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Analyzing Energy and Biomimesis Concepts in the Context of Sustainability on Building Envelope



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Abstract: *Humans have learned to mimic nature by observing and interpreting it to put outcomes to use in architectural design for centuries. In the 19th century, nature, imitated only in aesthetically architectural style, is now being used in architecture with the production of building shells and skeletons from biological information sources. Every work done so far has revealed how important the concept of biomimesis is and cannot be ignored. It can be said that the energy consumption of existing buildings around the world is about 40% of the whole consumption rate and that the energy resources are being depleted rapidly, the biomimesis approach should be more utilized in architectural designs.*

Accordingly, in this study, the studies on biomimesis and energy consumptions of structures adopting the biomimesis concept were examined. Two of the buildings examined were offices; Al Bahar Tower, Aldar Skyscraper, three housing functions; Tao Zhu Yin Yuan, Central Park I, II. The benefits in terms of energy consumption in buildings surveyed biomimesis concept is supported with certificates. Today, the importance of energy consumption is important to design sustainable constructions and to minimize the energy consumption of the buildings. The biomimesis approach shows that designs made with nature inspiration will reduce energy consumption in harmony with nature.

Keywords: *Biomimesis, energy, building envelope, sustainability.*

Sürdürülebilirlik Bağlamında Enerji ve Biyomimesis Kavramının Bina Kabuğunda İncelenmesi

Özet: *İnsanlar yüzyıllardır doğayı gözlemleyerek, öğrendiklerini taklit ederek ve yorumlayarak bunları mimari tasarımlarında kullanmışlardır. 19.yy da sadece estetik açıdan mimaride taklit edilen doğa, günümüzde biyolojik bilgi kaynaklı yapı kabukları ve iskeletlerin üretimi ile mimaride kullanılmaktadır. Biyomimesis olarak bilinen bu kavram ile ilgili yapılan çalışmalar giderek artmaktadır. Bugüne kadar yapılmış her çalışma biyomimesis kavramının ne kadar önemli olduğunu ve göz ardı edilemeyeceğini ortaya koymuştur. Dünya üzerindeki mevcut binaların enerji tüketiminin, tüm tüketime oranının yaklaşık %40 olduğu ve enerji kaynaklarının hızla tükendiği düşünüldüğünde, mimari tasarımlarda biyomimesis yaklaşımından daha fazla yararlanılması gerektiği söylenebilir. Bu çalışmada biyomimesis kavramı ve bu yaklaşımla yapılan örnekler incelenmiştir. Bu kavramı benimseyen binaların enerji tüketimleri incelenerek sağlanan kazançlar araştırılmıştır. İncelenen binalardan ikisi; Al Bahar Tower, Aldar Skyscraper ofis; Tao Zhu Yin Yuan, Central Park I, Central Park II ise konut fonksiyonundadır. Binalarda biyomimesis kavramının enerji tüketimi açısından sağladığı yarar sertifikalarla desteklenmiştir. Günümüzde enerji tüketimi ne kadar önemli ise sürdürülebilir yapılar tasarlamak, binaların enerji tüketimlerini en aza indirmek bu konuda çalışmaları yürütmek de o kadar önemlidir. Biyomimesis yaklaşımı doğadan ilham alınarak yapılan tasarımların doğa ile uyum içerisinde enerji tüketimini azaltacağını göstermektedir.*

Anahtar Kelimeler: *Biyomimesis, enerji, bina kabuğu, sürdürülebilirlik.*

1.INTRODUCTION

Since the first years of its existence, architecture has been of great importance in human life. People have developed architectural design to find effective solutions to their needs and problems, and have tried different way sover time. At this point, architects and engineers have turned to nature in creative and innovative solutions. Human has used metaphorical and analogy in architectural design by imitating, interpreting, and learning from nature. This metaphorical relationship, obtained using nature and scientific knowledge, has continued till day by day, with different focuses on different periods of architectural history. Nature with its revolutionary, innovative, universal, objective qualities; scientific concepts, theories, methods, architects have been seen as potential sources for finding solutions to the problems of their own knowledge domain [1].

In the 19th century, the nature imitated only in aesthetically architecturally is changing and transforming the approach of nature to architecture by the production of building shells and skeletons originating from biological information, not only from metaphorical and analogical aspects.

Today, rapid developments in computer hard ware and soft ware enable digital technology to be included in the design process, and computation is effectively used with all kinds of modeling and preliminary production. The development of this digital technology has revealed computer methods and design tools to better under stand and interpret the "emergence" process integrated with design approaches.

Many vital mechanisms in the nature can be used as a form of thought and design in which aesthetic, function, form – material and structure are considered together in a sustainable architectural approach. Thus, a new sustainable environment that is compatible with the eco system in the field of architecture, and new, feasible long-lived solutions inspired by biological systems are targeted [2].

2.PURPOSE AND METHOD

The use of a large portion of the energy by the buildings has brought the energy effiency concept to the forefront. This is especially important in higher buildings. In this study, architectural formation of buildings was examined through the biomimesis approach and evaluated in terms of energy consumption and sustainability.

The study of researches on the biomimesis and the study of five samples houses and ofice buildings selected from different geographical areas were examined within the scope of the study. The information about the examined samples was edited by cataloging method.

