

The Role of Structure in the Aesthetic Creation of Architectural Space

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ABSTRACT: One of tools for the architectural advent form is the structure, while architecture and structures, particularly in our sociable Iran, are separated from each other. Most successful buildings have dominating designers who are proficient in structural issues and have a comprehension of the structural system's behavior. The extent attention to the structure of the building will inevitably lead to beauty. If the structure has aesthetic considerations, a successful link between architecture and structure will occur. This research seeks to provide a solution and strategies to formulate both architecture and structure. The purpose of this paper is to articulate a sound and desired theoretical foundation in relation to the aesthetics of the architectural form and structure so that achieve a successful link between architecture and structure. The research methodology is applied in terms of the purpose of the research. The qualitative and quantitative research methodology is used to analyze the information as well as to provide analytical tables and matrix analysis in order to summarize the contents. The research has come to the conclusion that constructive requirements, along with functional requirements and aesthetic issues, bring together an unmatched effect. The study of successful works in the world suggests that if one of the subcategories of these three criteria works, it can be considered as one of the most successful buildings in the world. Formation of forces flow can be effective in the aesthetic structure of the structure.

Keywords: Architectural form, Structural, Aesthetics, Structural requirements, Functional requirements

INTRODUCTION

Architecture and structure have always been closely interrelated with each other so that they are to be integrated in a coherent, unified and beautiful universe, while in the contemporary era, architects and architecture proceed separately. Artistic thinking and limitless architecture is numerically and enclosed within the mathematical framework of the Civil Engineer. Successful architectures are those that are built between the structure and the architecture of the material, not the formal link, which is the structure of the aesthetic considerations. These aesthetic considerations are primarily between architecture and structure, and secondly, the structure has a number of aesthetic features. In this study, the aesthetic components of structural design are defined and specified in interaction with the architectural form, and the subsets of each component are distinguished. The method of research is to select a series of buildings in order

to test the hypothesis. Analytically, through matrix diagrams' representation, it is attempted to indicate a guide to design the structure. The hypothesis of this study is that aesthetic considerations can be one of the main components in order to achieve a successful architecture and structure link.

Theoretical Background

This section consists of two parts: the first part is devoted to the theoretical foundations of the research, so that by studying the evolution of structural and architectural harmony and the way of reaching the form of the structure in different historical periods, the components for the aesthetic structural design were achieved and in the second part, it is to define and describe the components obtained to test the hypothesis. (Table 1 and Table 2)

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Table 1: Summary of theories that are mentioned with a number of foreign theorists on the relationship between form and structure and research findings.

Gutiér: The new architecture will be right at the same time as the architecture of the new industry. Cast iron allows novel forms of architecture to be created and put into place. (Soleimani, 2007)
Herbert Marcuse: Human being is in technology domination. (Marcuse, 1971)
Heidegger: A techno-era man would have a sound and sensible approach to technology and establish a free relation with it. (Soleimani, 2007)
Le Corbusier: The aesthetics of architectural and aesthetic engineering is comparable. The car home is life. (Masini, 2015)
Peter Collins: The existence of a structure is essential for building architecture, so looking for the functional and aesthetic aspects of the structure. (She'r Baf & Ansari, 2017)
Fantin: It offers the interpretation of an internal structure, the pillar plays a key role in this building (experimental intuition) (Friedney, 2016)
Violet Leduc: Structural Design Based on Gothic Buildings (Original Builder) (Mozhini, 2015)
Sullivan: Form follows function (Mozhini, 2015)
Frank Lloyd Wright: Study Nature. Love nature and approach it. It will never fail you. (Vahedi, 2009)
Louis Kahn: It's my feeling that if all the plants and phenomena are gone, there is still a sun that falls and sets, and we always need nature, but he does not need us. (Vahedi, 2009)
Edward Allen: In the book of form and forces, as it goes from the name of the book, it tries to arrange the complex forms of architecture, the effect of the force on the structure and the distribution of forces in the form. (Edward, 2009)
Fuller: From geometry to innovative structures such as the geodesic dome that is efficient and beautiful. (Masini, 2015)
Adolf Loos: Beauty is the highest level of evolution. Beauty should be sought in the form and considered it to be a decoration. (Roohizadeh, 2014)

