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RESEARCH ARTICLE

NEW CONSTRUCTION SYSTEMS IN ENGINEERING

***Assist.Prof.Dr.Rabia KÖSE DOĞAN**
*Selcuk University-Faculty of Fine Arts-Department of Interior Architecture and Environmental Design 42079 Konya/TURKEY

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Corresponding Author

***Assist.Prof.Dr.Rabia KÖSE DOĞAN**

Abstract

At the beginning of 20th Century, in the changing architectural concept while it is being searched for a formal anxiety carriage system solutions and structure materials development developing in engineering progresses in parallel to this condition. From pile up structural materials such as stone and brick, a transition has been made to systems such as space cage system, folded plaque system, shell and pneumatic systems. A lot of new materials such as titanium, porcelain and composite materials have entered the structural world. These changes in the area of engineering affect directly the architectural design process and the limits of design are determined by imagination. We can define these structures which are wonders of architecture and engineering as imaginary places. In this context, the study searches the effects of developments in engineering at structure shells and place design and these shall be examined in the coverage of a declaration under two main headlines.

1. Organic and Amorphous Formed Structures
2. Rigid and Rational Formed Structures

As a result, the development of the form concept in architecture shows features in parallel with developments in engineering techniques and increasing of structural material options. Each structure designed is real as far as it can be built. In the context of the declaration, today's modern engineering solutions and renovations at materials selection shall be emphasized and imaginary places and structures which force the limits of the mind shall be examined.

INTRODUCTION

At the beginning of 20th Century, in the changing architectural concept while it is being searched for a formal anxiety carriage system solutions and structure materials development developing in engineering progresses in parallel to this condition. From pile up structural materials such as stone and brick, a transition has been made to systems such as space cage system, folded plaque system, shell and pneumatic systems. A lot of new materials such as titanium, porcelain and composite materials have entered the structural world.

Innovation in architecture represents developments in specifications of materials and functionality that is provided to the architect. Function of material and to discover innovative methods in its application require creative approach (1). As for the architectural design process, it is the mass established by deforming and fictionalizing, sites, surfaces, and an attempt becoming objective with structural elements. As a result, once looked at theproduct, we could see the architectural design as fictionalization, building of structure, and an action of formation (2).

As how important designing is, the application of a designed project, sturdy construction, and a structure that remains tall are as important as it is (3). Differences exist between physical structure and perceptual structure in modern-day buildings (4). While the physical structure provides carrier system to stand tall, as for the perceptual structure, the real carrier that varies from the system leads to an optical illusion. These changes in the area of engineering affect directly the architectural design process and the limits of design are determined by imagination. We can define these structures which are wonders of architecture and engineering as imaginary places.

In this context, the study searches the effects of developments in engineering at structure shells and place design and these shall be examined in the coverage of a declaration under two main headlines.

1.Organic and Amorphous Formed Structures: In today's Architecture, from now on, fragmented, curved shapes, and shapes and structures that are similar to the ones that form the universe are the point at issue (5). Last period works of Frank Gehry who began his architectural profession with cubist concrete structures are covered with colored titanium and organic forms. Spain's Guggenheim Museum and Marque de Rascal Hotel projects shall be examined in this context. Haydar Aliyev Cultural Center of famous architect Zaha Hadid who is renowned as de-constructivist shall be taken at hand as spatial effect and carriage system.

"The Guggenheim Museum Bilbao" designed and built by Frank Gehry in Spain-Bilbao in 1997 is regarded as the most remarkable building of the modern-days. The building designed as a "Museum of Modern Art" adds a touristic icon to the city within the scope of a rehabilitation project of Bilboa. As it is built in a port, the surface of the structure, planned to remind of a ship, is covered with titanium.The pattern on the titanium covered on a steel structure reminds of fish scale. A visual harmony is provided by the structure with a reflection on to water.

According to Gehry, in order to capture light, despite the confusion caused during the design process of the structural surface of the double curvature, the building was constructed easily through simple and rational approach taken during the design process. Gehry's structures had been modelled through a software named CATIA developed for plane designs later in 1970s (6). This type of modelling would ease the construction of the organic structured buildings. Some time had been taken off due to an increase in titanium prices during the construction process of the museum and later on, the construction had continued. The structure has been regarded as the most significant example of Deconstructivism (7).

