

# Design for appropriate size of fixed skylight in Famagusta, Cyprus

Aisha Mahmud Umar, Halil Zafer Alibaba

**Abstract**– Daylighting is necessary due to global warming and the benefits of natural lighting to the human health that was recently discovered. For centuries Skylights have been a very effective way of daylighting. This research briefly studied the basics of skylights through literature and found an effective way of finding the best skylight design for Famagusta Cyprus. A building was found in a known neighborhood in Famagusta, it was reproduced in an architectural design software (AutoCAD) and then exported to a lighting simulation software (DIALux evo) and the skylights of various sizes were placed in the living room and the lighting of the space when each skylight was placed was recorded. The months set for the lighting record were July and December, being the months with most and least sunlight in Famagusta respectively. It was found that in summer three skylights ranging from 1.2m by 1.2m to 1.5m by 1.5m were adequate and provided about 500lux-1000lux while in winter the skylights that provided adequate light from 500lux-750lux ranged from 1.2m by 1.5m to 1.5m by 1.8m. Skylights design and application has been made easy for the residents of Famagusta through this research.

**Index Terms**– Daylighting, DIALux evo, Lux, Skylights

## 1. INTRODUCTION

For a very long time, the sun was the only source of lighting for humans. From the beginning of architecture men created apertures in their buildings to bring light into the building during the day. This Idea originated from Rome around the middle ages [1]. After the advent of electricity, light bulbs almost completely replaced natural lighting. The main source of lighting especially in developed countries became through electricity [2]. Windows weren't incorporated in designs as a source of light anymore.

As a result of Global warming and Climate change the need for the reduction of energy consumption in buildings to reduce carbon footprints brought back the need for natural lighting.

The more energy is consumed through electricity the more carbon is increased in the atmosphere and therefore increasing carbon footprint which also increases global warming [3]. It was also discovered that natural lighting increases the psychological, physical and Social condition of the occupants of a building [4]. Therefore architects and people in general are coming back to all the means of lighting a building through Daylighting.

Daylighting refers to the act of placing openings or reflective surfaces to allow sunlight into a building to improve visual comfort or reduce the consumption of energy [5]. Windows are the most common way of daylighting, but Skylights are also very effective in lighting a space. The early skylights were open completely and allow light and also rain into a building. They were also in form of domes at the top of the ancient roman buildings building. As time goes by when glass when invented, this was developed into other shapes [1].

Famagusta has extreme climates, with a very cold winter and hot summer. During summer there is ample amount of sunlight and heat and therefore a lot of energy is consumed in cooling buildings alone. Skylights will be very helpful, as they would provide a source of natural lighting and therefore reduce the total consumption of energy of a building. This research provides a model of skylight that can provide an average size of room in a residential building with the appropriate visual comfort without compromising the thermal comfort of the space.

## 2. AIM

This researches main purpose was to determine the best size of skylight that will be sufficient for a room in Famagusta region of Cyprus, a 20sqm room to be exact. This is because the region has ample sunlight during some of the months and it is important to take advantage of the natural renewable sunlight in order to conserve energy.

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- Department of Architecture, Faculty of Architecture, Eastern Mediterranean University, Famagusta 99628, North Cyprus, via Mersin 10, Turkey. Ayooshmahmud@gmail.com
  - Professor at Faculty of Architecture, Eastern Mediterranean University, Famagusta 99628, North Cyprus, Turkey. halil.alibaba@emu.edu.tr

### 3. LITERATURE REVIEW

After electricity was invented and brought into home designs in the mid-19<sup>th</sup> century, daylighting was almost completely abandoned in building designs. Electricity replaced the sun in terms of lighting the interiors of a building [2].

In the 20<sup>th</sup> century however, global warming became a problem that needs to be look into. Energy consumption through electricity increases the emission of unwanted gasses into the atmosphere and increases the depletion of the ozone layer. Climate change is also becoming a big problem for the earth and the people on earth. Energy consumption is predicted to be increasing by the day [6]. It was discovered that in the 21<sup>st</sup> century has been the warmest years ever recorded, the temperature of the earth is increasing drastically and the effects of that rising sea levels, melting glaciers etc. are currently occurring [7]. This problem makes its control necessary and therefore brings the need for any system that will reduce the problem.

Energy consumption and global warming is not the only reason daylighting needs to be returned to building designs. Natural lighting has been proven from many sources to also have a good effect on the health of building occupants. Daylighting has a psychological effects on the building occupants. It creates the connection with nature for people and is seen to improve productivity in workplaces [4]. Daylighting improves the mood of occupants of the building, it reduces their stress level and affects their activities in a good way.

