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Varstvo kulturne dediģļ ine - Preskusne metode - Barvno merjenje povrģin

Conservation of cultural property - Test methods - Colour measurement of surfaces

Erhaltung des kulturellen Erbes - Prüfmethoden - Farbmessung von matten Oberflächen

Conservation des biens culturels - Méthodes d'essai - Mesurage chromatique des surfaces

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97.195	Umetniški in obrtniški izdelki	Items of art and handicrafts

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Conservation of cultural property - Test methods - Colour measurement of surfaces

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Erhaltung des kulturellen Erbes - Prüfmethoden - Farbmessung von matten Oberflächen

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Foreword

This document (prEN 15886) has been prepared by Technical Committee CEN/TC 346 “Conservation of cultural property”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

1 Scope

This European standard describes a test method to measure the surface colour of porous inorganic materials, and their possible chromatic changes. No reference to the appearance of glossy is described. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or natural ageing.

The method is suitable for in-situ measurement of colour coordinates of works of art located indoors or outdoors.

2 Normative references

The following referenced documents are required for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

WI00346002 *Conservation of cultural property - Main general terms and definitions concerning conservation of cultural property*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in WI00346002 and the following apply.

3.1
porous inorganic materials
they include natural stones as well as artificial materials, such as mortar, plaster, brick and others

3.2
treatment
any intervention that potentially changes the characteristics of the material under study such as cleaning, consolidation, protection or artificial ageing

3.3
chroma
attribute of colour used to indicate the degree of departure of the colour from a grey of the same lightness (according to ASTM E 284)

3.4
lightness
attribute by which a perceived colour is judged to be equivalent to one of a series of greys ranging from black to white (according to ASTM E 284)

3.5
hue
attribute of a visual perception according to which an area appears to be similar to one of the colors, red, yellow, green, and blue, or to a combination of adjacent pairs of these colors considered in a closed ring (according to CIE)

3.6
reflectance factor (R%)
percentage ratio of the reflected radiant power compared to incident radiant power

3.7
CIE standard illuminant D65
reference illuminant having approximately the same relative spectral power distribution as a phase of daylight with a correlated colour temperature of approximately 6500 K

If a different reference illuminant is used (i.e. illuminant C or A), it shall be indicated in the test report (see clause 10).

3.8
CIE XYZ trichromatic system
system for colour measurement established in 1931 by the Commission Internationale de l'Eclairage CIE (1931). The interpretation of numerical data is connected directly to visual perception. It is based on the principle that colours are obtained by mixing together the three colour imaginary primaries defined X, Y, Z. These primaries define the reference frame in the tristimulus space and any set (X,Y,Z) is a vector in this space. Principal property of the reference frame is that the Y component is the luminance factor, generally given on percentage scale.

3.9
CIE 1931 standard colorimetric observer
an average observer whose colour matching properties correspond to the CIE colour matching functions for the 2° field size.

3.10
CIE 1964 standard colorimetric observer
an average observer whose colour matching properties correspond to the CIE colour matching functions for the 10° field size.

3.11
CIE L*a*b* colour space 1976
mathematical transformation of the CIE XYZ space into a metric space (see Figure 1). The L*a*b* system is useful for calculations of colour differences because it allows them to be defined by numerical values.

In the CIE L*a*b* colour space the colour coordinates in this rectangular coordinate system are:
L* - the **lightness** coordinate. The scale for L* ranges from 0 (black) to 100 (white)
a* - the **red/green** coordinate, with +a* indicating redness and -a* indicating greenness
b* - the **yellow/blue** coordinate with +b* indicating yellowness and -b* indicating blueness.

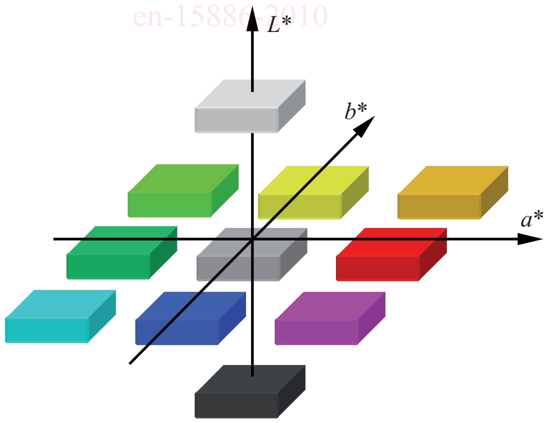

Figure 1 — L*a*b* colour space

4 Principle

The method is based on the determination of the colour of a surface with an instrumental quantification of colour, expressed numerically according to international methods. The colours are represented in a “colour space”, where any colour in the visible range is defined by three coordinates.

5 Test equipment

5.1 General

The instrument used for colour measurement shall be either a reflectance spectrophotometer or a tristimulus colorimeter.

It is recommended that the instrument geometry conforms to the d/8° illumination and viewing condition specified by the CIE, where the illumination is diffused with the specular component excluded.

5.2 White object colour stimulus

For the calculation of L*, a* b* values, the white reference shall be constituted by a perfect reflecting diffuser illuminated by the same light source as the tested object.

6 Colour measurement of specimens

6.1 Test areas

Test surface areas shall be representative of the colour of the material under investigation.

6.2 Number of specimens

A minimum of five representative specimens is considered suitable. However, if only a limited number of specimens is available, the most representative specimen(s) shall be used.

