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Araştırma Makalesi

The Use Of Daylight In Architectural Designs And An Architect

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Abstract

This study analyzes Le Corbusier's understanding of light in architecture and the original use of daylight in architecture. The incorporation of daylight into the building from the windows is explained and the original light-taking forms applied are evaluated. Le Corbusier, who took part in various periods of the modern architectural movement, is a pioneering architect who promoted the use of daylight. Le Corbusier made use of highly reflective objects such as white color and water objects to increase the indoor light level. In Le Corbusier's architectural projects, he paid attention to the functionality of the building and then its originality. Le Corbusier has made designs with strip windows intensively in his projects in order to achieve bright spaces in his architectural project designs. Accordingly, the facades of the buildings were formed by repeating the windows horizontally and vertically. In Le Corbusier's works, the way sunlight is taken into the building and the effects they create on the space are designed according to the light parameter. From another point of view, Le Corbusier has become a pioneering architect who saves energy in buildings by using daylight.

Keywords: Daylight, architecture, physical environment, energy saving with sunshine

INTRODUCTION

Daylight is an important spatial design input that increases the spatial quality and enables people to integrate with nature. With the concept of sustainability, which has been talked about frequently in recent years, more improvement of spatial comfort conditions has started to be demanded more from designers. The fact that energy efficiency is also discussed more in design has led designers to consider these issues at an earlier stage of the design phase. The benefits of effective use of daylight can be grouped into two main groups (Kazanasmaz, 2009; IESNA, 2005; ASHRAE, 2001). Energy gain and reduction in thermal load: Approximately 30% of the energy consumption of commercial buildings is used as lighting energy. For this reason, as the ratio of daylight and lighting increases, electricity and lighting costs, and energy costs decrease (Hayter and Torcellini, 1999). Human comfort, productivity, and health: It is a proven fact that daylight enhances human performance. For example, as the effectiveness of natural lighting in schools increases, it is seen that the experimental results also improve. Daylight in commercial spaces increases sales, people sleep more comfortably in spaces that are constantly exposed to sunlight in residential areas, and patients who are close to the window in hospitals have a higher recovery rate than those who are far away (Garris, 2004). Daylight appears in many different dimensions in architectural design. Since it is a subject directly related to other physical environment issues, it is an interdisciplinary subject that has been studied extensively (Arpacıoğlu et al., 2020;Kurtay, 2002).

Light Range In Buildings And The Le Corbusier Approach

Le Corbusier is the famous architect of the 1887-1965 modern architecture movement. This study analyzes the energy saving approach of Le Corbusier, the master of daylight use. When the daylight is taken into the building, it provides not only seeing, but also the perception of the space and the building elements that limit the space. It makes various warnings on people. Architects can make the feeling they want to create in their buildings more effective by using daylight appropriately. Since architecture is the art of creating a space and sunlight is an element of it, architects use daylight. Daylight is taken into the building in various ways. It is generally divided into two as side and top. windows inside lighting; They are low, medium, high in terms of their location in the vertical section and vertical in terms of slope, outwardly inclined (greenhouse type), inclined inward. Side windows can be arranged as a corner window in the plan, a window with or without an overhang, a single, adjacent (band-shaped), grouped, the special-shaped window on the facade. windows in overhead lighting; horizontal, inclined, vertical skylights. All windows, depending on their types, create different effects in the space. Low windows reflect light from the outside floor into the ceiling across the depth of the room. It receives very little light from the sky and sunlight falling on the floor. If the outer floor surface is excessively light reflective, it may create luminance contrast. Allows viewing of the landscape lower than the work plane. It is possible to take interesting natural images into the building with a garden or water element arranged on the outer ground. In single-story buildings, it may be difficult to provide privacy with low windows. Middle windows are windows that provide the best view of the landscape and can receive both the light

