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Architectural Form Aesthetic in the light of Conceptual Structural Design

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ABSTRACT

Architecture and structure have always been closely interrelated so that they should be integrated into a unified, coherent, and interaction, while in the contemporary era, both structures and architecture proceed separately. The purpose of architecture is the art of creating form and space and order for human service, and the goal of the structural engineer is the transfer of loads to the structure. This research seeks to achieve the goal by looking at the relationship between the form of architecture and structure from its inception to the present day to the Global Identification and Management Plan. Finally, by identifying the main components of the design of the structure in interaction with the architectural form, an effective step is conducted in the Professional training direction and solutions to professionals. Therefore, after reviewing the evolution of structural and architectural coordination in various historical periods as well as how to reach the form of the structure in different times and places, components are required to test the components and present the final theory that one hundred to be tested in this regard. Finally, this research indicates the fact that the form of architecture and structure has an aesthetic link, which is influenced by several components that could be edited and has a regular order throughout history that could be regular. The research methodology is analytic and it is comparative using analytical and matrix diagrams and diagrams and tools for conducting library research and interviewing.

Key words: Architecture, Structural Form, Structural and Architectural Coordination, Effective Components, Aesthetics

INTRODUCTION

For the advent of the architectural form, one of the tools is the structure if the artistic and limitless artistic thinking of numerically and enclosed in the mathematical framework of the civil engineer is being common. The architect is concerned with the spiritual connection of a person with the environment where he is located (Larsen, 2016), as well as his influence on the living environment and the induction of emotions and the biological role of the environment for humans (Kryukova et. al. 2021; Maroufan et. al., 2019). Therefore, the missing link between the two fields is defined. Structures, as an element ignored by some experts in expressing the effect of architecture, play only a static role, and thus do not take into account the interactive aspects of these two relatives in order to create an interconnected, beautiful and harmonious whole (vafamehr, 2012). In contemporary times, especially in Iran, the structure and architecture are completely separate, and this has led to a huge blow to the architecture. Deep attention to the structure of the building will inevitably lead to beauty (golabchi, 2011). Successful architectures are those among structures and architectures that are both substantive and non-formal, and this is where the structure has a number of aesthetic features. This research tries to both formulate and organize the evolution of the relationship between architectural form and structure in different times and places to a systematic model for the successful linkage of architecture and structure, and it is hoped to be able to improve the quality of construction and presentation. The model is to be used in the professional community and architecture students to further interact with the architecture and the effective step.

Hypothesis: Architectural and structure forms have an aesthetic link, which is influenced by components that could be edited and has an order that could be regular in history.

Research method

As indicated in Figure 1, in order to provide the final theory, three main categories of work are needed. First, the study of theorists and architects' views on the coordination of the architectural and structural form, the second is the study of how to reconcile the form of structure and architecture in different historical periods, and ultimately determine how to achieve the form of the structure in interaction with the form of architecture.