Table 2: Summarizing the views of a number of internal professors on the relationship between form and structure and research findings

Mohsen Vafamehr: The technology of the interconnection is the architecture and structure (Vafamehr, 2012)
Nader Ardalan: Meaning, beauty, form and structure are four basic factors of Iranian architecture (Nader Ardalan, Laleh Bakhtiar, 2001)
Katayon Taqizadeh: Factors affects the nature of structural design in structural and functional design. (Taghizadeh, 2010)
Azhang Baqae: Structures + Manufacturing technology = Architectural form. The formation of the flow of forces in the aesthetic structure is so significant (Baq'a'i, 2009)
Mahmoud Golabchi: The Role of Structural Systems in the Formation of the Architectural Effect (Mahmoud Golabchi, Hamed Mazaherian, 2012)
Functional requirements
Aesthetic criteria
Structural requirements
Executive rules
Arash Vahedi: The Nature of Inspirational Design Idea (Vahedi, 2009)

MATERIALS AND METHODS

Theoretical Conceptual Model

Nowadays, the specialization of science is highly significant in various fields of engineering as well as in the growing gap between architecture and structure which has caused dichotomy and declining any architectural effect. This specialization is not an issue, however it's critic so that the architect takes up the work of art and conducts it, and the structural part of it is assigned to the structural engineer. In fact, the range of architectural

and structural tasks in the design is not properly defined, so the balance is damaged between their roles in design and the whole architecture, too. Because architecture and structures are closely connected to each other, they should be integrated in a coherent, unified and aesthetic whole. In addition, the structure can have traits which enhance the quality of the architectural space. Therefore, in this regard, the following steps should be followed. (Fig.1)

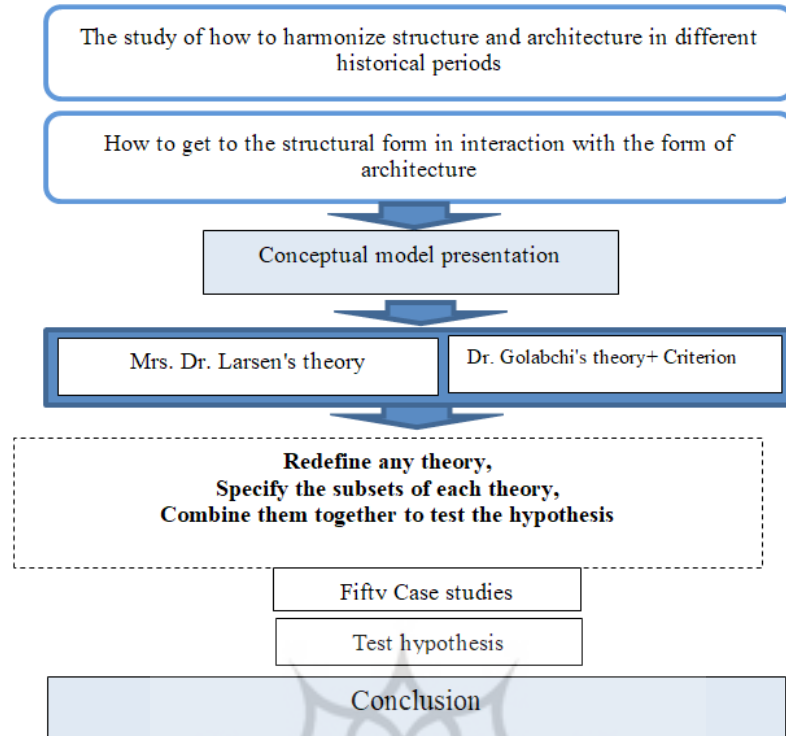


Fig.1: Theoretical conceptual model.

