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An Approach to Overhang Design, Istanbul Example

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1. Introduction

Control of solar radiation, by passive solar tools is an important part of building design. External shading device, which is the part of passive solar systems, is an artificial environmental variable or element to control interior solar radiation on the base of desirable orientation of window. Solar heat gain, particularly via fenestration, typically dominates cooling performance (Olgyay, 1957).

The proper application of energy efficient shading devices in new buildings have the technical potential to save 50-70% of total perimeter zone energy use. Therefore, even if only 25-50% of potential could be captured, the economical benefit due to decrease in the size of HVAC plant and the energy consumption make them competitive, with large spin-off benefit on the visual comfort (Data, 2001). Moreover, overshading of the windows reduces daylighting, which results in increasing energy use for artificial lighting or internal heat gains (Littlefair, 1998). In that case, this can be possible with determination of optimum dimension and shape in the shading device design. However, evaluation of many needed variables, such as dimensions of window, solar geometry and climate data in design of shading devices needs a period of long time and include complex process (Szokolay, 1980). This situation makes the designer to pay insufficient attention to the external shading device applications (Ralegaonkar, 2005). In addition, like eaves overhangs, terrace and beams horizontal building elements which are not designed as an external shading device but their shape on the face as an extension of functional or structural devices, shade to transparent surfaces and this shading can negatively influence the thermal performance of the building (Yezioro, 2009). For this aspect, external shading device's shape and dimension should be evaluated carefully at design of the building especially in the Mediterranean climate zone in which solar heat gain is effective.

In shading device design methods, the trigonometric connection between angle of altitude and azimuth of the sun with dimension of window and shading device are taken basic criteria. However, design criteria of shading device is classified in four basic groups as given below (Olgyay, 1957).

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A. Solar geometry data: The formulations and ground plane angle of the sun's yearly motion.

B. Shape and dimension alternatives of window and shading device: The formulations of determining the geometry of window and shading devices.

C. Geographical location and climate data: Climate data and the required comfort data obtained based on the climate data.

D. Function and usage: The shading device's material, detail and usage.

As mentioned above, the most important point in the shading device design is to show the dependence of shading device performance on the base of sun's one-year motion. Thereby, calculating the shading device design parameters with traditional methods requires comparison of various drawings and equations on the base of sun's one-year motion. Computerized design with simulation programming, in offering various numerical and graphical alternatives, is help to the designer by shortening the design period. In this article, computerized simulation program of solar tool is used to analyze shading devices in dimension and shape (Marsh, 2003).

2. Shading device design

Although the computer technology offers infinite numbers of graphics, shading device type and dimension alternatives, and the selection of the optimum solution belong to the designer (Siret, 2004). In other words, performance parameters such as comfort levels, energy saving etc., are those that the decision maker uses to judge the appropriateness of the product (Yezioro,2009). So, the most important part of the shading device design is the selection of the alternatives that provide optimum type and dimension.

This paper describes an approach to simplify and clarify external shading device design. In this regard, Table 1 above, on shading device design criteria has been generated in order to determine how to select the interior comfort shading device dimensions at any site. With the aim of clarifying and facilitating design, "shading device design criteria" have been divided in two main part as seen in Table 1. Some of these criteria vary and some are fixed. In this aspect, the shading mask, which monitors the shading device's performance, and solar radiation, day lighting, climate and comfort graphics, that are used to determine thermal and visual comfort were evaluated as a design criteria to determine the geometry of shading device's optimize dimension and its shape. Then, as seen in the Table 1, by taking into account the criteria interactions with each other, design criteria are selected on the basis of priorities of the climate data of the building's district.

When the design criteria stated in Table 1 are applied to a specific site , parameters related to the dimensions of the window and the shading device could become definite on the direction providing the interior thermal and visual comfort. However, in the building design, dimensions of the windows and shading devices, are used to determine the thermal comfort and sun lighting quality, which sometimes may interact with each other, such as, a shading device that can, on one hand, provide desired shading during the year, and, on the other hand, can reduce day lighting factor (DF) or prevent ventilation (Khaled,2007).