3.BIOMIMESIS/BIOMIMICRY

Biomimesis as a term has been derived from the Greek word "bios" (life) and mimesis (imitation), which was coined by Benyus towards the end of the 1990s. It is the study of nature by studying the architectural form of buildings through biomimesis approach and examining the models, systems, formation processes and elements, it is expressed as a new science for problem solving which utilizes, by imitating information or by taking creative inspiration.

Biomimesis aims to develop creative solutions by incorporating designs and designers into the process through inspiration from nature [3]. It has increased our ability to study Nature's 3.8 billion years of experience with existing tools and abilities [4].The importance given to concepts such as energy efficiency and sustainability is explaining the return to nature in this day.

Benyus lists nine (9) basic features in nature's designs in this direction:

- It benefits from sunlight,
- It uses the necessary energy,
- It creates the appropriate form,
- It provides the recycling of every thing,
- It supports rewarding of cooperation,
- It invests into diversity,
- It benefits from local elements,
- It keeps the excesses away,
- It forces the limits.

Within the principle, it is important that not only the products but also the infrastructures and processes can follow this way of natural design. Benyus (1997) expresses nature seeing as a model, criterion and mentor [5].

In addition to the basic work of Benyus (1997), Primlani (2013) lists the design principles of the biomimicry institute as follows:

- Adapt to changing conditions,
- Develop to survive,
- Harmonize growth with developments,
- Creating awareness and responsibility in local needs,
- Using chemistry compatible with nature,
- Be fruitful at sources.

In all these design principles, system emphasis is actually being made. As systems evolve over time to show adaptation, harmonize sub-structures within local constraints and conditions, create sustainable and always new designs using less resources and without damaging the environment [6].

Biomimicry, biomimesis, biomimetic, biognostic, and bionic, which are meant to imitate nature, are commonly referred to. Biology has been used in architecture since ancient times. Through the definition of biomimicry cooperation in biology and architecture,

- Biomorphic design
- Biomimicry
- Biodesign

are addressed under three different design approaches. Logistic imitation of nature with the metaphor effect is called "biomorphic" architecture. Biodesign aiims at direct use of nature as a benefit [2] .

The summary of the literature summarizing the works to be examined in the study and the studies on the subject are given below.

Radwan and Osama's biomimicry research focuses on the effect of this approach on energy efficient building facade design. Eiffel Tower, National Aquatics Center, Beijing National Stadium, Eastgate Center, HOK, Lavasa structures examining with biyomimesis approach, it is noted that how it is implemented in design and which problem of design is resolved [7].

The researches of Özdemir and Cengizoğlu focuses on the use of natural scientific knowledge in architecture (in the context of visual impact) through examples of architectural facades. Explained through examples of the architectural facades, nature-architecture interaction, comparative studies are set forth with similarities and differences. The approach is seen to be important in terms of its contribution to the architectural process and its visual impact. For this purpose, emphasis of this study is to make the complex features of nature by analyzing their visual impact in an architectural environment more understandable by using the knowledge of biology and to solve problems. It also focuses on studying nature as a beneficial area rather than a consumption field.

The systematic approach called biomimesis in the study of Selçuk and Sorguç; it is emphasized that the issues of minimizing the use of materials and sustainability will affect the cities of the coming centuries, the physical conditions of the places and the way people live, just as in nature. It is stated that "biomimesis" as a scientific and technical discipline could also be a candidate in the field of architecture to produce new solutions inspired by biological systems in order to live harmoniously with the answers of these questions in the world and create a sustainable environment [9].

Rajshekharise aims to demonstrate how the radical increase in resource efficiency can be achieved by utilizing the inspiration nature of biomimesis in his work. The Gherkin Tower, Watercube, Bird's Nest Stadium were examined from nature-inspired projects in the study. Architects and designers are contribute to the development of eco performance principles that can be used by industry professionals worldwide to create biomimic solutions for their designs [4].

Buildings are using natural energy sources throughout their lives, affecting the water, air, and soil that are necessary for the life of man and all living species, affecting the natural cycle in the ecosystem in an irreversible manner and damaging the environment. The globally accepted concept of sustainability deals with the ecological, economic, social and cultural dimensions of the building. In this sense, ecological sustainability is defined in a wide range of resources and ecosystem conservation, long-term use of economic sustainability resources and minimization of usage costs, and social and cultural sustainability in a wide range covering the protection of human health and comfort, social and cultural values. The concept of sustainability necessitated reviewing architectural design criteria with environmental and energy issues.

The building industry uses a significant portion of natural resources which causes to deteriorate ecological balance, create threatening environments for human health, and adversely affect human nature-environment interaction. 90% of the energy consumed in the world and 75% of the energy consumed in Turkey are supplied from fossil fuels such as coal, oil and natural gas [10]. In addition, 50% of the energy consumed worldwide and 42% of the water are spent in building construction or in usage of process [11]. 50% of the greenhouse gases that cause global warming, 40% of the contamination of drinking water, 24% of air pollution is caused by the activities associated with the structure [12].

Sustainability refers to the necessity of preserving nature and natural resources for future generations while supplying today's needs. For this reason, the design of the building, which has a negative impact on the environment and which is largely responsible for energy consumption, should be reconsidered in the context of sustainability. Sustainability should be assessed in a long-term process, including the entire planning, programming, preliminary design, design, application, usage, demolition and re-planning phases of the architectural design process.