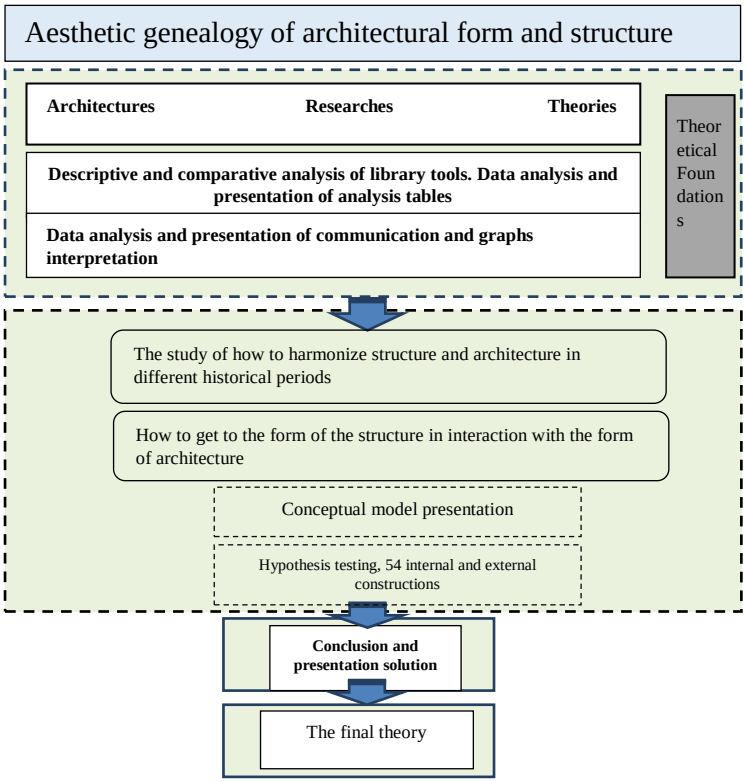

Figure 1: Compilation of a conceptual model

RESULTS AND DISCUSSION

Theoretical Background

This section consists of two parts: the first part is devoted to the theoretical foundations of the research (Table 1,2), 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: Summary of theories that are mentioned with a number of foreign theorists on the relationship between form and structure and research findings

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. (Mozayeni, 2015)
Peter Collins: The existence of a structure is essential for building architecture, so looking for the functional and aesthetic aspects of the structure. (Asem sher Baf, Mojtaba 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) (Mozayeni, 2015)
Sullivan: Form follows function (Mozayeni, 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. (Allen, 2009)
Fuller: From geometry to innovative structures such as the geodetic dome that is efficient and beautiful. (Mozayeni, 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 Baqaee: Structures + Manufacturing technology = Architectural form. The formation of the flow of forces in the aesthetic structure is so significant (Baqa'i, 2009)
Mahmoud Golabchi: The Role of Structural Systems in the Formation of the Architectural Effect (Mahmood Golabchi, Hamed Mazaherian, 2012) Functional requirements Aesthetic criteria Structural requirements Executive rules
Arash Vahedi: The Nature of Inspirational Design Idea (Vahedi, 2009)

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.

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	**SR**	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

Executive and Construction Issues

Table 6: Categorization of the component of executive and construction issues

4	Executive and Construction Issues	**C**	Access to manufacturing technologies	Have	Lack
			Resource cost	High	Low

Sustainability

Table 7: Sustainability component classification

5	Sustainability	**S**	responsiveness	
			Unresponsive	

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 (Table 8), which seems to be when one of the four structures has aesthetic considerations The following method has been developed in the form of a structure in interaction with architecture (Larsen, 2016).

Table 8: 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 main constructor in the aesthetic line. Finally, the hypothesis test table is set as follows (Table 9).

Table 9: Hypothesis test table

<table>
<tr><td rowspan="2">1</td><td rowspan="2">Functional requirements</td><td rowspan="2">F</td><td>Desirable space</td><td colspan="2">F1</td></tr>
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<tr><td>Flexibility</td><td colspan="2">S3</td></tr>
<tr><td rowspan="5">3</td><td rowspan="5">Aesthetic</td><td rowspan="5">A
<table><tr><td>Master Builder</td><td>Intuition</td><td>Technology</td><td>Nature</td></tr><tr><td>M</td><td>I</td><td>T</td><td>N</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td><td>Visible Dimension</td><td colspan="2">A1</td></tr>
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<tr></tr>
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<tr><td rowspan="2">4</td><td rowspan="2">Executive and Construction Issues</td><td rowspan="2">C</td><td>Access to manufacturing technologies</td><td>Have</td><td>Lack</td></tr>
<tr><td>Resource cost</td><td>High</td><td>Low</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Sustainability</td><td rowspan="2">S</td><td>responsiveness</td><td colspan="2"></td></tr>
<tr><td>Unresponsive</td><td colspan="2"></td></tr>
<tr><td colspan="6">Final sum:</td></tr>
</table>

How to choose a building

To examine contemporary architecture, it is important to determine the appropriate examples for analyzing the structures that could provide data for analysis. In this research, the samples studied are those that have a successful transplantation of architectural and structural form. In terms of the time scale, in addition to examine the architectures of the world after the industrial revolution, the architecture of the past is to be considered, both in Iran and in the world through the structure in the interaction of architecture.

- Structures and architectural interactions implemented.

-Blacks in specialized magazines and specialized architectural books in this regard (i.e., the structural and architectural co-operation).

- The objects that 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 buildings for each of the matrix buildings was formed. To choose the type 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 were selected based on the following items.

1. General welcome

2-Adoption of the public minds

3. Primary factors of the criteria

4. Based on the type of structures, tensile, compression, tensurance, cache and other.

As you can see, aesthetics and executive issues can be categorized into two broad categories, in which the emphasis will be on aesthetics and executive issues will be postponed to future articles (Refer to figure 2).

