The Balance between Daylighting and Thermal Performance Based on Exploiting the Kaleidocycle Typology in Hot Arid Climate of Aswan, Egypt

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Abstract

A building's facade has significant impact on energy consumption. This paper investigates a specific facade configuration based on origami: kaleidocycle rings that can be morphed to enhance daylight uniformity and reduce total energy consumed for heating and cooling. This paper utilizes simulation techniques for identifying the most efficient daylight and thermal performance by incorporating parametric optimization using Grasshopper and Diva-for-Rhino. Analysis was conducted using the Daylight Dynamic Performance Metrics (DDPMs) specifically Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE) based on the new IES approved daylight metrics. The simulation was carried out for a southoriented façade of an office room in Aswan, Egypt, through two phases both used genetic algorithm to drive kaleidocycle parameters. The first phase simulated daylighting for façade optimization which influenced the second phase that run to reach the balance point between daylight and thermal performance. Results demonstrate that kaleidocycle rings of 26 cm size and 64◦ rotation angle exceed the LEED V4 daylighting requirements and achieve a remarkable energy saving of 23% in comparison to non-optimized configuration.

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