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2

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Title : ROOF CONFIGURATIONS FOR DAYLIGHT PERFORMANCES IN MALAYSIAN ATRIUM BUILDINGS UNDER TROPICAL SKY CONDITIONS

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Some crucial elements in the daylighting design of atrium buildings are the shape of the atrium, roof configuration, building orientation, roof transmittance, internal surface reflectivity, and glazing areas. Apart from the various internal design factors, the outdoor sky distribution also has significant impacts on indoor daylighting. Therefore, the aim of this study is to investigate how typical modern construction techniques applied to atrium roofs attenuate daylight transmittance to predict the daylight performance of roof configurations for atrium buildings in Malaysia. An evaluation of the existing atrium roof systems and configurations for atrium buildings in the Klang Valley was conducted. Results show that the most preferred atrium form used for Malaysian buildings is the top-lit and enclosed central rectangular shallow atrium with an average atrium height of 4-storeys. A scaled model of an atrium building was built to emulate the characteristics of a typical atrium with a roof structure for tropical climates. Four models were developed to perform the daylighting performance analyses involving field experiments and computer simulations. The models used different roof fenestration designs and structural truss systems (flat, pitched, pyramidal-gridded and saw-tooth roofs) and were initially tested under real sky conditions to investigate the daylight distribution and illuminance levels on the horizontal surfaces in the atrium building. An internationally accredited Indoor Environmental Solutions Virtual environment (IES-VE) programme, specifically the IESRadiance application software was then used to simulate daylight penetration in the atrium space of the models. This software enabled the researcher to vary the design of various modern roof structures and constructions of the atrium to analyse their effects on daylight distribution patterns. The Daylight Factor/Daylight Ratio on horizontal surfaces under different types of sky conditions at different times of day and different days over a period of one year were obtained. The daylight distribution in the model atrium was consistent with current daylighting theory. Intermediate sky conditions, the predominant sky condition showed a generally linear relationship and good degree of correlation with the overall reduction of daylight levels in the atrium. Results showed that structured roof forms applied to the atrium model reduced daylight levels in the atrium well by 55% with similar patterns of losses for the four roofs studied. Internal roof obstructions created a relatively constant attenuation of daylight compared with the clear unobstructed roof for the four structured roofs. It was found that a high contribution of daylight penetration appeared at the centre nearest to the atrium opening, while the transmittance of the atrium roof structure decreased the illuminance level at the lowest corner by 50%. It was also found that under overcast skies, the illuminance levels greatly decreased at the corner of the atrium floor, especially for the north- and west-facing atrium surfaces for all types of roofs. The flat roof performed well in maintaining the acceptable limit of maximum light utilisation and was more consistent in terms of light distribution across the atrium floor. Meanwhile, complex roof configurations of the pyramidal-gridded atrium type obtained better daylight contribution at approximately 50%. As the most vulnerable one, the pitched roof was found to be less consistent and had poor distribution, especially at low transmittance levels. For a low-rise atrium with a Well Index of up to 1, a top-lit transmittance roof obstruction plays a major role in either limiting, reflecting or splaying daylight away to the corners and works efficiently with 50% or higher solid wall transmittance. The discrepancy of light distribution was increased if measured between the unobstructed atrium well with complex configurations. This work has paved the way for more design strategies using complicated atrium roof fenestration constructions to be analysed with accuracy while combining aesthetics with energy efficiency.