Row	Criteria	Count	Percent
1	Function		
2	Aesthetic		
3	Structure		
4	Construction		
5	Sustainability		

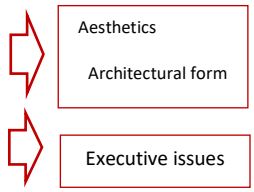

Figure 2: Classification of criteria

Exterior Case Study

Seattle Central Library, Rem Koolhaas, Seattle, 2004

This structure is due to the diamond form of the species with the least connections and minimum welding. The main loads tolerate trusses and vertical columns. The building has a US green building certification. The height of the ceilings is considered to be high enough to prevent verification and clustering (Roohizadeh, 2014). The double layer shell, which is also the most important form of the form, is a loose-shaped grid of glass and steel that completely covers the building, which not only maximizes the use of natural light and reduces energy dissipation in all classes, but also it has a structural role. It reduces the number of columns inside the plan and transfers the load to the wall of the building.

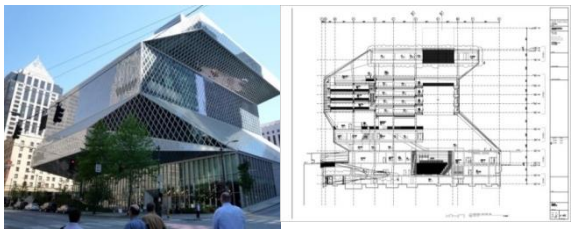

Figure 3: Seattle Central Library (Wikipedia, 2017)

Table 10: Seattle Central Library, Rem Koolhaas, Seattle, 2004

<table>
<tr><td rowspan="2">1</td><td rowspan="2">Functional requirements</td><td rowspan="2">F</td><td colspan="4">Desirable space</td><td>F1</td></tr>
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<tr><td rowspan="3">2</td><td rowspan="3">Structural requirements</td><td rowspan="3">SR</td><td colspan="4">Static</td><td>SR1</td></tr>
<tr><td colspan="4">Dynamic</td><td>-</td></tr>
<tr><td colspan="4">Flexibility</td><td>SR3</td></tr>
<tr><td rowspan="5">3</td><td rowspan="5">Aesthetic</td><td rowspan="5">A</td><td colspan="4">Visible Dimension</td><td>A1</td></tr>
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<tr><td></td><td>-</td><td>-</td><td>*</td><td>*</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Executive and Construction Issues</td><td rowspan="2">C</td><td colspan="4">Access to manufacturing technologies</td><td>Have</td><td>-</td></tr>
<tr><td colspan="4">Resource cost</td><td>High</td><td>-</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Sustainability</td><td rowspan="2">S</td><td colspan="4">responsiveness</td><td colspan="2">*</td></tr>
<tr><td colspan="4">Unresponsive</td><td colspan="2">-</td></tr>
<tr><td colspan="8">Final sum: FSR1,3A^{TN}S</td></tr>
</table>

Heydar Aliyev Cultural Center, Zaha Hadid, Baku, 2007

In most Zaha designs, what is most visible is the mobility and dynamic element that attracts the viewer and reflects the non-static structure of the mind of each passerby. Zaha could be considered a master of creating roles based on non-Euclidean geometry in space, as if a mythological mentality has influenced on them in imagination, has been influenced on paper, too and is obvious by the viewer in practice (Hadid,2010).

Volumetric shaping in a manner that is elaborate, with waves and splits, tweaks and flexibility, transforms the surface of the field into landscape architectures that have many functions, including welcoming, inviting, welcoming and directing visitors to various levels within the building. The advanced use of computer programs allowed continuous control and the establishment of sophisticated communications between all the different components involved in the project. The structure of the Heydar Aliyev Cultural Center consists of the participation of the two systems; the concrete structure combined with the spacecraft structure system to achieve spaced columns, and thus the vertical elements of the structure are constituted by the system of walls, so that the visitors have fluidity and flow without interruption in experiencing the inside. The special geometry of the surfaces required a graceful construction, and thus the curved pillars of a boot in the structure were used to make the overturned shells made possible from the surface of the earth to the west of the building, and the flappers that came out of the narrow beams. They are used to support building coverage to the east of the site. The space structure system allows the creation of a free structure form and can save considerable time in the construction process; the construction is interconnected by a flexible relationship between the rigid structure of the space and the seams of the free form of the cover (hadid, 2010).