Daylighting inarguably have so many positive effects. Architecturally and scientifically or medically. This means that any means of adapting it should be considered.

Windows on walls is the most common way of lighting a space. Although ways like using skylights are almost as old as using windows on walls, the windows are more prominent. Another way of effectively lighting a space using natural daylight sun is through using roof windows also known as skylights.

#### 3.1 SKYLIGHTS

A Skylight can easily be defined as an opening in a roof that is framed with either wood, metal, PVC etc. and fitted with glass or plastic to allow light or ventilation or both into a building through the roof [8]. Skylights can be dated back to the 13<sup>th</sup> century Rome. Romans during the middle ages

have domes on top of their buildings, these dome were open on the top completely to allow light into the space. Because of their open nature however, these openings also allow rain and other atmospheric factors to enter the building. These openings were called oculus. By the 14<sup>th</sup> century, glass was invented. The glass invented at that time come only in small sizes, were rectangular and also colored. The glass were then used on the top of the domes framed with wood, to stop rain and other atmospheric factors from passing through. These were called roof lanterns. After sometime it was discovered that the wood allows moisture to pass through, therefore it was replaced with metal. By the end of the century a way of making bigger and clearer glasses was discovered. Skylights were then made in bigger sizes and clearer and non-colored glass was put to allow only light to pass [1].



*Figure 1. Oculus of the round room of Museo Pio Clemeito at the Vatican [1]*



*Figure 2. Ancient skylight in Mersasa ben Youssef Morocco [1].*

As time passes. These skylights were made in different sizes and shapes and were placed on the roof of buildings at different positions on roofs and were used all over the world. Skylights now can be classified into three main types; Tubular skylights, which have a domelike shape top and a tube that is lined with a highly reflective surface and passes through the roof to the ceiling to transfer light from the sun outside to the internal space. Ventilating Skylights which open like regular windows and allow not only light but also air passage. They can be controlled either manually or with a remote control and they also come in different shapes and sizes and then lastly Fixed Skylight, the fixed skylights look a lot like ventilating skylights but they don't open to allow air. Their main purpose is to allow passage of light and also provide a view of the sky for the occupants. They are also placed directly on roofs and come in different shapes and sizes [9]. The fixed skylights are the type that are being used for this research. There are certain things that should be considered when installing skylights in a space like

- Dimensions of space
- Interior Barriers
- Position and size of windows
- Heat loss and gain
- location of building
- Intended use of space
- Climatic condition of area
- Slope of roof

These factors have a lot to do with how much the skylight works, how much light it will allow, heat conduction, appearance, the type of skylight that will be suitable, etc. and therefore it is very important [10].



*Figure 3. Fixed Skylight [1]*



*Figure 4. Tubular Skylight [1]*



*Figure 5. Ventilating Skylight [1]*

#### **4. METHODOLOGY**

A quantitative method of obtaining results was adopted. A Three bedroom family house in Tatlisu Province of Famagusta Cyprus was selected at random. The living room of the house was selected as the target area, this is because a living room of a house is usually a space that requires a lot of lighting and a lot of activities are carried out there. Also the occupants of the house usually spend more time there.

The room is about 20square meters in size. The floor plan of the house was reproduced using Autodesk AutoCAD Architectural software. It was then imported into a lighting simulation software DIALux evo [11]. In the software, the location of Famagusta was entered by longitude and latitude, and the dates were set in July 2017

and December 2017. These dates were chosen because July is the month with most sunlight and December is the month with the least sunlight in Famagusta, this will give an appropriate size that will be able to work throughout the year.



Figure 6. Floor plan of sample house

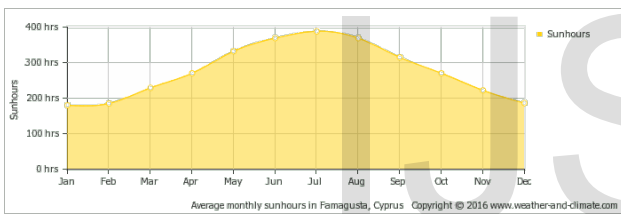


Figure 7. Average hours of sunlight in Famagusta [12]

Skylights were placed on the living room roof by the northern direction. The northern direction is the best direction to place an opening because in that direction they provide almost even lighting throughout, with no glare and have the minimal heat gain [13]. The skylights were placed six times, which means six different sizes were tested, and the result of the daylighting calculation was taken and recorded for each skylight. The sizes of the skylights taken were

1. 1m by 1m
2. 1.2m by 1.2m
3. 1.2m by 1.5m
4. 1.2m by 1.8m
5. 1.5m by 1.5m
6. 1.5m by 1.8m

The recorded values were evaluated and the perfect range of sizes of skylights that are appropriate for that room in Famagusta was established.

