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Daylight Performance-Based Design Model for Bio-adaptive Building Skin for Office Space of Administrative Buildings in Egypt

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Abstract.

Daylight Discomfort Glare (DDG) limits the effectiveness of natural light in office spaces, particularly in Cairo's hot climate, where varying sun angles throughout the day impact visual comfort. The research provides a parametric design tool that integrate building skin designs based on user specified parameters, a daylighting simulation engine that assesses daylighting performance using a single point-in-time method for each design variant, and an optimization tool that helps identify the most optimal design solution based on maximizing daylighting performance while reducing (DDG) for southern orientation in Egyptian office buildings. Through seasonally adaptive design, this study demonstrates how effectively biomimetic building skin can enhance indoor visual comfort. Across four specific test points, the proposed system reduced glare by up to 31% while maintaining indoor illuminance levels within the recommended range of 500–2000 lux compared to an unshaded base case. For June, a 90% perforation ratio with a 20 cm shading extrusion proved most effective, offering a balanced approach to daylight access and glare mitigation, especially in the morning and afternoon, while medium ratios performed better at noon. In December, perforation ratios of 50–60% combined with a 30 cm extrusion effectively blocked low-angle sunlight and reduced glare.

Keywords: Bio-adaptive skin, daylighting performance, parametric design, building envelope design.