Virtual Study of the Day-lighting Performance of Rawshan in Residential Buildings of Jeddah

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ABSTRACT
This paper aims to find out the advantages of using the Rawshan , traditional Arabic shading device, in the contemporary Middle Eastern architecture. It investigates the effects of Rawshan on the performance of day lighting in residential buildings in the city of Jeddah in Saudi Arabia. Many previous investigations in the field indicated that one of the most efficient methods in evaluating performances of buildings is by using a physical and computer model. Thus, the investigation used in this paper deploys a computer model to conclude the evaluation of day-lighting performance in a virtual space where Rawshan is applied with different possible scenarios in the city of Jeddah in Saudi Arabia.

1. INTROUDUCTION

As we know the Arabian Vernacular architecture is rich of architectural elements that reflect the Arabian Identity and enhance the environmental adaptability of habitable spaces. A remarkable example of those elements is Mashrabiya, which is used mainly to adapt to hot and humid climate. It has effective specifications that are used for hygrothermal comfort "ventilation and day-lighting control", at the same time it assures privacy and security solutions. Similar to Mashrabiya, Rawshan is an element that can be found on the western region in Saudi Arabia. It is an element for protection against sun glare, assisting the performance of shading devices, which is essential in hot climates. It provides protection from the direct solar radiation and both thermal and visual comfort, and it works as a tool to provide privacy for the inhabitants. It also allows a balcony like space covered with wooden panels, cut in simple geometrical patterns, and shutters that can be lifted outwards and upwards. It was developed hundreds of years ago by the Arabian people. The Rawshan is made of three parts. Each part has its own benefits and properties. While its bottom part is opaque, its middle part, at eye height, is made of solid or wooden horizontal panels, which admits fresh air. It is based on local materials but sometimes there is a need to import wood from far**.** A cultural role is smartly maintained by providing Muslim women seeking privacy their comfort, without isolating them from the external environment. The upper part of the Rawshan is made of a wide mesh that allows daylight penetration. At the same time, the shading system reduces solar gains in summer but allows sufficient daylight. This element has lot of properties, but is it efficient enough? Is indoor space enlightened enough? Many previous investigations in the field indicate that one of the most efficient methods in evaluating performances of buildings is by using a physical and computer model.

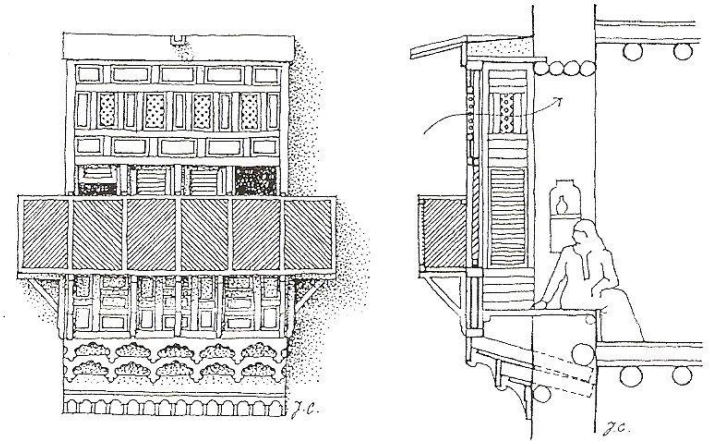
By working on virtual living space in Jeddah's historical houses, and making some evaluation and scenarios by using Autodesk Building Information Modeling Programs (BIM) in order to calculations for instance: day-light factor, day-lighting level, etc. In addition to that, what are the ways to develop and use this element in contemporary architecture?.

Keywords : Rawshan, daylight comfort, vernacular architecture, perception, Jeddah, Saudi Arabia .

