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# DAYLIGHT AND VISUAL COMFORT IN RESIDENTIAL BUILDINGS: A CASE STUDY IN CENTRAL COPENHAGEN

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## Abstract

### 1. Motivation, specific objective

Although several studies have explored the applicability of different daylight metrics to residential buildings, the visual comfort assessment methods in this building typology have not been addressed in a similar extent. Here we are presenting a study where visual comfort as well as view-out and daylight availability for 360 –degree visual span of the space was assessed in a newly built residential area in central Copenhagen. The selected indicators, which are namely “wide-visual-range” discomfort glare evaluation, “view out”, and exposure to direct sunlight are assessed for several affecting external parameters, e.g. surrounding buildings, and shading devices. To date, visual discomfort caused by daylight has been greatly investigated in commercial buildings with a general focus on office buildings. These studies have proposed several indices to predict discomfort caused by glare or unbalanced luminous contrast within a fixed Field of View (FOV) with respect to an office visual task-area, e.g. monitor screen. However, task-oriented visual comfort evaluation is not an optimal method for visual comfort assessment in residential interior spaces where the classification of a task and its position is less defined. Thus, a need for a wide visual span evaluation proves to be essential for such buildings. Another parameter that plays a crucial role in definition of comfort in buildings and more so in residential buildings is view out which is considered in this study. View out is a parameter that overrides the negative effects of excess heat and brightness. Studies have shown that people tolerate thermal and visual discomfort in exchange for view out. Finally, direct sun access has been stated to be appreciated in residential buildings and is highly recommended in order to guaranty a visually comfortable and acceptable daylit interior environment. In order to address visual comfort in residential buildings in a holistic manner, in this simulation-based study address the three mentioned aspects of visual comfort and visual quality in daylit spaces for residential buildings.

The new assessments are done in a comprehensive simulation-based study where several internal, i.e. surface materials, furniture, etc., and external parameters, i.e. adjacencies, vegetation, as well as several solar controls systems are considered in seven residential apartments. The apartments been carefully selected in a newly built and modern apartment complex in central Copenhagen.

### 2. Methods

Photometric behaviour of a selected case study is observed with simulations using the lighting rendering tool, Radiance. The chosen residential building for this study represents newly built building types in central Copenhagen. These buildings have relatively large windows for daylight access. Ten variations of shading systems are evaluated for their daylight performance, visual comfort using Daylight Glare Probability (DGP) index over a larger visual span and view out quality. Daylight performance of the simulated shading systems with manual control were investigated for two floors of the building and two neighbouring density scenarios (with or without). Visual comfort simulations are done for several view directions in order to assess the photometric behaviour in a larger visual span. For this part high dynamic range (HDR) rendering techniques with angular fisheye perspective view types rendered in Radiance. HDR renderings over a range of view directions were simulated and evaluated for visual comfort using the DGP model. The visual span was set to 112.5°, which started from a perpendicular vector to the south-facing window, and ended at 112.5° inside the room where the window disappeared from the FOV. This visual span was divided into six view directions and six 180° angular fisheye HDR images. The occupant position in a room (a viewpoint) was assumed to be at 1200 mm from the floor and in the middle of the room. All simulations are done for annual evaluations. Using geometrical methods, view out is assessed from the same occupant position. Direct daylight exposure is also investigated using geometrical methods and the same occupant position.

The three comfort indicators for the mentioned simulation scenarios are then assessed separately and compiled in order to present the comfort rating of each building based on the three indicators.

### **3. Results**

Our preliminary results show that the three indicators and their infographic representation can be a useful visual aid to assess the state of comfort in the design scenario at the hand. The effect of the simulation parameters and appropriate solutions regarding shading devices are seen in a simple overview of the results and by means of data visualisation.

### **4. Conclusions**

Daylight and visual comfort state in newly built residential buildings in central Copenhagen have been assessed based on three indicators. In order to show its applicability and strength in communicating the comfort rating, several simulation scenarios were considered and assessed. The main characteristics of these buildings are larger windows and attempt to access view out towards the sea. Discomfort glare is a major problem in some buildings and several solutions can be considered in order to alter these conditions which are derived from the simulation results.