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A Design Chart to Determine the Dimensions of a Horizontal Shading Device over an Equator-Facing Window as a Function of the Latitude and the Shading Height

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Abstract

The main objective of this paper is to introduce a simple quick tool for architects represented by a design chart that determines the dimensions of an external horizontal shading device over an equator-facing window as a function of the latitude and the shading height, resulting in an automatic seasonal adjustment. This chart is applicable for any city all over the world at lower or middle latitudes where shading is an essential passive strategy.

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Keywords: Design Charts; Shading; Solar Geometry; Shading Devices

1. Introduction

External shading devices are usually more effective than internal ones and according to (Ching & Shapiro, 2014), it is very valuable to block the sun before it reaches the building. And for an equator facing façade, a horizontal shading device is effective because of the higher angles around noon that would be easily blocked with a smaller surface area. If sized correctly, a horizontal shading device could effectively block the unneeded sun within the overheated period (summer) and allow solar gains in within the underheated period (winter). So, the paper mainly concentrates on the sizing of such devices using a simple quick tool represented by a design chart that could be generic and applicable for most cities all over the world, where shading is a need.

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Nomenclature

HSA	horizontal shadow angle	°
VSA	vertical shadow angle	°
LAT	latitude	°
h	shading height	m
d	horizontal shading device depth	m
p	protrusion of horizontal shading device exceeding the window opening length	m
w	window opening length	m
l	horizontal shading device total length	m
x	spacing between horizontal shading device and wall	m
y	horizontal shading device thickness	m

1.1. Background and Previous Studies

This paper introduces a simple quick tool to find the dimensions of a horizontal shading device. This tool is represented by a design chart that could be considered a continuation of another design chart (made by the author in a previous research (Saifelnasr, 2013). The first chart determines the depth of a projected structure over an equator-facing window as a function of the latitude and the shading height. The projected structure in that case is handled as a horizontal shading device which is characterized by a vertical shadow angle (VSA) and neglecting the effect of the horizontal shadow angle (HSA) assuming the uniform broadening of that projected structure along the façade. But in this paper, the design chart is developed such that it involves the integration of both shadow angles to design the required horizontal shading device and find its dimensions, as a function of the latitude and the shading height. These obtained dimensions would ensure complete summer six months sun exclusion (for an equinox cut-off) at the selected hours (cut-off times), for any location at low or middle latitudes where shading is a need.

Some previous studies as (Brown & DeKay, 2001) proposed similar charts but for a single latitude, i.e., a specific city, that finds out the depth of a single overhang or the spacing between multiple louvers as a function of the shading height. But this chart is more generic and applicable for any location (city) within the low or middle latitudes, where shading is a need during the overheated period, i.e., summer.

1.2. Main Objectives and Hypothesis

The main objective of this paper is to introduce a simple quick tool for architects represented by a design chart that integrates HSA as well as VSA to determine the dimensions of a horizontal shading device over an equator-facing window as a function of the latitude and shading height for the selected cut-off times, resulting in an automatic seasonal adjustment, i.e., full shading in summer but allowing solar heat gain in winter.

2. Methodology

To carry out the aimed design chart, a number of measuring techniques were used associated with some simplifications and assumptions as follows.

2.1. Used Measuring Techniques

Shading design for the exclusion of solar input is a geometrical task, so, the different dimensions of the horizontal shading device could be determined when all the other parameters are given represented in the shading height (h), shadow angles; (VSA) and (HSA) for the selected hours (cut-off times).

The different curves within the design chart signify the (VSA) as well as the (HSA) for the selected hours (cut-off times). Therefore, the different dimensions; depth (d) and protrusion (p) could be obtained as ratios with the shading