The sustainability approach has led to the redefinition of building design, which has a significant share in energy consumption, as architectural design criteria, defined as technology-functionality-aesthetics and economy, expanding and becoming widespread the conservation and comfort of nature-environment energy.

The fact that sustainability is a very broad concept has led to the emergence of applications in this context at different scales and in different concepts. Sustainability is being moved to a new level where buildings are indispensable for nature, rather than intervening in the sustainable ecosystems of nature and supporting nature's work.

In his work, Yanping and his colleagues point out that the bionic green architecture means the harmony obtains between the buildings and the natural environment. Building functions, structures and materials constitute the bases of bionic technologies. The buildings utilize the wisdom of nature and use it with architectural innovations through examples such as the convenient natural ventilation systems built on the termites. In the study, it is also stated that passive construction technologies with solar energy sources both improved the indoor thermal environment and provided low energy consumption in the buildings. Used solar energy, natural ventilation, water condensation, natural lighting and metabolism technologies in Bionic architecture are given to provide energy efficiency in the buildings. It is stated how bionic architectural structures use cables, thin crust, membrane and cavity structures and apply bionic architectural materials [13].

Lopez and his colleagues have investigated facade design solutions developed with new technological solutions, which are possible in particularly changing environmental conditions, by examining the relationship between biology and architecture [14].

Aziz and his colleagues demonstrate how designers and architects learn from nature and how optimizing solutions are achieved in multifunctional structures. It is also stated that biomimicry will be a good solution to problems related to buildings by improving ecological approaches [15].

4. EXAMPLES

In the scope of the study, the design and construction of buildings inspired from different countries (houses, offices) through selected examples of buildings (houses, offices) were examined through the catalogs on how the concept of biomimesis was used in terms of energy efficiency and sustainability.

Information on the properties of the buildings (location, year of construction, construction system, architecture, if there is any award) and their contribution to energy efficiency and the use of the concept of biomimesis are given in photographs, figures and details.

Five sample buildings surveyed in turn:

- Aldar Skyscraper
- Central Park I
- Central Park II
- Al Bahar Towers
- Tao Zhu Yin Yuan Tower.

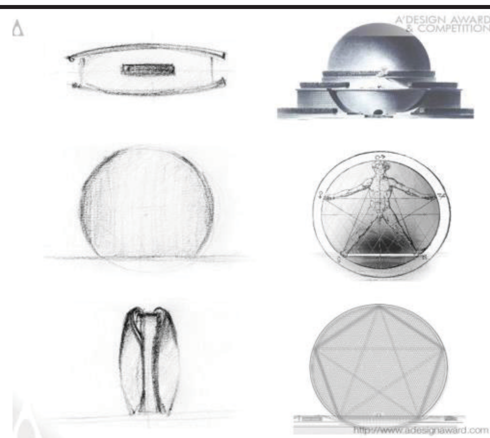
Different inspiration sources such as sea shells, waves, DNA spiral and cellular structures which exist in nature in the design and application of buildings are used. The buildings examined as an example are the tall building features built between 2007 and 2017 with a floor number between 20-50. Inspiration resources are combined with design and technology, which is provided energy efficient buildings, and with these properties, they are also entitled to receive certificates or awards at different levels. Figures 1-5 show catalogs prepared for sample buildings.

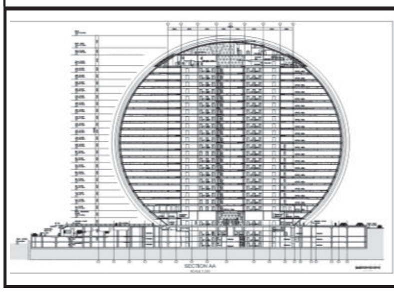
Building Name:	Aldar Skyscraper	Location:	Al Raha Beach-Abu Dhabi		
		Stories:	23+3	Height:	121 m
Function:	Office	Architect:	Adeas Architects (AHR)		
Construction System:	Concrete,Steel, Glazing,	Engineer:	Al-Futtaim Carillion		
Inspiration:	Sea Shell/ Mussel	Year of Construction:	2007-2010		

The facade of the building is inspired by the shell of the mussel. diagrid exterior side has been developed With Abu Dhabi's maritime legacy and a geometric rounded symbolic. The load on the structure is evenly distributed with the diagrid design on the facade. Depending on the Diagrid system, although 10,000 pieces of different glass fragments were needed, it could be reduced to eight different forms [16,17].

The building is mostly illuminated with natural lighting. All waste products from the building are transferred to the local waste station for recycling and compaction with an automatic vacuum waste system in underground. This system was used for the first time in Abu Dhabi [17,18].

The project was developed in accordance with the LEED rating system of the US Green Building Council. The efficiency of the building being classified as 82%, was made it the most efficient as a safe area [18,19].