reflected from the ground and the light from the sky. However, the greatest illuminance occurs in the parts of the room close to the window. Ceiling and floor illuminance levels decrease as you move away from the window. High windows let in more sky and sunlight onto the floor throughout the room depth, but let the light reflected from the outside floor into very little of the ceiling. Because they are high, they provide confidence, but the view becomes difficult to see (Phillips, 2004; Özdeniz, 2003; Djalilova and Şahin, 2020; Kurtay and Esen, 2019; Öztürk, 2003; Okutan, 2008). Vertical side windows are the most used windows. Inward-sloping side (greenhouse type) windows are used in places where more sunlight is required. However, since such windows get dirty easily, it is necessary to use special glasses with an external silicate coating that does not repel dirt. Since the outward-sloping side windows increase the reflected light, they are mostly used in buildings where the environment must be observed for a long time without tiring the eyes. Corner windows can be arranged in one corner, in two adjacent or diagonal corners, as a single or corner-turning window. Corner windows in one or two corners allow the light to reflect on the sidewalls, creating bright and shadowy walls. Corner-turned windows allow light from different directions and a wider view. Overhanging windows are not suitable for daylight to reach the depth of the room. However, an excessive level of brightness in the section where the exit is located, and dimness in other parts of the room, if no other windows are arranged. In the arrangement of the side windows on the facade; There are many factors such as places where light should be taken, landscape, building type, window production module, physical factors such as light, heat, solar radiation, architectural expression, building aesthetics, etc. However, in the simplest form, the arrangement of windows on the facade; can be classified as single (square, horizontal or vertical rectangular), adjacent, grouped, special shaped windows (Kutlu, 2019; Köknel Yener, 2002; Özdeniz, 2003; Arpacıoğlu, 2012). Of the overhead windows, horizontal skylights are the windows that see the sky the most. Transparent or translucent, glass, and plastic materials are used in these windows. There are rainwater seepage problems. By arranging horizontal skylights close to the wall, it is possible to reflect its light from the wall or to an element on the floor such as a pool, sculpture, etc. The rainwater infiltration problem is more easily solved in sloping and vertical skylights. It is possible to provide different light conditions by directing such windows towards the equator or in other directions. Slanted and vertical skylights oriented towards the equator also receive sunlight. Those oriented to the east receive sun only in the morning, when the air temperature is low. Those directed to the poles receive a homogeneous light in summer and winter. It is possible to arrange inclined and vertical skylights, like light scoops, both to direct them to the sun and to receive the light by reflecting it from the side surfaces. Light scoops are used in buildings where the highest degree of light is desired to be included in the building, but where the sun's rays and heat are not desired. It is possible to get more daylight by arranging courtyards, atriums, and litriums in large wide structures. Since the courtyards keep the cool and humid air of the night and provide coolness to the building throughout the day, they are ideal for hot dry, and mild dry climates. Courtyards cause moss in cool or humid climates. In such climates, the courtyard should be