2. WHAT IS THE RAWSHAN?

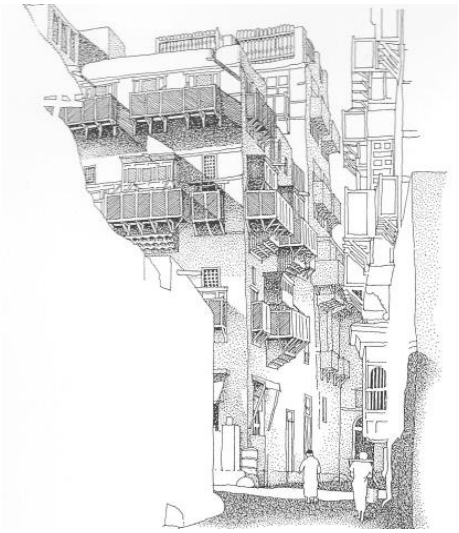
Rawshan is an architectural device made of a combination of wooden strips and screens, which is commonly used for large external openings. It has the same function as the Mashrabiya. Both are generally considered to fulfill their common functions such as cross ventilation, light control, humidity control, cooling of water in clay jars, and ensuring social privacy for occupants. The Rawshan provides a resting place where at least one person lying full-length. It is constructed as a shallow three sided box projecting from the façade of the building. Strong wooden beams fixed firmly into the thickness of the house wall to secure its great weight below. These supports are sometimes visible, but they are often concealed by ornamental wooden stalactites, or by decorative wooden panels. The lower and upper walls of the Rawshan are wooden panels, cut in simple geometrical patterns, while the middle register of shutters can be lifted outwards and upwards to admit air and light. The screens that fill these shutters are made of flat wood mesh. The turned wood screens common in Egypt. On the ground floors of the houses, there are often vertical steel bars to protect against intruders, for that reason shutters open inwards(fig.1).

Figure 1. Detail of Rawshan window (Ragette 2006)



Glass is occasionally used for the windows inside the houses, though it seems to be a late development on the Rawshan; the tradition was for shutters and windows to be without glass panels. One the obvious reasons for the need to import so much wood in Jeddah was the Rawshan that is dominant in most houses' facades. (fig.2).

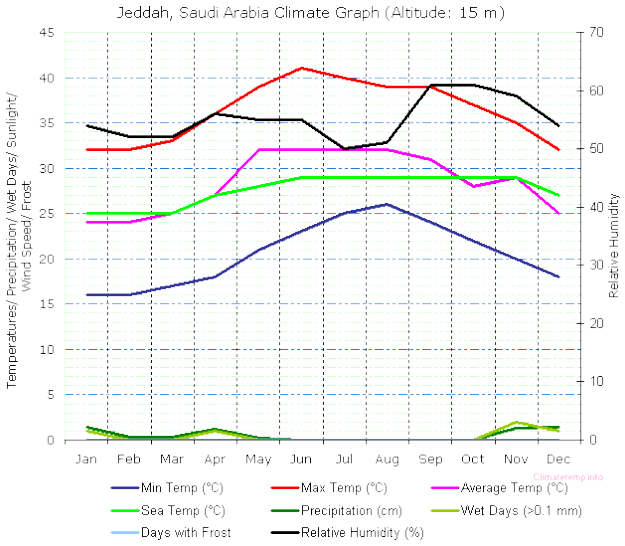
Figure 2. Facades of old Jeddah(Ragette 2006)



3. CLIMATE OF JEDDAH:

Jeddah features an arid climate under Koppen's climate classification. Unlike other Saudi Arabian cities, Jeddah retains its warm temperature in winter, which can range from 15 °C (59 °F) at midnight to 25 °C (77 °F) in the afternoon. Summer temperatures are very hot, often breaking the 43 °C (109 °F) in the afternoon and dropping to 30 °C (86 °F) in the evening. Rainfall in Jeddah is generally sparse, and usually occurs in small amounts in November and December, it means that the sky is almost always clear.

Fig. 3. Jeddah Climate Graph



4.1 EVALUATION OBJECTIVES:

The study in this paper evaluates the performance of various scenarios of using the Rawshan in term of day-lighting performances in daytime.

The goal is to demonstrate the ability of Rawshan in reducing the glow of solar lighting in interior spaces of the old houses in Jeddah in Saudi Arabia. Moreover, this element is used in all buildings in the old city, which shows that it was an irreplaceable element. This is especially the case of the basic material to fabricating the Rawshan, wood, which is imported from areas far from the region. Another goal is to evaluate the performance of Rawshan along with an important factor, namely the need for shading according to the need for lighting inside the rooms. This factor is discussed in the early stages of the next section.