SHADING DEVICE DESIGN CRITERIA			
VARIABLE PARAMETERS		**FIXED PARAMETERS**	
Solar Geometry	**Fenestration**	**Location**	**Climate**
*Angle of the sun VSA: Vertical shadow angle HSA: Horizontal shadow angle ALT: Altitude of the sun ORI: Orientation	*Window dimension *Rear wall dimension *Shading device dimension	*Latitude *Longitude *Time zone *Altitude	*Annual average temperature *Annual wind direction *Annual solar raddiation
	DESIGN	**TOOLS**	
Sun Path Diagrams	**Design Options**	**Comfort Charts & Standards**	
*Stereographic *Orthographic *Equidistant	*Material, cost *Function, montaj *Aesthetics, color *Economy	*Bioclimatic chart *Psichrometric chart *ASHREA (Standard 142, 199) *ISO (Standard 7730) *SC% (shading coefficient, ASHREA, DOE)	
MANUAL OR COMPUTER AIDED DESIGN PROCESS			
OPTIMUM DIMENSION-INTERIOR COMFORT-ENERGY EFFICIENCY			

Table 1. Shading device criteria

Furthermore, a shading device dimension, which provides shading in summer months, can provide the same shading in winter months but reduces interior thermal comfort (Szokolay, 1980)). Also, design options of the window and shading devices criteria tools like material, usage, economy and application details may affect the shading devices dimension, too (Miguel, 2008). The colours of the building materials show different behaviour in the aspect of reflecting and absorbing the sun light (Olgyay, 1957). Shading devices, which are made from a material that absorb sun light, used for shading in summer months, may increase heat in the interior space. Besides, window glasses with coatings aimed at reducing incoming solar irradiation, partially reflect or absorb incident solar radiation (Miguel, 2008), so, glazing system effectiveness in controlling solar penetration also affect the shading device in form and material (Alibaba, 2004). In order to resolve the above mentioned problems, shading device dimension and type should be determined first. In this situation, determining optimum device dimensions in a building, that will provide energy efficiency during the year demands series of drawings, which are repeated for every window's dimension, specifying the orientation and geographical position and using the climate data , is essential. Finally, evaluation of all the design criteria stated in Table 1, introduces the design procedure which takes long time and contains complex process. More importantly, it could not always be possible to evaluate all criteria that are in continuous interaction. In this aspect, to give priority to variables or eliminate some of them will be an approach to shading device design. For example, in hot climate zone, interior heat comfort, which can be acquired naturally, could be a priority design criteria for shading device. Furthermore, in cold climate zones, shading device may not be required. Otherwise, protection from sun and heat plays an important role in the Mediterranean zone with a hot climate during the summer, while the problems of areas with cold climate are quite different (Cardinale, 2003). In the residential building district, (which is determined with this procedure)?, selection of one of the effective shading device types and elimination of the others are a solution for making the design easier. Examining the subject critically, only the material, colour, cost and economy that depend on these, can be applied to a shading device with undetermined dimension and shape. From this aspect, in this study, for a selected building area, the necessity of shading device type determination and dimension analyses were made. So, the sun control elements that the users or designers can apply to buildings at Istanbul city, Mediterranean climate zone with latitude 41° North, are seen can not provide the expected energy efficiency because the types and dimensions of external shading devices are not suitable. In this case, priorities of shading device criteria presented in Table 1 are determined on the base of sequence stated below.

2.1 Reasons of the shading device priority that will be applied to the site layout

Location data and climate in Istanbul city, the area of the research, are given in Figure 1. In general, Mediterranean climate conditions are manifested in Istanbul city (Figure 1). In the Mediterranean climate, prevention of solar heat gain is a preferential criterion in building design (Cardinale, 2003). In Istanbul city, in the planned residential areas which were designed without taking into consideration of solar heat gain, the compulsory mechanical cooling systems to obtain interior comfort in summer results in significant or considerate energy consumption.