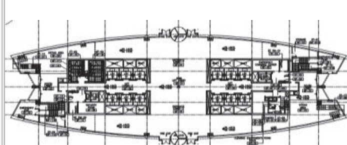
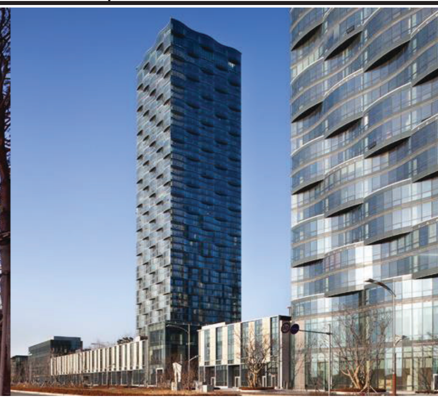


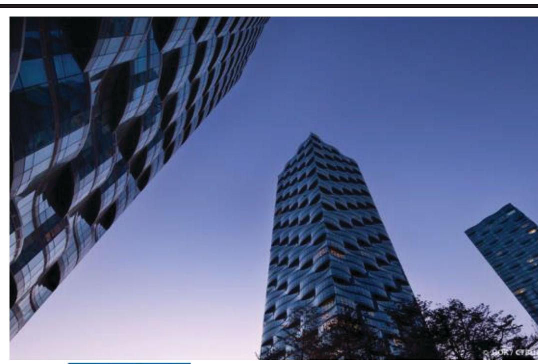
Figure 1. Aldar Skyscraper catalog

Building Name:	Central Park I	Location:	New Songdo - South Korea		
		Stories:	50+2	Height:	163 m
Function:	Residence	Architect:	HOK		
Construction System:	Concrete	Engineer:	Midas IT,Arup		
Inspiration:	Waves	Year of Construction:	2007-2010		



It was inspired by the waves in the facade design of the building. The fine fluctuation in the front was created by balancing the two layers [20].

The housing-towers ,which made from glass and aluminum, residence benefited from facade in the south with cage-like facades and unique interiors and scenes for each unit. Landscaped roof gardens were constructed in low-rise buildings as accessible areas around residential buildings. The building is illuminated with 95% natural daylight. Additional sustainable design features on site include recycling of 75% of the waste generated during construction, water use reduction, lighting system controllability and energy reduction [21]. The building is a candidate for LEED silver energy certificate [21,22].



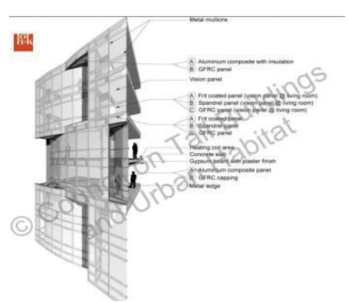
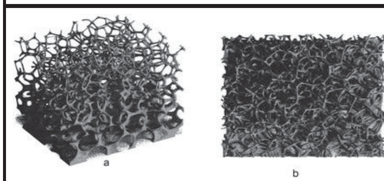


Figure 2. Central Park I catalog

Building Name:	Central Park II	Location:	New Songdo - South Korea		
		Stories:	45+2	Height:	180 m
Function:	Residence	Architect:	HOK		
Construction System:	Concrete	Engineer:	Midas IT,Arup		
Inspiration:	Cellular Structure	Year of Construction:	2008-2011		



The facade design of the building is inspired by the cellular structure. There are 632 luxurious residences in the vertically constructed building [21].

The design of the towers was developed by applying glass to the front of the concrete and aluminum skeleton facing south and north. It provides the appearance of a glass sliding tower reinforced with diagrid in the house.
To maximize sunlight in the project, a 10% improvement was achieved compared to ASHRAE 90.1 by keeping the glass area at the highest level. More than 95% of the areas designed in this way can provide access to natural light [21,23].

The building, which has a high performance facade and many sustainable design features, is candidate for the Silver LEED certificate [21,22].

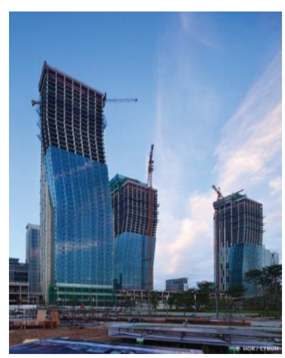
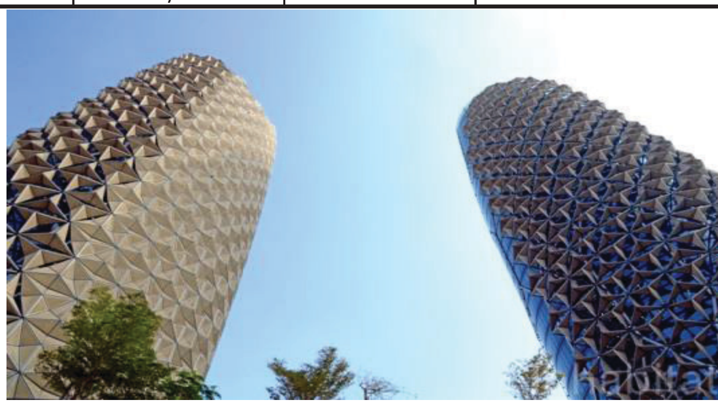


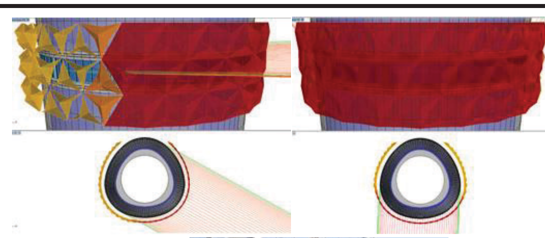
Figure 3. Central Park II catalog

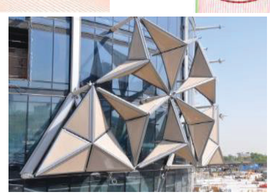
Building Name:	Al Bahar Towers	Location:	Abu Dhabi		
		Stories:	29+2	Height:	121 m
Function:	Office	Architect:	Adeas Architects (AHR)		
Construction System:	Concrete, Steel, Glazing.	Engineer:	Al-Futtaim Carillion		
Inspiration:	Mashrabiya	Year of Construction:	2009-2012		



The design of the building was inspired by mashrabiya, which was used as a secrecy element in arabic architecture, shading, ventilation. This structure of Mashrabiya was applied to the structure with strengthened by technology and controlled by the sunlight [24,25].