6.3 Preparation

The surface to be measured shall be smooth and flat.

The specimens shall be in equilibrium with the surrounding environment. Temperature (T) and Relative Humidity (%RH) should be recorded.

Measurements taken before and after treatment shall be performed under the same environmental conditions.

7 Colour measurements of indoor and outdoor object

7.1 General

The area of measurement is the section of the surface of the object on which the colour measurements are carried out. It shall be uniform in colour. Inhomogeneous areas, such as veins in marble, shall be avoided. Moreover, the area of measurement shall be as plane and non-textured as possible.

7.2 Measurement of indoor objects

The temperature (T) and relative humidity (RH) of the indoor environment should be recorded. Colour measurements before and after treatment, and any subsequent measurement, should be carried out under the same environmental conditions.

7.3 Measurement outdoor objects

The colour measurements shall not be carried out on wet surfaces because this can alter the colour of inorganic materials, depending on their hygroscopic characteristics.

The temperature (T) and relative humidity (RH) of the surrounding environment should be recorded. Colour measurements before and after treatment, and any subsequent measurement, should be carried out under the same environmental conditions.

8 Test method

8.1 General

The surface to be measured shall be representative for the specimen as a whole. Inhomogeneous areas, such as for example veins on marble, shall be avoided. The readings performed shall be representative for the perceived colour of the porous, inorganic material.

8.2 Measuring field and readings

The diameter of the measuring field shall be appropriate to the type of phenomenon under investigation, and the size of the specimen. Heterogeneous surfaces may be measured using a measuring field with a diameter as large as possible, in order to compensate variations in colour and texture, and to even out structural unevenness on the surface of the specimen, thus imitating the human visual process. Uniform specimens with or without well-defined areas of different appearance (such as dark veins on light marble) may be measured with a much smaller (1mm) measuring field diameter to avoid (or defining) any areas of in-homogeneity.

At least five single readings are necessary to obtain a reliable average value per specimen. The readings are taken at arbitrary locations on the surface of the specimen.

When the number of readings has been determined, the measuring points for the after-treatment colour measurement shall be localized by reference spatial coordinates in order to ensure precise repeated measurements. A grid delimiting the measurement field may be useful for this purpose, depending on specimen size.

8.3 Reproducibility of measurements

Reproducibility of measurements is assessed by comparing two series of measurements made on the same surface under the same conditions and at different times, defined as turning the instrument on and off, and recalibrating it. The difference, expressed as ΔE, between the L^*, a^*, b^* average values of the two series of measurements shall be $\leq 1{,}5$.

9 Calculations and interpretations of results

9.1 Calculations

9.1.1 CIELAB values

Calculate the CIELAB (CIE L^* a^* b^* 1976) values from the X, Y, Z values for each specimen. Daylight illuminant (D65) and 10° observer shall be used.

9.1.2 Calculation of total colour differences

9.1.2.1 General

The total colour difference ΔE* between two measurements ($L^*_1 a^*_1 b^*_1$ and $L^*_2 a^*_2 b^*_2$) is the geometrical distance between their positions in the CIELAB colour space. It is calculated using the following equation:

$$\Delta E^*_{1,2} = \sqrt{(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})}$$

where:

$\Delta L^* = L^*_2 - L^*_1$; corresponds to the lightness difference

$\Delta a^* = a^*_2 - a^*_1$; corresponds to the red/green difference

$\Delta b^* = b^*_2 - b^*_1$; corresponds to the yellow/blue difference

9.1.2.2 Recommended options

Because the L*a*b* colour space does not have exact equidistance between perceived colours (differences in the saturated colours are more difficult to perceive), the colour difference formula ΔE_{94} modifies the lightness, chroma and hue (L*C*H*) of L*a*b* colour space by incorporating factors that correct for variation in perceived colour difference magnitude. It is therefore recommended that the colour differences for each specimen are calculated from the equation ΔE^*_{94} .

The colour difference, or ΔE^*_{94}, between two colours is:

$$\Delta E^*_{94} = \left[\left(\frac{\Delta L^*}{k_L S_L} \right)^2 + \left(\frac{\Delta C^*_{2,1}}{k_C S_C} \right)^2 + \left(\frac{\Delta H^*_{2,1}}{k_H S_H} \right)^2 \right]^{1/2}$$

where

$\Delta L^* = L^*_2 - L^*_1$

$\Delta C^*_{2,1} = C^*_2 - C^*_1$

$C^*_1 = (a_1^{*2} + b_1^{*2})^{1/2}$

$C^*_2 = (a_2^{*2} + b_2^{*2})^{1/2}$

$$\Delta H^*_{2,1} = \left[\left(\Delta E_{2,1}^* \right)^2 - (\Delta L^*)^2 + \left(\Delta C^*_{2,1} \right)^2 \right]^{1/2}$$

Where S_L, S_C and S_H are weighting factors for lightness, chroma and hue, respectively, and are given by the following formulas:

$S_L = 1$

$S_C = 1 + 0{,}045\, C^*_{1,2}$

$S_H = 1 + 0{,}015\, C^*_{1,2}$

Note: in S_C and S_H, $C^*_{1,2} = (C^*_1 \cdot C^*_2)^{1/2}$

$k_L = k_C = k_H = 1$ (default)