As stated in Figure 1, the temperatures in June, July, August and September are at the level that affect interior comfort negatively on the base of ASHREA temperature standards (Table 1.). In addition, solar heat gain that are earned in November, December, January, and February is necessarily for interior comfort. In this case, the 6th, 7th, 8th, and 9th months, bright sunshine duration are priority for shading device criteria for latitude 41°N. In this respect, shading blocks which shading device has scanned through in one year period, must stay in June, July, August and September months and between 8:00-16:00 o'clock that the time interval solar heat gain is at the highest level. In Figure1 (yellow line), Latitude 41, are seen the time, month, and orientation that are needed for shading.

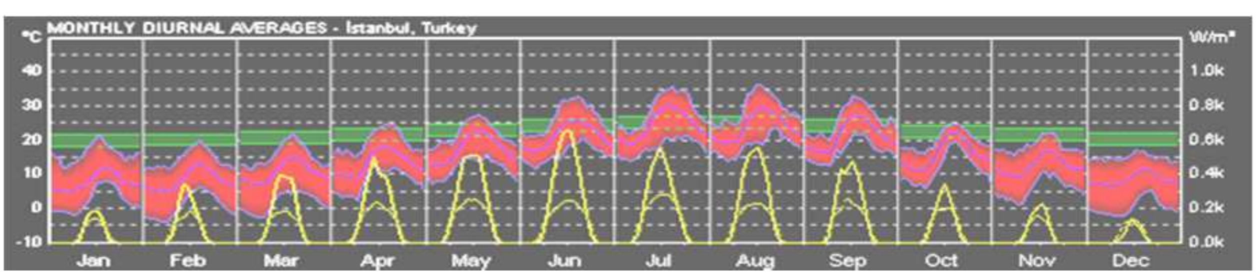

Fig. 1. İstanbul climate (Green: Comfort zone, Yellow : Solar radiation, Red: Average temperature)

2.2 Determination of the shading device type that provides shading only at the required time during one year period

Stereographic diagram in Figure 2 shows shading blocks which includes time, month, and orientation of 180°. In Figure 2, the time, at which the Sun returns from North to South and South to West are considered the base for Istanbul city, which is located at latitude 41°North and longitude 28°West.

The scanned shading blocks in Fig.2 define the required shading block in one year period at latitude 41°.The scanned shading blocks in Figure 2 and Figure 3 can be defined as the "horizontal" type shading device. In this case, horizontal type and south facade (180°) are a priority-shading device for latitude 41.