kept very wide or there should be ventilation openings so that the humid air does not stay in the courtyard. Atriums are spaces left in the upper few floors of tall buildings. It can be covered with glass or left open. Litrium is a type of atrium. However, towards the last floor, its opening increases so that it has more luminosity than the atrium. All window types have various control schemes for the reception of daylight. With the deep arrangement of the window, the light is reflected from the side surfaces of the window and taken in. It is ensured that the luminosity gradually decreases inwards. Thus, the luminance contrast that can cause glare is prevented. Small-sized deep windows do not reduce the luminance contrast, as they create a dimness in the building, they also have a dramatic effect. Since the outer side surfaces of the windows are inclined outward, it will reflect some of the incoming light outward, so it is preferred in sunny areas. Direct penetration of the sun's rays can be prevented by using various shading elements. From shading elements. Alternatively, by using light-reflective surfaces, it is possible to reflect the light entering from the side and upper windows in the desired direction. By reflecting the light on the floor, ceiling, wall, or various building elements, the boundaries of the space or the structure can be clarified. The height, light-reflecting capacity, shape, and slope of the ceiling also affect daylighting. Generally, increasing the ceiling height reduces the luminance. One way to avoid this is to use a second-tall window, also called a skylight. Another way is to cover or paint ceilings and floors with light-colored materials. Beams hanging from the ceiling also reduce the luminosity as they cut off the light reflected from the ceiling. Flat ceilings reflect light better. By giving the ceiling various shapes, it is possible to obtain a ceiling that is all bright or gradually changing light. Diffuse or directional light and its direction are also important in daylight lighting. Since directional light casts a sharp shadow, it is used when it is desired to reveal the form and texture. Diffuse light has a soothing effect. Daylight can be directed into the building by using transparent glass, or it can be widely received by using translucent glass or by reflecting it from various matte surfaces (Köknel Yener, 2003; Şerefhanoğlu Sözen, 2011; Özdeniz, 2003; Erlalelitepe et al., 2011). Spreading the light horizontally and vertically in a space creates different feelings in people. The daylight composition should be considered not only in the plan but also in the vertical section. Interesting spaces can be created by providing different levels of illumination vertically and horizontally. Although he lived 500 years ago, the traces of modern architecture can be seen in his works, and it is seen that Mimar Sinan used this phenomenon skillfully in his mosque design. Window joinery and glass are used for indoor spaces. Except to cut the wind, it is not necessary to use glass in windows in semi-open spaces. Such glassless openings add depth to the façade and enable the perception of the depth of space. Whether artificial or natural, lighting design uses not only light but also the colors of the surfaces and their light-reflective properties. Various emotions are tried to be created on people with light and shaded compositions on the wall, ceiling, and floor.

Light Architecture Applications

Le Corbusier, one of the architects who showed mastery in the use of daylight, has also made progress in this regard throughout his professional life. For this reason, it would be more appropriate to examine the daylight use approach as a different period. This

approach reminds me of the architectural works that Mimar Sinan made when describing himself as "apprenticeship, journeyman and mastery works". Villa Falet, one of the first works of Le Corbusier, was built in 1905, Villa Stotzer in 1908, Villa Jaquemet in 1908, Villa Jeanneret-Perret in 1912 and Villa Favre-Jacot in 1912. In Figure 1, Villa Falet-1905, one of the buildings built by Le Corbusier in the early periods of the architectural profession; Villa Stotzer-1908 in Figure 2; Villa Jaquemet-1908 in Figure 3; Villa Jeanneret-Perret-1912 is seen in Figure 4 and Villa Favre-Jacot-1912 is seen in Figure 5.

Figure 1. Villa Falet-1905
(https://divisare.com/projects/198389-le-corbusier-cemal-emden-villa-fallet#lg=1&slide=0)

Figure 2. Villa Stotzer-1908
(http://www.ad.ntust.edu.tw/grad/think/homework/University/corbusier/a9013009/foto/fotoindex)

Figure 3. Villa Jaquemet-1908
(https://larryspeck.com/photography/villa-jacquemet/)

Figure 4. Villa Jeanneret-Perret-1912
(https://en.wikipedia.org/wiki/Villa_Jeanneret-Perret#/media/File:Maison_blanche_01.jpg)

Figure 5. Villa Favre-Jacot-1912
(https://www.thehourglass.com/new-watch/42447/)

It is possible to make the following generalizations for these structures, which are the first works of Le Corbusier. More window space is used on the south-facing façade. Rooms that receive light from one and both directions were used. In addition, there are windows in the corner that turn the corner to the right and left. The windows are in the form of narrow and long rectangles, which are side by side in the form of bands. Thus, widespread daylight was taken more into the interior area. In addition, some objects from nature, such as leaves, also used special shaped windows. In some windows, the window glass is divided into small squares. In these structures, shading is provided by large overhanging eaves. In Le Corbusier's early works, the luminance contrast between spaces was reduced with glass doors. In Le Corbusier's structures in this experiment, he tried to create a luminous contrast within the spaces with the circular projections and the windows extending to these projections, sometimes next to them, sometimes opposite. It covers the works that we can define as the second period for Le Corbusier, which started in 1916 and ended in 1923. Villa Schwob is seen in Figure 6, Vaucresson-1922 in Figure 7, Ozenfant-House-1922 in Figure 8, and La Roche Villa-1923 in Figure 9.

