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## Identity, Aesthetic and Ionic Values of Atrium: Reflecting Role in Architecture

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### ABSTRACT

Global warming and constant depletion of resources shows needs to reduce energy consumption, however energy used for thermal comfort of buildings remains important; even in well-designed atriums. Atrium has become a strong feature in entertainment urban centers among which Bhopal (M P) is remarkable example. It has got organized development with Indian organized retail which is likely to grow at the rate of 25-30%. Our city is served with famed local atrium buildings, which are reviewed to give a stronger picture on application of atrium building design. The occurrence of atrium was found 3000 BC in Mesopotamia and later found as central courtyard in Roman and Greek houses. This paper discuss about benefits and disadvantages of atrium that could be clearly acknowledged in architectural, environmental and economic features due to continuous development with changing scenario respectively. Furthermore, building with atrium, fire safety problem is more serious, since human life is involve so, due consideration should be given to smoke discharge systems from the atrium to the outside, the reason being atrium space and the nearby spaces differ in terms of size, usage, number of occupants and their activities. Safety target of the building is also studied by predicting what types of fires may occur and their possible effect on people, reason being unplanned design can give certain adverse effects for which further views are needed to ensure fire safety and safeguard human life.

**Keywords:** atrium; formatting; thermal comfort; energy conservation; fire safety; daylight

### INTRODUCTION

The advancement of building with feature atrium drew back to conclude the reason why it has been a popular design throughout present conditions. The emergence of atrium can be traced back to 3000 BC in the archeological remains of a courtyard house in Ur, Mesopotamia and later found as a central courtyard in Roman and Greek dwellings.[1] (a'treem), term for an interior court in Roman domestic architecture and also a type of entrance court in early Christian churches. With timeline, changes in terms of configurations and purposes occurred. Today atrium means an enclosed multi-storied space that is open vertically to multiple stories.[2] Atriums are considered the heart of public buildings (hospitals/ shopping centers/ educational center / office buildings etc.).[3] Not only the main spaces where social activities happen, people gather/socialize but also connect to the nature (sun/ green spaces) to meliorate the indoor environment/ levels of comfort of the buildings. The atrium is generally incorporated in many building types including offices, hotels, hospitals, and shopping malls all over the world. It has change the scenario of commercial buildings by contributing to scale up of market values of buildings. It has become a part of advance technology that adds up an extraordinary building feature than common slab laying process. This dynamic feature popularize the building with architectural aesthetic that draws attention of the designers and the owners. Irrespective of climate everybody is incorporating

atrium in commercial project to catch public flow and use beneficiaries option of having daylight, connectivity between floors, interactive space and sheltered courtyard serving all seasons. The distinctive characteristic increased the frequency of application in current projects.

The paper will present about the qualities of atrium focusing architectural, environmental and economic features with the purpose of their implementation in design. Correspondingly the other side of the erecting issues should to be taken into notice without any avoidance and negligence. From the past centuries after industrial revolution fenestrations and roof tops of glass panes benefits in introducing natural light to the interior of building, thus making an impression of more pleasant and energizing environment than artificial light. It is also assumed to have cut off in electricity bills using maximum daylight in consuming the space daytime. It is true to an extent, mixing of daylight into artificial light can resolve the purpose of reducing electricity bills especially in offices. At the same time infiltration of solar heat through these glass panes upturns the inner temperature termed as “Solar heat gain”, resulting in increasing cooling load to avoid overheating. The responsibilities concerning advantages and disadvantages of atrium building become one of the challenges the building designers and architects confront.

Discussing about the other issue such as fire hazard atrium becomes most concerning feature as it is unbiased, unobstructed path for the spreading of flame and smoke of the adjacent area. This open feature of atrium develops potential of expansion of hazard in the area thus pushing more people to risk. Therefore a special point to be considered for the fire prevention in buildings with an atrium is that spaces for various purposes are provided adjacent to a large, common, high-ceilinged space called the atrium, and that there can be many people in the peripheral spaces who have varying activities. Special designed fire protective systems should be installed with advance technology as it is a risk on human life and property.

