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Outdoor Thermal Comfort Strategies: The Case of Cool Facades

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Abstract : Mitigating urban overheating is key to achieving the environmental and energy sustainability of cities. The management of the optical properties of the materials that make up the urban envelope -roofing, pavement, and facades- constitutes a profitable and effective tool to improve the urban microclimate and rehabilitate urban areas. Each material that makes up the urban envelope has a different capacity to reflect received solar radiation, which alters the fraction of solar radiation absorbed by the city. However, the paradigm of increasing solar reflectance in all areas of the city without distinguishing their relative position within the urban canyon can cause serious problems of overheating and discomfort among its inhabitants. The hypothesis that supports the research postulates that not all reflective technologies that contribute to urban radiative cooling favor the thermal comfort conditions of pedestrians to equal measure. The objective of this work is to determine to what degree the management of the optical properties of the facades modifies outdoor thermal comfort, given that the mitigation potential of materials with high reflectance in facades is strongly conditioned by geographical variables and by the geometric characteristics of the urban profile aspect ratio (H/W). This research was carried out under two climatic contexts, that of the city of Mendoza-Argentina and that of the city of Campinas-Brazil, according to the Köppen climate classification: BWk and Cwa, respectively. Two areas in two different climatic contexts (Mendoza - Argentina and Campinas - Brazil) were selected. Both areas have comparable urban morphology patterns. These areas are located in a region with low horizontal building density and residential zoning. The microclimatic conditions were monitored during the summer period with temperature and humidity fixed sensors inside vial channels. The microclimate model was simulated in ENVI-Met V5. A grid resolution of 3.5 x 3.5 x 3.5m was used for both cities, totaling an area of 145x145x30 grids. Based on the validated theoretical model, ten scenarios were simulated, modifying the height of buildings and the solar reflectivity of facades. The solar reflectivity façades ranges were: low (0.3) and high (0.75). The density scenarios range from 1th to the 5th level. The study scenarios' performance was assessed by comparing the air temperature, physiological equivalent temperature (PET), and thermal climate index (UTCI). As a result, it is observed that the behavior of the materials of the urban outdoor space depends on complex interactions. Many urban environmental factors influence including constructive characteristics, urban morphology, geographic locations, local climate, and so forth. The role of the vertical urban envelope is decisive for the reduction of urban overheating. One of the causes of thermal gain is the multiple reflections within the urban canyon, which affects not only the air temperature but also the pedestrian thermal comfort. One of the main findings of this work leads to the remarkable importance of considering both the urban warming and the thermal comfort aspects of pedestrians in urban mitigation strategies.

Keywords : materials facades, solar reflectivity, thermal comfort, urban cooling
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