BEHAVIOR OF LIGHT AND SHADOW IN BUILT SPACES

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ABSTRACT

Light and Shadow as a design element applied to architectural design, can embellishand even enhance the subject. The shadow can also add energy and personality to the design work. This paper will explain the term Light and Shadow, its significance, role, and effect in architecture using real-life examples. It will also assist in the investigation of the role of light and shadows in spatial relationships.

Shadow has the potential to provide people with an unforeseen visual appeal as well as a metaphysical shock. And provide people with a much richer experience and much more in-depth thought. The architects create contrast and infuse the room with imagination by mixing light and shadows. Humans may also appreciate the elegance of architectural spaces by using such a mix. The use of light and shadow as an architectural design tool to help and enhance a space is reconciled in this paper, which establishes a relationship between light, the built environment, and its users. The architecture is improved by the expression of sunshine, artificial illumination, architectural shape, material physical properties, and spatial ambiance.

Keywords- light, shadow, architecture,spatial design.

1. INTRODUCTION

1.1 Background of the study

Light is required for a number of activities, and shadows are associated with it. Light, like darkness, is inextricably linked to the concepts of shape and space. When light hits the object, the shadow gives it form and life. The relationships between objects are revealed by the casting of shadows. Architectural design uses light and shadow as a design feature to complement and even enhance the subject.

The use of both can be separated into two main categories – Natural and Artificial.
Natural light and shadow were used in early architecture to give spaces aspect and dimension. It is the primary light source for the projects, and using it effectively as a tool not only creates complex spaces but also encourages energy conservation.

Designers in modern architecture are able to precisely set the atmosphere of a room, such as through the use of natural light. These sources are investigated and selected to work with daylighting systems, including a detailed review of light fixture types and light levels.

Figure:1.1 Shadow giving shape to the subject after Light strikes in.

2.UNDERSTANDING LIGHT AND SHADOW

2.1 Light:

The soul of architecture design is light and shadow. They allow us to see, to understand where we are and what is going on around us.

Light models objects to improve visual and help us identify the real world, and shadow has the ability to mask items and serve many purposes visually in terms of composition, detail, and tonal range.

They also help you to communicate and display things to your mind's eye that aren't clear to the physical eye. It assists in the redefining of people's relationships with the world and with themselves.

There are two types of light: normal and artificial.

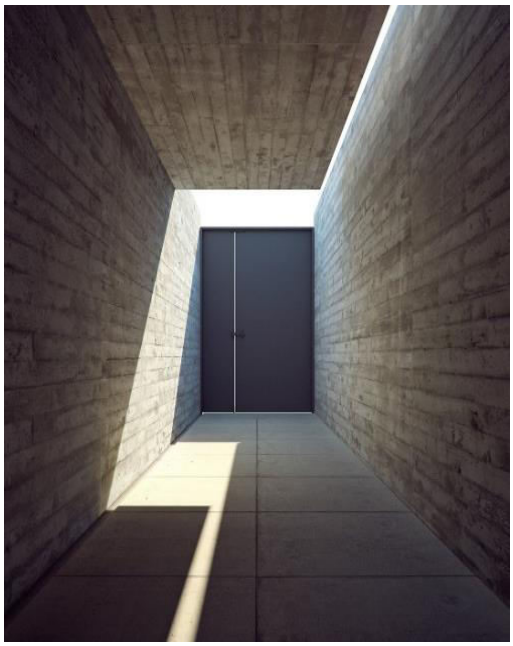

Figure:2 Light enhancing a pathway

There are two ways to control light and shadow: Size & Distance.