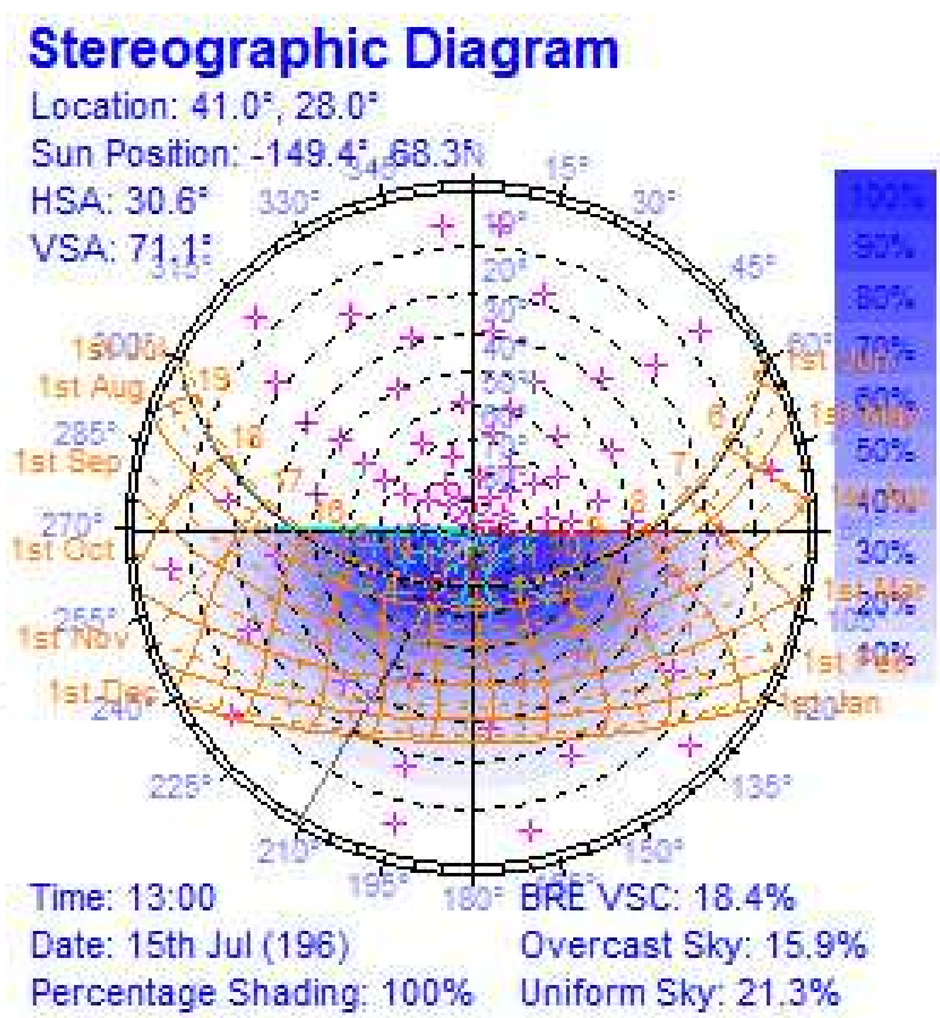

Fig. 2. The scanned shading blocks on diagram (Pink plus: Daylight factor, DF, Blue tone: Shading SC%, Black: Altitude of the sun, ALT, yellow: Date, time)

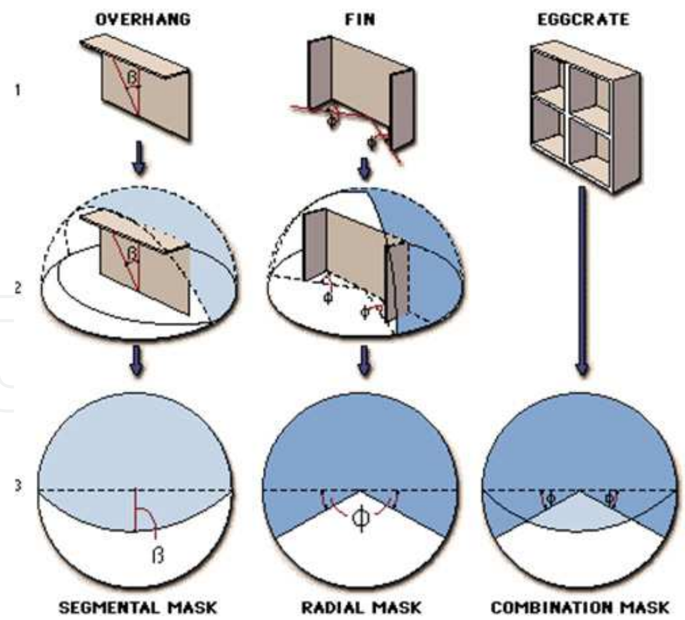

Fig. 3. Shading device types

2.3 Determining shading behaviours of established type dimension alternatives

investigate established The horizontal type shading devices with their dimension behaviours, window, wall and shading device's dimension alternatives, which affect directly performance of shading device, have been determined. In this situation, horizontal device priority-dimension alternatives, like "overhang" priority-dimension alternatives, are applied separately to a fixed "W " type window with width 1.00m., height 1.20m., and the shading blocks are analyzed as seen in Figure 4. Here, overhang is 65 cm wide. Effective Shading Coefficients are seen Figure 5. So average shading coefficients are 15% in winter and 83% in summer which provides energy efficiency.