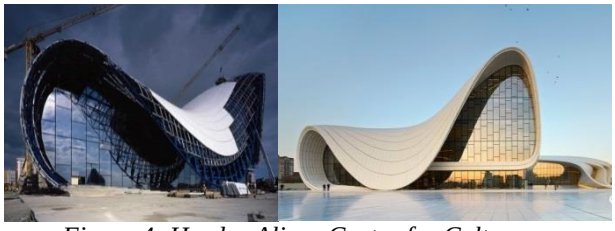

Figure 4: Heydar Aliyev Center for Culture

Table 11: Heydar Aliyev Cultural Center, Zaha Hadid, Baku, 2007

<table>
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</table>

Internal Case Study

Mosque of Yazd, Yazd, 1400

Dome of the two shells, Advantages of two shells: the appearance of being outsourced, the closer to the human scale from the inside, the thermal insulation of the air, the ability to repair and reconstruct each of the domes separately, brick walls, domes have been connected (Roohizadeh, 2014).

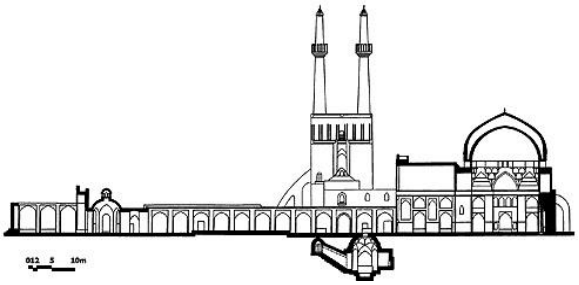

Figure 5: Yazd Mosque (Wikipedia, 2017)

Table 12: Yazd Mosque, Yazd, 1400

<table>
<tr><td rowspan="2">1</td><td rowspan="2">Functional requirements</td><td rowspan="2">F</td><td>Desirable space</td><td colspan="2">F1</td></tr>
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</table>

Cinematic Campus of Mellat Park, Reza Daneshmir, Tehran, 2008

The form of the ground largely determines the final shape of the work, which is Amobi or Papion. If the form of the earth was not so, it would have been confronted with a different structure than is now seen. One interesting comment about this structure is that it is said to be a monolithic building, when seen by the viewer, it is not relevant. This is a natural look and comes from the fact that people like this structure. They are (daneshmir, 2018).

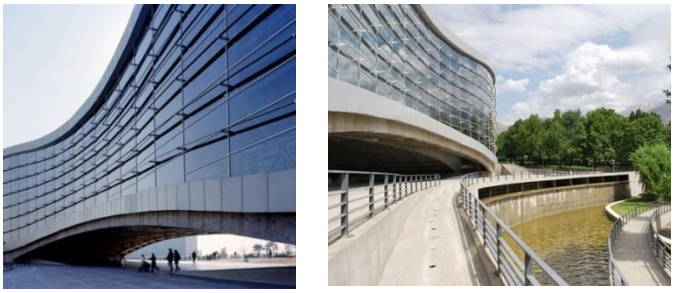

Figure 6: Cinematic Campus of the Nation (Dasmiri, 1397)

Table 13: Mellat Park Cinematic Campus, Tehran, 2008

<table>
<tr><td rowspan="2">1</td><td rowspan="2">Functional requirements</td><td rowspan="2">F</td><td colspan="4"></td><td>Desirable space</td><td colspan="2">F1</td></tr>
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</table>

Information analysis

Similarly, 54 buildings were tested using the above tables, which are summarized and the results of the tables are listed below. As demonstrated in the hypothesis, the architectural and structural forms have an aesthetic link which is affected by components that could be compiled and has a regular order throughout history. These components are depicted in the figure. Concerning the hypothesis 54, its test was conducted. The result was that adjusting structures via 5 criteria, at least 3 or more are considered, and thus; the structural and architectural forms co-occurrence occur. Certainly, the permanent buildings at the same time cover all the criteria and part of their subcategories. On the other hand, after reviewing 54 studies, this study concludes that structural requirements are combined with an unmatched effect along with functional requirements and aesthetic issues.