The oldest use of atrium goes back to the Roman houses in which a building would be designed with a large entrance, a central court and a semi-public roofed space. Together with the exterior spaces, the main function of an atrium was to let in the controlled light and fresh air.[4]In fact, atrium acts like a filter against the impacts of unwanted exterior environmental phenomena such as rain, snow, wind and etc. (Brown and DeKay, 2001). Meanwhile, atrium makes the suitable exterior environmental elements such as sunshine and fresh air usable (Laouadi et al, (2002), Bryn, (1993)) [4]. Social qualities enhanced by this design became the reason for its further development. The first atrium was introduced in the western countries in the 19th century. In the late nineteenth century, the cognizant natural lighting was introduced to increase the light where atria played a major role (Saxon, 1986). [4] Atrium erected of glass and steel integrated with passive solar heating was emerged, one of them could be Crystal Palace by Joseph Paxton.[5] It gave rise to the development history of the large glass enclosures which was influential to the nowadays appearance of atrium. Later in that century, natural lighting was deliberately utilized to light up the interior street with shops. In the next century, sky-lit internal space became main focus by some of the architects.[5]It gave rise to the development history of the large glass enclosures which was influential to the nowadays appearance of atrium.[5].

The most representative example that influenced many architects to use atrium feature in the recreational areas was the Hotel Hyatt designed by John Portman in 1968. Several facilities were provided around the central covered courtyard. It served the people a refreshing and pleasant atmosphere which was lacking in traditional buildings. Impressing with the atrium

feature designers further started introducing it in their commercial projects to increase the inner ambience for ranking up the market value of building.

Since this features has many beneficiary points which declares the building as energy-conscious building therefore, some Energy Conscious practitioners being aware of the features used atria as a device for energy-efficiency control showing intelligence, as they very well know that improper use of energy may damage the natural environment by emitting excessive harmful gases. Since then, atrium design became an acknowledged method to get better thermal comfort by using less energy. By watchful considerations and application it was believed to be able to reduce energy consumption by artificial lighting and cooling load. [5]

### Reflection of architectural role of atrium in buildings

Atrium aims to express the iconic character of the building. The protective features of atriums have been favoured during centuries. Tall building are often principally concerned with making landmark public statement through ionic forms and soaring heights. Full-height of atrium can create a sense of wonder due to contrast of atrium with its surroundings, and indeed with human proportion for example, the height and sheer scale of an atrium, particularly in tall buildings create a monumental sense of awe as seen in Jin Mao Tower in Shanghai[6] have been built purely for aesthetic delight and are an impression of wealth and extravagance, power and grandeur. Adding the feature atrium, the building ambience increases and gives a feeling of grandness, vitality and becomes pivotal element for circulation. Incorporating atrium to urban design generates market value of building and can attract public flow with its unique interior. Many pioneer Architects has made it feature of futuristic building by playing it in creative shape, thus resolving the purpose of its implementation. Architects have also used this tool to revitalize traditional and historical building by attaching it with the old structure providing with a fresh breathe for example, there is extensions, refurbishment and conservations done in British Museum in London by providing glass canopy over the Great Court of Museum. A remarkable plaza can be created by grouping several adjacent building in the premises by one roof top showing unification in structure. Nowadays explosion of public to commercial markets can be channelized treating atrium as a space with amusement, exhibitions etc. and edible corners can be adjacent to atrium. This feature can still generate scene of human interaction in the busy world.



**Fig. 1. .Atrium of Jin Mao Tower in Shanghai**

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### Reflecting Urban Connector Characteristic

Atrium role is intended to link the building with public activities within its urban context. It has also proved to be an urban connector. It serves as a sensitive medium through which high rise building is connected and its setting with the urban fabric, infrastructure and the wider city. For example, At Scotia plaza, headquarters of the Bank of Nova Scotia in Toronto, a striking 11 storey atrium is used as an entrance connecting a 68 storey office tower with a historic limestone bank Headquarters buildings. [7] They can play many different roles in urban design: being the key point in the city structure, being the path between two important destinations, attracting people and enriching their movements inside, enhancing the quality of the urban public space. For example, the atrium in Chemical Bank Building on Park Avenue, New York is really a splendid one. The building also has a glasshouse-style enclosed former draughty plaza at the bottom of its tower. It works very well in urban terms. It should be mentioned as well that another atrium in Niagara Falls, New York also be a typical atrium, which has mixed ownership and styles of building in the neighborhood. The city in this case uses its civic role to enhance the public realm. [8]