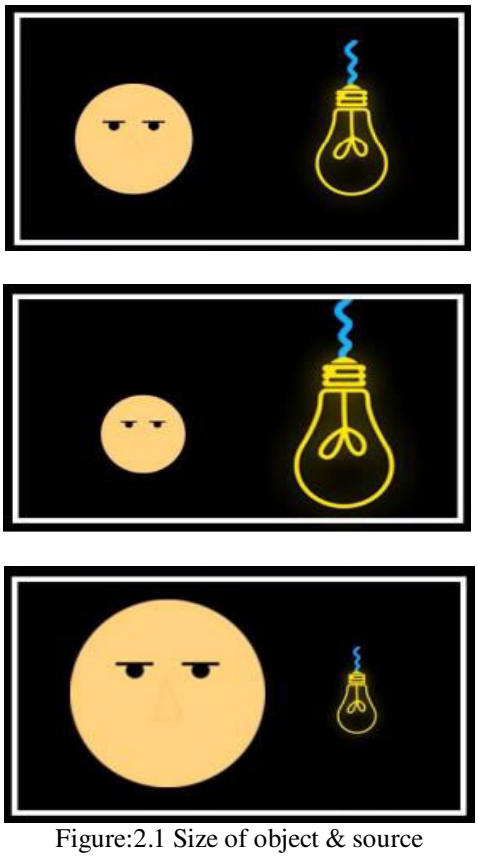

Figure:2.1 Size of object & source

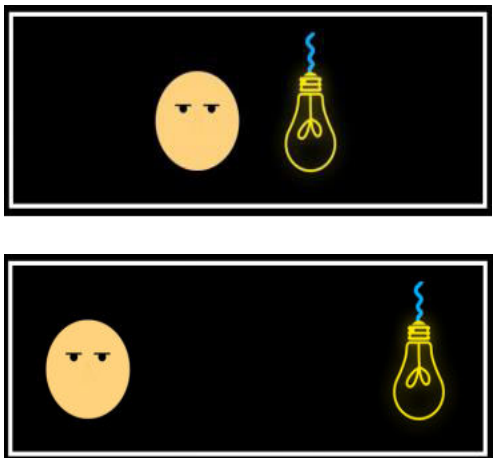

Figure:2.1.1 distance b/t object & source

2.1.1TYPES OF LIGHT:

A. Hard light-A concentrated, bright light that casts harsh shadows and draws attention to a specific subject in an environment is known as hard light. The transition between light and shadow in hard lighting is very sharp and established. When your subject is in direct sunlight, their outline will cast a distinct, hard shadow.

Figure:2.1.1Hard LightFigure:2.1.1.2Example of Hard Light on Surface

B. Soft light- Soft lighting is a form of light that is bright yet balanced, with few hard shadows. The change between light and shadow in soft lighting is more of a gradient and much smoother. There will be little or no shadows on your subject's face when they are bathed in soft light. And, if there is a shadow, it is not as dark as shadows cast in direct sunlight.

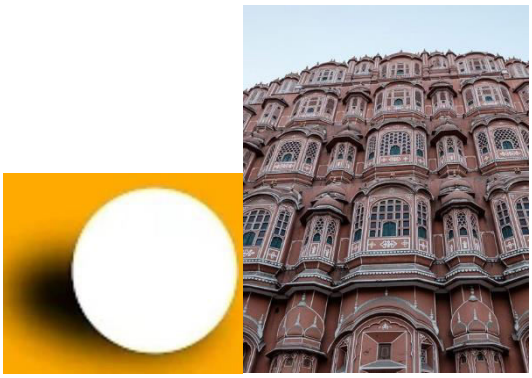

Figure:2.1.1.3 SoftFigure:2.1.1.4Example of light Soft light on Surface

C. Diffuse light- Diffusion breaks straight beams of light from the source, scattering them in different directions and producing a glow, rather than a shine. Its aim is to replicate soft natural sunlight (diffused naturally by clouds and the atmosphere), remove harsh shadows, provide greater expanses of continuous illumination, and increase aesthetics and occupant comfort. It's vital to note that diffused light doesn't necessarily indicate less light. The majority of light diffusion methods and degrees produce a bright and usable space with less intensity – meaning more comfort and a more appealing,natural aesthetic. Uneven light and contrast are totally removed.

Figure:2.1.1.5 Diffuse Figure:2.1.1.6 Example of light Diffuse light on Surface

2.2 Shadow:

Shadows are created when light cannot pass through a substance, leaving a dark void in its place. The significance of darkness, as well as its effect on perception and experience.

Figure:2.2 Shadow revealing the form and shape of the subject in different light

Deep shadows and darkness are essential because they dim the sharpness of vision, make depth and distance, and invite unconscious peripheral vision.

2.2.1 TYPES OF SHADOW:

A. Attached shadow-Attached Shadows are created by the blockage of light from a light source projected onto a portion of the object itself. There are light-emitting spots on the surface that are facing away from the light source.

