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Discomfort glare perception in daylighting: influencing factors

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Abstract

The mechanism behind the discomfort glare phenomenon, the kind of glare provoking an irritating or distracting effect, is not well understood. Since some of the factors influencing this phenomenon are still unknown, no current indices can properly explain the high variability existing between individuals' discomfort glare perception. A list of potential factors influencing the degree of perceived discomfort glare in daylighting has been established from existing literature. In addition to the physical quantities commonly used in glare indices, other variables, whether psychological, physiological, related to light or to the context, could influence the degree of perceived discomfort glare.

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1. Introduction

Energy efficiency and well-being are both major challenges in construction nowadays. Due to the growing interest given to these matters, discomfort glare indices are becoming more significant and increasingly used.
On the one hand, automatic management systems are implemented in buildings to optimise interactions of special techniques including heating, lighting, ventilation, and air conditioning. With regard to visual comfort management, control models implemented in this kind of system aim to use indices such as the Daylight Glare Probability (DGP)

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or the Discomfort Glare Index (DGI). Thresholds of visual discomfort are predetermined in the models so that when in-situ measured values exceed these thresholds, actions are taken by the system [1, 2].
On the other hand, office buildings windows are optimised to maximise the amount of daylight. Since a large amount of glazing implies an increased risk of discomfort glare, recommendations to limit discomfort glare from daylight are now being written and will be part of the new European daylight standard (prEN17037). These recommendations use the Daylight Glare Probability (DGP) as a reference index. Concerning discomfort glare from artificial lighting, CIE recommendations are based on another index, the Unified Glare Rating (UGR).

However, these discomfort glare indices cannot properly explain the high variability existing between individuals' discomfort glare perceptions. Since the mechanisms governing discomfort glare are still unknown, unidentified variables, such as physiological or even psychological factors, could influence the degree of perceived discomfort glare and explain this high variability between individuals' discomfort glare perception.

This paper aims to review factors potentially influencing the degree of perceived discomfort glare from windows. Every factor having at least been the object of an experiment as a potential element influencing discomfort glare perception is listed. The conclusion suggests a prioritisation list for future research.

2. Assessment of daylight discomfort glare factors

Discomfort glare is defined by the CIE [3] as "glare which causes discomfort glare without necessarily impairing the vision of objects". Indices developed to predict the degree of perceived discomfort glare, such as the Daylight Glare Index (DGI) or the Daylight Glare Probability (DGP), are generally based on four physical quantities:

- the luminance of the glare source, which is the intensity of the luminous flux emitted par unit area of the source;
- the adaptation level, which is the luminous flux reaching the eyes and setting the adaptation of the eyes;
- the solid angle of the glare source, which expresses the size of the glare source as seen by the observer;
- the position index, which is a correction factor considering the different perceptions of glare sources for the horizontal and vertical displacements from the line of vision of the observer.

The influence of these variables has been proven through statistical inferences. Several laboratory experiments have been conducted in which subjects were asked to rate their perceived discomfort glare while measures of the luminous environment were taken. These four variables have been adopted in discomfort glare indices, as up until now, they have ensured the best correlation between the perceived and measured assessments of discomfort glare. But this correlation is far from perfect. Therefore, similar experiments have been conducted to evaluate the influence of other factors on discomfort glare perception. Each factor having been the object of at least one experiment as a potential variable of discomfort glare perception is discussed in this paper. Factors are described and classified according to whether they are related to the lighting, to the context, or to the observer. References to the most significant studies having investigated each factor are also mentioned. Finally, an indicator is suggested, which expresses the probability of influence of the factor on discomfort glare perception. This probability is evaluated as either certain, likely, unlikely, uncertain or null. This evaluation is made by considering the number of studies supporting or rejecting the influence of the factor as well as the methodological and statistical relevance of these studies. When there are contradicting results, that is to say a similar number of studies supporting and rejecting the influence of the factor, the influence probability is assessed as uncertain.

3. Daylight discomfort glare factors

Table 1 lists all factors studied in the literature for their potential influence on discomfort glare perception. The most significant studies having examined these factors are specified, as well as the influence probability indicator.