AIC 2009

Proceedings of the 11th Congress of the International Colour Association

Sydney, Australia
27 September to 2 October 2009
LUMINANCE FACTOR VALUES OF CARD-BORDER PLASTER PLATES.

Ana Paula Alonso1, Joaquin Campos2, Alicia Pons2, Rafael González1 and Antonio Corrons2
1 School of Architecture. Department of Construction and Architectonic Technology.
Polytechnic University of Madrid. Spain
2 Instituto de Fisica Aplicada (CSIC). Department of Metrology. Madrid. Spain.

ABSTRACT

Card board plaster plates are frequently used to build up inner faces of modern buildings. Therefore knowing their optical properties regarding light reflection is important in order to design luminous environments within these buildings. Luminance factor of card board plaster plates with different finishes has been measured and analysed in this work. The luminance factor has been calculated for different angles of incidence (0 deg, 30 deg and 45 deg) and different observation angles within every incidence. This calculation is done from the spectral measurement of radience angular distribution of samples made with a goniophotometer designed and built at the Institute of Applied Physics (CSIC). Standard card board plaster plaques as well as plaques finished with a vinyl layer or a glass fibre layer have been studied in this work. Since standard plaques are normally painted, the luminance factor of painted plaques has also been studied.

Keywords: luminance factor, card-board plaster plates, angular distribution of luminance factor.

CONTACT

anaalonso_78@yahoo.com

INTRODUCTION

Cardboard plaster plates are frequently used nowadays to build up the inner space of buildings, replacing this way other more traditional systems as walls made up of bricks and plaster or ceramic. Selecting the most appropriated material is particularly important in designing a luminous environment to feel comfortable to do the intended visual task. To be able to do that; it is necessary to know how the light is reflected by the material as a function of the incidence angle, but very few manufacturers provide any information on that subject: reflectance behaviour of the materials they make for vertical and horizontal interior faces.

The object of this communication is to present luminance factor values of layered card border plaster plates used in interior environments to provide these important data to the lighting community. The luminance factor has been calculated from the radiance measurements as explained below. The radience has been measured at different observation angles and incidence angles by using a goniophotometer designed, built and calibrated at Institute of Applied Physics (CSIC. Spain). These measurements are just a first step approximation to the bidirectional reflectance distribution function (BRDF) which is the physical quantity completely describing the behaviour of these plaques regarding illumination design. Nevertheless this step allows a first comparison to a perfect diffuser in order to model the luminance distribution.

Furthermore, since plain or bare card-board plaster plates are not frequently used in interior faces, but painted, the luminance factor of painted plates is also presented in this communication. Of course, this is highly dependent on the paint itself and the way it is spread on the plaster. A plastic paint, normally used for these plates, has been used in for this work.
SAMPLES AND MEASUREMENTS

The sample set used in this work consists of five pieces: two standard layered card board plaster plates (Fig. 1), one standard layered card board plaster plate covered by a thin opaque vinyl film, called vinyl sample from now on, and two standard layered card board plaster plates covered by a thin layer of glass fibre, called glass fibre plate from now on. Vinyl plates are being used in ceilings of interior environments because of its easiness for cleaning. One of the standard plates and one of the glass fibre plates were painted with a white plastic paint made of acrylic dispersions, as they are used so in some environments. Before painting, a coat of modified acrylic resins was applied over the plaster card board as it is done in construction. The samples’ appearance is matt. Samples are approximately 5 cm x 5 cm square taken from regular plaques produced by the company “Knuf".

Fig 1. Standard card board plaster plate used in this work.

Fig 2. Gonio-spectrophotometer used in this work.

Angular distribution of samples’ spectral radiance has been measured in a gonio-photometer (Fig. 2) designed and built at the Institute of Applied Physics (CSIC). Samples were illuminated at normal, 30 deg. and 45 deg. incidence by a slide projector system producing a uniform illumination over the whole sample with a correlated colour temperature of about 3000 K. Incidence angles other than normal were obtained by rotating the sample around a vertical axis contained in the sample surface and passing through its centre. Radiance has been measured with a spectroradiometer Minolta CS 1000 at azimuth angles ±10 deg., ±20 deg., ±30 deg., ±45 deg., and ±60 deg. at normal incidence and every 15 deg. from −60 deg. to 30 deg. at 30 deg. and 45 deg. incidence, except for the angle matching the incidence. The zenith angle was 0 deg., i.e. the spectroradiometer turned around the sample’s centre on a horizontal plane. All azimuth angles are referred to from the surface’s normal. Negative angles are on the left hand side of the sample and positive ones on the right. A Ceramic reference standard was used to obtain the equivalent perfect diffuser radiance.

The field of view for measuring radiance was 1 deg. and samples were measured one time since the measurement time was long. Nevertheless the system repeatability and temporal stability are such that increasing the number of measurements does not yield a significantly lower uncertainty.

RESULTS

Luminance factor has been calculated as the ratio between the sample luminance and the perfect diffuser luminance. Luminance was calculated as recommended by CIE from spectral values given by
the spectroradiometer every nanometer from 380 nm to 780 nm. Figures 3 to 5 show the results obtained for the samples measured.

Fig 3. Standard cardboard plaster plate and painted plate luminance factor distribution

Fig 4. Vinyl plate luminance factor distribution

Fig 5. Luminance factor distribution of the glass fibre and painted glass fibre plates

At normal incidence, luminance factor decreases as the observation angle increases respect to the normal for all the samples studied, following a typical bell shape. The largest excursion from maximum to minimum is found for the standard and the glass fiber samples. In painting both types of samples (standard and glass fiber) the luminance factor variation get decreased.

As the angle of incidence (illumination) increases the behavior is different for observation angles close to normal than for those away from normal. In the first case, close to normal, the luminance factor starts to decrease as the angle of illumination increases and then starts to increase, being even bigger at
45° than at normal incidence. However, in the second case (observation angles away from normal) the luminance factor always increase as the illumination angle does.

The paint smoothes the luminance factor variation in both plates at every incidence angle, approaching the pattern to a horizontal plane. In the case of standard card board plaster, the paint diminishes the reflectance at the specular angle, while in the case of glass fiber, the paint diminishes the retro-reflection component of the reflectance.

CONCLUSIONS

The illuminance factor of samples of card board plaster plates with three different finishes has been measured as a function of observation angle for three incidence angles (0 deg., 30 deg. and 45 deg.). The distribution pattern cannot be easily described. Some samples show an increased reflectance at the regular reflection angle, while other do at the retro-reflection angle. Painting the surface of card board plaster plates contributes to smoothing the pattern.

ACKNOWLEDGEMENTS

Authors want to acknowledge Mr. Rosendo de Silva, from Knauf GmbH (Delegation in Madrid) for supplying the samples measured in this work and Mr. Rodrigo Díaz González from Instituto de Física Aplicada for his support for making the measurements.

REFERENCES