The facade panels were built in an independent frame two meters away from the structure. The active facades were formed from a large number of side transparent PTFE panels. With the building management system, panels that open and close according to sunshine conditions have reduced heating by 50% and carbon dioxide emissions by 1,750 tons per year. The need for 2098 units of dynamic unit coatings was removed and thanks to that it reduced the need for artificial lighting and mechanical air conditioning [24].





According to the US Green Building Council, LEED is candidate for Silver [24]. It was given 2012 Tall Building Innovation Award [25].

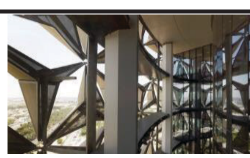
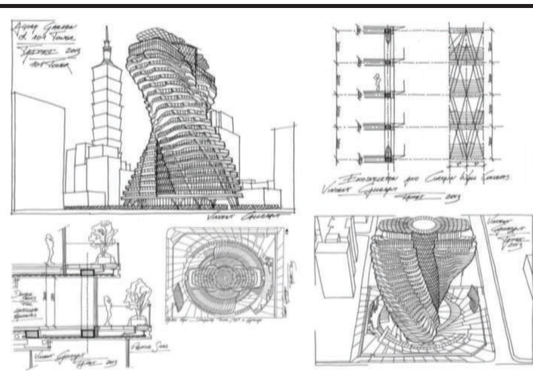


Figure 4. Albahar Towers catalog

Building Name:	Tao Zhu Yin Yuan Tower	Location:	Taipei - Taiwan		
		Stories:	21	Height:	93 m
Function:	Residence	Architect:	Vincent Callebaut		
Construction System:	Concrete, Steel, Glazing.	Engineer:	King-Le Chang & Associates		
Inspiration:	DNA Spiral	Year of Construction:	2013-2017		

The design of the building was inspired by the DNA spiral. The DNA spiral building was rotated at an angle of about 4.5 degrees on each floor and the building was rotated 90 degrees in total. This method avoided visual axes and gave privacy to each apartment unit [26,27].

The building was designed as a green icon. In the ground-floor and residential-level balconies will be planted with over 40,000 trees and the public space ventilation system managed by solar energy on the roof, the self-balancing design of the towel is just one of many features of the green housing project. When the building is completed, it is estimated that it can absorb around 130 tons plants of carbon dioxide emissions. In addition to the moving geometry of the building, the project represents an ecosystem built by bringing back fauna and flora in the heart of the city and creating a new environment for a single subtropical biodiversity [26,27,28].



It was finalist in the Innovation Award 2015 [29].
It is candidate for USA Green Building Council, LEED Gold certification, Low Carbon Building, and Diamond Level.[27,29].

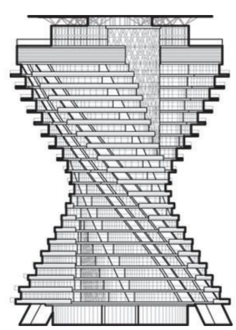


Figure 5. Tao Zhu Yin Yuan Tower catalog

5. CONCLUSION

The biomimesis approach investigated in this study seems to have been used by architects for many years. Every work done so far has revealed how important the concept of biomimesis is and can not be ignored. When the energy consumption of existing buildings around the world is approaching 40% and energy resources are thought to be consumed rapidly, the biomimesis approach needs to be reflected more in designs and applications. Because the biomimesis approach does not harm nature, it is an approach that can reduce the environmental damage when various regulations in the nature are applied to the buildings as a design criterion. Samples examined in this study, two of them are offices and three of them are residential. The importance of designs for energy consumption and sustainability have increased since 2007 and this issue has begun to be supported by certifications. Considering the office buildings, Al Bahar Tower received the 2012 Tall Building Innovation Award and came to the fore with a reduction of 1,750 tons / year of carbon dioxide (CO2) emissions. In addition, it provided a 50% reduction in the heating of the panel construction. Aldar Skyscraper was developed in accordance with the US Green Building Council (USGBC) rating system. Building efficiency classified as 82%, was emphasized that it was the most efficient design for floor space. When the residential buildings are dealt with, The Tao Zhu Yin Yuan residential bulding which is a candidate for LEED Gold certification also has the 2015 Innovation Award. It is expected to reduce carbon dioxide (CO2) emissions by around 130 tonnes per year. This reduction will be provided by planting over 40.000 trees on the balconies. In Central Park I and Central Park II residential buildings, natural lighting and lighting expenses are reduced using glass. Central Park I is among the other sustainable design features of recycling 75% of the wastes generated during construction and reducing the use of water. At the same time Central Park I and Central Park II are candidate for the USGBC LEED Silver Certificate. This study demonstrates again that biomimesis approach which is inspired by nature will reduce energy consumption in harmony with nature. Nowadays, it is very important to design sustainable constructions and to work towards reducing the energy consumption of the buildings. By studying and learning the existing systems in the nature and combined their utilization with today's developing technologies, it is easy to produce healthy, non-polluting and efficient products in every aspect.