RESULTS AND DISCUSSION

Hypothesis Test Components

As mentioned in the table of thoughts of thinkers, one of the main components of the interaction between the structure and the architectural form is the functional requirements of the architecture, which consists of two subsets, a desirable atmosphere and a conditional response. On the other hand, the structural requirements are defined with three subsystems of the static, dynamic, and flexible one, and finally, the aesthetic criteria defined by the three sub-dimensions of the hidden ones, the dimensions and the accuracy of the structural system behavior. Similarly, the following tables are set out to test the

hypothesis.(Table 3 to 5)

To obtain a successful architectural and structural link, aesthetic considerations could be one of the main components, in Table 5, the aesthetics of code A was assigned to it with dimensional dimensions, hidden dimensions, and structural design accuracy. After conducting the survey, the evolution of the structural and architectural coordination in different historical periods as well as the way to achieve the form of the structure of the four basic items are as follows in structural design, which seems to be when one of the four structures has aesthetic considerations. The following method (Table 6) has been developed in the form of a structure in interaction with architecture (Larsen, 2016).

Functional Requirements (Table 3)

Table 3: Component categorization of architectural performance requirements

1	Functional requirements	F	Desirable space	F1
			Responsive to the situation	F2

Structural requirements (Table 4)

Table 4: Component categorization of structural requirements

2	Structural requirements	S	Static	S1
			Dynamic	S2
			Flexibility	S3

Aesthetic criteria (Table 5)

Table 5: Aesthetic component classification

3	Aesthetic	A	Visible Dimension	A1
			Hidden Dimension	A2
			Behavior of the structural system	A3

Table 6: Encoding how to get to the form of the structure

Encoding and categorizing how structures and architectures are synchronized			
Master Builder	Intuition	Technology	Nature
M	I	T	N
			Final sum

These four items are nature, technology, intuition and the master Builder in the aesthetic line. Finally, the hypothesis test table is set as follows. (Table 3)

In the set table, a number of concepts are presented as a subset of the main criteria that need to be redefined before testing the hypothesis.

Desirable space: The goal is to provide optimal space for the desired activity.

Responsible to the situation: This item includes attention to the climate conditions of the area and the essential standards, such as fire, etc., as well as internal architecture.

Flexibility: The concept of flexibility in the subset of structural requirements means a structure that is flexible and resistant to forces, the useful life of the structure is high and the structure is deformed.

Visible Dimensions: Expressing the Effect of Architecture

Hidden Dimensions: Static Structure

How to choose a building?

To examine contemporary architecture, it is important to identify the appropriate examples for analyzing the structures that will provide data for analysis. In this research, the studied samples are those that have a successful transplantation of

Table 7: Hypothesis test table

1	Functional requirements	F		Desirable space	F1
				Responsive to the situation	F2
2	Structural requirements	S		Static	S1
				Dynamic	S2
				Flexibility	S3
3	Aesthetic	A		Visible Dimension	A1
				Hidden Dimension	A2
				Behavior of the structural system	A3
		Master Builder	Intuition	Technology	Nature
		M	I	T	N
Final sum:					

architectural and structural form.

- Structures and architectural interactions implemented.
- Blacks in specialized magazines and particular architectural books in this regard (i.e., structural and architectural cooperation).
- The objects which are considered in the specialized architectural ideas in relation to the subject matter, namely, the coordination of the architectural and structural form.

Consequently, after the study and classification of 50 internal and external structures for each of the matrix buildings was formed. To select the sort of buildings, there are some functions that the interaction of the architectural and structural form in the design and implementation of the structure is as best as possible, so after reviewing more than 300 buildings, fifty ones were selected based on the following items:

1. General welcome
- 2-Adoption of the minds of people
3. Primary factors of the criteria

4. Based on the type of structures, tensile, compression, tent structure, cache and etc.

Time threshold

Given that the topic of aesthetics is the aesthetic science of the contemporary era, so in terms of time; the monuments option goes back to the aftermath of the industrial revolution to date.

