Development of Monographs for Shading Devices in Sri Lankan Residential Buildings

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Abstract **- Shading devices are not a new concept for the world, those have been used to achieve aesthetically pleasing building facades, but not effectively sized or positioned to minimize the heat gain or provide the thermal comfort inside the buildings [4]. The extensive studies about sunshades have been carried out in the other countries and technical tables are developed for the public use but such are not available for Sri Lankans [5]. This short paper investigates the designing of a horizontal shading device for the openings facing on north and south directions in the Sri Lankan residential buildings. Sun paths for north and south directions are studied for all twenty-five districts and developed guidelines to design the shading device as well as a table and a graph to determine the length of the shading device for common dimensions used in the construction for windows and doors. Research shows that the length of the continuous horizontal shading device for north and south directions does not significantly change due to the position in Sri Lanka.**

keywords- Sun path, Shading device, Altitude of the sun

I. Introduction

Sri Lanka is an island located at a latitude of 5.9° and 9.8° N, and longitudes of 79.79° and 8.1° E (Presidential Task force on Energy Demand Side Management, 2018) [6]. As a result of low latitude, all external surfaces of buildings are liable to receive direct sunlight during the daytime [2]. The sun path for Sri Lanka does not show a great variation unlike other countries which are situated in higher latitudes. Reason for not showing a much difference between the sun angles for different locations in Sri Lanka is the tilt of Earth's axis of rotation with respect to the orbital plane. The axis of rotation is tilted by an angle of 23.5 degrees with respect to the plane in which all the planets go around the Sun [3]. This research leads to develop a chart that helps the general public on designing shading devices for different areas in Sri Lanka. There are different types of shading devices but here, it mainly focuses only on continuous horizontal shading devices, which is being commonly used in residential buildings in all parts of the country. All the calculations and the guidelines are tabulated covering all twenty-five districts in Sri Lanka.

II. Objectives

The objective of this research is to inform the general public about how to design and build an effective shading device for the openings which faces for north and south directions depending on the location of their construction. Therefore, the author's main target is to prepare a simple guideline that can be adopted by the general public for designing shading devices for residential buildings in Sri Lanka. Having properly designed effective horizontal shading devices will contribute to maintaining a comfortable indoor environment as well. This will also reduce the consumption of the energy used to maintain the thermal comfort of the building which is a motivation factor for the general public in accommodating the effective shading devices in residential buildings.

III. Methodology

The main focus is to build an effective shading device for openings facing north and south directions of a building. The variation of the sun path in Sri Lanka was studied with respect to the altitude changes as indicated in the Fig 1. In calculations, the height from the ground to the window is neglected and only the window height is taken. The lowest sun altitude was considered because according to the equation (1), the lowest angle provides the maximum length needed for the shading device.

The sun angle is obtained by 3D sun path software by Andrew Marsh [1]. The calculations were done for the north and south directions for all twenty-five districts. The findings for 25 districts are illustrated in two graphs (Fig 5 and Fig 6) for north and south directions.

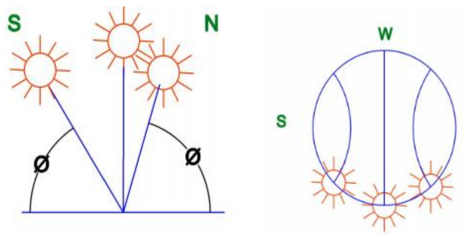

Fig 1. Annual Sun Path

For Horizontal Shading Device:

∅ = Altitude of the sun (VSA; Vertical Shadow Angle), L = Length of the shading device, H = height of the window.

$$\tan(VSA) = HL \qquad (1)$$

$$Length = H\tan VSA \qquad (2)$$

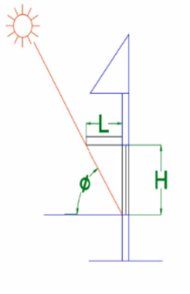

Fig 2. Horizontal sunshade Device Dimension

For Vertical Shading Device:

