

The Role of Structure in Creating Architectural Space

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ABSTRACT

What is the role of structure in creating and identifying architectural space? The structure and architecture be may related through a variety of methods which includes a full range of priority of the structure over architecture to the structural requirements ignorance in determining the shape and beauty of the building. In this study we are determined to first examine the relationship between structure and architecture as two monotonous elements and consider the position of "high-tech" architecture in the same tone as well as the structural position in creating space and especially architectural space. This study is an analytical study in which the library method is used for data collection. It is concluded from the various studies in the area that although in the past the building structure must had been remained hidden and covered and the had to be no traces of structure within or outside of the buildings but with the development of science and technology the role and position of structures have changed as far as the structure itself creates architectural space and gives identity.

Key words: high-tech architecture, architectural space, structures, facade structure

INTRODUCTION

At first glance structure only provides stability of the building, and it cannot be the creator of architectural space. But, such an approach creates the border between structure and architecture. In the past, due to lack of coordination between structures and architecture and due to the structural limitation many buildings did not finish and in fact architecture had lost its identity and become a horizontal and vertical cover to the building structure.

Also in cases of lack of coordination between structure and architecture after the implementation of the building, it would totally ruin quickly because of the absence of adequate strength and stability. In fact, the former executive architectural metaphor, not mathematical equations(Gomez ,1983). A the time passed, especially after the Industrial Revolution and modern architectural thinking and the subsequent formation of a new architectural ideas such as "high-tech", "deconstruction¹", "Folding²" and... new

horizons appeared in the area and architectural space and structure were considered from a new point of view.

The position of structure is not constant as it may be combined with non-structural parts. Sometimes the structure and the space that surround the element may be the same like an igloo. Sometimes the structure and space are distinct elements quiet like a tepee in which the cluster is a fabric or skin which does not have the necessary strength and stability to shape a space and it relies on a framework of spears (Macdonald ,1997).

This research examines the relationship between structure and architecture and expresses the building function and examines the relation between structure and architectural space.

This paper has examined the relationship between structure and architectural space, as architectural space has a structural related identity.

Paying attention to the relationship between structure and architectural space as well as considering aesthetic principles can play a role in determining form and the structure function and expression of optimal space concepts for humans (Falahat *et al.*, 2007)

Architectural and structural coordination have long been discussed in the context of architecture. Particularly after the industrial revolution and the pursuit of new materials and the subsequent formation of a powerful and professional Structural Engineering and Creation and application of modern structural architecture systems followed by the evolution of the separation of feeling and thought (Giedion, 1982). Thus the overview of the relationship between structure and architecture of the building is necessary.

MATERIALS AND METHODS

The relationship between structure and architecture

Structure and architecture are two key components in shaping building formation. Interaction and conflict between the two components and their balanced growth in the manufacturing process and the development of construction technologies has led to the creation of a new generation of buildings with advanced technological structure (Mahmudi *et al.*, 2011) Therefore the review of the history of the presence of structure in building and its integration with architecture is necessary. The relationship between structure and architecture is expressed as follows:

- Structural design: The structural requirements imposed the form and formal logic has been praised and admired as a part of visual language.
- Structure as a design: Structural elements are selected and controlled by primarily visual standards.
- Neglected structure: Structure is ignored during the design of the building will and not considered as part of the aesthetic programs.
- Accepted structure: Structural requirements may considerably affect the form of the

building even if the structure is not necessarily exposed.

- Structures as productive forms: This option is the same as in part.

Structure and the architecture

There have always been buildings made of structures and they have been always existed throughout history and prehistory of humanity. In the world of history and architectural criticism these buildings are considered local rather than architectural monuments. Sometimes these buildings have entered into architectural domain which was mostly due to their large-scale like the Crystal Palace building in 19th century and CNIT building in 20th century (Macdonald, 1997).

