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Research Article

Use of Daylight in Houses and Villas from Modern Architectural Buildings

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Abstract

Architects need to consider daylight as an important element in their designs, which are shaped by location, climate, and directions, no matter what type of building. For the functions to be realized in the spaces in the building to be realized in comfortable conditions, the illumination levels specified in the standards must be provided. Issues such as the dimensions of the openings that will allow direct or indirect sunlight to be designed on the outer surface of the space, and the determination of the dimensions of the windows and doors to be used are discussed in architecture. The geography, climate, and topography of the building should be examined in terms of daylight. The direction in which the building is located should be chosen according to human comfort as much as possible. In the designs, the texture of the surfaces and the amount of daylight taken into the space by reflecting or refracting from these surfaces should be calculated. In this study, while examining the effects of daylight on residential design, well-known architects of the recent period who used daylight as an architectural element in their designs were examined. Architects such as Le Corbusier, Steven Holl, and Tadao Ando, who incorporated daylight into their work, succeeded in transforming the indoor environment into an architectural space with daylight. In this way, they have achieved different and original results in their building designs. Since the architects who are the subject of this study use daylight as a design principle, it has been seen that the houses-villas belonging to these architects have reached more original designs thanks to the use of daylight. For this reason, it has been observed that these types of residences-villas are preferred more by the users.

Keywords: Modern architecture, Daylight, Space, House, Villa.

Modern Mimari Yapılarından Konut ve Villalarda Günışığı Kullanımı

Öz

Mimarlar, yapı türü ne olursa olsun, konum, iklim ve yönlere göre şekillenen tasarımlarında gün ışığını önemli bir unsur olarak ele almalıdır. Bina içerisindeki mekanlarda gerçekleştirilecek fonksiyonların konforlu koşullarda gerçekleştirilebilmesi için standartlarda belirtilen aydınlatma seviyelerinin sağlanması gerekmektedir. Mekanın dış yüzeyinde tasarlanacak doğrudan veya dolaylı güneş ışığına izin verecek açıklıkların boyutları, kullanılacak pencere ve kapıların boyutlarının belirlenmesi gibi konular mimaride tartışılmaktadır. Binanın coğrafyası, iklimi ve topografyası gün ışığı açısından incelenmelidir. Binanın bulunduğu yön mümkün olduğunca insan konforuna göre seçilmelidir. Tasarımlarda yüzeylerin dokusu ve bu yüzeylerden yansıyarak veya kırılarak mekana alınan gün ışığı miktarı hesaplanmalıdır. Bu çalışmada gün ışığının konut tasarımına etkileri incelenirken, tasarımlarında gün ışığını mimari bir unsur olarak kullanan son dönemin tanınmış mimarları incelenmiştir. Gün ışığını çalışmalarına dahil eden Le Corbusier, Steven Holl ve Tadao Ando gibi mimarlar, iç mekan ortamını gün ışığı ile mimari bir mekana dönüştürmeyi başarmışlardır. Bu sayede yapı tasarımlarında farklı ve özgün sonuçlar elde etmişlerdir. Bu çalışmaya konu olan mimarlar tasarım ilkesi olarak gün ışığını kullandıklarından, bu mimarlara ait ev-villaların gün ışığından yararlanması sayesinde daha özgün tasarımlara ulaştığı görülmüştür. Bu nedenle bu tip konut-villaların kullanıcılar tarafından daha çok tercih edildiği gözlemlenmiştir.

Anahtar Kelimeler: Modern mimari, Günışığı, Mekan, Konut, Villa.