REFERENCES

[1] İnceköse, Ü., 2008. Çağdaş Mimarlık Söylemleri ve Doğa bilimsel Bilgi: “Yeni” Mimarlık için “Yeni”den’ Bilimsel Kavramlar, Mimarlık Dergisi, Sayı: 341, s.32-34.

[2] Yedekçi, G., 2015. Doğayla Tasarlamak Biyomimikri ve Geleceğin Mimarlığı**,** Mimarlık Vakfı İktisadi İşletmesi.

[3] Benyus, J. M., 1997. Biomimicry: Innovation Inspired by Nature, Harper Collins: New York.

[4] Rajshekhar R., 2014. Biomimicry in Architecture, International Journal of Advanced Researchin Civil, Structural, Environmental and Infrastructure Engineering and Developing, Volume: 1, Issue: 3 08-Apr-2014, ISSN: 2320-723X

[5] Volstad, N.L., Boks, C., 2012. On the Use of Biomimicry as a Useful Tool for the Industrial Designer. Sustainable Development, Dec.20.

[6] Primlani,R.V., 2013. Biomimicry: On the Frontiers of Design. XIMB Journal, Vol.10(2).

[7]Radwana, G.A.N., Osamab, N., 2016. Biomimicry, An Approach, For Energy Effecient Building Skin Design (Biyomimikri, Enerji Verimli Binada Cephe Tasarımı İçin Yaklaşım) , Improving Sustainability Concept in Developing Countries ELSEVIER Procedia Environmental Sciences 34 (2016) 178 – 189.

[8] Özdemir, E.E., Cengizoğlu, F. P., 2016. Mimari Yüzeylerde Biomimesis Etkisi,8. Ulusal Çatı & Cephe Sempozyumu 2– 3 Haziran 2016 Mimar Sinan Güzel Sanatlar Üniversitesi Fındıklı- İstanbul.

[9] Arslan Selçuk S., Gönenç Sorguç A.,2007. Mimarlık Tasarımı Paradigmasında Biomimesis'in Etkisi, Gazi Üniv. Müh. Mim. Fak. Der. Cilt 22, No 2, 451-459.

[10] Esin, T.,Arıkan, T., Sevinç Kayıhan, K., Aydın, A. B., Onat, M., Akyürek, G., 2002. Marmara Bölgesi için Ekolojik Yapılaşma Kriterlerinin Belirlenmesi ve Örnek Bir Yapı Tasarımı, Gebze Yüksek Teknoloji Enstitüsü Araştırma Fonu, 01-A-02-01-12,Gebze.
[11] Sayın, S.,2006. Yenilenebilir Enerjinin Ülkemiz Yapı Sektöründe Kullanımının Önemi ve Yapılarda Güneş Enerjisinden Yararlanma Olanakları, Yayımlanmamış Yüksek Lisans Tezi, Selçuk Üniversitesi Fen Bilimleri Enstitüsü, Konya.
[12] http://www.yapi.com.tr/Haberler/bir-paradigmadegisikligi-olarak-yesil-bina_66169.html, last accessed on November 2017.
[13] Y. Yanping.,Y. Xiaoping, Y. Xiaojiao, X. Yimin, B. Xiang, W. Yi, 2017. Bionic Building Energy Efficiency And Bionic Green Architecture: Ariview, Renewable And Sustainable Energy Reviews 74 771-787.
[14] Lopez, M., Rubio, R., Martin, S., Croxford, B.,2017. How Plants İnspire Facades. From Plants To Architecture: Biomimetic Principles Fort He Development Of Adaptive Architectural Envelopes. Renewable and Sustainable Energy Reviews 67 692- 70.
[15] Aziz M. S., El Sherif, A.Y., **2016.** Biomimicry As An Approach For Bio- İnspired Structure With The Aid Of Computation, Alexandria Engineering Journal55, 707-714.
[16]http://www.ctbuh.org/TallBuildings/FeaturedTallBuildings/AldarHeadquartersAbuDhabi/tabid/3277/language/en-US/Default.aspx, last accessed on November 2017.
[17]http://www.arup.com/projects/aldar_headquarters, last accessed on November 2017.
[18]http://www.archdaily.com/240524/al-dar-headquarters-mz-architects, last accessed on November 2017.
[19]https://competition.adesignaward.com/design.php?ID=27372, last accessed on November 2017.
[20]https://skyscrapercenter.com/building/the-central-park-i-101/8873, last accessed on Nov. 2017.
[21] Drucker, K., Design Director, HOK, 2012. Biomimicry Inspired Design for Nine Towers at Central Park in New Songdo City, Ctbuh Research Papers, 2012. http://global.ctbuh.org/resources/papers/download/957-biomimicry-inspired-design-for-nine-towers-at-central-park-in-new-songdo-city.pdf, last accessed on November 2017.
[22]http://www.hok.com/design/type/tall-buildings/new-songdo-city/, last accessed on Nov. 2017.
[23]https://skyscrapercenter.com/building/the-central-park-ii-201/8876, last accessed on Nov. 2017.
[24]http://www.ctbuh.org/TallBuildings/FeaturedTallBuildings/AlBaharTowersAbuDhabi/tabid/3845/language/en-US/Default.aspx, last accessed on November 2017.
[25]http://www.archdaily.com/270592/al-bahar-towers-responsive-facade-aedas, last accessed on November 2017.
[26]http://www.designboom.com/architecture/vincent-callebaut-twisting-carbon-absorbing-tower-taipei-tao-zhu-yin-yuan-taiwan-11-25-2016/, last accessed on November 2017.
[27]http://aasarchitecture.com/2016/11/tao-zhu-yin-yuan-vincent-callebaut.html, last accessed on November 2017.
[28]http://edition.cnn.com/2017/01/04/architecture/vincent-callebaut-tao-zhu-yin-yuan/, last accessed on November 2017.
[29]http://www.skyscrapercenter.com/taipei/tao-zhu-yin-yuan/15196/, last accessed on November

