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Domesticating Daylight via Atria

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A B S T R A C T

Atrium is a semi-open space area that is located within a building. It usually includes a large space that was a distinctive part of ancient Roman dwellings are with providing natural daylight and organic ventilation to the interior spaces are its basic functions. In other word it is a semi-pubic area such as; large opening or courtyard since 2000 years ago. After modernity of architecture, they have some large windows and/or a glazed roof. In resent centuries of development, benefits of atrium can be identified in environmental, economic and architectural aspects. As it mentioned, atrium is being used in the large-scale building such as; complexes, retail shopping malls and large office. Some of the valuable local buildings which include atrium are reviewed to render some clear picture on the design and its application of the feature building emphasizing on the solar renewable energy. In this paper, four roles of atria are presented in urban, architecture, space and climate. However, the atrium provides: lighting, ventilation, heating, cooling into the interior spaces and also in the other hand, causes an integration and correlation in space between inside and outside of building, and also between building and city. Some examples such as; the Crystal Palace at Sydenham, Royal Library of Copenhagen and some Roman atrium are shown in this paper. Finally, availability of daylight via atria considered in four models and alternatives after defining the rate of light penetration.

1. Introduction

Atria have different roles in urban, architecture, space and climate. Its urban role is can be clear to undertnd while considering about cityscape. The public performance of atria highlights in urban due to cityscape. Secondly, atria can perform as an architecture element. Albeit it can include a vast domain in architecture but its iconic feature had considered in this study. This part of atria performance depends on conceptual designing [1]. So, it did not analyzed as its practical performances. Then, its climate role is mentioned here. For example; It is useful for balancing the temperature in summer and winter. In winter, designing environments with some distinctive materials or forms as a stimulus could provide different temperature qualities. Anyway, the atrium provides: lighting, ventilation, heating, cooling into the interior spaces and also in the other hand, causes an integration and correlation in space between inside and outside of building, and also between building and city.

In the last role of the atria, this paper considered its spetial role. Space in architecture depents on architect`s concept and users requirments. So, the architect can control the activities within these areas in order to provide the process obvious to the users. For example, the Roman atria act well. It was the central part of the buildings in order domesticating natural light into building. Atrium plays an effective role where daylight can be introduced into the internal areas. There are three limited areas in the buildings with atrium regarding to the daylight that have

mentioned in the last part of this paper. Also, different alternatives of atria formation presented there.

2. Role of Atria

The performance of atria includes interior and outdoor spaces and its roles are classified into four titles such as; urban, architecture, space and climate.

2.1. Urban Role of Atria

cooling into the interior spaces and also in the other hand, causes an integration and correlation in space with good between inside and outside of building, and also between building and city.

Atria could be assumed as a townscape in urbasn [2]. As it is clear, townscape is an inseparable part of the cities that presents some perceptions of space quality to distinguish urban identity [3]. Crystal Palace is a famous example in this topic that had constructed as a great exhibition in 1851 [4].

Figure1.The Crystal Palace at Sydenham (1854)

Figure 2. The great exhibition at Crystal Palace, 1851, Add. MS 35255

2.2. Architectural Role of Atria

As an architectural role it highlight iconic feature of architecture that the features depend on contains [5]. It should not be forgotten that the iconic features are bonded with concepts. It means, the architect presents some distinctive concepts by the using of atria. For example; an atrium with a form of book can be a good alternative for formation of a library that the mentioned form brings the light to the darkness as presented in figure3.

2.3. Climate Role of Atria

Atrium as a space includes all environmental elements such as; water, plants and etc, with different forms which works on its different infrastructures such as coordination between urban spaces. Also its effects on the sustainability of city, could improve the townscape. It also permits the residents to experience indoor and outdoor simultaneously.