The 1995 Osaka World Trade Centre Atrium is designed such that the complex assimilates with its context while also providing principal access to its tower. Jean-Paul Vigier's 2001 Coeur Defense building in the heart of La Defense in Paris is Europe's largest office complex comprising one hectare of floor space. It successfully employs an atrium as a physical and symbolic unifying entity. The soaring 44 storey atrium space links 180 meter tall twin towers and three other eight storey buildings. [9]

Atria forms a seamless link between the public and private realms, drawing people into the heart of a building via a warm and welcoming entrance and reception spaces. [9]

### Environmental Role of Atrium In Buildings

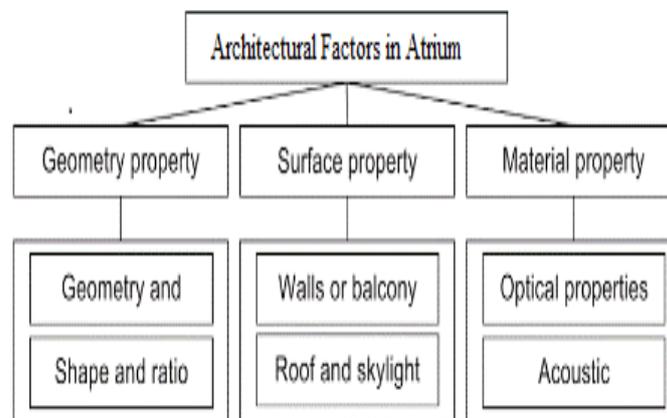
An atrium is a pleasant all weather gathering place providing shelter from the more extreme climate conditions outside. The atrium replicates a desirable outdoor environment by providing the benevolent aspects of the outdoor environment; natural light, moderate temperatures while sheltering us from the harsher elements of extreme temperatures, rain, and winds. Atriums also provide more desirable work environments by providing more space with a connection to natural daylight and the outside environment. Many believe that access to natural full spectrum lighting creates a more healthful and productive environment. There have been several studies that support this view. [2] The environmental features of an atrium is fundamental and it is achieved mainly through passive heating, cooling and daylighting. It shows its vital appearance in atrium buildings as the view into an atrium can and in most cases is more entertaining and connective than an exterior view for example Hotel Hyatt Regency Atrium.

The other purpose of introducing atrium in building is to provide effective control of environmental stimuli (sunshine, temperature, humidity, noise, etc.) for people oriented design. The reason being the environmental optimization can ensure the comfort of human activities. The atrium building has at least one glass side, which makes it an ideal natural lighting space. It acts as a collector and produces a transparent and changeful effect by the change of seasons and shadows. This feature has completely broken the sense of closure in an ordinary parallelepiped space. [2]

In the atrium of public buildings, the physical environment is determined by architectural features in various ways; therefore, an integrated consideration of the overall physical

environment is important. It is important to find out the common factors, which influence the daylighting, acoustics, natural ventilation, and thermal environment from the viewpoint of architectural design. Different effects of material properties, atrium geometry, atrium shape, roof structure, and adjoining spaces on the daylighting, acoustics, natural ventilation, and thermal environment effect the physical environment.

Configuration of atrium also show impact on environment of atrium as position and forms have substantial different environment with its context of thermal comfort. Typical atrium configurations can be totally surrounded by building elements or partially enclosed. They maybe top lit, side lit or a combination of both.[2] Atrium located inside the buildings, such as centralized and linear ones would give a more steady temperature; effectively decrease the fluctuation of temperature. Therefore, double benefits of thermal comfort and daylight could be attained. The configuration of the atrium dictate many of the fundamentals of atrium components such as Geometry, Natural Light, Exterior Envelope, Landscaping and Acoustics. Some small elements, like internal landscaping, internal finishes and light shelves are also able to reflect and diffuse lighting into the interior. Shading devices, such as louvers, blinds, retractable roof and low-E glass could be applied to prevent glares and overheating of the occupied spaces.