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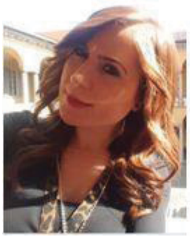
Evaluating the Ecological Architecture: using the Wooden Material

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Abstract: *In consideration of many concepts such as "sustainable, ecological, green, climate and environment-friendly, high performance, intelligent, passive, carbon-neutral buildings" the objective of the applications, becoming evident today, is to produce structures, making us respect and take care of the "nature" with reference to the risk of failure of future generations to survive. The objective of this study is to draw attention to the utility of wood, a renewable material, in this respect in sustainable, organic and ecological architectures, which have gained more importance nowadays, based on the increasing interest in natural life and use of natural materials in the world in recent years. In this regard, technical specifications of wooden materials are mentioned, wooden-material based several structures are analyzed and samples are provided thereof.*

Keywords: *Sustainabilty, ecological architecture, wooden structures*

Ahşap Malzeme Kullanımının Ekolojik Mimari Yapı Örnekleri Üzerinde Değerlendirilmesi

Özet: *Günümüzde, "sürdürülebilir, ekolojik, yeşil, iklim ve çevre dostu, yüksek performanslı, akıllı, pasif, karbon-sıfır bina" gibi pek çok kavram incelendiğinde ortaya çıkan uygulamaların amacı, gelecekteki kuşakların varlığını sürdürememe riskinden hareketle, "doğaya" saygı duymamızı ve ona gereken özeni göstermemizi sağlayacak yapılar üretebilmektir. Bu çalışmanın amacı; son yıllarda dünyada doğal yaşam ve doğal malzeme kullanımına olan ilgideki artışa bağlı olarak günümüzde daha da önemli hale gelen sürdürülebilir, organik ve ekolojik mimari yapılarda yenilenebilir bir malzeme olan ahşabın bu çerçevede kullanılabilirliğine dikkat çekmektir. Bu bağlamda sürdürülebilir ahşap malzemenin teknik özelliklerine değinilmiş, ahşap malzeme ağırlıklı çeşitli mimari yapılar incelenmiş ve örnekler sunulmuştur.*

Anahtar Kelimeler: *Sürdürülebilirlilik, ekolojik mimarlık, ahşap yapılar*

1. INTRODUCTION

The design of built environment has a significant role to maintain the inheritance of future generations, which is under threat due to climate change and unsustainable development with regard to continuation of human race and thousands of other species. The need for sustainable urban development requires an architectural and planning approach addressing both the city and individual buildings as complicated interactive systems, which are in a common living relation with their natural environments.

Primary objectives of sustainable design may be summarized as the use of renewable, non-polluting, environment-friendly energies and eco-technologies, materials; performance of protection, savings and recovery concerning all sources, particularly water and energy; and optimization of the potential of land and its environment and of the procedures regarding the operation, maintenance and repair of buildings. In this day and age, we need a paradigm shift, in which sustainability consciousness, on the agenda of environmentalists for the most part,will be on the agenda and practice of each individual,so that our existence could be sustained in the future.

Architectural construction materials and design criteria have also experienced many changes from past to present. In each period, constructions were built with a different method, different materials and in different styles. Most of them have reached up to present days. From time to time, studies, researches and critiques have been made regarding these structures. Many scientific researches, articles and several studies have been conducted with respect to the issue and studies have been and are still being made on either a national or international scale, which reveal theoretical bases and critical perspectives of the issue, itself.

2. ECOLOGY

Sustainability is, now, an integral part of ‘modern’ life in consideration of the global conditions today. Furthermore; it is also understood that sustainability requires an extensive planning, which should be valued inevitably above all policies when it is considered that vital sources are in danger.

The aim of sustainable architecture is to design environmentally-conscious, low-energy buildings that have the least adverse impact on the environment, provide healthy indoor environments for users and that ensure optimum levels of comfort conditions.

With reference to such definitions, sustainable architecture refers to the fact that all architectural process is ecologically, socially and economically sustainable. Here, the architectural process defines the period of architectural process from planning to recycling.

2.1. Sustainable Architectural Design Criteria

At the head of design criteria, it is essential to lay emphasis on combination of human rights with nature in a healthy, supportive, different and sustainable design.

