Assessment of Thermal and Visual Micro-climate of Street Design in Traditional Commercial Spines in a Hot Arid Climate 2016

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Abstract

In the hot arid contexts, the impact of urban climate is often associated with negative effects on outdoor thermal comfort and an increase I the urban heat island (UHI) effect.

The primary aim of this research is to investigate the outdoor thermal performance of traditional commercial urban allies located in the hot arid context of Cairo in Egypt. A number of methods were used to understand the existing urban thermal conditions including field measurements and social surveys. Consequently, urban air flows and daylight simulations to assess existing and possible improvement scenarios to extend pedestrian thermal and visual comfort were tested. The field measurements were conducted twice in order to first assess the UHI intensity in the urban street, and to investigate the effectiveness of the traditional design solutions in ensuring comfortable outdoor conditions based on human-biometeorological assessment methods. Validation of results was carried out by comparing measured and simulated results of thermal conditions in the commercial spine.

ENVI-met is a three dimensional microclimatic model based on computational fluid dynamics (CFD) models and is designed to simulate surface-air interactions in urban environments. It was used to calculate the mean radiant temperature and obtaining the microclimatic maps with problematic areas concerning the pedestrian's thermal comfort for the existing urban configurations. Results indicated possibilities and limitations of introducing shading systems to improve thermal comfort in the urban spaces of hot arid cities.

Outdoor thermal comfort was assessed based on a thermal sensation survey and the outcome developed local physiological equivalent temperature (PET), with a comfort range of (24˚C - 32˚C). Additionally, local subjects adapted to thermal environments by seeking shelter outdoors from direct solar radiation.

To improve outdoor thermal conditions at pedestrian level seven different shading scenarios addressing the form and the opening of shading devices were simulated using

CFD fluent, based on two dependant variables including air temperature distribution and wind velocity. The daylight analysis software (DIVA) was used to evaluate the solar access for the tested cases. The findings show that typology and the opening locations are one of the paramount factors in providing a temperature reduction in the urban scale. As the air temperature was reduced by (2.3˚C) for the best case compared to the base leading to a lower PET for the best case recording 32.9 ˚C against 35˚C for the base case.