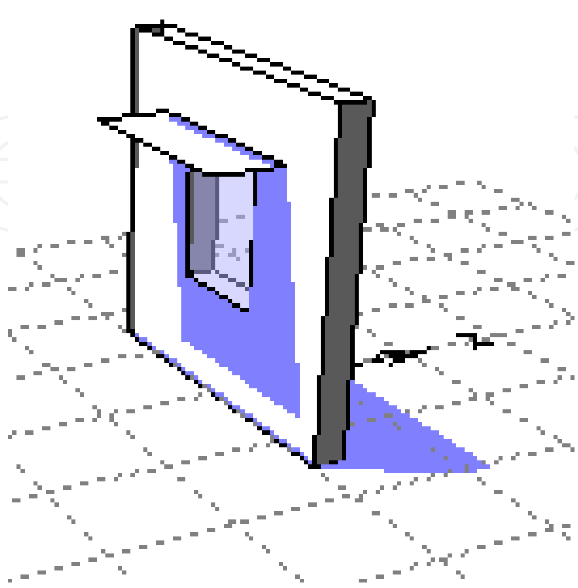
Fig. 4. Overhang

Latitude: 41.0°
Longitude: 28.0°
Timezone: 30.0° [+2.0hrs]
Orientation: 180.0°

Month	Avg.SC	Max.SC	Min.SC
January	13.8%	22.0%	0.0%
February	23.3%	39.0%	0.0%
March	38.2%	64.0%	0.0%
April	69.5%	100.0%	23.0%
May	83.5%	100.0%	48.0%
June	87.3%	100.0%	50.0%
July	78.6%	100.0%	38.0%
August	62.3%	91.0%	23.0%
September	35.5%	58.0%	0.0%
October	21.1%	35.0%	0.0%
November	12.5%	22.0%	0.0%
December	10.4%	20.0%	0.0%
Winter	15.8%	27.0%	0.0%
Summer	83.1%	100.0%	45.3%
Annual	44.7%	62.6%	15.2%

Fig. 5. Effective Shading Coefficients

3. Conclusion

In the design of shading devices, evaluation of many variables data makes the design a complex process. This paper describes an approach to simplify and clarify external shading device design. So a table is generated to determine how to select the criteria for the interior comfort in any building area. Phases and priorities of shading device criteria are analyzed and presented in table 1. Therefore, the design strategies that were followed in this study could be applicable to any building area.

The criteria which are determined from the results of analyses, should be used as a substructure for commercially supplied shading devices like awnings, louvers, shutters and Venetian blinds by designers and users. Furthermore, "the design strategies" which are established in this study are applicable to any building in residential district.

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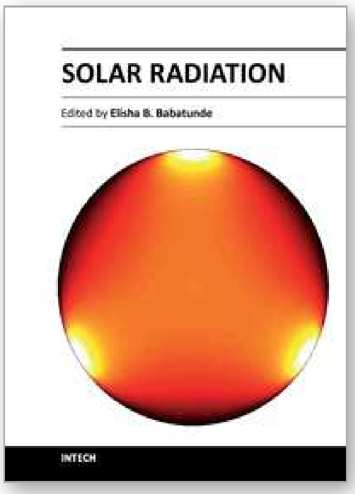

Solar Radiation

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The book contains fundamentals of solar radiation, its ecological impacts, applications, especially in agriculture, architecture, thermal and electric energy. Chapters are written by numerous experienced scientists in the field from various parts of the world. Apart from chapter one which is the introductory chapter of the book, that gives a general topic insight of the book, there are 24 more chapters that cover various fields of solar radiation. These fields include: Measurements and Analysis of Solar Radiation, Agricultural Application / Bio-effect, Architectural Application, Electricity Generation Application and Thermal Energy Application. This book aims to provide a clear scientific insight on Solar Radiation to scientist and students.

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