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1. Introduction

Daylight is of great importance for human life. In case of deficiency, physiological disturbances can be seen in people, while psychologically depressed mood states can occur. It is very important that the volumes can be illuminated by daylight in terms of the time people spend in closed volumes in their daily life. The illuminance created by daylight in the volume varies depending on the effects on the settlement, building, and volume scales. Daylight utilization is an important issue in all spaces where people spend time, except for spaces where daylight is not desired, such as special exhibition spaces. It is of great importance for various reasons that the volumes are illuminated by daylight as much as possible. Examples of these reasons are saving the energy to be consumed for lamplight, affecting people psychologically positively, being able to establish a visual relationship with the outside environment during the time they live in closed spaces, watching the changing weather conditions, and benefiting from the landscape. Many factors such as function, number, characteristics of users, and frequency of use play a role in shaping the various volumes inside the buildings and determining their position in the building. Regardless of the function of a volume, it should be given importance to illuminate it with daylight as much as possible. Lighting the volumes with daylight saves the energy to be spent on lighting and has a positive effect on human psychology. In addition, thanks to daylight, the users of the House-Villa achieve benefits such as establishing a visual connection with the outside environment, getting information about the time of day, and weather conditions, and benefiting from the view. The changing characteristics of daylight in terms of brightness level and light color throughout the day also positively affect people's moods. The main purpose of a building is to provide shelter for people against the challenges of the external environment and to provide the most suitable indoor climate conditions for its users. Solar radiation and climatic factors constitute the most important data for architectural design. In this sense, Socrates, who lived in ancient times, was one of the first to associate the sun with architecture with the known history, and he argued that the sun could be benefited by paying attention to the orientation of the houses. Again, in Anatolian Culture, a structuring consisting of the sun, natüre, and the human triangle is seen. In many parts of Anatolia, the north-facing direction of the buildings is thick-walled. The front of the buildings, that is, the living areas, face south. In the artificial environment created together with the physical environment, benefiting from the sun in different climatic regions or being protected is the first goal of the design. In Anatolia, people used thick walls in their homes. In this way, the wall, which keeps the interior cool by absorbing the sun's heat during the day, allows the space to warm up with the heat it stores at night. The phenomenon of daylight, which has such an important role in the design and increases the quality of life in the space, was primarily considered during the design phase as a physical environmental value.

The relationship between daylight and space, which has an important role in the traditional teachings that have been going on for thousands of years in the history of humanity, is an important parameter that has been redeveloped by designers today and its use in modern designs has increased. Considering the relationship between daylight and architecture, it is seen that daylight and many physical environmental values are related. Today, it has been proven by scientific studies that the interaction between daylight and architecture cannot be regarded only as a relationship that provides enlightenment. For this reason, the daylight phenomenon and other associated physical environmental values, the effectiveness of which is tried to be increased in the design process, should be defined in the design process. The activation process of daylight in design is also important in terms of sustainable architecture. A phenomenon that affects the quality of life, energy use, and spatial comfort so much, helps the designer to create spaces that consume relatively less energy with the right design decisions, and where people feel like a part of the natural environment. Today, design processes are getting more and more complex day by day. These expectations can be more abstract expectations such as comfort, aesthetics, and sustainability. Daylight is one of the basic inputs of architecture. The effective use of daylight in design increases the quality of life of the space and the success of the designer in creating a satisfactory space. Therefore, the effective use of daylight in space design is important. The effective use of daylight in design is of course possible when considered together with other physical environmental values. For buildings, it is necessary to ensure interaction with the physical environment and to organize environmental data in design in a way that increases the quality of life. Adaptation of daylight and other physical environmental values to the design during the design process is a very difficult issue. The subject of this study, prominent architects who have come to the fore with their experience in the houses and villas they have built, such as Le Corbusier, Steven Holl, and Tadao Ando, have recently been examined and distinguished architects who have specialized in their fields.

Daylight is not a new concept in design. Daylight is an important spatial design input that increases the spatial quality and enables people to integrate with nature. Before the spaces were illuminated with electricity, the relationship between space and daylight was of great importance for architects. Every day, new issues are added to the connection between energy, daylight, and space in terms of space quality and energy conservation. Indoor quality, occupant health, visual comfort, and efficiency are interrelated physical environmental issues. About 30% of the energy consumption of commercial buildings is used as lighting energy. Therefore, as the ratio of daylight and lighting increases, electricity and lighting costs, and energy expenses decrease (Hayter S.J., 1999). It is a proven fact that daylight improves human performance. As the effectiveness of natural lighting increases in schools, 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 residences, and patients who are close to the window in hospitals have an increased recovery rate compared to those who are farther away (Garris, 2004). Whatever the type of space, light is an important factor for the action to be taken in it. Light is the most important element necessary for the space to be seen, perceived, and used. Considering daylight as a building element while designing the architectural space creates different and original results in the design. Concepts of daylight, space, design, and perception affect the physical and symbolic design of natural light in architectural space. In this context, the use of daylight and its effect on the design of the building should be examined in the context of space. For this purpose, the use of daylight in the designs of modern architects of the recent period has been examined. A selection was made among the main architects who used natural light in various forms in their designs and accepted this as a design principle. By comparing the physical use of daylight, that is, the way the light is taken into space, the spaces where the light spreads horizontally and vertically are examined

