The University of Nottingham
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ARCHITECTURAL AND SOLAR POTENTIAL OF CURVED AND FLAT ROOFS IN HOT ARID REGIONS

(With Reference To Egypt)

By

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ABSTRACT

This thesis investigates the effect of various vaulted and domed roof geometries on their solar behaviour under given summer and winter conditions. Roof is the building-envelope element that is most exposed to the sun as it receives a high amount of solar radiation, which is the main cause of summer overheating in hot-arid climates. In addition, to other climatic and physical factors, indoor thermal comfort in hot-arid climates is also influenced by the intensity of solar radiation received by roof surfaces. Therefore, roof form and geometry should be designed with careful consideration to insolation parameters. Domed, vaulted, and curved roofs have been used for a long time in hot-arid regions for historical, cultural, climatic, and structural reasons. The review of previous research work showed that different explanations have been given to the climatic effects of their forms and the environmental behaviour of their enclosed spaces.

The research explores the previous attempts that discussed the relevant principles of solar radiation and solar geometry on horizontal and tilted surfaces with different orientations. The previous work that applied these principles and theories to evaluate the solar behaviour of architectural elements with arbitrary forms was also investigated. In order to evaluate the solar performance of flat and curved roofs geometrical configurations, a parametric study testing the received solar radiation intensity (W/m^2) on flat, vaulted, and domed roofs with different span-to-height ratios and orientations was carried out using a published solar computer model. The results of this model were followed by validation tests using other two commercially available computer tools to carry out a brief solar and thermal analysis of selected curved-roof geometries. The evaluated curved-roofs solar performance and main findings of the present research have been compared with recently published independent research.

It is believed that this research establishes a sound theoretical basis for the validity of various claims of the climatic advantages of different curved-roof forms in hot-arid regions. As part of this research outcome, solar and architectural design-guidelines for curved-roofs are introduced. The research concludes with a discussion of the architectural and solar potential of curved-roof forms, which is believed to be novel contribution to the knowledge and the understanding of curved-roofs solar behaviour and architectural applications in hot-arid climates.