**Fig. 2. Architectural factors of Atrium**

### **Economic Importance Of Atrium Buildings**

Since the success accomplished in Hyatt Regency, hotels, shopping malls, office buildings and some of the mixed-use development have exploited the atrium concept. Therefore at an early design stage there are many opportunities to develop an integrated approach to energy use and savings, including the determination of the physical form and characteristics of the atrium building. The atrium space should attract public flow as social quality and human interaction are important elements to stimulate the popularity of the building and the investment return from these public flow define the successful story of the building. Investment return more can be accompanied by using some space for retailing shops or restaurants which attract more users and shoppers.

Since Cost implications are variable. The design choices can lower capital costs through reducing building service requirements as the inner construction of components such as walls elevators, staircase are reduce to the requirement due to the common usage of the atrium space. In addition, the passive energy saving measures typically require little or no maintenance and last throughout the lifespan of the building with no energy input. More

savings on energy cost by an environmental-responsive design could be used to cover the excessive expenditure in the construction. Proper designing with energy control system also reduce to noticeable difference from conventional buildings. It becomes an Energy saving building and we can say energy saving is energy producing. All on economic part makes building owner as well as user happy.

### Local Examples

**Bhopal**, (Madhya Pradesh) in India is a city that combines scenic beauty with urban living and charmingly displays the rich historical heritage, finally woven with the threads of modernity. Existing side by side is the old city with its crowded marketplaces, mosque (Taj-ul-Masjid, the largest) and place bearing the aristocratic imprint of its former rulers including the powerful Begums who ruled Bhopal from 1819 to 1926. The prime focus of organized development taking place in Bhopal with Indian organized retail expected to grow at the rate of 25-30%, the action has shifted to "tire II" cities, such as Bhopal and Indore. Bhopal is fast becoming center of attention for retailing giants across the country.

Some of the famous buildings constructed with an atrium are listed below:

**C21 Mall Bhopal (Location- Hoshangabad Road, NH-12, Bhopal – M.P)**



Fig. 3. Atrium of C21 Mall Bhopal (MP) 1

Fig. 3. Atrium of C21 Mall Bhopal (MP) 1 Shows the inner space of atrium and is provided with the single atria of area 820sq m with volume 16000 m<sup>3</sup>. The mall is designed as cluster of office space connected with skylit multi-story atria. Users and occupants during peak hours observed were 15,000 per day. The project ended up with a four-storey high atrium in the center of building. Roof top with translucent fabric was utilized for direct daylight for the interior space. Diffused daylight penetrating the inner of atrium increases the ambience of the space and create a comfortable environment. The public flow around the atrium are maintained by giving proper distribution of smaller and larger shops to avoid congestion and balance environment and thermal comfort psychologically. During hot weather the thermal parameters were maintained within comfort standards by the use of hybrid ventilation. Relative humidity was between 30°C to 40°C, Relative temperature is 25°C to 28°C.

*DB mall (Location - Area Hills, Zone 1, MP Nagar, Bhopal – MP)*



Fig. 4. Three Atrium in DB City Mall Bhopal (MP)

Fig. 4. Three Atrium in DB City Mall Bhopal (MP) Illustrates about three atriums in mall for its elongated plan. With coordinates-23.2326 N 77.4300 E it is spread over 13 laces sq. Ft. of floor space. DB City Mall is a part of Bhaskar Group and its ventures. In area it is the largest shopping mall in central India. The Mall is provided with three circular atrium among which the central circular atrium of volume 18,200 cum is enclosed and is near to entrance. The central atrium has two elevators and escalator connecting basement and the ground floor the atrium space is used for setting up temporary kiosks, decoration during festive seasons and as an interaction space for different programs, as illustrated in Fig. 5. Inner View of Atrium - DB Mall Bhopal (MP) whereas the other two atrium, i.e. north court and south court has permanent food joint and kiosks with sitting spaces. For the first and second floor provision of daylight is through glass facade and third, fourth floor receive light from translucent fiber on roof top of atrium. Relative humidity was between 24°C to 36°C, Relative temperature is 26°C to 36°C.