through examples. According to the evaluation made, the differentiation of natural light according to the hours of the day and seasons creates richness in the space where the light is used. It is seen that the use of the sun, which is a natural source of light in today's architecture, is increasing because it is everywhere and can be applied without requiring complex technology. Daylight has always had an important place in human life. The use of natural light, which has psychological and physiological effects, in daily activities has continued since ancient times. In the early ages, the penetration of daylight into the space was provided through small holes in the buildings, but the presence of glass made the use of daylight in the space very effective. With the use of glass, the boundaries between indoor and outdoor environments have weakened. In this way, the use of natural light as a design element in architectural spaces has provided a refreshing effect in residences.

Daylight is a building element that gives physical and symbolic meanings to the architectural space. Today, when world energy policies are oriented towards natural resources and serious investments are made in this field, the importance of using daylight more in residences has increased. Daylight has been used for centuries not only to create bright spaces but also to create behaviorally effective spaces. Daylight, which has gained new meanings in the designs of distinguished architects, still maintains its mystery on people today and is a source of inspiration for architects. In this study, the plans, sections, appearances, etc. of the designs of 3 architects selected from among the modern architects who are known for their buildings living in various parts of the world, and who successfully use natural light as a design element in their works today and in the recent past, are presented. A detailed comparison was made with the help of drawings and building photographs. The works of modern architects Le Corbusier, Tadao Ando, and Steven Holl, who use natural light extensively in their works and realize the designs of world-renowned residential-villa structures, are analyzed. The physical or symbolic use of natural light in the sample buildings of these architects, the horizontal or vertical light coming into the space, and the use of light directly or by reflection were analyzed. According to this analysis, the effects of the use of natural light in houses are explained. Similar architectural works belonging to Le Corbusier, Tadao Ando, and Steven Holl can be seen in Figure 1 (URL1-URL3).

Figure 1. Similar architectural works by Le Corbusier, Tadao Ando, and Steven Holl

2. Daylight Effect in Architectural Design

Daylight is a very effective factor in perceiving and using space. Structure, material, color, and form create the space, but it provides light about the whole and to each other. Therefore, the role of light is important in the visual perception of the space. If daylight is considered as a part of the interior, the most important parameter is the light, the way it is taken into the interior, its intensity, the type of building elements, the form of the limiting elements that make up the space, and the desired semantic effect. With the effect of natural light in a place, the activities planned to be done in it become easier. In various uses of natural light, it is possible to draw attention to a direction or the desired point and thus to give this point a meaning other than measurable values. From the past to the present, architects have sought ways to use natural light more efficiently and effectively in their buildings. With the understanding that emerged in the historical process, the use of daylight is becoming widespread to provide brightness and visibility in the natural light space. The most important factor in the realization of the work in a place is the daylight entering the space. Without daylight, the person cannot see the place and the equipment and cannot perform the work he will do. Different levels of light are required for different actions. When the light is below a certain level, the relevant building cannot be used efficiently. Contrary to this approach, when the level of daylight entering a house is high, people can use the house unproductively, as they are uncomfortable due to reflection and glare. It is necessary to pay attention to the aspects according to the use and duration of use of the spaces in the residences. The effects of daylight on the use of space can be psychological and physical. Although the effects of light are physiologically the same, it creates different psychological effects. Because light has many meanings according to the psychological state and creates different perceptions according to people with its color, movement, and direction.