In this context, paying attention to the "high-tech" architectural thinking which is another way of thinking about the structure as architecture is essential. The architects consider "high-tech" as the Great achievement of the modernity and the most important factor in the development of twentieth century. According to them the extract and physical characteristics of each era has embodied in the architecture of that period. For example, Greek temples with their perfect fit with the geometric regularities are the elaboration of the ancient Greeks perfectionist mentality. Similarly, modern buildings should represent the mental and technical essence of the present age of technology. Therefore the "high-tech" architecture takes origin from the idea of modern architecture. However, there are some differences between them and as we know there are no traces of the simplicity on the modern architecture in the "high-tech" architecture. Another difference is that for example if Modern architects show designs tools of a car, the "high-tech" architect represents the inside of the cabin and its components. The thinking and design principles of this style may be summarized in the following ten factors (Ghobadian, 2010)

- Being optimistic about the progress of science and technology
- Representing technology as the extract and achievement of the new era,
- Representing building process,
- transparency, layering and displaying the movement of the building,

- Representing the structure and components of the building facade and the plan,
- Using simple and bright colors,
- Structure and construction as the design,
- Applying light, tensile elements,
- Separating the service provider parts from the parts that need to be serviced,
- Roof design as the fifth façade (Ghobadian ,2010)

Skyscrapers have a special place in the “high-tech” architecture. Structurally building high buildings has two difficulties:

- Providing vertical elevators.
- The problem of retrofitting buildings against the top side loading such as the dynamic effects of the wind (Macdonald ,1997).

Expressing the structure as a function

The structure In addition to its role in three concepts of strength, performance and beauty has major influences on architecture. These effects have defined a wide range for structure that causes the structure be directly related to the strength and stability as an effective mental element and the related fitness besides its main role. On the other hand observing the dimensions and proportions of the structure stabilizes (Javaherian ,2007) Such as the Pyramids: The pyramids as the oldest buildings in architectural history can be a symbol of survival and sustainability(Figure 1).

In this building using the pyramid volume as the most static volume not only the stability is provided but also the architectural identity is defined. In other words the general identity of this structure is consistent with the general structure idea and in

a minor scale the huge rocks that shape the volume are considered as the structural (Shakouri ,2007)

In the past the restricted materials and building techniques prevented the implementation of the architectural projects and imposed structural requirements such as the Parthenon temple in which this factor led the pre industrial revolution buildings do not have appropriate interior spaces and they were designed as if they did not fit the human beings and the structure was hidden. with the scientific progress as mentioned before, the development of modern thinking and formation of “high-tech” architecture provided a chance for the architects such as Norman Foster, Santiago Calatrava, Renzo Piano, Michael Hopkins and Nicholas Grymshav to introduce their works with amazing structures to the world. After studying and understanding the works of these architects the author of this paper believes that they have merged the structure and space and create a suitable, identified space for human being through recognition of structure as a key element in architectural space creating. Here the study of the works and ideas of Calatrava, Foster, and Herzog and de Meuron as powerful examples of facade structures and combinations of structures and architectural space seems essential.

What is very evident in the works of Calatrava is the presence of the structure as a principle of design. Calatrava’s designs work in three levels:

As a structure, ie the stability and the resistance to the disintegration,As container. ie their level of capacity over the people and their activities and finally as a cover or their coverage of an area. It should be emphasized that Calatrava uses differentiation methods.He differentiates the structural elements based on their performance and distinguishes materials based on their best performance and gives them a special feature based on their best performance Such as the Milwaukee Museum, and Elko City Hall; Calatrava designed this hall salon on the routine aspects of the architecture. In this project Calatrava has used the mechanical space researches in his sculpture. Curve composition indicates the structural implications of Calatrava’s work, however, the relationship between the elements still represents the traditional



Fig. 1: The Pyramids(Shakouri ,2007)




approach and the same approach inspires a sense of movement well(Tzonis ,2007)