Figures 1. 2. 3. Guggenheim Museum Bilbao Front and Construction Views (8-9)

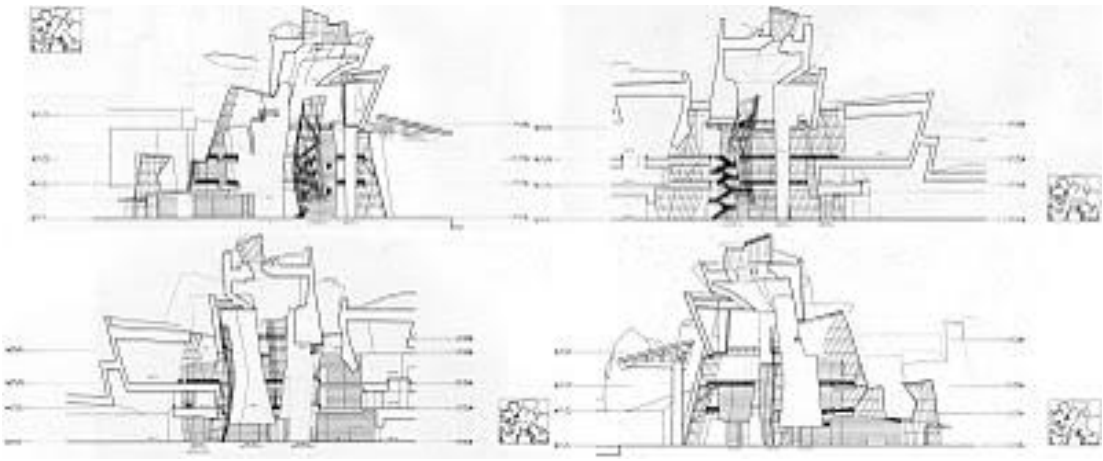


Figure 4. Drawings of the Guggenheim Museum Bilbao (10)

The style of the Marque de Rascal Hotel, built by Frank Gehry in Spain in the year of 2006, overlaps with the style of the Guggenheim Museum Bilbao. In a historical texture, the structure is comprised of an hotel, a spa, buildings for wine production and tasting, and a restaurant.Sand stone is used in traditional structures of this Spanish townconsidered as the heart of wine. In this structure, Gehry designed this building by placing glass and metal folds on a right-angled body with sand stone. That starts from local, and it is a metamorphic "architectural tectonic" structure.

The hotel is located on a hilly point. Righ-angled sand stone that imitates the patterns in surroundings, stainless-steel raising over the floors, vineyards with titanium construction, overlooks the city. Folded revetment mixed with steel-titanium for the hotel incorporates symbolic meanings also. Titanium metal revetments are supplied in a rosy shade for them to remind of the color of wines. Anolog is made for the zigzag lines with golden colors on the bottles of Marque de Rascal, and as for the silver color, analog is made for the silver colored corks on the wine bottles (11).

Figures 5. 6. Marque de Rascal Hotel, Front and Construction Views (12-13)

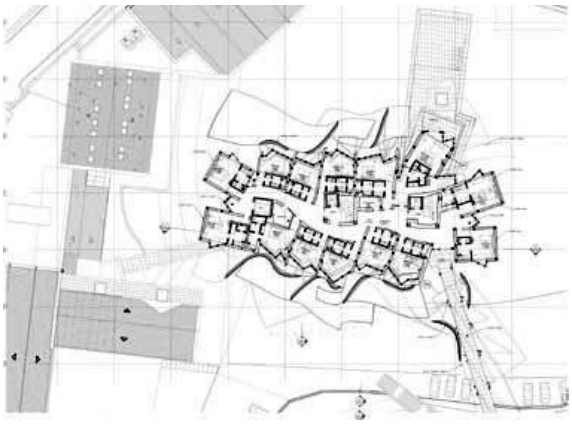


Figure 7. Marque de Rascal Hotel Plan (14)

The Haydar Aliyev Cultural Center was opened in Bakü, the capital of Azerbaijan, in 2013 and it consists of an area, 101.000 m^2. It is comprised of a hall, 19.000m^2; a library, 14.000m^2; a museum, 12.000m^2; a closed parking lot, 41.000m^2. In the building of the Cultural Center, material and labor used with parametric design play a crucial role. In the exterior revetment, 15.000 of curvilinear composite panels at angles vary one from another were used. The panels manufactured in Europe were combined at the site one by one (15).