Figure 6. Villa Schwob-1922
(https://en.wikipedia.org/wiki/Villa_Schwob)

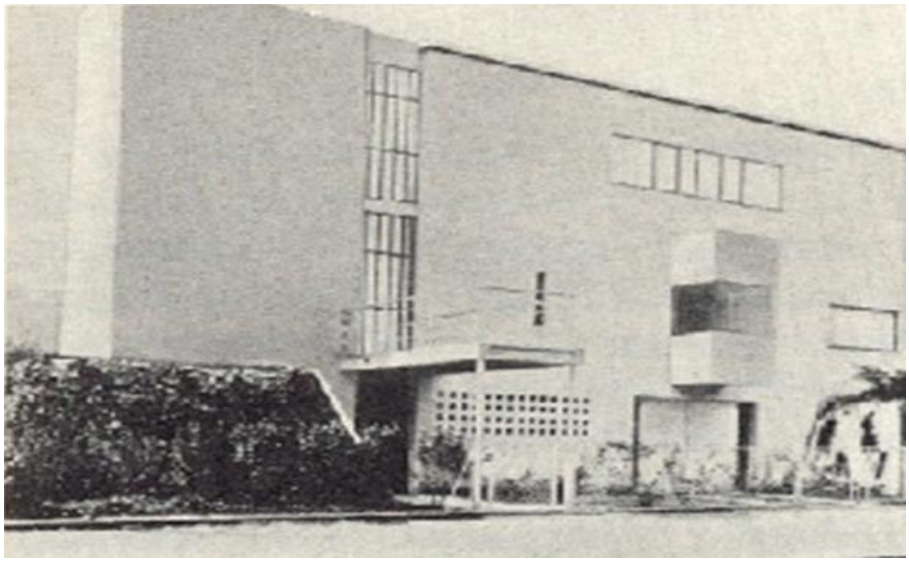

Figure 7. Vaucresson-1922
(https://www.researchgate.net/figure/Figura-6-Villa-Besnus-en-Vaucresson-Le-Corbusier_fig2_352100942)

Figure 8. Ozenfant-House-1922
(http://astudejaoublie.blogspot.com/2016/06/paris-maison-atelier-ozenfant-le.html)

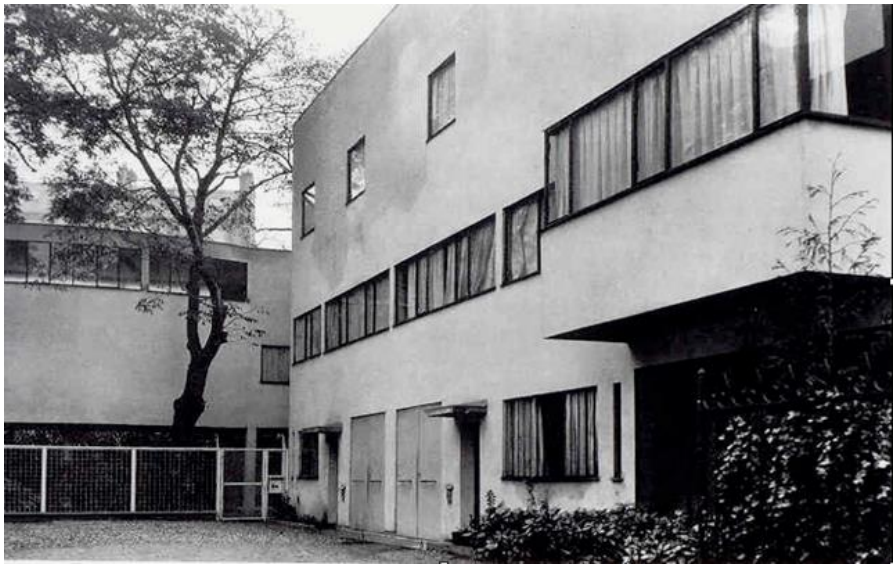

Figure 9. La Roche Villa-1923
(https://tr.pinterest.com/pin/500251471080297065/)