B. Cast shadow- Cast shadows are the result of the light being blocked by the object. The shadow is then "cast" onto surrounding objects or surfaces**.**

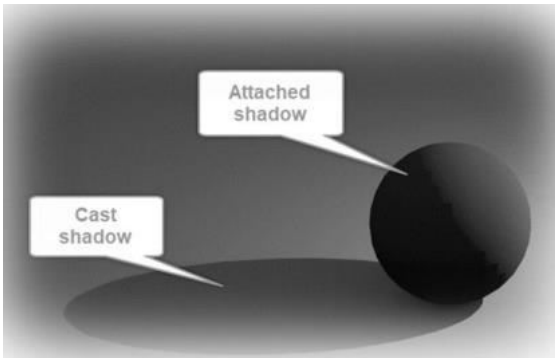

Figure:2.2.1 Cast & Attached Shadow

Figure:2.2.1 Examples of Cast and AttachedShadow

2.3 RELATIONSHIP BETWEEN LIGHT AND SHADOW WITH SPACE AND HUMAN

Different colours in the electromagnetic spectrum have been shown to influence how people perceive and experience the world, according to research. The body responds to blue light by being more alert and awake. Blue light helps to boost one's ability to concentrate, improve response times, and elevate mood throughout the day. You're slowing down by the time sunset comes, not just because you're sleepy, but also because the energising blue light is gradually slipping away, becoming warmer and losing strength. Warmth and relaxation are evoked by the yellow, warmer light colour.

Figure:2.3 Color of the Sky varying throughout the day

Understanding the various effects of light on the human body opens up design possibilities for implementing and improving the built environment. Blue light, for example, can be used in workplaces that require high efficiency

and alertness in the evenings or mornings. In order to help the sleep cycle, it can also be shortened in the evening.
In the evening, lighting designers consider using these warmer colours in bedrooms and living rooms, while colder, blue-ish lights should be reserved for workspaces like kitchens and home offices.

Fig:2.3.1 Type of Light in different Space affecting human behaviour

Light, space, and humans all have an impact on and interact with one another. Space requires light to illuminate it, light requires space to receive it, and light within space alters human perception.

3. ARCHITECTURE AS A VEHICLE TO EXPRESS LIGHT AND SHADOW

The study of light and its effects on the human body, perception, and user experience allows architects to incorporate both natural and artificial lighting into their designs.
The built environment is exposed to users by light, and architecture has the ability to expose the specific characteristics of light. The type of lighting a space receives has the ability to perceptually transform the characteristic and experience of architecture through the use of material properties and spatial ambiance.

The interplay of light and shadow in architecture provides users with varied sensory stimuli during the day. Light's effects on user understanding, incorporation into the built environment, and architectural experience are all considered when it's used as an innovative design tool.


Figure3: Play of Light and Shadow through colonnade of Arches.

Understanding the impact of light inside architecture necessitates the assessment of architectural lighting design techniques by sensory observation. The poetic relationship between light, the built environment, and its consumer is enhanced by design consideration of sunlight, artificial light, material properties, architectural shape, and spatial ambiance.

Architectural environments become perceptually fluid, changing the user experience during the day, thanks to the innovative incorporation and expression of light and shadow.


Figure3.1 Enhancement of an area through elements with Light and Shadow

3.1 Material Based

Light and Shadow explores the physical properties of material as a method to articulate and express light within architecture.
Regardless of whether the illumination is low or high, direct or indirect, materials will perceptually change their surroundings.

The physical properties of a material, as well as its assembly and construction, as well as its

interaction with light, can alter how people experience and interpret built environments.

Figure3.1:Material texture revealed

Opaque materials appear rigid, stopping light from moving through them. When light is stopped at the surface, these materials reflect and absorb light, forming a spatial boundary and generating shadows.

Figure3.1.1:Building having Opaque material façade restricting light from entering.

Transparent materials enable light to pass through, establishing a visual link between spaces.

Translucent materials behave similarly to opaque and translucent materials, allowing light to pass through while being absorbed and mirrored in some cases.

Figure3.1.2:Building having translucent material which reflect the light back to the surrounding

Reflective materials cause light to bounce off their surfaces, reflecting the surrounding environment's colours and shapes. As they reflect and absorb varying amounts of light, their unique properties cause them to perceptually transform during theday.

Figure3.1.3: Reflective materials allow light to bounce off the surface.

3.2 Form Based

Form is used in the second strategy to express, incorporate, and expose light inside architecture.

Forms allow for the creative expression of light in the built environment, and they have the ability to incorporate light in situations where natural light exposure is limited due to current site conditions.

The architectural type can be designed with a focus on its relationship to light, resulting in powerful light and dark effects.