The front glass is shaped with a sculpturesque perspective appearing between the exterior scale and the floor. The floor of the museum transforms into the exterior scale, forms new sites by integrating with the topography of environment. The library overlooks to the north, reading and the floors of archives overlap and combine with a scale. As the floor coverings are tied to each other through ramps, an area of circulation is continuously formed. The library and the museum merge with a ramp on the floor, the floor of the museum and the first floor of the museum are formed. Additionally, the library is connected to the conference hall via a bridge and this bridge covers the top of the entry lounge of the library. 3 different sized auditoriums reside in the conference hall. The floors of the auditoriums that go towards the Cultural Arena, thus obtain natural slopes of seatings. The three auditoriums and domains related to them gain direct access to the Cultural Arena. The main structure takes shape similar to waves, the general aspect of the structure is reminded of the floor movements. With the continuation of this status at the site, waves spread around from the structure (16).

Figures 8. 9. Haydar Aliyev Cultural Center, Front and Construction Views (17-18)

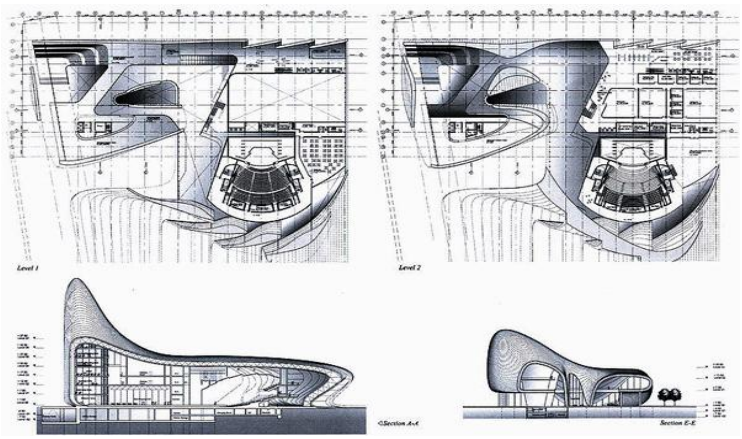
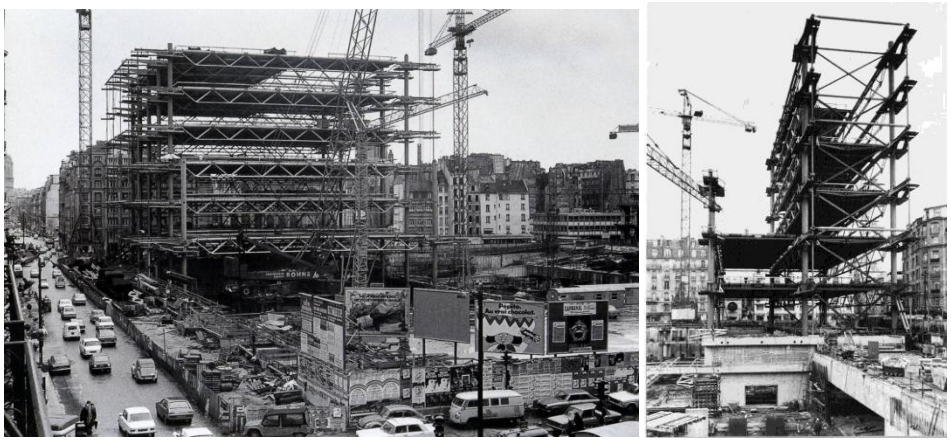


Figure 10. Drawings of Haydar Aliyev Cultural Center (19)