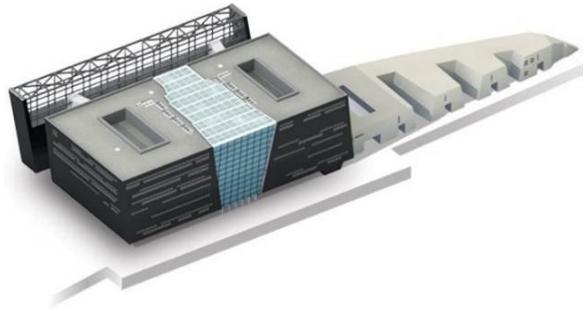

Figure 3. Royal Library, Copenhagen [6]

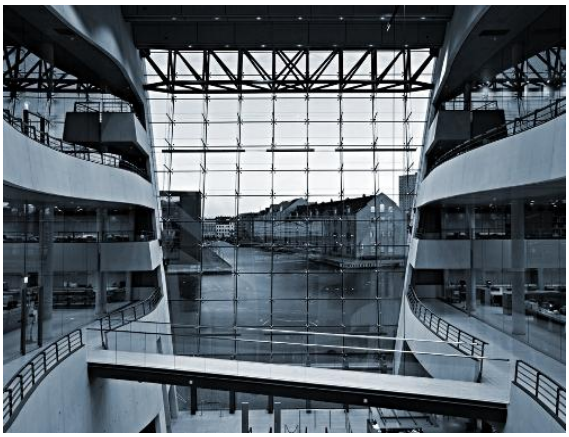

Figure 4. Royal Library, Copenhagen [6]

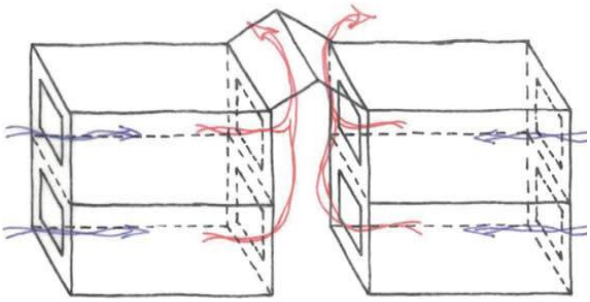

Figure 5. Atria located between two separated building to controlling temperature [7]

Implementing glass for the formation of atrium in order to create different unified areas with distinctive geometry is effective on space qualities. Using glass is accessible and also simplifies connections [8]. It is useful for balancing the temperature in summer and winter. In winter, designing environments with some distinctive materials or forms as a stimulus could provide different temperature qualities. Albeit some kinds of atria designed for energy saving purposes in the winter but they are used as a public space all of the year.

As it mentioned above, atria can be evaluated as a climate and environmental element to absorb solar energy but it should be mentioned that thermal performance is another advantage of atria. There are various methods and techniques to domesticate solar energy in the form of the atria such as; trombe wall, chimney effect and etc. that provides green-house effect as shown in figure6.

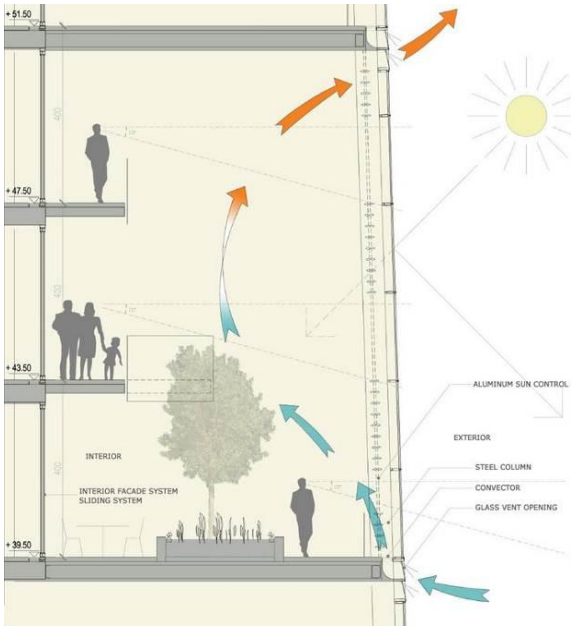

Figure 6. Using chimney effect for absorbing passive solar energy in atria [9]

2.4. Spatial Role of Atria

The architect forms distinctive areas via the atrium with variety plans such as atrium. The architect can control the activities within these areas in order to provide the process obvious to the users [10] For example, the Roman atria act well [11] In the atrium inside, courtiers could have confidential negotiations between columns in halls while reach the entrance to throne, at the same time, they also could gather around a pool or impluvium and enjoy a cup of beverage, in some parts of the atrium.