The recorded values of the lux levels of the room for the various skylight were compared together on the tables below. The appropriate value of the lighting for a living room is between 500-1000lux. Lux is the SI unit derivation of Illuminance, it is equal to one lumen per square meter [14].

Table 1. The daylight lux level of the room for July

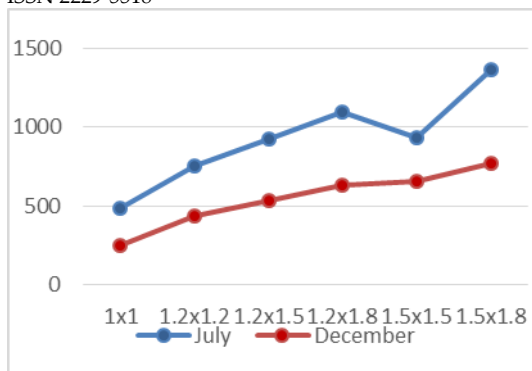
	Skylights Sizes	Lux Value
1	1m by 1m	483
2	1.2m by 1.2m	758
3	1.2m by 1.5m	927
4	1.2m by 1.8m	1099
5	1.5m by 1.5m	930
6	1.5m by 1.8m	1364

On this table it shows that there are only three sizes of skylights that are suitable for the room. The first skylight doesn't allow enough light into the room and therefore it will be insufficient and the 4<sup>th</sup> and 6<sup>th</sup> one will create glare as they allow too much light into the building. The best skylight designs for this room in July will be between the sizes of 1.2meters by 1.2meters to 1.5meters by 1.5meters. Anything below or above that will be either too much or too low.

Table 1. The daylight lux level of the room for July

	Skylight Sizes	Lux Value
1	1m by 1m	249
2	1.2m by 1.2m	440
3	1.2m by 1.5m	539
4	1.2m by 1.8m	655
5	1.5m by 1.5m	630
6	1.5m by 1.8m	773

For the month of December, which has lower sun hours and intensity, the first two skylights do not provide enough lighting into the space. The remaining however, provide appropriate lighting for the space. From this table. The ranges of skylights that are appropriate are from 1.2meters by 1.5meters to 1.5meters by 1.8meters.



**Figure 8. Amount of light in the room in lux for December and July.**

If the two months are put together, the most appropriate size will be established. For July, The smallest skylight does not allow enough light into the building, the three medium sizes provide perfect lighting and the two biggest sizes bring in too much light and may cause problems. In December, the two small sizes do not provide enough light, and the rest of the four sizes provide appropriate lighting into the space. From these results, we can safely say that the two sizes that provide appropriate lighting in both months are the most appropriate designs for the room. These sizes are the 1.2m x 1.5m and 1.5m x 1.5m x 1.5m.

The normal recommended level of light for a medium activity space like a living room ranges from 500-1000 lux. Anything below 500 will be too dark and above 1000lux will create glare.

From the results found during this research it shows that for a room of 20sqm and one (1) window towards the north, a fixed rectangular skylight of sizes ranging from 1200 by 1500mm to 1500 by 1500mm placed towards the north axis of the room will be adequate to provide enough lighting. A size just slightly below or above that will either create too much low light or too much respectively. A skylight of 1200mm by 1800mm as seen above in Table 1 will create glare. Therefore the skylight should be between 1200x1500, 1200x1600 and 1500x1500.

## 5. CONCLUSION

Skylights in Famagusta Cyprus will be very helpful. Especially during the summer when there is enough sunlight and a lot of energy is already consumed in homes for cooling. This research investigated the perfect size of skylight for an average sized room in Famagusta. In order to do that the researcher was able to bring to light the factors that were considered in choosing the sizes of the

skylights and to what orientation to place it in literature. The research was carried out and it was discovered that for a room to get enough lighting during the day in such a way that no artificial lighting will be required throughout the year, the sizes of the skylight needed ranges between 1.2m x 1.5m to 1.5m x 1.8m. It was also discovered that anything below or above that will not be suitable.

In a space with the appropriate size of skylight, there will be no need for artificial lighting during the day [15]. The perfect size of skylight for a room is essential. It can be too small and not allow enough light or too big and create glare. This research has been able to find the perfect range of sizes of skylight for an average size of room of about 20sqm. With the data got from this research a lot of Residents in Famagusta will be able to decide and find the perfect skylight design for their homes.

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