Fig. 5. Inner View of Atrium - DB Mall Bhopal (MP)

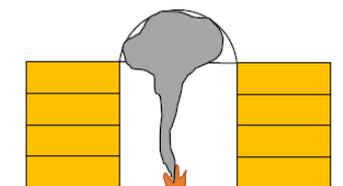
Case study condition states that natural ventilation along with mechanical system contribute to comfortable environment. Strong thought in design is required for insignificant wind flow in dense urban areas as building are closely placed. Without proper movement of air the natural driven force stack effect is not efficient for change of air. Furthermore, for the change of air the received air should be pollution free or should be treated before admitting inside. Concluding above, possibilities become more on using mechanical ventilation for atrium building in such locations.

### Fire Prevention

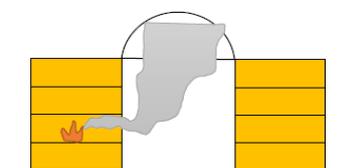
Basically, a fire prevention plan for a building should be made from an overall point of view, aiming to attain the safety target of the building by predicting what types of fires may occur in it and their possible effect on people and the building. This principle is true also for buildings with an atrium. The Chief Fire Officer shall examine these plans to ensure that they are in accordance with the provisions of fire safety and means of escape as per these bye-laws and shall forward two sets of plans duly signed for implementation to the building sanctioning Authority.[10]

While atrium design breaks with conventional building configurations Fire / Life Safety in atrium buildings is comprised of the same three elements as in conventional buildings—means of escape, smoke control, and fire control. Means of escape, emergency egress is a fundamental plan issue and must be integral with the circulation concept of the building. Emergency egress must be incorporated from day one. Smoke control strategies are also fundamental and must be part of the initial ventilation concepts. Fire control and firefighting provisions must also be integrated in to the original concepts.[2]

Many design approaches are intended to prevent occupants from coming into contact with smoke. The idea is to control smoke so that it descends only to a predetermined height during the operation of the smoke control system. Other design approaches are intended to maintain a tenable environment when people come into contact with smoke. In many locations, there are code requirements for the predetermined height. In Chapter 6 of the new ASHRAE publication, Handbook of Smoke Control Engineering.[11] Fire load density will be varied from time to time so that it requires for high degree of caution when examining the application of short-term tenants. With different events held at the atrium, occupant load nearby is not fixed either that the evacuation pattern should be carefully worked out. It falls on one of the important parts in fire safety management.[12]



**Fig. 6. Fire at Atrium**



**Fig. 7. Fire at Adjacent Shop**

The openness of atrium could successfully create spatial quality which encourages human interaction. However, fire hazards are accompanying with this characteristic. The void spanning several stories would become an effective channel for the spread of smoke and hot gases in case of a fire, as illustrated in Fig. 6. **Fire at Atrium** And Fig. 7. **Fire at Adjacent Shop** Smoke and flame are stopped spreading by the compartmentation walls which are specified in the local codes. It is envisaged as an effective means for this purpose in the traditional building with small compartmentation sizes. As regarding, atrium is often used as a social area where occupant load should be considerable. The rapid spreading of heat and toxic gases can cause life losses, human injuries and property damaged. Among which, human life loss is usually caused by inhalation of hot smoke.[5]

In 1974, the Federal Fire Prevention and Control Act established the Center for Fire Research. Today, the Building and Fire Research Laboratory—established in 1991—conducts fire safety research. An emphasis on modeling exists, resulting in the development of more than 15 fire simulation programs.[13]

## CONCLUSIONS

Mechanical cooling systems in buildings are the main producers of carbon dioxide emissions, which have negative impacts on environment and amplify global warming. Therefore saving energy and Building green are becoming principal global inclination in construction industry. Creating green designs with proper daylight and thermal environment is one way of intelligent means for saving energy. Energy issues should be given consideration at the early stages of design (ideally at project initiation) to enable to achieve the best technical and economic solutions as these design measures are influenced by decisions made throughout the design process. Moreover, natural ventilation in an atrium allows for removal of excess heat and if designed properly can replace or supplement mechanical systems.

The most important to be pointed out is the inherent fire safety problems. Safety in a building during a fire can be secured, without compromising rationality or reducing freedom of design, by means of systematically applying the codes and standards as per requirements. This could be done by using developing computer programs and analyzing the condition of controls.

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