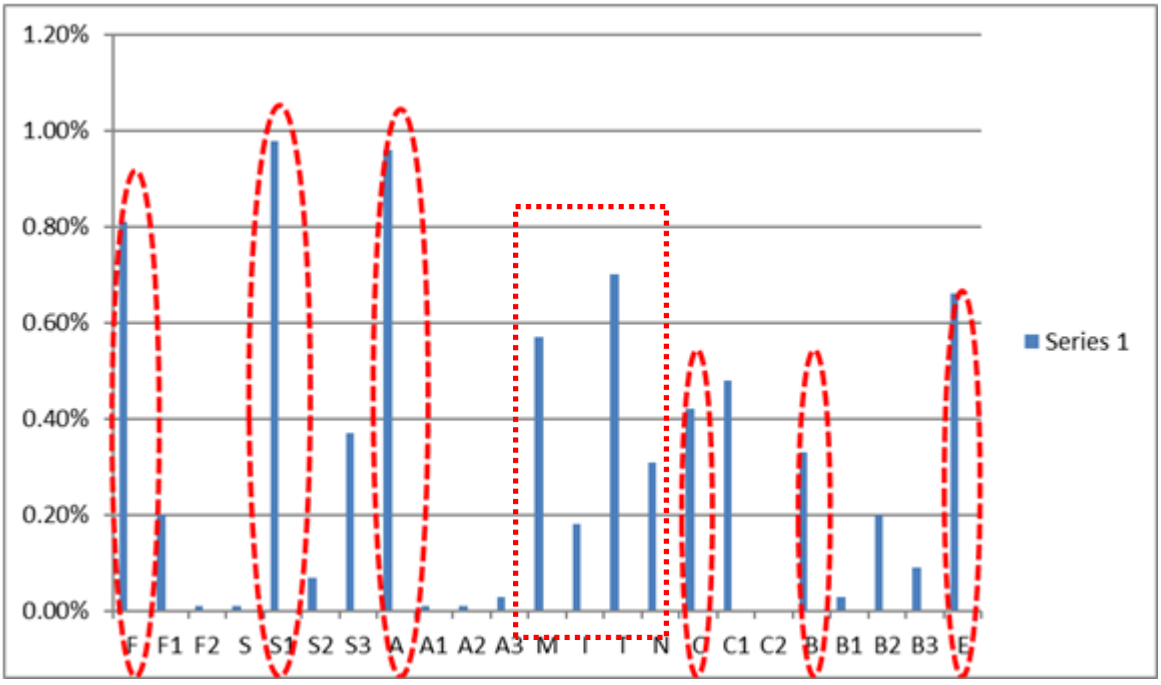

Figure 8: The number of buildings according to the percentage of frequency, hypothesis 1

Table 14: The number and percentage of buildings by criterion

Hypothesis									
Criterion	A1	A	SR3	SR2	SR1	SR	F2	F1	F
Number of 54	1	52	20	4	53	1	1	11	44
Frequency	0/01	0/96	0/37	0/07	0/98	0/01	0/01	0/20	0/81
Criterion	A3	A2	C1	C	N	T	I	M	S
Number of 54	2	1	26	23	17	38	10	31	36
Frequency	0/03	0/01	0/48	0/42	0/31	0/70	0/18	0/57	0/66

