THERMODYNAMIC BEHAVIOR OF TRANSITIONAL SPACES IN ARCHITECTURE. REVIEWING THE MAIN THERMAL TEMPERING PARAMETERS

Carlos Rivera-Gómez, Carmen Galán-Marín Carmen, Eduardo M. Diz-Mellado, Victoria López-Cabeza

Keywords: *Climate change; Courtyards monitoring; Aspect ratio; Diurnal Temperature Range; Maximum outdoor temperature;*

1. Introduction:

Due to the ongoing global warming, heat mitigation strategies are becoming more and more important. Furthermore, the growth of the cities influences the urban climate and may lead to a localized increase of air temperature. Elevated air temperatures, especially during the summer season, may have major implications for building energy demand, local air quality, and outdoor thermal comfort.

Courtyards have been traditional popular architectural resources, common in warm- climate Mediterranean cities. Thermal regulation provided by passive strategies such as the courtyard design can lead to considerable energy savings. There are many possible strategies to improve the thermal tempering efficiency inside the courtyard. Especially in hot and dry climate (Zamani, 2018), the geometry of the courtyard form affects considerably the shadows produced on the building envelope, and, consequently, the received solar radiation and the cooling and heating loads of the building (Taleghani, 2018). Therefore, heating and cooling loads for different courtyard shapes should be evaluated. Courtyard shape can be defined by basing on the aspect ratio (AR). AR is the ratio of courtyard width (W) to courtyard length (L) (Al-Masri , 2012).

2. Materials and methods

The possible feedback between the courtyard geometry and its effectiveness as a thermal regulator depending on the outdoor temperature has been investigated. Accordingly, several studies done through field measurement regarding the thermal behavior of a number of courtyards in different Spanish cities are described. Specifically, we explored the diversity of microclimatic conditions in and around a number of geometrically different courtyards.

The results show the importance of the specific geometry of a courtyard in view of the courtyards' microclimate.

3. Results and conclusions

The evaluation of the courtyard performance in a complete daily cycle through the DTR analysis supports the tendency detected for the maximum outdoor temperature, according to which a greater thermal range shows greater effectiveness of courtyard thermal tempering. It is also possible to establish a correlation between the courtyard aspect ratio and the diurnal thermal range gap between the outdoor and courtyard. Furthermore, analyzing the courtyard diurnal thermal range percentage within the proposed adaptive thermal comfort range, it can be verified that for the bigger aspect ratio the courtyard is 100% within an adequate thermal comfort zone.

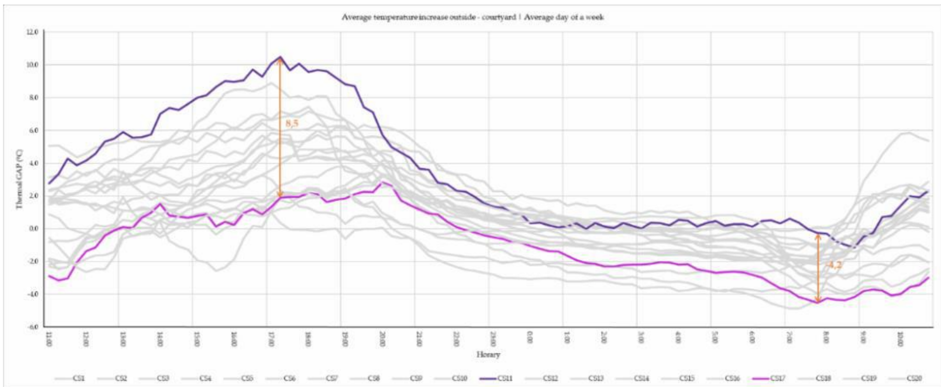

Figure 1: Thermal gap representation contrasting all the courtyards temperatures versus the outdoor ones.

4. Acknowledgment:

This work has been supported by the National Government of Spain Research Project MTM2015-64577-C2-2-R, Ministerio de Economía y Competitividad. The authors also want to thank AEMET (Agencia Estatal de Meteorología - State Meteorological Agency, Spanish Government) for the data supplied.

5. References

Zamani Z, Heidari S, Hanachi P. Reviewing the thermal and microclimatic function of courtyards. Renew Sustain Energy Rev. 2018;93(April):580-595. doi:10.1016/j.rser.2018.05.055

Taleghani M. Outdoor thermal comfort by different heat mitigation strategies- A review. Renew Sustain Energy Rev. 2018;81(October 2016):2011-2018. doi:10.1016/j.rser.2017.06.010

Al-Masri N, Abu-Hijleh B. Courtyard housing in midrise buildings: An environmental assessment in hot-arid climate. Renew Sustain Energy Rev. 2012;16(4):1892-1898. doi:10.1016/j.rser.2012.01.008