Daylight has lighting and heating properties. In places with cold climates and where sunlight is not very effective, daylight is a preferred element in residences. However, in residences in hot places where the sun is very effective, the irritating, excessively bright, and warming effect of natural light is tried to be prevented by different methods. Again, reflective, permeable, or semi-permeable wall materials change the effect of natural light on the space. The texture of the materials adds richness to the space with the shadows it creates. Reflective surfaces can provide more light to the space, and impressive spaces can be created with the animated games of light, depending on whether the surface is flat or textured. Le Corbusier, Tadao Ando, and Steven Holl are the architects who use natural light as a design element and prefer the use of daylight intensively in the residences.

2.1. Daylight Use according to Le Corbusier

Referring to daylight, Le Corbusier defines this event, which starts with the sunrise, then includes the rise and sunset of the sun and repeats periodically, as the most important parameter affecting life. The following generalizations can be made for the use of daylight in the first works of Le Corbusier, Villa Falet, Villa Stotzer, Villa Jaquemet, Villa Jeanneret-Perret, and Villa Favre-Jacot. More window space is used on the south-facing façade. Rooms that receive light from one and both directions are used. It also has corner-turning windows. The windows are in the form of narrow and long rectangles, which are side by side in the form of bands. Thus, it was tried to get more diffused light. He also used specially shaped windows such as leaves. Some of the windows

are also divided into small squares with joinery. Shading is provided by large overhanging eaves. In these first-period buildings, the luminance contrast between the spaces was tried to be reduced with glazed doors. He tried to create a luminous contrast in the space with the circular projections and the windows he arranged in these projections, sometimes next to them and sometimes opposite them. Villa examples belonging to Le Corbusier can be seen in Figure 2 (URL4-URL7).

Figure 2. Examples of Villas by Le Corbusier

There are similar features in Villa Besnus, "Ker-Ka-Ré" Vaucresson (1922), and Ozenfant's House, Paris (1922), built at the same time. Band windows, large transparent surfaces, and various horizontal/vertical single windows appear to be used together to form a composition. With different window compositions, different purpose floors of the building are tried to be shown. In the house of Ozenfant, an artist, light was taken from the roof with light scoops to the study located on the upper floor. In addition, with its windows that turn the corner, both the daylight and the view are given continuity. Parallel to these developments, the use of daylight is seen in La Roche Villa (1923). 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. In addition, the light courtyard has been seen in the plan and the spaces with plenty of light have been discussed. Examples of House-Villa by Le Corbusier can be seen in Figure 3 (URL8-URL11).

Figure 3. Examples of House-Villa by Le Corbusier

In Villa Schwob (1916), unlike his early structures, he contrasted transparent and deaf surfaces instead of band-shaped windows. However, Le Corbusier partially included band-shaped windows on the ground floor and the balcony floor. Villa Schwob by Le Corbusier is seen in Figure 4 (URL-12).

Figure 4. Villa Schwob by Le Corbusier

In Villa Savoye (1929), Villa Savoie, band windows formed by the repetition of a module, a light courtyard, and windowless wall openings that add depth to the structure were used. Villa Savoye by Le Corbusier is seen in Figure 5 (URL-1).

Figure 5. Villa Savoye by Le Corbusier

2.2. Daylight Use according to Tadao Ando

Tadao Ando's use of daylight; The Row House is being studied at Sumiyoshi, Osaka (Azuma House). The life source of the house is the light courtyard in the middle. With this courtyard, the mass is opened to the light. The facades facing the courtyard are large glazed surfaces. The light entering here is reflected from the adjacent walls, creating a luminous contrast. The matte texture of the bare concrete surfaces used reflects light in different grays and is effective in perceiving the boundaries of the space. Also known as the Sumiyoshi row house, it has a rectangular plan divided into three parts, with front and rear rooms connected by a bridge through a courtyard dedicated to the play of wind and light. The building, which consists of simple geometry and a solid concrete facade facing the street, has no openings in the side walls. Figure 6 shows Azuma House by Tadao Ando (URL-12).

