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Toplighting for Enhancing Daylighting Performance in Wide Span Spaces

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STATEMENT

This thesis is submitted to Ain Shams University for the M.Sc. degree in Architecture.

The work included in this thesis was carried out by the researcher at the Department of Architecture, Faculty of Engineering, Ain Shams University, during the Period from April 2011 to April 2015.

No Part of this thesis has been submitted for a degree of a qualification at any other university or institute.

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TO MY DEAREST FAMILY

TO MY PRECIOUS FATHER AND MOTHER

TO MY BELOVED HUSBAND

TO MY SISTER AND BROTHERS

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Abstract

By the development of technology that allowed huge enclosed spaces to be constructed, the issue of how to daylit these spaces was necessary. Toplighting was the suitable solution to provide even distribution of daylighting performance inside wide span spaces. Different types of toplighting was created to meet the design and the function requirements. However in wide span spaces as in sport halls, many designers neglect daylighting for the sensitivity function needs. The thesis aims at identifying toplighting concepts and configurations that can be used in wide span spaces like sport halls to create a pleasant environment. The research concentrates on sawtooth roofs as a type of toplighting and investigates the effect of using different shading techniques integrated with sawtooth roof such as: louvered overhang, internal louvers or baffles and external louvers The thesis also investigates the effect of changing the roof configuration on daylighting performance of toplighting. The research tries are chosen under the sunny clear sky of Cairo, Egypt**.**

This thesis consists of three parts and ends with the conclusions and recommendations. The first part (chapter 1) investigated the different types of toplighting and its design considerations. It also discussed the types of shading techniques. In the second part (chapter 2) four performance metrics were specified. These metrics are Daylighting Availability, Spatial Daylight Autonomy (sDA), Annual Sunlight Exposure (ASE) and Daylight Glare Probability (DGP). A standard multi-sport hall was selected in Cairo as a case study with sawtooth roof with different design variants and its daylighting performance was analyzed. In the third part (chapters 3 and 4) the effect of using shading techniques was studied. Moreover, an investigation was conducted on the effect of roof configuration on daylighting performance. Parametric design was used for modeling using Grasshopper and Rhinoceros 3D modeling software. Diva-for-Rhino a daylighting simulation plug-in was used to interface Radiance and Daysim for annual daylighting simulation and illuminance calculation.

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The results provide the daylighting performance of different design variants, different techniques and parameters. Results present design guidelines for toplighting in multi-sport halls under sunny clear sky of cairo.

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