formulation as well as in the latter mixing process, it has to be considered that the pigments must be completely disaggregated, i.e. showing no pigment agglomerates. The following procedure has proven itself in practice:

- Select the pigments with the aid of the "Scholz Shade Card" and fix the approximate pigmentation level as suggested above.

- Produce a plaster mixture considering the conditions applicable in the latter production process and assess the outcome of the dry mortar. If the outcome is not as expected, the formulation has to be modified by using another pigment or altering the pigmentation level and/or adding further pigments. Repeat this procedure until obtaining the colour shade desired. The assessment can be made either visually or by using optical colour measurement systems. For the visual assessment it is recommended to separate the coarse grain over 1mm by screening. The particles having passed through the mesh are then spread by a spatula or similar tool on a smooth, white substrate for assessing. Now, none pigment lumps or streaks are to be revealed. If any, the material has to be mixed as long as the pigment is dispersed homogeneously.

- If the colour shade of the dry mixture meets the expectations, plaster a test surface and assess the same after curing. If necessary, make further adjustments in terms of the pigmentation in order to obtain a satisfying outcome.

Factory production of dry plastering mortar

Factory production of coloured dry plastering mortar requires special care. Therefore, it is absolutely necessary to adhere to the production parameters and the formulations worked out and determined carefully. Any kind of alteration will inevitably result in colour deviations. This particularly applies to the pigments and raw materials used. Where appropriate, carry out receiving inspections and/or request test reports indicating the compliance with the relevant product specifications and stating the test results.

To achieve a homogeneous dispersion of the pigments the mixers have to be furnished with impellers or similar additional mixing tools. The product quantity in the mixer plays as well an important role because the shearing force is often insufficient for grinding pigment agglomerates and dispersing the pigment homogeneously if the used quantity of the mixture is too small. The respective mixing times and batch quantities must be determined in trials beforehand.
To prepare a powder drawing the best way to evaluate the colour shade of the dry mixture and the quality of the pigment dispersion. For this purpose, sieve as above-mentioned a small amount each of the standard determined previously, e.g., of a laboratory mixture or of the first production as well as a sample taken from the mixer. Place small heaps each of the screenings of the standard and the sample next to one another so that they strike each other (Fig. 4a). Then spread out both mixtures equally with pressure in one direction using a wide spatula. The mixtures have to lay with a smooth surface as a wide strip next to each other without leaving any space between them (Fig. 4b). Deeply coloured spots or streaks on the drawing reveal pigments that are not completely dispersed (Fig. 4c). In the event of inhomogeneity, extend the mixing time accordingly or make use of the "pigment concentration" described in the following section.

Preferably, the pigments alone are pre-mixed at first with the aggregates because the additives and binders reduce the shearing force, thus making a homogeneous pigment dispersion more difficult. After an appropriate pre-mixing time the remaining parts are added. In case of very small proportions of pigment (< 0.1 weight percent), it is recommended to mix at first the pigment with the aggregates in a ratio of 1:10 and to homogenize this in a small intensive mixer. This "pigment concentration" is then added to the dry mixture. In particular, when producing pastel shades this method is recommended because automatic plants are not able to meter such small batches with the accuracy required.
Application

In order to avoid complaints on the part of the client or the user, following specific measures must be taken into account. The plaster batches prepared should not exceed the amount being applied in one working step without further addition of water. The water content calculated on the dry mortar should always be constant. It is recommended to use an adequate plastering machine with preset parameters. The plaster must not be applied to strongly heated or soaked through substrates. Driving rain, intensive solar radiation or varying wind and temperature conditions during the curing and/or drying phase must be absolutely avoided. Where necessary, the surface of freshly applied plaster must be protected by means of tarpaulins or sheetings. Substrates with varying sucking properties, such as mixed masonry, may also be a reason for occurring colour differences. However, the finishing treatment of plastered surfaces may also cause colour differences or stains. The surface treatment (felting, grinding) brings differing degrees of the coloured binders to the surface (Fig. 5); it is essential to work in a rapid and consistent way in order to get a visually appealing exposed surface. However, the finishing treatment may also result in interesting effects.

Fig. 5: Staining as a consequence of an inappropriate finishing treatment
However, even appropriate handling may cause subsequent colour changes of the plaster. In most cases, so-called efflorescence – primarily lime efflorescence – is above all the cause for visual variations at the exposed surface. In the course of time, the ageing process (weathering, contamination, algae growth) leads furthermore to a changing appearance. However, both aspects apply to coloured as well as non-coloured plaster equally.

Owing to the above-mentioned reasons it is recommended to furnish coloured plasters with a "colour levelling coat", that is a coat in the same colour as the substrate. This results in a quite even visual appearance, subsequent damages at the coating due to weathering, mechanical damages, etc., will not be obvious or hardly obvious owing to the primer coat of the same colour. A new paint finish often is not necessary for quite a long time. Therefore, there are even less expenditures of time and costs for due cosmetic repairs, the savings distinctly exceed the extra costs for using coloured plasters.

Our experts are gladly available to assist you in all questions relating to the subject of plaster – please do not hesitate to contact us!

This Technical Information of Scholz is updated constantly. The latest version (for the number of the version see the footnote) is available for download on the Internet at www.harold-scholz.de.

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