HSA = Horizontal Shadow Angle (Azimuth), D = Depth of the shading device, L = Length of the Window, H = Height of the Window.

$$\tan(HSA) = LD \qquad (3)$$

$$depth = L\tan HSA \qquad (4)$$

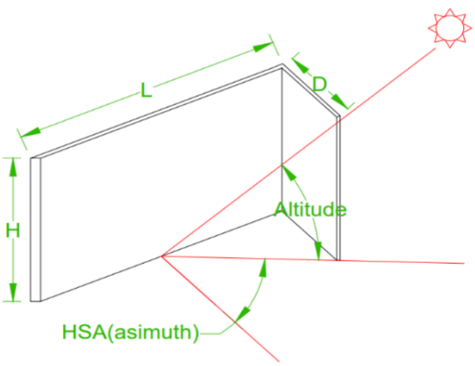

Fig 3. Vertical Sunshade Dimension

IV. RESULTS AND DISCUSSION

The study on sun paths shows that there is no significant variation of sun angles hence the horizontal continuous shading device lengths are considerably equal for north and south directions in Sri Lanka.

In the case of vertical shading device, openings facing on the south direction has larger variations for the depth. The values for the depth of the vertical shading device for southern districts are smaller compared that for the districts in the northern part as shown in fig.7.

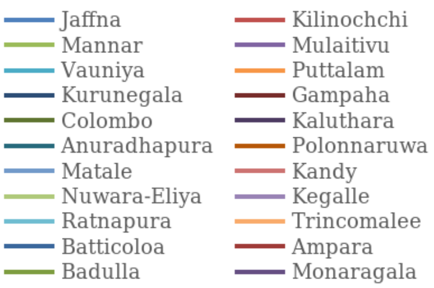

Fig 4. Legend for districts in North Horizontal Shade Length

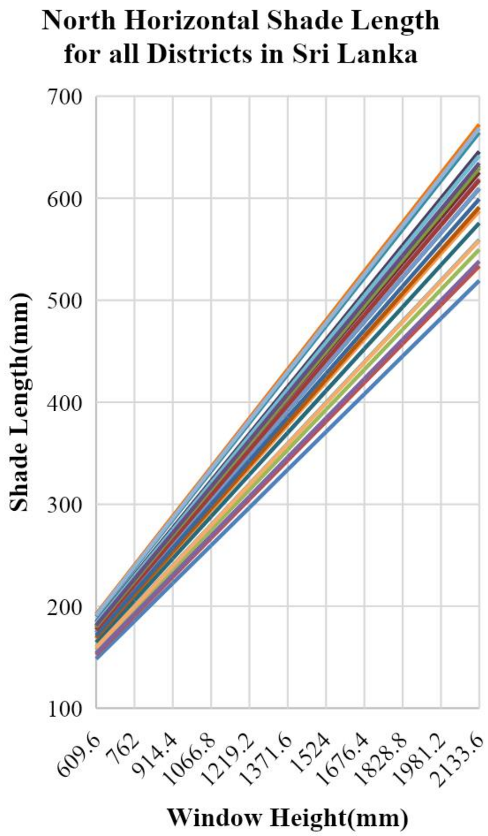

Fig 4. North Horizontal Shade Length

But for the northern direction there is no significant change as shown in fig.6. This is because the latitudes and longitudes for different locations in Sri Lanka do not have large variations like other countries. The calculated lengths for horizontal shading devices show approximately equal for all 25 districts as illustrated in (Fig 4 and 5) for both north and south directions. But there is significant difference for depth of the vertical shading devices for north (fig. 6) and south (fig. 7)