In the Roman and Greek architecture, the sunken place of atria has called impluvium where exposes in the sun [14] It was the central part of the buildings in order domesticating natural light into building. However, they were some distinctive shadow parts as follow.

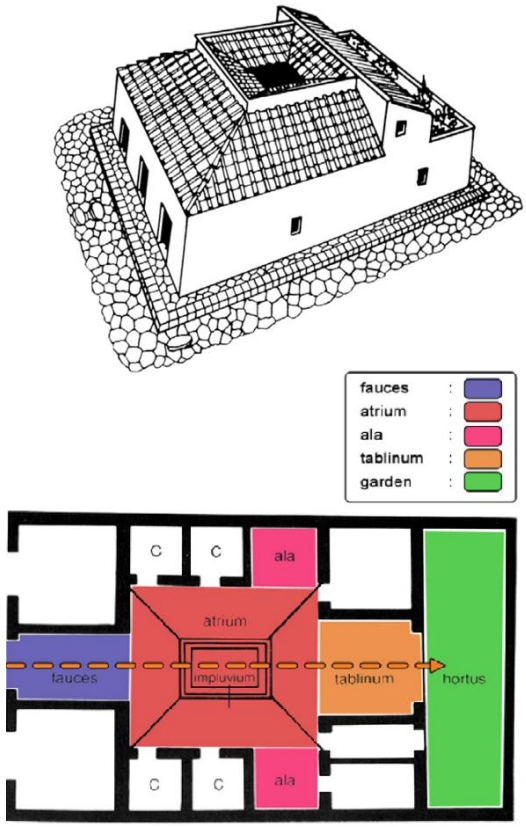

Figure 8. The Roman Atrium [13]

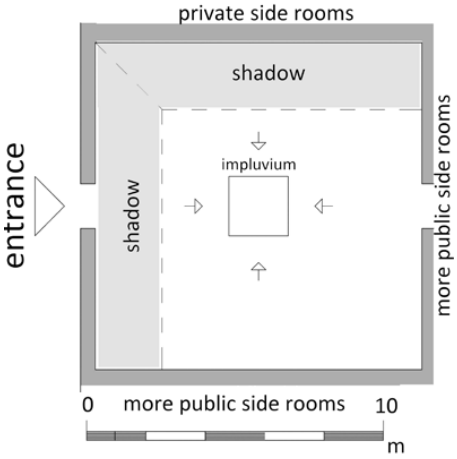

Figure9. Hypothetical plan indicating the light and shadow effects associated with the more public and more private side rooms around the roofless atrium

3. Availability of Daylight via Atria Concept and Architectural Design

Providing visual comfort is an important factor of space quality that requires a large amount of artificial lighting that means spending fusil fuels. So, atrium plays an effective role where daylight can be introduced into the internal areas [15]. Sun beams or daylight pierces into building and its intensity decrease passing interior spaces gradually [16]. There is a difference between buildings with and without atrium.

There are three limited areas in the buildings with atrium regarding to the daylight such as; maximum daylight area or exposed area, partial area or middle parts and minimum daylight or core of the building. On the other hand, there is just two areas in the buildings with atrium such as; expose area and middle part as given in figure10.