First Case Study

Swedish Trade Development Building, Berlin, 1998
 Designer: Grimesha

Repetitive arched structure; the floors are suspended from the arches by tensile pendants. The designer has to run arches with different openings in order to implement the irregular shape of the building, in order to reconcile the site (Fig.2). Tensile pendants were worn in a grip of stainless steel (Roohizadeh, 2013). (Table 8)

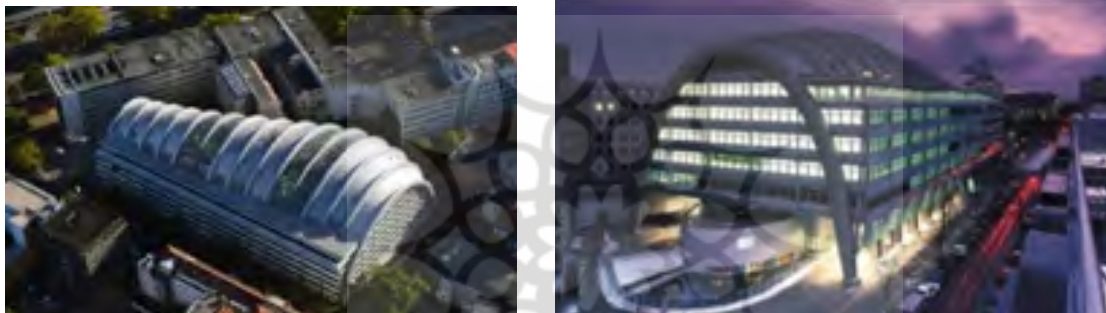


Fig. 2: Swedish Trade Development Building (Etude, 2017)

Table 8: Criteria Review, Building Trade Development

F1	Desirable space	Functional requirements		
	Responsive to the situation	Responsive to the situation	F2	1
S1	Static	Structural requirements		
	Dynamic			
		Dynamic		
	Flexibility	-		2
		Flexibility		
		S3		
A1	Visible dimension			
		Aesthetic		
A2	Hidden dimension	Master Builder	Intuition	Technology
		M	I	T
A3	Behavior of the structural system	-	*	*
				N
				-
		:Final sum		
		Final sum: FS1,3A^{IT}		

Second Case Study

London Municipality, London, 1998-2002

Designer: Norman Foster

The building is designed using advanced computer modeling techniques which provides a fundamental revision of the architecture. Given the unusual form of the design team, they wanted to achieve optimal performance in the energy issue (Fig.3). This was achieved through the maximum use of awnings and minimizing the surface of a building exposed to direct sunlight exposure. The relatively spherical shape of the

building reduces the area of the outer wall by 25% compared to a cubic structure of the same volume, which leads less heat loss in the winter and warming of the interior space in the summer is prevented. However, critics have pointed out that energy consumption is far more than the advantages offered by the form of energy, due to the unique and special use of glass materials. (Table 9).

Unconventional geometry of building structures has been developed based on scientific analysis and computer simulations (Yazdi, 2017).

Table 9: Criteria Examining, London Municipality

1	Functional requirements	F	Desirable space	F1		
			Responsive to the situation	F2		
2	Structural requirements	S	Static	S1		
			Dynamic	-		
			Flexibility	S3		
3	Aesthetic	A	Visible Dimension	A1		
			Hidden Dimension	A2		
			Behavior of the structural system	A3		
			Master Builder	Intuition	Technology	Nature
			M	I	T	N
			-	*	*	-
Final sum: FS1,3A^{IT}						



Fig. 3: London Municipality (Yazdi, 2017)

Data Analysis

After reviewing the 54 buildings above, using the table, the matrix diagram of the buildings was plotted based on the number and percentage of the components as follows. (Table 10)

Structural requirements along with the functional and aesthetic requirements in combination combine an unmatched effect, and the study of the successful effects in the world suggests if only one of the subcategories of these three criteria is provided. It can be considered as one of the most successful buildings in the universe. Either from the author's point of view or from the perspective of other experts and designers, and even the audience that ordinary people will be provided. As it can be observed in the above table, when functional requirements or other components are 100%, the plan responds to half of all subsets. (Fig. 4)

After drawing the matrix of buildings, it can be seen that the structures that have become a continuous interconnected all three criteria have structural requirements, functional requirements and aesthetics. Certainly, no architectural plan could claim that it covers all the requirements of the master

plan, so it is based on the theory of the hypothesis based on providing 50% above the defined components. Some of the criteria together are meaningful, such as aesthetics that comes along with functional requirements and structural requirements. Design of the form and structure of each design must be used to achieve the goals.