Using the techniques as a constant principle is evident in Norman Foster's works. In other words it is the direct link between architecture and the world of industrial technological research production, (manufacturing) art and science. Foster's work because of the consistency and the relationship between aesthetic results, scientific-technical, functional is related to one of the main -technical-architectural concepts of modern thinking. The link which is emerged by the relationship between the target / tools in architecture and form created through this relationship For example in Foster's Hong-Kong and Shanghai Bank regarding the building structure which is evidently designed by special forms and shapes also enjoys a dynamic and living component. It can be considered as a combination of historical avant-garde images (from Future Orientation to structuralism) and Archykam group. In this project the tendency toward advanced and complicated building technologies and environmental control in a harmonious form and constant thrive toward experiencing and innovation are evident. This is a constant element in Foster's works and a reason of the cohesion and coherence of the successive stages of his professional life. On the other hand he represented his minimalism through designing Sunvary Qlyd Visual Arts Center. In this project

he considered the symbolic values of the visible structure(Benedetti , 1995)

The structure is also visible in all of the works of Herzog and de Meuron. Their works are based on the surface design (outer shell) of the building. Their works are classified into three categories: creating double layer crust, creating texture on the external crust, creating texture with the external crust. Here it is necessary to analyze one of their works which represents their idea in creating architectural space. For example the design of the National Stadium of Pecan known as the birds nest resembles a giant and consistent shape. When you look at it from a high distance not only it is possible to recognize the circular shape but also it is possible to recognize the network structure loaded on the cage. From the distance the geometric configuration and wise selection of lines are visible but as you get closer they vanish that eventually becomes an apart huge figure. The components are like irregular beams and stairs resembling an artificial forest. This space i.e. the space inside the stadium is the main facade of the building, structure, decoration and a public space. Spatial impact of the stadium is new and fundamental but still simple and intuitive as an old building. It seems unique and the view and structure are the same. Structural elements support each other and orient toward each other as a spatial network(Raeisi ,2014). (Table1)

Table1 :Represents the idea of the architects who used the structure as the base of designing a building

Row	Architect	Design idea	Example	picture
1	Santiago Calatrava	Recreating human body in design The presence of the structure as the base of design	Elko city Hall	
2	Norman Foster	Using technique as a constant All parts of the building are non-decorative and functional	Hong Kong and Shanghai Bank	
3	Herzog and de Meuron	Using the façade as the main structure Designing the outer crust	Birds' nest stadium	

Source: the authors

Architectural space and structure:

Structure is the underlying basis of construction of the interior (Ching ,1998) Structure consists of different aspects in space structure. The structural elements in interior spaces in

addition to providing the building separator clusters provide proper isolation in order to prepare comfort conditions. It also provides the openness of the spaces from micro sized (openings) to macro sizes (glass walls) (Javaherian ,2007) Thus understanding