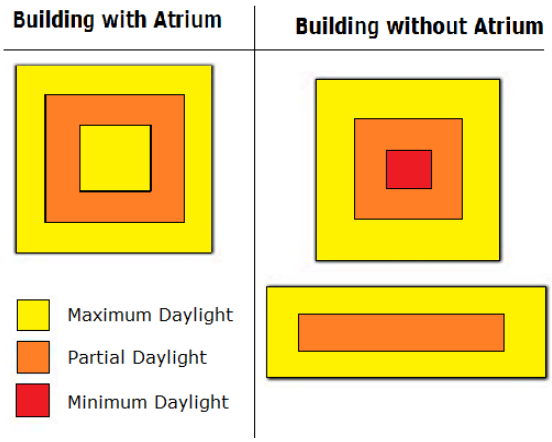

Figure 10. Availability of daylight

Formation of atrium can include a large alternatives but it is classified in four types including centralized, semi-enclosed, attached and linear as presented in Figure 11[17]. Every mentioned type of atria has different thermal performance. According to the mentioned figure, atrium is surrounded by other spaces in the centralized type of atrium. It shows the most effective performance of atria. Because, the place where the atrium orientated is the core of the space with minimum rate of daylight but at least one aspect of atrium is not closed in the semi-enclosed type of atria. Subsequently, the efficiency of centralized atrium is more than semi-enclosed type. On the other hand, the shape of attached type is like linear type of atria.

Attached type is closed just with one aspect but liner atria are located between two aspects. Anyway, semi-closed and attached types of atria operate like each other and the most effective factor in their efficiency is their orientation according to the sun directs (southern aspect in northern hemisphere). Also, the centralized type of atria is presented below graphically to compare its location and relation with other spaces as given in figure 12.

4. Conclusion

Atrium is one of the most effective elements in order to use of daylight and absorbing passive solar energy. Implementing atria in buildings means using renewable solar energy for lighting during days and also using or saving passive solar energy in winter.

the most effective factor in their efficiency is their orientation according to the sun directs (southern aspect in northern hemisphere).

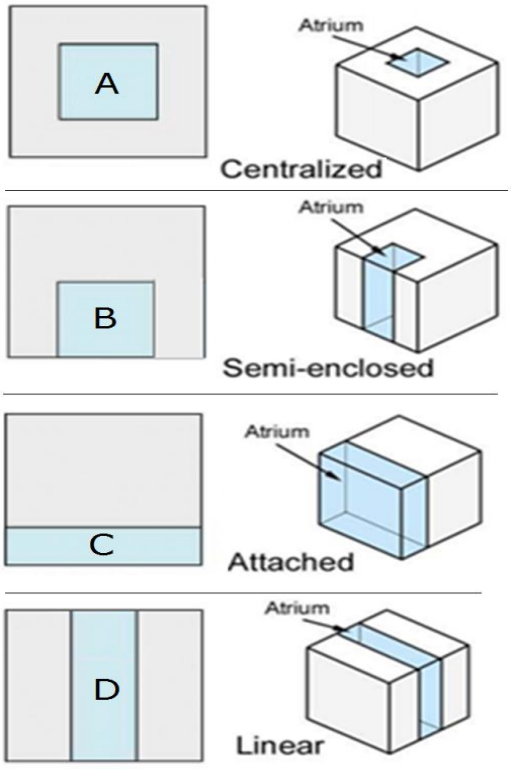

Figure 11. Atria types

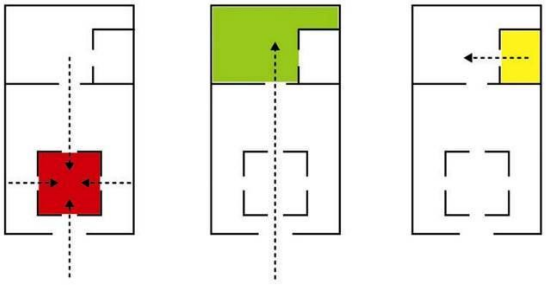

Figure 12. The Schematic View of the Atrium (Liminal), Peristyle (Terminus) and Banqueting Room (Perforated Enclosure)

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