The design of the structure consists of visible dimensions and hidden dimensions of the architectural effect. The forces on the building are statically and dynamically. Similarly, both static and dynamic structures could be considered for the building. Obviously, technology is at the highest point, after which experimental intuitions and nature are considered as the next criteria for designing a structure. In the upper matrix, the main constructor, or the omniscient master who dominates both structural and aesthetic issues, is eliminated from the contemporary scene in contemporary times, although the construction work is owed to individuals such as previous professionals (Fig.5). Due to the use of technology and human mind's errors in complex calculations, the main symbol is not in the contemporary era.

Table 10: Summarizing the criteria based on the defined components

Number and percentage of buildings based on the specified components													
F	F1	F2	S	S1	S2	S3	A	A1	A2	A3	-	Criterion	
53	-	-	20	33	1	28	53	-	-	-	-	Number of 54 buildings	
0/100	-	-	0/37	0/62	0/01	0/52	0/100	-	-	-	-	Frequency	
												Criterion	
M	I	T	N									Criterion	
2	31	53	16									Number of 54 buildings	
-	0/58	0/100	0/30									Frequency	

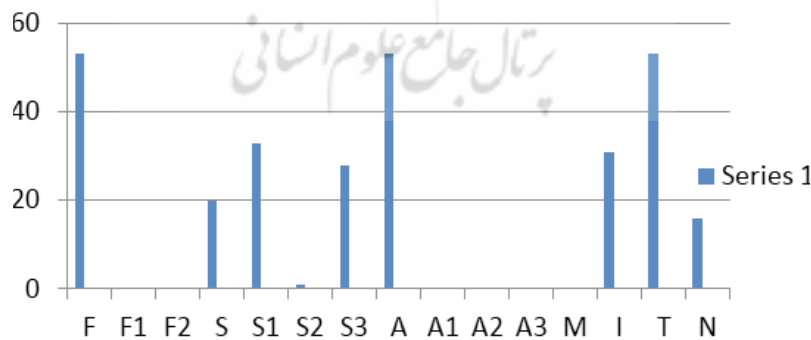


Fig. 4: The constructed buildings on each scale based on the number.

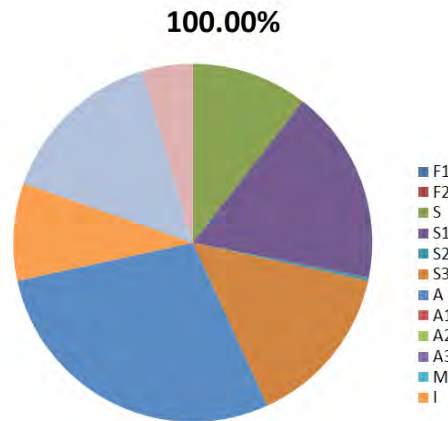


Fig. 5: The percentage of buildings based on criteria

CONCLUSION

Some architects and theorists believe that the architecture begins at the same time and results in the use of technology. On the other hand, many believe that aesthetics should be sought in the form, the form that responds to the function and could be inspired by nature. One of the ways to get to the form of geometry that has been the forerunner is to help designers achieve innovative structures. Another way of reaching the form of the structure is to interact with the experimental intuition architecture form; this item was obtained based on the survey of 50 contemporary buildings. Many architects are of the opinion that the development of the forces' flow could be effective in the aesthetic structure of construction. (Fig. 6) The research believes that structural constructs, along with the functional and aesthetic needs in combination, display an unparalleled work, and the study of successful work in the world indicates that if only one of the following works, the branches of these three criteria can be considered as one of the most successful buildings in the world (Fig.7). Either from the author's claim or from other experts and designers points of views, and even the audience that ordinary people this concept is comprehensive which is displayed in Fig. 8. Another important finding of the study is that the architectural

effect is combined with a structural form, which in aesthetics, in addition to the hidden dimensions, which is the same as static; the dimensions are also considered to be a successful work. The designer will have an understanding of the structural system behavior. And also, from the study of its effects, most successful buildings have mastered designers that have dominated structural issues and lead the behavioral comprehension of the structural system. It could even be possible to claim that they are dominant over engineers to structural issues. As discussed above, there are four main paths to reach the architectural form in interaction with the form of the structure. After examining some of the buildings, this study concludes that inspiration from nature would be realized either consciously or unconsciously. And finally, the main constructor could have been posed in the past, previously it was the same system of student- master, but both in the modern era and in the postmodern period, and the neo-modern architect, designer, and engineer can also be considered as the main constructor creator of the architectural effect. Through the hypothesis consideration, the structure occurs when aesthetic considerations result in a successful link between architecture and structure.

