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ScienceDirect

Solar Energy 133 (2016) 1–13

SOLAR ENERGY

www.elsevier.com/locate/solener

Shaping the slats of hospital patient room window blinds for daylighting and external view under desert clear skies

Ahmed Sherif *, Hanan Sabry, Ayman Wagdy, Islam Mashaly, Rasha Arafa

The American University in Cairo, AUC Avenue, P.O. Box 74, New Cairo 11835, Egypt

Received 4 September 2015; received in revised form 18 December 2015; accepted 27 March 2016
Available online 16 April 2016

Communicated by: Associate Editor Ursula Eicker

Abstract

Provision of daylighting and external view in hospitals is crucial as they create a positive healing environment. They could help in reducing patient stress, fatigue and length of stay, while increasing patient and staff safety and satisfaction. However, in desert locations that are typically characterized by year-long clear skies, control of solar penetration is essential. Window blinds were used to decrease patients' visual discomfort and improve illuminance levels. The shape of blind slats influences daylighting performance and exposure to external view.

The objective of this paper was to identify the shapes of horizontal blind slats that best suit a common hospital patient room layout design under the predominantly clear-sky of Cairo, Egypt. The paper utilized parametric tools and simulation software to systematically test possible slat shapes. A total of 77 slat shapes were examined. The objective was to fulfill year-round daylighting adequacy on the bed surface and the room area, and to maximize patient's access to external view.

The shading system examined in this paper was an internal horizontal blind that looks similar to Venetian blinds, but fixed with no movement. The shape of all slats of the tested blinds was simultaneously adjusted for examination. The effect of changing slat shapes was examined by evaluating daylighting performance in terms of Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE) on both the bed surface and the room surface planes. Exposure to external view, expressed as External View Factor (EVF) was also addressed. The two tips of each slat were kept fixed in position. The position of an intermediate point on the slat surface was systematically adjusted in the horizontal and vertical directions creating curved blind slat shapes.

Results revealed that the sDA on the room surface plane was the limiting factor in determining acceptable slat shapes. The range of acceptable slat shapes according to the sDA on the bed surface criterion was larger than that of the whole room area. In addition, all tested slat shapes provided acceptable ASE performance. Blinds with flat or gently curved slat shapes scored better results in both daylighting and external view exposure. Position of the intermediate point of the slat – in most of the accepted cases – fell in a narrow vertical range around the horizontal base line. Changing the position of the intermediate point horizontally in either direction resulted in a marginal effect on the performance of the accepted cases. It was observed that the closer the intermediate point to the center of the slat, the better was the performance.

Keywords: Daylighting; Clear sky; External View; Hospital; Internal blinds; Slat shape

* Corresponding author.
E-mail addresses: asherif@aucegypt.edu (A. Sherif), drhanansabry@gmail.com (H. Sabry), aymanwagdy@aucegypt.edu (A. Wagdy), islammashaly@aucegypt.edu (I. Mashaly), rashamahmoud@aucegypt.edu (R. Arafa).

http://dx.doi.org/10.1016/j.solener.2016.03.053
0038-092X/

1. Introduction

In desert climates, there is an abundance of solar exposure and a large potential for utilization of daylighting under the year-round clear skies. This could be especially useful in hospital patient rooms, where exposure to daylight and external view creates a positive healing environment. Provision of daylighting and external view in hospitals could aid in improving patients' health and staff morale. The variability of illumination during the day, in terms of intensity and color temperature, generates dynamic indoor environments that may contribute positively to patient health outcomes. It could help in reducing patient's stress, fatigue and length of stay in the hospital, while increasing patient and staff safety and satisfaction.

However, excessive solar penetration could lead to non-uniform illuminance distribution and/or visual discomfort. Shading devices have proven useful in control of solar access while providing adequate daylighting performance. Internal horizontal shading devices, such as Venetian blinds, were commonly used for this purpose. Fixed blinds were suggested as an alternative to movable blinds in order to avoid operational problems and inconsistent user manipulation.

The shape of blind slats plays an important role in control of daylight and exposure to external view. Parametric search tools could help understand the year-round effect of these slats on performance. They can also help define optimum slat shapes that can achieve satisfactory year-round performance.

Review of literature demonstrates that there is a body of research that addressed the effect of blinds and their slats on daylighting performance. However, very little research work addressed the effect of blind slat shapes on daylighting for healthcare facilities, especially under the desert clear-sky. Hospital patient rooms have specific needs in regards to providing an adequate level of light on the bed surface, in addition to the lighting of the whole room area. Moreover, very little research addressed the need for providing access to external view in these establishments. The following is an overview of related literature.

The positive impact of daylighting and external view on patients was addressed in a large number of publications (Walch et al., 2005). One of the most important publications in this regard was by Ulrich (1984). In Ulrich's study, the effect of external view exposure on patient's recovery from surgery was investigated. Patients staying in rooms with windows facing a natural setting had a shorter length of stay and took fewer pain killers compared to those who stayed in rooms with window views facing a brick building wall. Pechacek et al. (2008) also studied the positive correlation between lighting, human health and performance in a patient room located in Boston, USA. Ulrich (1991) explained that natural light improvement could help in reducing stress and fatigue, while increasing the effectiveness of delivering care, patient safety and overall healthcare quality. Aripin (2007) conducted a review in Malaysian hospitals on the effect of daylighting on healing patients and reducing artificial lighting energy consumption. The research studied hospitals' daylight and artificial lighting and their relation to other environmental aspects.

A number of publications addressed the configuration of hospital patient room windows. Sherif et al. (2014a) examined three common patient room layouts to investigate the influence of room shape on providing sufficient and comfortable daylighting under the clear-sky desert of Cairo, Egypt. The range of Window to Wall Ratios (WWRs) that provides acceptable daylighting performance for each room layout was identified. In another research regarding the three common patient room designs, daylighting performance was addressed in combination with energy consumption (Sherif et al., 2014b). A range of window sizes was tested. The windows that balanced daylighting and energy requirements were sized at 70–90% WWR for patient rooms having an outboard bathroom and 30–40% WWR for patient rooms having nested and inboard bathrooms. In another publication, Shikder et al. (2010) addressed the optimization of window openings in a hospital patient room aiming at providing daylighting and external view, while minimizing energy consumption. An optimization methodology was demonstrated through parametric computer simulations to determine the optimum window design in the form of window width, sill and lintel heights and shading device depth. In a study more related to this paper, Sherif et al. (2014c) investigated the improvement of daylighting and external view in hospital patient rooms as means for achieving a Salutogenic hospital design. Salutogenic design, as coined by Dilani (2008), is related to the design of health-promoting healthcare facilities. It provides a framework that supports health and well-being by relying on psychological means though the adoption of daylighting, nature and other features. In Sherif's paper Daylighting and external view simulations of different room configurations were conducted under clear-sky desert conditions. The optimum window size and their associated external shading systems that suit three more common patient room layout designs were identified. In a more recent paper, Sherif et al. (2015) utilized parametric workflows and optimization for the optimization of patient room external façade geometry for control of solar penetration, and thus improving daylighting performance. This was achieved through the manipulation of the external façade wall that included sun shading devices at efficient inclination angles and change of window distribution.

The performance of fixed and movable shading systems was addressed in several publications. The vast majority of these publications were not concerned with healthcare facilities. Mazzichi and Manzan (2013) compared different shading configurations for optimum daylighting and energy performance in office spaces. It was concluded that fixed Venetian blinds with angle inclination control followed by overhang and deployable devices attained adequate daylighting and energy performance. Yaik-Wah