Figure 6. Azuma House by Tadao Ando

Bansho House is a dim living space after a bright entrance. Close to the floor, the floor surface is illuminated by the light leaking from the two windows. The light leaking from the thin strip emphasizing the stairway to the upper floor is imprisoned between two narrow deaf surfaces and indirectly taken into the space. The glazed surface of the triangular-shaped built-in balcony, obtained in the bedroom on the upper floor, brings sunlight into the space and creates contrast with other deaf surfaces. With its thin and long rectangular form, it accompanies the window that invites the light into the space (Üçüncüoğlu, 1995).

Tatsumi House displays similar features to Tomishima House. Here we see the window jambs protruding like a lattice shading element. These windows are square and they are used one by one wherever light is desired. On the other hand, we see a mass resembling a light bucket sticking to the surface. The lateral faces of this part let in light, again indirectly letting it in.

Unlike the Tomishima House, the illuminated center is not used. However, in this building, too, the desire to separate the inside of the building from the outside and create an introverted space atmosphere is striking.

In the Soseikan House, Ando continues his efforts to direct people with individual square windows shaded by lattice shading elements, a building center illuminated by roof light, and long low parapet walls. Each of these two residences, which are connected by long stair landings, opens into the bright central space like a flower directed towards the sun. The excess of deaf walls makes the light more valuable and creates a dramatic three-dimensional luminance contrast within the building.

The Umemiya House consists of two interlocking square modules. Although it is located in a completely open area, it has a massive mass understanding with the desire to create an inner atmosphere. The residence is two-story and the staircase rises on completely deaf surfaces, while the beam of light falling on the landing comes from Ando's long, narrow strip windows. Other windows are rectangular and continue along the surface, bringing sunlight directly into the space. Figure 7 shows the Umemiya House by Tadao Ando (URL-13).

Figure 7. Umemiya House by Tadao Ando

Tomishima House is a corner building. The bare concrete exterior surfaces are so large that the building is not residential. The staircase is illuminated from the side by slender and long strip windows. The building is rather shaped to distribute the light it receives from the roof to the spaces. This illuminated section, including the staircase, is located in the center of the building. This direct light gives a natural rhythm to the building as it softens and descends through the distorted floor levels. In Figure 8, Umemiya House belonging to Tadao Ando is seen (URL-14).

Figure 8. Tomishima House by Tadao Ando

Koshino House is another tune by Ando, the light instrument. It consists of two massive boxes and another semicircular mass located on both sides of the courtyard, which is reached by stairs. The massiveness of the building; Again, a characteristic of Ando, the sharp light and shadow created on the walls by the light coming in through the long and narrow strip windows disrupt the contrast. Even if this type of lighting is far from meeting the need for daylight, it creates a space within the building that makes people feel and affect them. Against this problem, Ando opens the concrete surface on the roof, as in the living room, allowing the light to enter the space directly. With the sharp light-shadow composition in the space, the poetry of the space comes to the fore. The Koshino house consists of two parallel rectangular concrete boxes connected by a tunnel under the outer staircase. The house is partially buried in the ground. It is designed not to interfere with the natural environment. (URL-15).

Figure 9. Koshino House by Tadao Ando

Rokko Settlements, Kobe is nestled on a hillside. The masses are divided by letting the light in. Terraces are facing each other with elevation differences between them. In the large-surfaced windows of the living spaces, overlooking the green valley, thin blinds are used to allow the light to be taken in under control. In the disintegration of the mass, the formation of the courtyards, and the summoning of daylight to the space were taken into account. Rokko settlements belonging to Tadao Ando are seen in Figure 10 (URL-16).

Figure 10. Rokko Settlements Houses of Tadao Ando

Matsutani House's sense of mass is displayed with glass surfaces. On the glazed surface consisting of four parts, two parts let the light directly into the space, while thin blinds that filter the light were used to prevent glare. Part of the glass surface is blocked by a concrete wall, indirectly letting the light in. Bare concrete surfaces, glass, and black joinery windows are perceived by creating a luminous contrast. Very large pieces of glass are used on transparent surfaces.