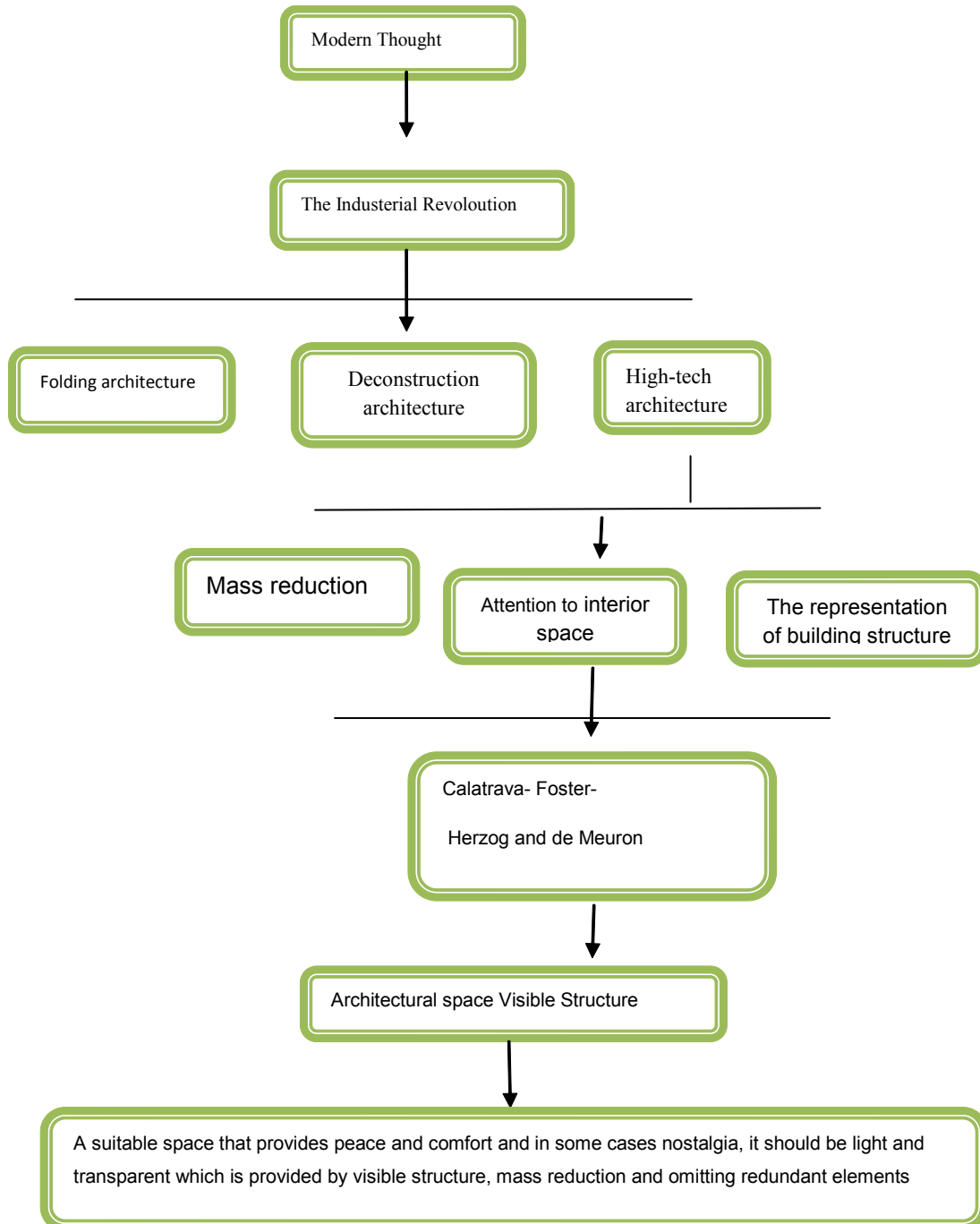


Diagram 1: Process by creating a structural architecture

the architectural spaces is important in recognizing the architectural spaces from urban spaces and considers the role of structure in these spaces. In this context, we overview the concept of space within the architecture and describe the link between these elements with their structure.

Space and architecture

Space is the beginning and ending of architecture. Thus, the spatial definition, in our terms, is a means criticizing and judging the effectiveness of the architecture. Space and vacuity are the key factor in architecture and they are considered natural. Because architecture is not just art It is not only the picture of life, or the life we or others have passed. But it is an environment, a scene(Zevi ,1957)

According to the theory proposed by Marcus Vitruvius Pollio architecture based on combining three elements of performance, stability and beauty of architectural form and must meet all three of these elements are necessarily coincide (Vitruvius , 1979)Judgment is about the interior architecture Unless this judgment is due to the lack of internal space, "Arch of Tito" or "Trayana" are Out of the architectural history, or since they are considered a volume, they are within the jurisdiction of the history of urban planning. So it is concluded that the 4 facades of a church or a huge building, no matter how beautiful, they are just some boxes that embrace the architectural gem inside(Zevi ,1957).

Structure

Structure is the design of forms with different materials that provides various load bearing on horizontal parts or the roof (Falahat *et al.* ,2007) .Thus understanding of the structure as well as the architect demands elegance, taste, art and creativity. Structures are architected before being calculated. Understanding the structure as an architect to understand the subtlety, taste, art and creativity can be calculated Tlbd.saz-h before, are architectural. Mies van as stated in this connection that the structure of the first real interaction with the architectural space(Meiss , 1992).It means geometry of the structure to provide the aesthetic and structural levels are considered(Hashem pour ,2011) Nowadays the structure of the building is presented in architectural designs and also designing the architectural space and sometimes the architecture

is born out of structure. Like the Crystal Palace and The Eiffel Tower in both of which the architectural space is created. It is clear that being light is one of the main characteristics of modernity and as Foster indicated the weight of the Eiffel Tower is less than the air that erects the cylinder surrounding the tower(Wilson ,1982)