In Villa Schwob (1916), unlike his early structures, he contrasted transparent and deaf surfaces instead of band-shaped windows. Vaucresson's residence (1922) and Ozenfant's House, Paris (1922), which were built at the same time, have similar features. It is seen that band windows, large transparent surfaces, and various horizontal/vertical single windows are used together to form a composition. It is tried to show different purpose floors of the building with different window compositions. In the house of Ozenfant, who is an artist, the light was taken from the roof to the study room on the upper floor with light scoops. In addition, with its windows that turn the corner, both the daylight and the view are given continuity. In the building called La Roche house, in 1923, in parallel with these developments, the use of daylight is seen. On the first floor, there are band windows, on the other floors, there is a composition of small individual windows with large window surfaces according to the requirements of the space (Özdeniz, 2003). In addition, the light courtyard has been seen in the plan and the spaces with plenty of light were discussed. Figure 10 shows La Roche House-1923.

Figure 10. La Roche House-1923
(https://www.arkitektuel.com/la-roche-evi/)

The relationship between light and mass was emphasized in the Art Workshops, which coincided with Le Corbusier's professional period. In his work, known as Artist's Workshops (1924), Le Corbusier engages in interesting light/mass experiments. He used the simple cubic building mass he tried in the buildings of this period this building as well. He tried to create a dramatic effect with the light he received from the roof on the landing of the staircase leading to the gallery. The single window on the ground floor side wall casts sharp shadows, while the large glass surface on the opposite wall reduces the light contrast. The massiveness of the other walls is contrasted with the sunlight entering through both types of windows. Artist workshops are the first step in Le

Corbusier's use of daylight as an element that communicates with the space. With this structure, he used daylight to give the space a dramatic effect and clarity, rather than being a mere means of illumination. There is a different approach in the Pessac settlement (1924). In this two-story building, atriums and roof gardens are generously trying to get daylight into the building. Figure 11 shows Pessac campus-1924.

Figure 11. Pessac-1924
(http://www.fondationlecorbusier.fr/corbuweb/morpheus.aspx?sysName=redirect64&sysLanguage=en-en&IrisObjectId=4705&sysParentId=64)

In the Cook House (1926), as in many other buildings, the side window composition obtained by the horizontal and vertical repetition of a module is seen. Figure 12 shows Cook house-1926.

Figure 12. Cook House-1926
(https://en.wikiarquitectura.com/building/villa-cook/)

In the Plainex House (1927), light scoops were used on the upper floor where the workshop is located. In order to reduce the effect of solar heat entering the building, the floor height was increased on this floor. Figure 13 shows Plainex House-1927.

Figure 13. Plainex House-1927
(https://www.amc-archi.com/photos/corbu-sous-l-objectif-de-richard-pare-livre,9466/le-corbusier-maison-et-atelie.6)

In Villa Stein, in addition to the features of Villa Garches, built-in 1927, the light received from the side windows is reflected the interior walls, to create a luminous contrast on the surfaces. In this way, more daylight was tried to be reflected inside Villa Stein. This phenomenon highlights the effect of curved surfaces used within the structure to create a contrast to the cubic form structure. In a way, this is an effort to clarify the building elements with daylight. Figure 14 shows Villa Garches-1927. Figure 15 shows Villa Stein-1927.

Figure 14. Villa Garches-1927
(https://nickkahler.tumblr.com/post/87712150064)

Figure 15. Villa Stein-1927
(https://en.wikiarquitectura.com/building/villa-stein-de-monzie/)