2.3. Daylight Use according to Steven Holl

Steven Holl can be rated as the best architect to practice light since Le Corbusier. It is the architect who brings the mass and light together and makes the light volumetric in this building. Steven Holl uses day and night lights and shadows as architectural elements. Steven Holl interprets by combining light, shadow, and space. According to Holl, space does not attract attention without light. He used the tones, opacity, transparency, translucency, reflection, and refraction properties of daylight about each other in the space. Steven Holl uses light more symbolically. According to Holl, the transparency of a space wall, the reflection of opaque glass, or a ray of sunlight mixes in the same environment, creating symbolic effects. Holl considers the daylight of the region as a design element in his designs. By calculating the reflection and refraction of daylight, he incorporated the optimum daylight into the design. Holl developed a new form of expression, which he called "parallax", to eliminate a possible contradiction between the existing architectural expression and the building. Parallax is defined as the different direction that occurs when looking at a building from two different points that are not on a line. In this case, an image that can be obtained as a result of experience and movement from at least two points of view is formed, and the surfaces that make up the space are arranged depending on the posture and movement of the observer. Holl decides on the design after examining the pure data felt, seen, and tried from the physical environment on the model by trial and error method in the perception of the space. In Holl's Fukuoka residences, spaces are defined with the concept of "hinged space", aiming for

multifunctional use. Accordingly, a part of the area used as a bedroom at night is used as a living area during the day. Another type of hinges allows changes in the number of rooms in houses according to the needs that occur in families over time (Anon., 2000b). The sun creates shimmering reflections on the ceilings of the northern courtyards and the interiors of the apartments (Holl, 2000). Thick facades with concrete load-bearing walls in Makuhari Residences have openings that continue with a rhythmic repetition (Tanyeli, 2002). According to the arrival of daylight during the day, the openings in the design establish an internal relationship with the structures and connect the spaces. This idea is supported by the shape of the building, considering that the building reflects light in places where the effect of sunlight is low. The slope of the roof reflects the sunlight to the galleries, the upper galleries receive light from above and from the sides, and the lower part receives sunlight from both the sides and these special parts. The water landscape, which increases the effect of the horizontal light of the northern latitudes, also functions as an urban mirror (Holl, 2000). In addition, it is seen that the buildings use sunlight for heating in winter and cooling in summer. The architect consciously uses the idea of orientation and daylight as design criteria in his buildings. It creates different visual effects for the users in the space, sometimes horizontally and sometimes vertically from the roof, with the daylight it takes into the space. It controls the light it enters into the space with the gaps it creates in the form of large holes on the building facades. It creates a warm environment with the light it receives from the roof in the buildings designed in cold climates. Houses by Steven Holl can be seen in Figure 11 (URL-2).

Horizon House Planar Villa

Ex of in House, Hudson Valley Daeyang Gallery and House

The New Residence At The Swiss Embassy Planar House

Turbulence House Y House

Nail Collector's House Writing With Light House

Little Tesseract Stretto House

House At Martha's Vineyard Tower of Silence

Sun Slice House Oceanıc Retreat

Figure 11. Houses by Steven Holl

3. Material and Method

It is observed that the shading elements used to protect from the disturbing effect of the sun's heat in climates where the sun is effective affect the facade design. In climates where the sun is effective, different types of houses are seen in different regions, and it is seen that the disturbing effects of the steep sun rays in summer are prevented with the cages used in the courtyards, eaves, and windows. Evaluation of daylight as a building element provides original results in design. Since it is the light that reveals the relationship between form, structure, material, and color in space, the change of light creates different perceptions of space. Different sources, shades, opacity, transparency, refraction, and reflection of light affect the perception of the space. While the light is taken into the space, its horizontal or vertical spread serves different purposes. The difference in light in terms of color, movement, and direction has caused many meanings to be attributed to light, especially in religious worship. Light can be described physically by allowing us to see surrounding objects. Light shows different spreads according to the characteristics of the space it reflects. While the mirror shows the surface it reflects, shiny surfaces such as glass showcase and metal reflect the light, while opal glasses reflect the light diffusely. Thanks to the light, a place can be made to feel high or low by reflecting the light to the ceiling in the environments where lighting is made. Again, the amount and color of light used in a space affect the psychology of the user, and the absence of daylight makes the person tired, while the excess of light disturbs the eyes by glare.