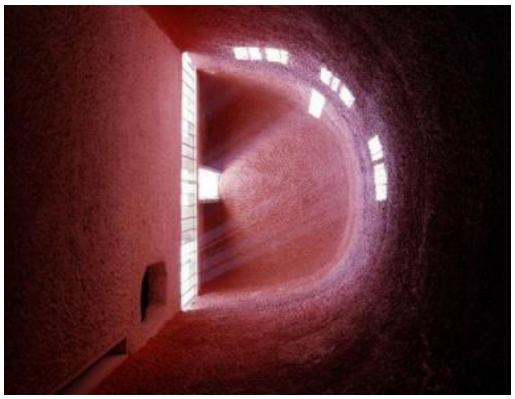

Figure3.2.1Le Corbusier – Ronchamp

Figure3.2.2: Renzo Piano - Menil Collection.

3.3 Spatial Ambiance

This strategy looks at how light influences the form of perception and ambiance it generates in the built environment.

The purpose and characteristics of a space are defined by the type of lighting it receives.

Figure3.3: OMA - Seattle Public Library

Figure3.3.1: Peter Zumthor - Kunsthaus Bregenz

3.4 Solar Orientation

Solar orientation is used in this strategy to plan, form, coordinate, and create an architectural experience within the spatial context.

The architectural incorporation of daylight corresponds to the user's perception, ambiance, and programmatic necessity.

The spatial environment's strength lies in its ability to be built for high solar exposure, resulting in energetic and engaging environments, or low solar exposure, resulting in intimate and relaxing environments.

When the sun travels through the sky, the built environment has the ability to creatively incorporate and expose light to its users, creating spatial experiences that are viewed at a particular point in time.

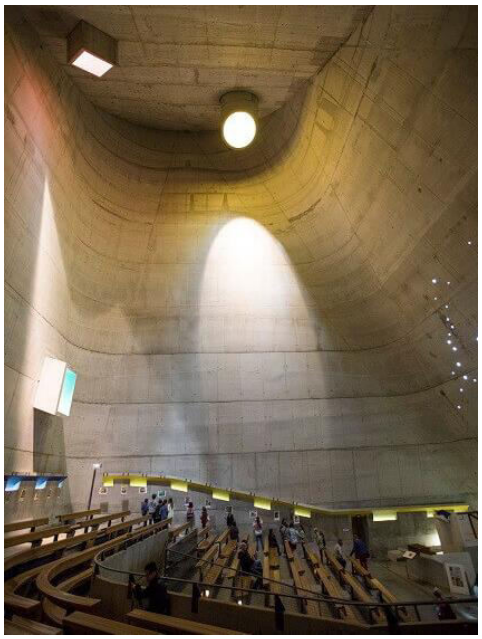

Figure 3.4: Le Corbusier - Church of Saint-Pierre

3.5 Balance

Balance is one of the more subtle aspects of good design.If we consider forms to be weighted, each one needs a counter-weight to keep it balanced.

Large forms must be balanced by a variety of small forms, such as fat and slim, flat and sculpted, dark and bright, and so on.

Figure 3.5:Shadow providing Balance to the form

Even though a shadow has no real weight, by contrast, it has perceptual weight and can be used to balance solid forms in a composition.

3.6 Pattern

Certain projections on a building create shadow patterns that liven up the structure's surface. Vertical or horizontal railings, for example, produce shadows that rise and shrink, serving as a subtle reminder of the passing of time. Interruptions and delays in music establish patterns, and the shadows are identical.

Figure 3.6: Shadow formed by window on wall

Figure 3.6.1: Dynamic shadow casted from horizontal element

3.7 Unifying

In some cases, certain parts of a structure may feel at odds with the whole composition. Because of its position or programmatic requirements, an ill-manneredpart of the building may stand out too proudly or the overall structure may seem disjointed due to competing forms.

Shadows that invade these discordant forms can reunite them with the overall structure.

Figure 3.7: Extension of window uniting with the structure.

For instance, the shadow of a window or door trim that is extended beyond just the size of the opening, integrates and engages the opening more completely into the wall.

3.8 Articulation

Baroque architects and builders were masters at sculpting space and form. Shadows created by carved surfaces dramatically mold and define the architecture of that period. We can use the same techniques to draw attention to significant elements of a building.

Figure 3.8 Hawa Mahal

Bordering shadows describe the edges of physical form. They accentuate the shape of an unshaded portion of the building.

3.9 Artificial Illumination to Perceptually Transform Architecture during the Night

The final approach aids in the expression of innovative architecture, redefining how people view and interpret the urban environment at night. While there are parallels in the usage of both, the ability to monitor and illuminate space on demand poses different challenges than working with natural light, such as sunlight. Under the night sky, an environment that appears bland and inert throughout the day can become dynamic and fascinating. When it comes to shaping specific environments and creating an overall architectural experience, the ability to control and manipulate artificial light is a powerful design tool.