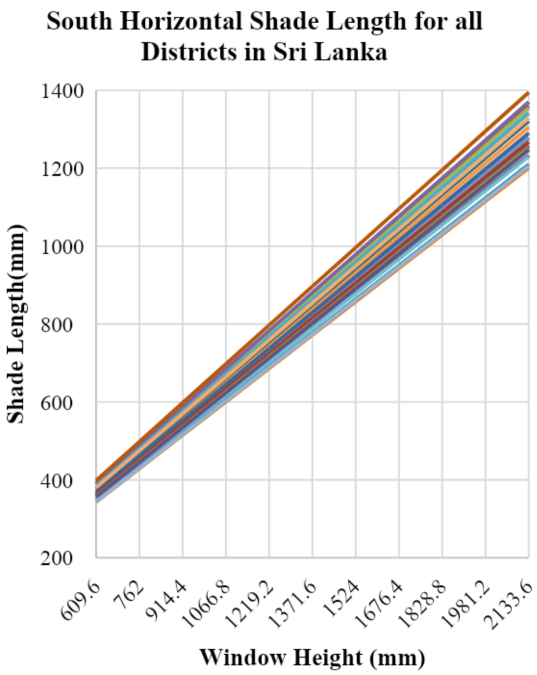

Fig 5. South Horizontal Shade Length

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V. Conclusion

External shading devices such as horizontal or vertical louvers, overhangs are designed to protect the building envelope and the occupants from direct sunlight and provide thermal comfort.

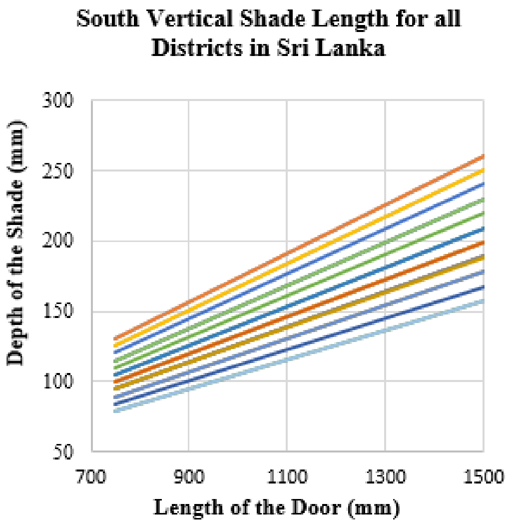

Fig 6. North Vertical Shade Length

3D sun path diagram was used to obtain the sun altitude for different areas and calculate the length of the shading device. This paper presents a step-by-step approach for designing the shading device guidelines for the general public. Here the length of the continuous horizontal shading device and depth of the continuous vertical shading device are calculated. For Sri Lanka, the variation of the lengths of the continuous horizontal and vertical shading devices from district to district is considerably negligible for the openings facing to north and south directions.

FUTURE WORK

The calculations will be carried out for horizontal and vertical shading devices which are not continuous. Energy efficiency simulations will be carried out to calculate thermal comfort. The results will be tabulated in a booklet and made available to the general public for designing shading devices for residential buildings.

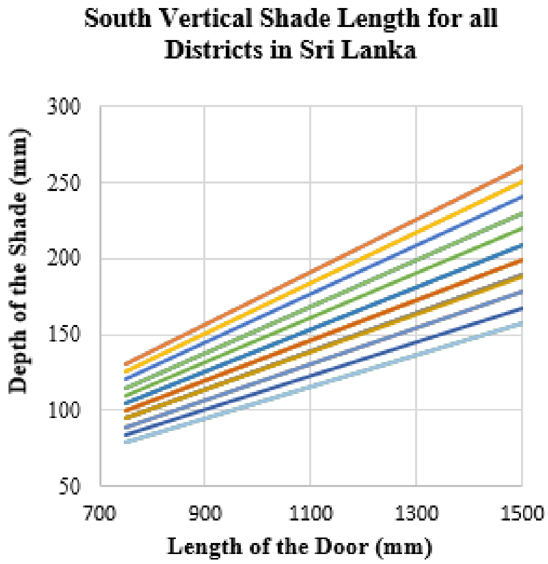

Fig 7. South Vertical Shade Length

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