4.2 EXPERIMENTATION APPROACH:

The research work focuses on the analysis of the levels of daylight factor and day-lighting levels in a specific room with different scenarios of daytime uses of Rawshan. In each scenario, the room with full geometry will be tested using the Rawshan windows modelled.

4.3 INTERPRETATION OF DATA

The assessment of daylight quality is based on an interpretation of the measured data as presented in Table [**1].**

Table 1 : Performance indicators and their interpretation

Performance indicator	Interpretation
Daylight Factor	
< 1 %	Unacceptable
1-2 %	Acceptable
2-5%	Preferable
> 5 %	Too bright
Work plane day-lighting level	
<100 lux	
100-500	Unacceptable
>500	Acceptable
	Too bright

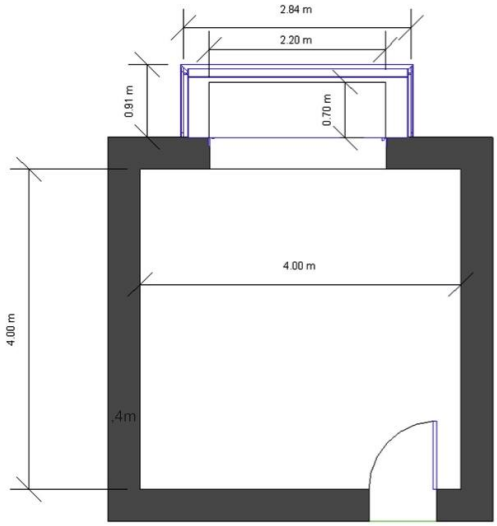
5.1 EXPERIMENTAL SPACE

This study was entirely carried out through measurements of daylight in a virtual living room located in Jeddah, with three scenarios:

- Room with closed main openings by venetian blind.
- Room with opened openings.
- Room with single glazed window.

It measures 4.00 m (width) by 4.00 m (depth) with a floor to ceiling height of 4m. The aim is to study the difference between a room with a normal single glazed window and a room with Rawshan (fig.4).

Figure 4. Plan of the experimental room

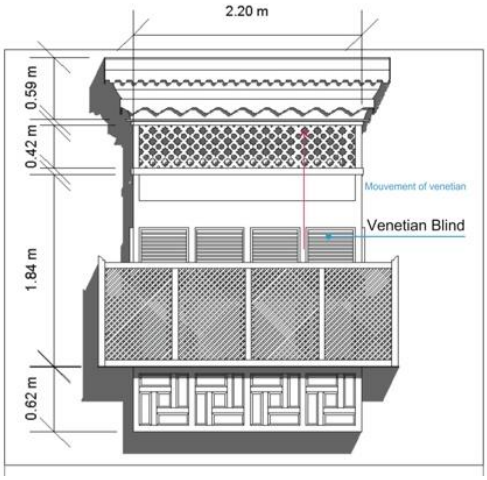


5.2 WINDOWS

For each scenario, the room has a 2.20 m wide by 2.5 m high window. This window is located 0.6 m from the floor and is centered with respect to lateral walls (see Fig. 5). The access to the room is through a door located in the wall opposite to the window. This door was removed for the measurements and replaced by a wall with the same color of the rest of the walls.

The window of the experimental room is single glazed:
Direct visual transmittance: 80 %.
Diffuse visual transmittance: 70%.

Figure 5. Selected Rawshan dimensions



5.3 WALLS, FLOOR, CEILING

The walls of the room are covered by a white paint, which acts as a diffusing surface. The ceiling is made of wood strips covered by off-white paint color; the floor is covered by beige carpet. The reflectance for each component is: Walls: 75%, Ceiling: 70 %, Floor: 40%.