There are different uses of daylight according to the functions of architectural spaces. Daylight is a variable design element and it changes from morning to evening, from day today. The use of natural light in space varies according to geography and culture. In countries with less sunbathing time and narrow angles of sunlight, large windows are included in the buildings designed because daylight is not sufficient, while in countries with a hot climate where the sun's influence is greater, daylight from small windows is sufficient. Today, it has become easier to realize architectural designs for light with the use of daylight in the space, the increase in light entrance openings, and the use of glass depending on the developing technology. Since sunlight is necessary for human actions and health, it has been one of the elements of religious places starting from an early age. Sunlight was used in symbolic meanings that made divine connotations in dark places. Today, by using glass instead of walls, continuity between indoor and outdoor environments can be provided. Daylight can be used for functional or symbolic purposes in the space. While the architectural space is being designed, daylight can be taken into the space in various ways. Sunlight shapes the identity of the design by influencing the design, façade character, and rhythm, and can be taken into the space in a vertical or horizontal direction. Architects should consider daylight as an important element in their designs, which are shaped by location, climate, and directions, no matter what type of building. While the architectural space is being designed, daylight can be taken into the space in various ways. The light, dark or shiny surface features affect the perception as they reflect the light in different ways. The generally preferred methods for absorbing daylight into the houses are listed below (Öymen Özak, N. and Pulat Gökmen G. 2009; Tezel, D. 2007).

• In areas where the sunlight is very bright, it is possible to receive the light by reflecting it into the space, thus reducing the dazzling effect.

• Different positioning in the settlements of residences or villas and the effect of different elevations on the land and the surrounding buildings affect the daylight values provided in the volumes. Accordingly, the daylight and illumination conditions of the volumes of the same plan type differed from each other according to the conditions specified.

• Constructing a built-in balcony may cause insufficient daylighting provided in the volumes. Increasing the width of the window opening to the balconies can improve adverse conditions.

• Daylight illuminance values change depending on the depth of the volumes, and although there are large windows, sufficient daylight cannot be provided as the depth of the volume increases.

• More positive results are achieved in the volumes located at the corners of the buildings and accordingly have windows on both walls.

• Sunlight gives direction to the identity of the design by affecting the design, façade character, and rhythm, and can be taken into the space in a vertical or horizontal direction.

• The space illuminated from above is brighter, but because the light is diffused, the necessary shadows to define the objects cannot be created. The light entering the space horizontally may not provide sufficient illumination, and skylights illuminate every part of the volume, creating more effective results.

• Window orientation also affects light conditions, windows oriented to the east receive the morning sun, while those oriented to the north receive homogeneous light. Deep windows reflect the light and let it in, preventing the light contrast that can cause glare.

• In sunny areas, windows with sloping lateral surfaces reflect some of the light outwards, while low windows reflect the light reflected from the outer floor to the ceiling.

• The distance and height of the obstacles affect the daylight illuminance that occurs in the volumes. In this respect, the effect of obstacles close to the structure in which the examined volume is located is great.

• The settlements of the buildings on the land, the ground level levels, and the distances between the residences and villas significantly affect the use of daylight in the volumes.

• The slope of the land increases the barrier effect of the buildings in the settlement on each other.

• Existence of a water element in the exterior creates interesting light plays in the interior.

• The location, size, height, and inclination of the windows on the façade affect the amount of light taken into the space.

• Middle windows let in the light coming from the sky and reflected from the ground.

• Inclined windows receive more sunlight, but with the use of special glasses, contamination can be prevented in a short time.

• Outward sloping windows are preferred because they do not tire the eyes when it is necessary to observe the environment by reflecting more light to the outside.

• If the number of windows in the volume and their width are sufficient, the disadvantageous effect of the balconies can be overcome and sufficient daylight illumination can be provided.

• Keeping the windows on the balcony wall equally wide while designing large balconies reduces the barrier effect caused by the balcony for daylight intake.

• As the window width increases, the area where the desired daylight illumination is provided in the working plane of the volumes increases.

• Elements for façade design such as the gable wall applied in the building reduce the incoming daylight by creating an obstacle effect and creating significant differences in luminance levels compared to spaces of the same shape and size without gable walls.