Villa Savoye was built in 1929, Notre-Dame-Du-Haut Ronchamp Chapel was built in 1950, La Tourette Monastery was built in 1957, and the Supreme Court in India was built in Chandigarh 1951. These are structures that showcase Le Corbusier's mastery in the use of sunlight. In Villa Savoie, band windows formed by the repetition of a module, a light courtyard, and windowless wall openings that add depth to the structure are used. The building is almost floating in the light. Known as a masterpiece of modern architecture, Ronchamp Chapel emerges as a structure that interprets the presence of light in space. A dim space was created in the building in accordance with its function and religious philosophy. The building is entered through the doors on the north and south facades. The light entering through the small deep windows on the south façade creates a contrast to the dimness of the space. Le Corbusier used light scoops in this structure as well. The light reflecting off the inner surfaces of the tower creates another contrast in the space (Özdeniz, 2003). Another feature of the building is that the structure of the building is revealed by means of light. All vertical surfaces and the roof shell are illuminated by daylight. Figure 16 shows Villa Savoye-1929. Notre-Dame-Du-Haut Ronchamp Chapel was built in 1950, La Tourette Monastery was built in 1957, and India's Supreme Court Chandigarh 1951.

Figure 16. Villa Savoye-1929
(https://www.arkitektuel.com/villa-savoye-2/)

A courtyard plan was applied in La Tourette Monastery, which is located on the southern slope of a hill. The most interesting aspect of the building is its south façade. The windows on the lower floors of the building are shaded with vertical panels. It is noteworthy that the vertical panels are placed at different intervals. There are two rows of square module windows on the upper floors. These, too, are shaded by the placement of the joinery on the inside of the window. Monk rooms have no side windows at all. They receive sunlight only with their funnel-shaped scoops of light. Thus, dim rooms that receive light only from the sky were obtained. It can be said that La Tourette Monastery was created by the control of light and light. Many elements have been used to play with light in the Chandigarh Governor's Palace. Wide eaves as horizontal shading elements, vertical shading panels as in La Tourette Abbey stand out. In addition, it uses a different dimension of light by taking the flickering light reflected from the large water surfaces outside the building into the building. While providing natural ventilation against the hot humid climate of the region gains weight in the shaping of the building, efforts to control daylight continue. He tried to clarify the structure of the building by striking the light on flat in some places and curved surfaces in others. This structure was the last link of Le Corbusier's efforts to play with the sunlight. Figure 17 shows Notre Dame du Haut Ronchamp-1950. Figure 18 shows La Tourette Abbey 1957 and Figure 19 shows High Court Chandigarh-india-1951.

Figure 17. Notre Dame du Haut Ronchamp-1950
(https://www.tesadernegi.org/notre-dame-du-haut-sapeli-ronchamp.html)

Figure 18. La Tourette Abbey 1957
(https://www.arkitektuel.com/la-tourette/)

Figure 19. High Court Chandigarh-india-1951 (https://www.researchgate.net/figure/High-Court-Le-Corbusier-Chandigarh-India-1955-Source-Wikimedia-Commons_fig14_260519330/)

CONCLUSIONS

In the use of interior color, Le Corbusier has benefited from the reflection property of light by using the color white. Le Corbusier has increased the level of illumination in his architectural projects or works by using water. Artificial ponds created for this purpose are used to reflect daylight into the building like a mirror. The architect controlled the light reflected from the water and the amount of light that would enter the building. In other words, it tried to provide a kind of natural mirror function. As a result of these efforts, Le Corbusier brought light to spaces and structures. In Le Corbusier's architectural projects, first of all, the building must be functional. However, the principle that each of these buildings is unique has been adopted. With Le Corbusier's light approach, bright spaces have been achieved in architectural project designs. Accordingly, Le Corbusier was able to create bright spaces in his designs with strip windows in his projects. When we look at the later development process, he used light as a design data in buildings such as La Tourette Monastery and Ronchamp Chapel, where the spatial expression of daylight comes to the fore. In the works of Le Corbusier, the facade composition formed by the horizontal and vertical repetition of a certain module of the windows is dominant. Such windows are in a way the signature of Le Corbusier.

He is one of the first to adopt the principle of energy saving in architecture. While transferring the daylight into the building in the architectural sense, it actually indirectly contributed to the reduction of energy consumption. Le Corbusier's building designs pioneered energy savings in architecture as well as the use of daylight.

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