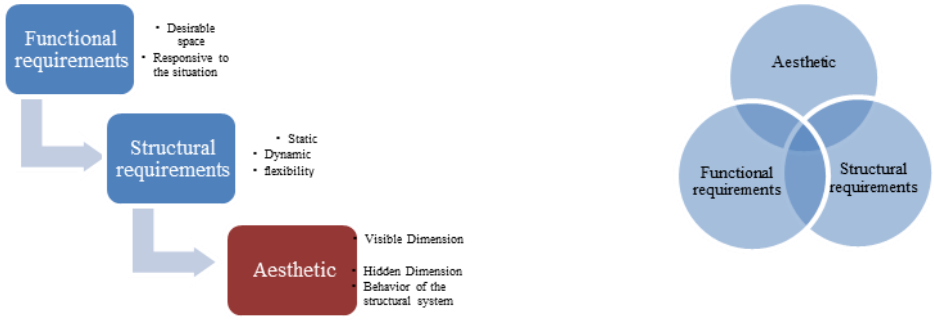

Figure 9: Relationship of aesthetic criteria with other criteria

CONCLUSION

So the first theory is that in the aesthetic link of the form of architecture and structure, the following components are presented in the picture. In other words, the necessary condition for the achievement of aesthetics is to pay attention to the obvious, hidden, and correctness of the understanding of the structural system's behavior, but it is not sufficient. To obtain the interaction of these two relatives, the structure and architecture, attention is paid to the paths to get the structure form, the nature geometry, technology that appears as a very powerful tool, intuition that can be found in many architectural works at the moment, is that many architects achieve the form of build by replicating and loading, and the original builder could not be an uneducated person or the best professional team. Regarding the original constructor's results, the findings of the works analyses is that the main constructor could be the student's master's system and also be much more advanced than a highly skilled designer.

Another result of the works analyses is that the architecture that created the survival effects is dominant in structural issues, both in terms of the static and dynamic system and in terms of the perception of structural behavior, and could be combined, extend a structural system or create a structural system for a structural masterpiece. In all works, the architect is much more dominant than the structural engineer to structural issues. The problem which exists in Iranian universities is the lack of sufficient control over structural issues. After examining several buildings, this study concluded that in identical functions, the works had almost identical codes, that is, all executives of construction work used a set of principles to get the effect and success of its presentation.

Also, for urban elements, some criteria are meaningless to them of which the cost of energy and climate issues are highly mentioned in terms of executive and construction issues that could be emerged as a problem, it is a constraint that becomes an opportunity, as well as technology that provides a lot of advanced tools for a work creation, and from the modern era, familiarity with the types of technologies and how to use it is considered as a concern. As mentioned earlier, the engineered and architecturally technology could be enhanced, and obviously, the pace of technological progress is so that when the technology is overcame, hundreds of more advanced tools and technologies have been replaced.

Finally, the result is that in many buildings, the sustainability criterion is not considered which has not been successful in the progress of the structural and architectural coordination. After reviewing the works, it is deduced that the essential condition for achieving the architectural effect is to look out at least four criteria among the five, as well as to consider only one path from the four main defined paths.

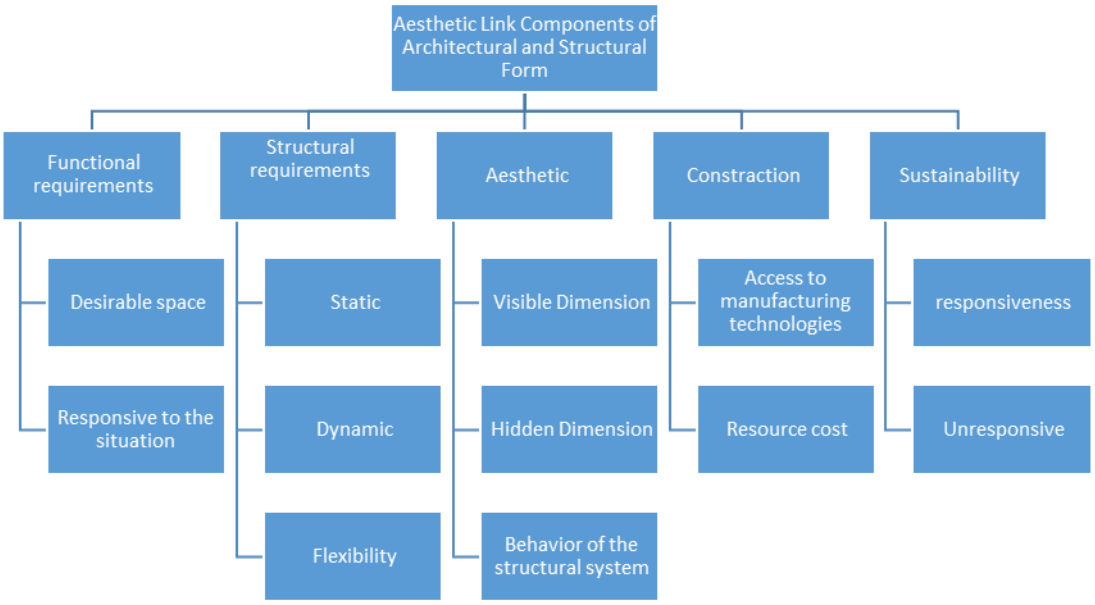

Figure 10 - The Aesthetic Link Components of the Architectural and Structural Form

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