• The use of daylight, depending on the floor height of the volumes in the building, varies according to the presence or absence of obstacles in the environment. While there is no change according to the floor where the volumes are located in the condition of no obstruction, there are significant differences in the condition of obstruction.

4. Conclusions and Recommendations

While examining the effects of natural light in space design, the examples of modern architects Le Corbusier, Tadao Ando, and Steven Holl, who use natural light as an architectural element in their designs and have world-renowned buildings, are examined. Tadao Ando used natural light in his buildings, generally in a symbolic sense and by reflecting it, and in Holl's and Le Corbusier's designs, he used natural light by reflecting it. Architects, who used natural light as a design element and included it in their works, were able to transform the volume into an architectural space with daylight and gave their designs original qualities. The surfaces on which daylight reflects in the interior have been carefully selected and the meaning it brings to the space has been taken into consideration. Architects, who use daylight as a design element, also considered the effects of natural light in the selection of horizontal or vertical surface materials.

Le Corbusier uses daylight both symbolically and for the function of the building. However, functional use comes to the fore in Le Corbusier's residences. While taking the daylight into the space, it has established a relationship with the structure of the building and mostly reflects the sunlight from the surface and takes it into the space. In the architect's first buildings, more south-oriented windows, corner windows, or continuous windows were used to bring more light into the space. Later, he achieved contrast by using transparent and deaf surfaces, using different window types for different functions. It has included courtyards and roof gardens in its designs, and maximizing natural light into the space or making use of natural light as much as possible has been the basic design principle.

It has been observed that Tadao Ando uses natural light symbolically in his residential and religious buildings. The architect took the natural light into the space more in the vertical direction and preferred wide glass windows against the concrete surfaces in the horizontal. Ando establishes a relationship with nature in his designs, therefore he prefers massive masses in buildings where the function is appropriate, creating a sharp contrast of light and shadow on the walls with the light received through long and narrow strip windows. In their structures, light adds depth to the space. The architect uses glass surfaces as thin horizontal stripes or on large surfaces. In his works, it is seen that the relationship between light and design is at the forefront. By reflecting the light from the water element he placed outdoors, he sometimes brought it into the space from low windows and brought interesting light plays to the space. He used the water element frequently, reflected the sunlight to the building like a mirror with the water elements used, and tried to control the light reflected from the water.

It has been observed that Steven Holl uses natural light functionally in the examined residential buildings. It is seen that he uses natural light horizontally or vertically, linearly or reflected, depending on the meaning he wants to give to the space. The architect uses the most appropriate way by calculating the reflection and refraction of the daylight of the region in his designs. It is observed that he uses human-scale modular windows in his buildings. It is seen that he uses light by reflecting it from water elements like Ando and Corbusier. It is seen that all architects try to indirectly bring natural light into the space in their buildings that they have built-in hot climates. For this purpose, the gaps and gaps left on the façade and their balance with each other are important. It is seen that the shading elements used to protect from the disturbing effect of the sun's rays in climates where the sun is effective affect the facade design. In climates where the sun is effective, different types of houses are seen in different regions, and the irritating effects of the steep sun rays in summer are prevented with the cages used in the courtyards, eaves, and windows.

In Le Corbusier, the facade composition formed by the horizontal and vertical repetition of a certain module of the windows comes to the fore. Shading elements are also used on these facades. It is seen that Tadao Ando carefully observed Corbusier's works, but applied some of his solutions such as roof gardens and water surfaces with his interpretation. Tadao Ando throws light on interior surfaces and creates luminance contrast with other surfaces, thus creating a dramatic effect in the building and prompting people to think. Steven Holl, on the other hand, avoided the dramatic effect and created a feeling of spaciousness by keeping the brightness ratio high with wide glass surfaces. Holl used light with its physical dimension in his designs. preference The common feature that draws attention in Steven Holl, Le Corbusier, and Tadao Ando is the use of water during design. Artificial ponds created for this purpose reflect the sunlight on the building like a mirror. All three architects tried to control the light entering the building by reflecting it from the water.

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