2. Rigid and Rational Formed Structures: Basic forms such as cube, prism, cylinder, pyramid, identified by Modernism Rationality, seem differently and meet various functionality through diversification (20). The Pompidou Cultural Center of Renzo Piano and Richard Rogers, Turning Torso Tower of Santiago Calatrava, the famous engineer-architect known for the analogs made related to the structural carrier system, and Datong Art Museum of Norman Foster will be considered as form and carrier system. In the year of 1977, Pompidou Cultural Center built by Renzo Piano and Richard Rogers in France-Paris, was constructed through a system that was out of ordinary as of residential historical environment and building system. Plumbing, air conditioning, and vertical circulation systems reside outside of the building. At the side built on an area of 90.000 m^2, the red color symbolizes circulation spaces; the green color symbolizes water plumbing; the yellow color symbolizes electrical system; the blue color symbolizes air circulation. Piano and Rogers for the museum indicate that "In a way that would allow any future probable regulations, we cleansed out the interior space from the carriers, such as plumbing pipes. By pulling the reinforcement elements out of the building, we have established the frontage with metal frames, aisles, and various plumbing pipes. Painting the reinforments holding distinct functionality to various colors, has provided an advantage over assembly of frontage. Lastly, escalator where Paris could be viewed from while inside and surrounded by a glass tube, has become an appealing element to attract people to the museum. Once viewed from outside, mobility of the escalator has been perceived as a powerful symbol with regards to an emphasis in dynamism of modern art museum" (21). The Cultural Center was renovated in the year of 2000. Steel cage joists, its carrier system hanging on big pylons, and having a system of skeleton from Gerber joists, were supported by guy lines (22)

Figures 11. 12. Pompidou Cultural Center, Frontage and Side Views (23-24)



Figures 13. 14. Pompidou Cultural Center, ConstructionViews (25)

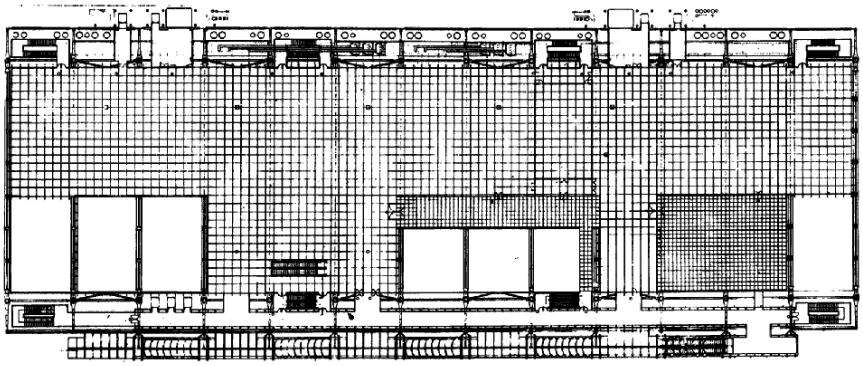


Figure 15. Pompidou Cultural Center, the First Floor Plan (26)

In the year of 1999, Turning Torso Tower built by the engineer-architect Santiago Calatrava, is comprised of 9 separate cubic units. Each of the units was considered as a 5 floor housing, and it was about 2000 m^2. Spaces left among the cubic units are used for technical duties. In the core assembly of the structure, a concrete apartment exists. The thickness of the concrete is at 250 m. at the base, it would plunk until about 40 m. as ascending. The escalator and stairs appear inside the concrete within the core assembly.

To human body, concrete and steel tower, which make analogs, at the length of 190 m., from floor to the peak turns around with a 90 degree angle.The one amplifies the core assembly of the carrier is the additional skeleton system formed by the outer triangle. This system is connected to each unit in the form of triangles through many links that are horizontal and diagonal. Backbone connects to each floor by small buttresses. The outer face is comprised of about 2800 aluminum panels and 2250 glasses. In each unit, 300 panels reside (27).

Nowadays, what kind of a plastic impact could be arosen plastic at towers that go beyond a certain height is observed with curiosity.

Figures 16. 17. Turning Torso Tower View and Construction View (27-29)

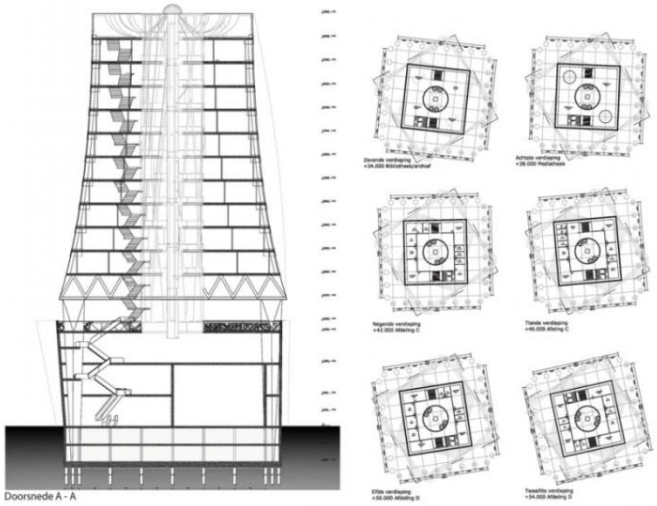


Figure 18. Drawings of Turning Torso Tower (30)

