Daylighting Standards: Some lessons from history

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Abstract

This paper explores architects' use of the daylight factor historically, to investigate whether non-statutory daylighting standards, based on the daylight factor, were effective in promoting good daylighting in housing in England and Wales. Semi-structured interviews were conducted with 11 interviewees, including practising and retired architects and lighting consultants. Interviewees suggested that undertaking daylight factor calculations at the design stage was time-consuming and required skill. Time pressures meant that architects rarely undertook daylight factor calculations, unless required to do so by funding bodies or Local Planning Authorities. Those architects who had a robust understanding of daylight factors reported that this knowledge enhanced their understanding of the principles of good daylighting, even if they did not routinely calculate daylight factors.

Background

British post-war planning guidance proposed that cities be rebuilt according to scientific principles.[1] Mathematical tools were devised to determine built form; daylight levels within buildings were to be evaluated using a metric called the daylight factor.[2]

The daylight factor is a measure of the illuminance within a room (usually on a horizontal plane), relative to the total amount of light that would be available under an unobstructed hemisphere with an overcast sky, expressed as a percentage. Recommendations on daylighting were expressed in terms of daylight factors in post-war guidance, including in the Code of Practice BS CP 3 Chapter 1(A) (1949) *Daylight: dwellings and schools*.[3] However, statutory daylighting standards for dwellings were not introduced at this time. Instead in 1952 the Ministry of Housing and Local Government introduced permissible height indicators, for use by local planning authorities in evaluating new housing.[4] These indicators offered a means of assessing whether there was sufficient space between buildings to permit rooms to receive adequate daylight, based on assumptions regarding the typical size of windows. Similarly, standards affecting daylighting in dwellings, incorporated into the Building Regulations introduced in England and Wales in 1966, controlled the space about buildings rather than daylight levels within buildings.[5]

The range of methods available to building designers, for calculating daylight factors at the design stage, expanded over the course of several decades. Developments in calculation methods can be charted in successive British Standards documents on daylighting. The 1949 British Standards, which drew on work undertaken by the National Physical Laboratory,[6] provided tables setting out the maximum distance from a window a given sky-factor-contour penetrates into a room, for a range of different window sizes. Mention was also made of the use of Waldram diagrams and Building Research Station (BRS) protractors, which enabled the calculation of sky factor at a given point in a room.[7] These methods, however, took no account of internally or externally reflected light. Following research undertaken at the BRS in the 1950s,[8] more sophisticated methods were devised of evaluating the daylight factor at a point, which took inter-reflected light into account. These methods were incorporated into the 1964 British Standards document, BS CP 3 Chapter 1 Lighting: Part 1 (1964) *Daylighting*.[9] A further development was the introduction of the average daylight factor formula,[10] which simplified the calculation process, and which was incorporated into the 1992 British Standards document, BS 8206-2: 1992 *Lighting for buildings – Part 2: Code of practice for daylighting*.[11]

The daylight factor is still the principal metric used in guidance on daylighting, including in the current British Standards.[12] Previous studies indicate that few architects undertake daylight factor calculations when designing housing. A survey conducted in 1966 showed that 33% (26 of 80) of architects surveyed used BRS protractors to predict daylight levels in rooms at the design stage, but only one respondent reported calculating the internally reflected component (IRC).[13] In a similar survey conducted in 1994, 42% (14 of 33) of the architects surveyed claimed to use BRS protractors, but again only one respondent mentioned calculation of the IRC, while only 9% (3 of 33) used the simpler average daylight factor formula.[14] Recent research indicates that many new-build

housing schemes do not comply with recommended daylight factors.[15] This is a cause for concern given the proven health benefits of daylight.[16] Some commentators argue that the daylight factor is now obsolete.[17]

Aims and Methodology

This paper explores whether non-statutory daylighting standards, based on the daylight factor, were effective in promoting good daylighting in housing in England and Wales. The study draws on archival material, and on interviews with practising and retired architects and lighting consultants, specifically:

six retired architects, of whom three also worked in academia
one practising architect
one retired academic/lighting consultant who taught in schools of architecture
two lighting consultants (still working)
one retired senior planning officer

Interviews were recorded using a digital audio recorder and transcribed verbatim. Transcripts were analysed thematically, using N-Vivo software to store and retrieve data.

Findings

Interviewees for this study reported that many of the daylight prediction techniques developed around the daylight factor were difficult and time consuming to use. For example, the methods developed in the 1950s by the BRS for calculating daylight factor at a point, and which were incorporated into the British Standards, required a three-stage process; the externally reflected, internally reflected and sky components had to be calculated separately. In describing the time and effort required to calculate the sky component alone, one retired architect said:

> "The Waldram diagram… my God it took time… [clients] couldn't understand where the time went, I said well you try [drawing] a Waldram Diagram!" (Interviewee no.9)

Even architects who had received good training in daylight prediction methods reported that pressures on time made it difficult to undertake lengthy daylight factor calculations. As a practising architect described:

> "…once you got out there into practice [with] sort of real, real life demands… did I ever get out that, those charts and actually in practice start working on daylight factors? I think I probably did in the case of one, one major scheme…" (Interviewee no.6)

An alternative approach to evaluating daylight factors at the design stage was to use photoelectric cells, which could be placed in a scale model of the building under development, but this required specialist equipment and a high degree of skill. In addition, this method was only really effective when used in conjunction with an artificial sky, which allowed the effects of diffuse light from an overcast sky to be measured independently of the effects of direct sunlight.

Some interviewees argued that it is possible to design a window without undertaking a calculation. In discussing the use of gnomonic projections and BRS protractors to calculate the sky component for daylight factor calculations, one retired lighting consultant said:

> "Nobody's going to count dots or mess about with protractors… Life's too short!" (Interviewee no.7)

Those interviewees who were knowledgeable about daylight factors reported that this expertise enhanced their understanding of the principles of good daylighting, even though they did not routinely calculate daylight factors (Interviewee nos.5 and 9).

Conclusion

Given the time and skill required to undertake daylight factor calculations, practitioners rarely used them, except where required by funding bodies or Local Planning Authorities; requirements to use such daylight-prediction

techniques were rare in the design of housing. Daylight prediction methods developed around the daylight factor were useful in establishing objective standards. Also, crucially, architects who became familiar with such techniques often developed a robust understanding of the science of daylighting, even if they did not calculate daylight factors for every building they designed.

References

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