Human specific environment is created when it is created by a human made structure. Whatever than we are capable of doing in this space, because human being can move and determines our reaction to it. As soon as a structure turns a space into a human scale space, that space becomes a part of our personal world(Wilson ,1982)

From the perspective of structuralism the architectural space is created through the interaction of a human being with his environment which is kept as a technical or artificial totality. The components of an architectural space interact between human, form and environment. In this system structure protects the form of the elements and the total system and it is the main factor of defining the space, scope or body that the architectural space is willing to define (Engel ,2006)

We are usually warned about the disappearance of the form and space we know by the new form and structural compositions through nostalgia. These ties to the past are a part of our emotional reservoirs that form our every day feelings. They are deeply rooted in our unconscious mind and they can not be eradicated without causing emotional pain. If the buildings do not satisfy human experience and understanding and their structures do not create human space, people will leave them((Wilson ,1982)

Research findings

Based on the above mentioned information the creation architectural space is due to structure. The type of the space and structure relationship can be an important factor in shaping architectural spaces and its quality with the audience (Falahat *et al.* ,2007). In modern period the attention to the quality and beauty of the optimal space and the creation of spatial consistency increased through the technological and scientific progress and change of attitude toward architectural space which lead to

an independent identity of structure and creation of this space. In order to facilitate what was mentioned above the following diagram is represented to introduce the course of architectural space created by structure.(Diagram1)

RESULTS AND DISCUSSION

The human space architecture components are form and environment. Therefore it is important that the spatial constructions be interactive with human otherwise if the building does not consider human characteristics and pays attention to other criteria, it will face human reactions and it will be useless. Based on what is discussed so far the

architectural space identity depends on its structure and the function of the structure and geometry are the factors of space design thus the interaction of space and structure is necessary in creating human space... Sometimes structure becomes the center of attention and sometimes it is neglected during the process of building design. But it must be confirmed that the best structure is the one that is accepted and synchronized by architecture. Based on the discussion if the structures attend in the body it makes it lighter and transparent and these elements are important in human spaces and the inside and outside relationship. Therefore in planning a building the human being and his desired space are the most important criteria.

REFERENCES

1. Benedetti, A. Norman foster, (Gustavo Gili, 1995).
2. Ching, F., Juroszek, S. Design Drawing(Van Nostrand Reinhold, 1998).
3. Engel , H. Structure systems .(Hatje Cantz, 2006).
4. Falahat , M.S. Kalami , M. Structure and development of architectural space. Structures and Architecture Conference . 20-21may, Tehran (2007)
1. Gomez , P.A .Architecture and the Crisis of Modern Science(Massachusetts MIT,1983)
5. Giedion , S. Space, Time & Architecture (Harvard University ,1982)
6. Ghobadian ,V. Theories and Concepts in Contemporary Western Architecture (Cultural Research Bureau,2010)
7. Hashem pour , R., The red line and the common architectural and structural . Structures and Architecture Conference. 15-16 may ,Tehran(2011)
8. Javaherian , M. Structures in Architecture. Structures and Architecture Conference . 20-21may, Tehran (2007)
9. Macdonald, A . Structural design for architecture (Architectural Press,1997)
10. Mahmudi , M.M . Eslami , L. Architectural requirements and guidelines for structural. Structures and Architecture Conference. 15-16 may ,tehran(2011)
11. Meiss, P.V.Elements of architecture(Van Nostrand Reinhold, 1992)
12. Raeisi , I., Sanaati , H. Herzog and Demoren (Kasma,2014)
13. 8- Shakouri , R. The architectural structure of the identity or function independently . Structures and Architecture Conference . 20-21may, tehran (2007)
14. 9- Tzonis ,A . Santiago Calatrava: Complete Works, Expanded Edition (Rizzoli, 2007).
15. Vitruvius., Les dis livres d'architecture, (Balland, 1979)
16. Wilson,F.Structure: The Essence Of Architecture (Van Nostrand Reinhold. 1982).
17. Zevi , B. Architecture as Space: How to Look at Architecture (Horizon Press,1957)