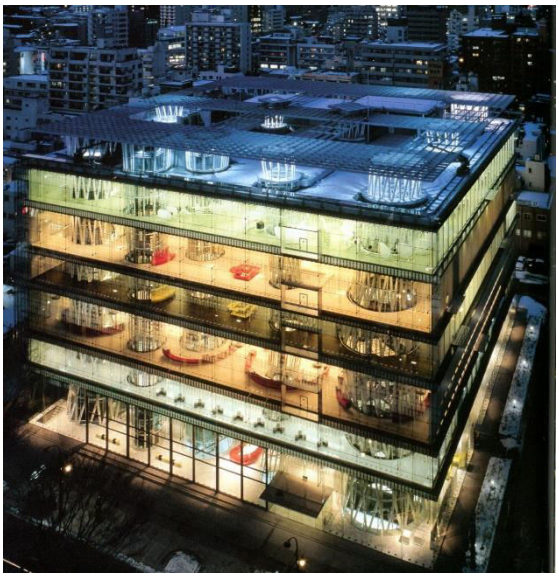

Figure 3.9: Sendai Mediatheque

4. CASE STUDIES

4.1 Pantheon, The Rome Temple, Itly

- The gods were seen or linked to the use of natural light in early architecture. The opening at the very top of the Pantheon allows light to enter and pass through the room, implying that god is permitted to enter the structure.

- One of the earliest attempts to use light to build and give life to a room is the Pantheon. The design not only makes use of the dome's curves, but also of the roof's notches to give the structure dimension.The opening is at the very centre of the dome, the light moves around the domes as the hours changes. This in turn creates a different kind of shadow.
- The quality and quantity of light gives certain quality and quantity of shadow. The physical and spiritual appearance of this architecture changes with the changes of its exterior light.


Figure 4.1: Pantheon

- Shadows are cast by the dome's curves and notches. The formation of shadows gives the overall structure depth and a spirit. The steps on the notches give the illusion of a window and create a light and shadow pattern.


Figure 4.1.1: Dome creating shadow

4.2 The Great Court, London.

- Glass panels designed by Norman Foster cover the previously open courtyard. This allows visitors to enjoy the entire museum regardless of the season, as natural light from outside will shine into the courtyard during the winter, illuminating and warming the room while keeping the cold air out. Visitors would be able to remain in the courtyard for longer periods of time, even in the cold of winter, which is something that an open courtyard cannot do.


Figure 4.2: The great court with the glass roof

- The courtyard's glass roof is made up of thousands of triangular glass plates. These panels cast a patterned shadow on the courtyard's surrounding walls.

  The shadow breaks up the walls, creating the illusion of space between them, giving the courtyard a more spacious feel than if it were completely enclosed.

  This is a great example of how light can be used to create an illusion as well as brighten a room.


Figure 4.2.1: The shadow reflecting the triangles of the glass roof

4.3Hawa Mahal, Jaipur

The effect of light and shadow has a decisive effect in the shaping of buildings and space. It has been used to express the dimension of time since the beginning of human civilization.

Figure 4.3 Hawa Mahal at Natural Light

Figure 4.3.1 Artificial Lighting

Light and Shadow depicted throughout the day by natural and artificial source can be seen in the above picture of the Hawa Mahal. During the day time, natural light from the sun creates shadows of the detailing of the windows and creates a bold effect around the detailing.
Whereas during night time, the use of artificial lights enhance the beauty of the building and increases the essence of the building.

CONCLUSION

Light and shadow articulation within spaces is intended to improve social experiences. Different spaces can be influenced by the casting of specific lighting and shadow effects as the sun travels throughout the day.

As a result, the body is able to explore and occupy various spaces during the day. As light exits a vacuum, the body is triggered to move from one space to the next. The study of Light and Shadow behaviour started with an introduction to Light and Shadow and their typologies, in which we learned how to formulate Light and Shadow in order to achieve a certain amount of Light and Shadow.

This was followed by exploring their relationship with Space and Human perception and then by understanding the impact of Light and Shadow on architecture and its user with various attributes such as Material based, building orientation, pattern, form based, unifying, etc.

After conducting research on the 'Behaviour of Light and Shadow in Built Spaces,' it was discovered how light and shadows can bind and separate spaces, how time influences perception, and the bodily experience that the user may have.

As a result of the primary and secondary research conducted through literature review and case studies, I have come to the conclusion that – "Architectural elements of a building improve the quality of a room through dynamic use of light and shadow."

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