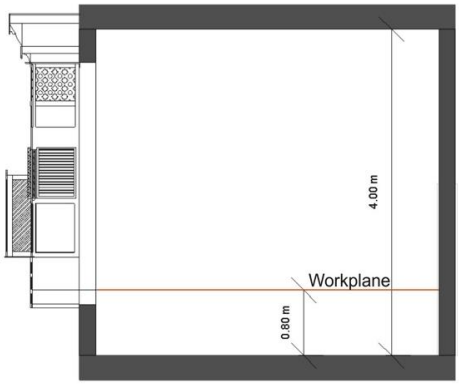
5.4 SHADING SYSTEM (RAWSHAN)

A wood frame with a total of eight openings with Venetian wood screens. The shading system is mounted on the interior side of Rawshan. The Wooden Venetian was a standard type with 20 mm wide and 60-degree angle (sun breaker 30%). It is projected 0.7 m from the exterior of the space, adding the thickness of the wall 0.4 m.

6.1 MEASUREMENT OF DAYLIGHT FACTOR

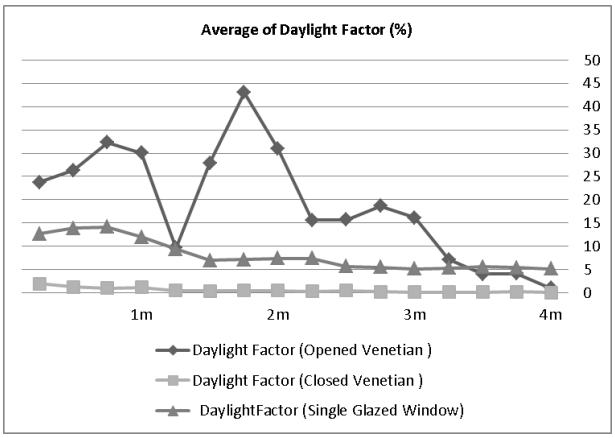
The Daylight Factor on the work plane was measured at 0.80m from the floor by using analysis grid in Autodesk ECOTECT (fig.6). The analysis is based on using specific points on the plan, which is about 16 vertical points by 20 horizontal points. Three case studies were chosen for this evaluation: an opened Rawshan windows with a 40% perforation, Closed Rawshan with 5% of perforation and Single Glazed window facing North at daytime. The different case studies of window openings were tabulated according to the different scenarios (fig.7). The daylight factor (D) was studied to see how the shading devices affected indoor lighting levels under overcast conditions. In general, it is demanded that the D be above 1 % but 2-3 % is more desirable as it will provide 200-300 lx of day-lighting when the outdoor global day-lighting level is 12 000 lx.

Figure 6.Assumed design, parameters of the analyzed indoor space



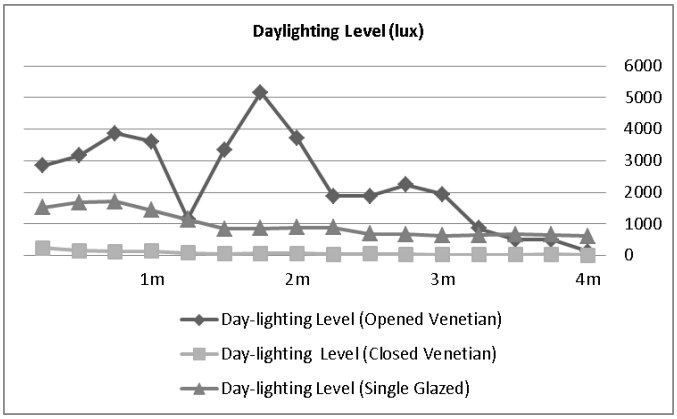
Figures 7.1 and 7.2 show that the Rawshan with closed screens has *D*s well below 1.0 %, which is unacceptably low, but it prevents direct solar radiation. In the scenario of opened Venetian, we find among these systems, beige and plastic are the worst. Black2 is somewhat better with an average *D* of 0.75 % for detectors A1-A4 and B1-B4, but this value is still very low. On the brighter side, the screens White1-2 provide more light with an average *D* above 1 %, in both rooms. The values close to the window were even quite good (between 1.5 and 2.0 %) for the screen White2 and the middle point had a *D* between 0.5 and 1.0 % in both rooms.

