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Thermal, energy and daylighting performance of solar envelope courtyard blocks in Cairo, Egypt.

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Abstract. Courtyard buildings are acknowledged for their thermal benefits in hot-arid regions. However, the design for thermal performance in these regions often entails compact urban forms, compromising other environmental qualities, e.g., daylight availability. This paper presents the Solar Envelope Block (SEB) as a sustainable urban form in hot-arid regions, by addressing the drawbacks of a Conventional Courtyard Block (CCB). The study uses ENVI-met to account for the thermal performance, as well as Ladybug-tools for Grasshopper/Rhino, to account for the energy and daylight performance of both typologies. The performance metrics, air temperature and wind speed, calculated by ENVI-met on a typical hot summer day, are extrapolated as EnergyPlus boundary conditions for energy calculations over the summer season. Further, spatial Daylight Autonomy (sDA) is calculated by Radiance to compare their annual daylight availability. The results show that SEB's are on average 1°C lower, and 0.6 m/s higher throughout the day. Boundary conditions adjustments show improvements in cooling loads by almost 14%, compared to basecase conditions. Daylight analysis shows respective improvements of 16% and 69%, in SEB's electrical loads, and daylight availability, over CCB's. The study concludes SEB's sky openness is more favourable to the overall environmental performance.

Keywords: Solar envelope, Thermal comfort, Energy loads, Daylighting, Courtyards.