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Thermal and Visual Comfort Assessment in Office Buildings in Relation to Space Depth

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Abstract : In today’s compact cities, bringing daylighting and fresh air to buildings is a significant challenge, but it also presents opportunities to reduce energy consumption in buildings by reducing the need for artificial lighting and mechanical systems. Simple adjustments to building form can contribute to their efficiency. This paper examines how the relationship between the width and depth of the rooms in office buildings affects visual and thermal comfort, and consequently energy savings. Based on these evaluations, we can determine the best location for sedentary areas in a room. We can also propose improvements to occupant experience and minimize the difference between the predicted and measured performance in buildings by changing other design parameters, such as natural ventilation strategies, glazing properties, and shading. This study investigates the condition of spatial daylighting and thermal comfort for a range of room configurations using computer simulations, then it suggests the best depth for optimizing both daylighting and thermal comfort, and consequently energy performance in each room type. The Window-to-Wall Ratio (WWR) is 40% with 0.8m window sill and 0.4m window head. Also, there are some fixed parameters chosen according to building codes and standards, and the simulations are done in Seattle, USA. The simulation results are presented as evaluation grids using the thresholds for different metrics such as Daylight Autonomy (DA), spatial Daylight Autonomy (sDA), Annual Sunlight Exposure (ASE), and Daylight Glare Probability (DGP) for visual comfort, and Predicted Mean Vote (PMV), Predicted Percentage of Dissatisfied (PPD), occupied Thermal Comfort Percentage (occTCP), over-heated percent, under-heated percent, and Standard Effective Temperature (SET) for thermal comfort that are extracted from Grasshopper scripts. The simulation tools are Grasshopper plugins such as Ladybug, Honeybee, and EnergyPlus. According to the results, some metrics do not change much along the room depth and some of them change significantly. So, we can overlap these grids in order to determine the comfort zone. The overlapped grids contain 8 metrics, and the pixels that meet all 8 mentioned metrics’ thresholds define the comfort zone. With these overlapped maps, we can determine the comfort zones inside rooms and locate sedentary areas there. Other parts can be used for other tasks that are not used permanently or need lower or higher amounts of daylight and thermal comfort is less critical to user experience. The results can be reflected in a table to be used as a guideline by designers in the early stages of the design process.

Keywords : occupant experience, office buildings, space depth, thermal comfort, visual comfort
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