Figure 7.1 Average D in the test room with different case studies



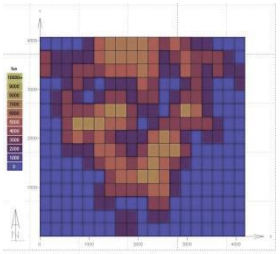
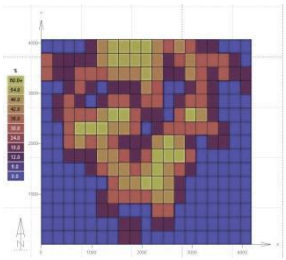
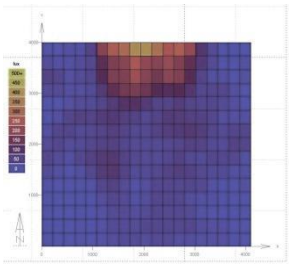
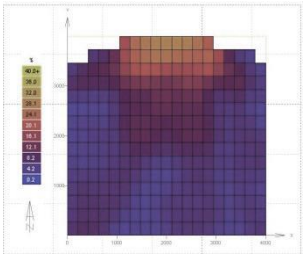
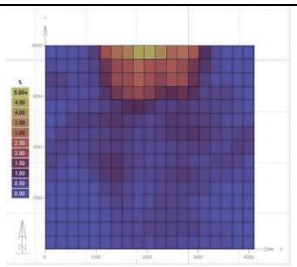
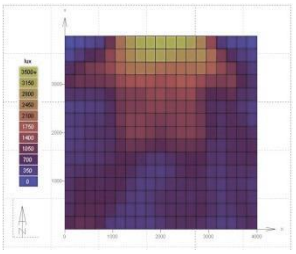
	Daylight Factor (Opened Venetian)	Daylight Factor (Closed Venetian)	DaylightFactor (Single Glazed Window)
4m	1	0,1	5,1
	4	0,2	5,4
	4	0,2	5,6
	7	0,2	5,4
3m	16	0,2	5,2
	19	0,3	5,6
	16	0,5	5,7
	16	0,4	7,4
2m	31	0,5	7,4
	43	0,5	7,2
	28	0,4	7,0
	10	0,5	9,4
1m	30	1,2	12,0
	32	1,0	14,2
	26	1,2	13,9
	24	2,0	12,7

Figure 7.2 Average Day-lighting levels in the test room with different case studies



	Day-lighting Level (Opened Venetian)	Day-lighting Level (Closed Venetian)	Day-lighting Level (Single Glazed)
4m	123	8	616
	498	28	648
	488	21	670
	855	19	642
3m	1941	20	624
	2241	28	667
	1882	55	686
	1872	39	886
2m	3709	58	885
	5165	59	860
	3346	51	839
	1158	81	1132
1m	3607	139	1434
	3873	121	1700
	3164	149	1672
	2849	238	1520

Figure 8. Daylight Factor and Day-lighting level in different scenario

	Daylight Factor	Daylighting Level
Opened Venetian		
Closed Venetian		
Single Glazed		

6.2 RESULT OF SIMULATION

Through the study of three cases, we found that Rawshan with opened Venetian bind allowed the largest amount of daylight in daytime, the depth of Rawshan works like reflective plane for the light into the ceiling which in turn diffuses it into the room space. On the contrary, we see that the space with closed Venetian is dark , but at the same time, there is some light entering from the top of Rawshan allowing daylight to enter with small quantities (<1%). It works as a protection from the direct sun light and glare and to reduce glare inside the room. In the last scenario, the single glazed diffuses the daylight into the interior of the room and reflects partial of daylight to the exterior. Interior lighting is high compared to closed Rawshan. As a result, Rwashan Scenarios have wide possibility to control day-lighting levels in the interior space which can be an Intelligent advantage in comparison with the Single Glazed scenario that demonstrates difficulties to control the amount of light inside the space.(fig. 8).

7. CONCLUSION

The use of Rawshan unlocks great deal of abilities in controlling the amount of natural light coming into a space. Not only that, it also ensures the privacy of the space's inhabitants. Thus, Rawshan has great potential to go further in development and become a type of contemporary green technologies in the region and we should take a look into the beauty and richness of traditional restraint in facades design.

Last but not least, architecture is a result of society and culture. We can notice that in Traditional Arabian Architecture, achievements took place in the past thanks to trial and error without the use of technology all in respecting an ecological environment. At the present time, considering technology, modernism and elements of comfort in our spaces, we wonder what is the result of the present architecture in Arabian Society !.

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