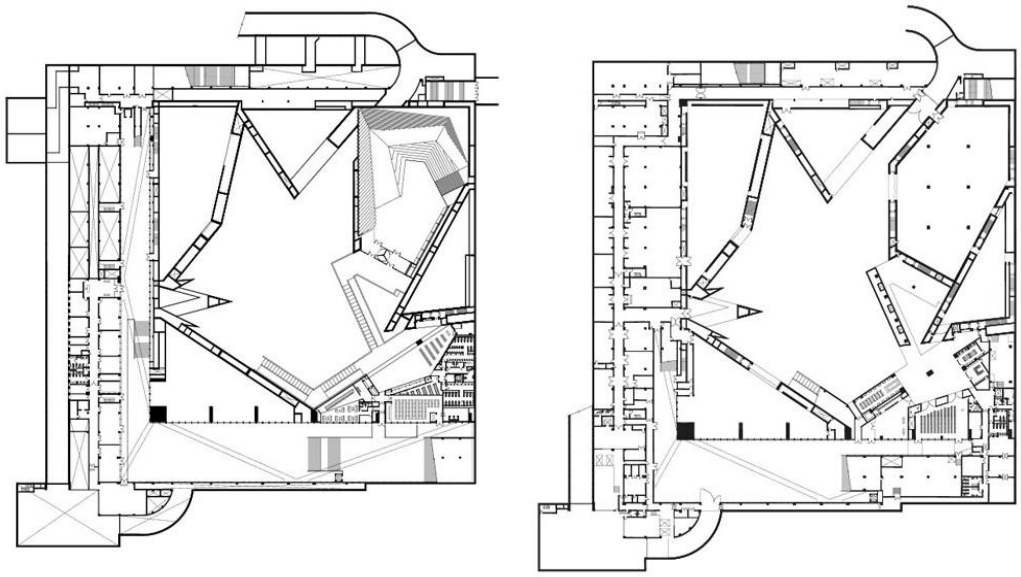
Daton Art Museum defined as the museum of the 21. century, designed by Norman Foster and inaugurated in China in 2013, constitutes one of the four main structures surrounding the city's Cultural Arena. The enormous gallery of 32.000 m^2 located at the Center is emphasized with a substantial size, this area at a height of 37 m. and a width of 80 m. is designed to exhibit a giant size of monuments. Flexibility and being effective enables big vehicles to get in. Air conditioning is provided and natural light among the structural face layers is captured. These layers also form the appearance of a lighthouse in arena lighting.

Through connection of the structure to the new urban arena, it interacts with other cultural structures. Pyramidal appearance of the structure makes analog to the hills, color of the face covered with steel layers makes analog to the soil tones.

Visitors are able to reach out to the structure by means of a soft ramp and stair, arena integrates into the structure and forms a natural amphitheater within inter section. Exhibition spaces, children galleries positioned around the center, entry lobby, cafe, restaurant and other locations are situated as they are located in a courtyard.

In the structure, passive energy is used. It is aimed that the top level roof windows reduce the effect of sun to the minimum and the most proper environment is provided. The layers with a high performance prevent a great amount of energy from being used (31).

Figures 19. 20. Datong Art Museum View, Construction View (31)



Figures 21. 22. Datong Art Museum, Floor Plans (31)

Figure 23. Datong Art Museum, Floor Cross Sections (31)

As a result, the development of the form concept in architecture shows features in parallel with developments in engineering techniques and increasing of structural material options. Within studies, as it is seen in organic and amorphous formed structures with rigid and rational formed structures, modern-day contemporary engineering solutions and through innovation in material developments, in architecture, building of imaginary structures that pushes the limits to the brain are recognized.

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