On the one hand, the aesthetic standard is linked to criteria of structural requirements and functional requirements. On

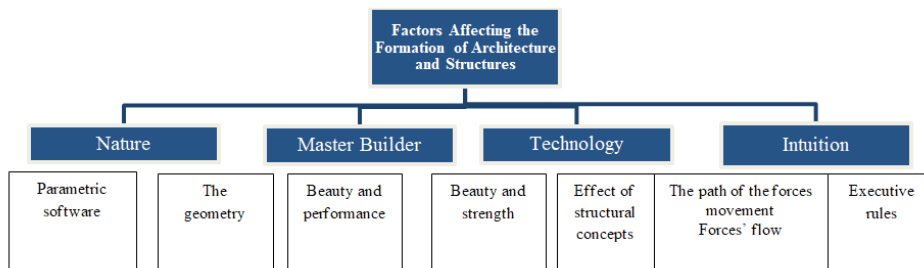


Fig.6: Factors affecting the form of architecture and structures



Fig. 7: Relationship of aesthetic criteria with other criteria

the other hand, the aesthetic criterion has two main subsets, one of which is the issue of the form, and the other relates to the process of obtaining the architectural form in interaction with the structural form. Through reviewing 52 buildings, this study has come to the conclusion that, in all the architectural works that have been constructed and architectural, there are at least one of the subcategories of aesthetics. In other words, the essential condition for the achievement of aesthetics is to look out to the obvious, hidden, and correctness of the understanding of the structural system's behavior, but it is not sufficient. In order to obtain the interaction of these two relatives, the structure and architecture, attention to the paths of reaching the form of the structure, the geometry of nature and technology that appears as a very powerful tool, the intuition that could be found in many architectural works at the moment, is that many architects achieve constructive form by

constructing a replica and loading it, and the original builder cannot be an uneducated person or an excellent professional team. Regarding the original constructor's conclusion, the result of the analysis of the works is that the main constructor can be the student's master's system and can also be much more advanced than a highly skilled designer. Another finding of the works analysis is that the architecture of the lasting effects of the construction is of fundamental importance to structural issues, both in terms of the static and dynamic system and in terms of comprehending the dominant's structural behavior, and it could be the combination of expansion of a structural system or the creation of a structural system for a structural masterpiece. In all the works, the architect is much more dominant than the structural engineer to structural issues. The issue which exists in Iranian universities is the lack of sufficient control over structural issues.

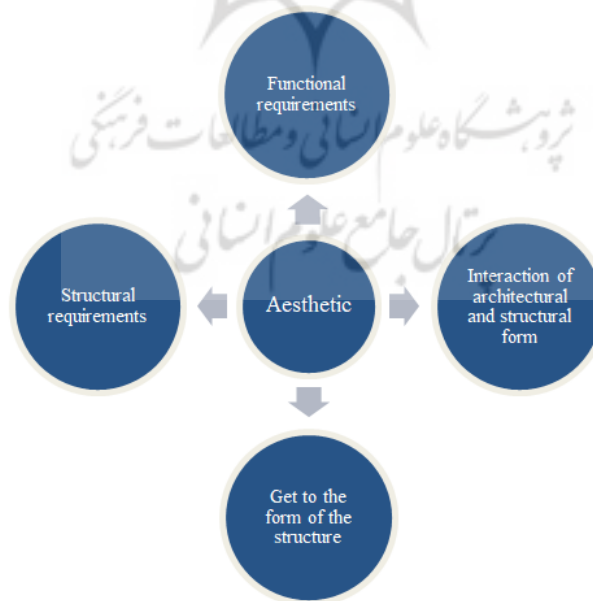


Fig. 8: Subcategories of aesthetic criteria

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