Design specific to human and design elements interact with each other together with natural world, in a way dependent on nature and on every scale. Human beings take responsibility in design decisions for his welfare, natural systems and about applicability of correctness of such together. In the long run; they aim to create valuable and reliable objects for future generations. The objective of design criteria is to improve and evaluate all life-cycle of products and operations and deal with the status of waste-free natural systems.

Following criteria are considered such as minimizing the use of raw material as well as having natural materials to be used without making no concessions on quality and comfort, collecting recyclable wastes, creating a separate area in the building for such wastes and reusing the resources.

2.2. Ecological Architecture in a Sustainable World

Seeking solutions and recent inclinations against environmental problems experienced in the world are intensively discussed today. Now design criteria are re-questioned and it is proceeded through ecological projections in consideration of the areas surrounding the cities. From now on, it is the aim of architecture to prefer materials and methods for the structures that will minimize environmental pollution, ensure environmental conditions appropriate for human health and that protects ecological balance.

Combining requirements such as sustainability, environmental consciousness, green architecture, natural and organic approach; ecological architecture is the approach of design in compliance with the construction and its surrounding, topography as well as local micro and macroclimate conditions. The use of natural material and recyclable sources is the basic principle of ecologic architecture. Recovery of the resources, which come from the nature, without harming the nature again constitutes the basis of use of these sources.

2.2.1. Design criteria of ecological architecture

Minimizing environmental pollution, ecological structures, which further have positive impacts on local life, protection of construction culture and architecture, provide healthy, reliable and original construction service for the users.

In the light of all these useful aspects of ecological structures, it draws attention that there are some important points which should be emphasized regarding design criteria; These may be listed as follows:

- to minimize impairment of natural sources as regards the design and use of environment,
- to design in compliance with nature, to perform designs in compliance with climate conditions and topographical characteristics,
- to use recyclable materials,
- to consider ecological principles as regards vertical distribution just as horizontal distribution within the building,
- to allow for flexibility and variability criteria for design and have multi-functional spaces and,
- to have designs for the use of solar energy [1].

2.2.2. Technical specifications in ecological architecture

When technical specifications of ecological architecture are discussed under the title of "the details of the utilized material and application systems" it would be seen that the material is the principal parameter. Design approach is inspired by the nature, and the structure develops in the field with its surrounding. Appearance of a structure is similar to that of growth and development of plants from seeds in the nature.

Structures, which are in a relation of compatibility or incompatibility with the people living inside due to material requirements, and that can be considered as an organism in this respect, gradually remove from nature. In the past, organic materials (such as wood, hay, bulrush) at the rate of 30-40% and inorganic materials (such as adobe, building tile, stone and lime) at the rate of 60-70% were used in the buildings. But now, 90-100% artificial construction materials, unfamiliar to nature and people are used and many artificial materials are pretended to be natural [2].

When it comes to the relation of ecology and material, it is no doubt that **wood materials** are the leading among those materials which exactly comply with the ecological design criteria. Wood is the only construction material that can renew itself.

2.2.3. Wooden material in ecological material and wood specifications

Wood is one of the oldest construction materials. People have used wood since antiquity for accommodation and protection purposes. Wood has increased in value once more because forests decrease due to several reasons, failure to grow recent forests in place of the old ones or late cultivation therewith. Although plastic, metal, aluminum, concrete and cement products are used instead of wood with the advancing technology, wood has always continued to be a reason for preference due to appearance, isolation and easy performance of desired formation.

Wood is an organic-based construction material with a fibrous, heterogeneous and anisotropic tissue, obtained from trees, which are living organisms.

Physical properties; moisture, unit volumetric weight, thermal expansion, heat conductivity, electrical conductivity and durability.

Chemical properties; natural resistance, i.e., its woody tissue is the most durable in comparison to other plant tissues.
Mechanical properties; it is difficult to analyze mechanical properties of wood as it is a heterogeneous and anisotropic material. All properties regarding its fibers; pressure, tensile strength are higher than transverse strengths. As the wood is a swelling, shrinking material as a function of its water content, it is also a material with changing mechanical properties.

There may occur several deformations in wooden materials due to color change, corrosion and insects. It is essential to protect wood withmercury chloride, creosote, copper sulphate, zinc chloride, chromium, arsenic, boron or fluorine salts or linseed oil in order to protect wood from these damages [3].

3. WOOD USAGE AREAS in STRUCTURES

Wooden materials are included as carrier, coating, chopping, panel insulation and molding elements in the structures. Furthermore; they have a wide field of application as furniture elements.

As wood base elements; beamsused to provide space for the structure, lattice beam, box beam or glued laminated beam, pillar, corner post, floor, support, main beam, floor beam, yoke; and used in the areas such as ceiling beam, suspension beam, cushion, strainer, tie beam, as for roof systems. The types of the trees used are pine, fir, spruce, beech, oak and chestnut.

As wood siding elements; it has a wide field of use today in thin coated plates, plywood, fiber and flake boards as well as natural wood included in the building as floor, roofing, ceiling, internal and external wall covering. The types of trees used are generally pine, fir, beech, oak, ash tree, hornbeam, elm and walnut tree.

As woodwork elements; used as frame, sash, glazing bar, drip in windows; as cap, doorpost, glazing bar in doors and on the platforms. Woodwork elements are generally produced from trees such as pitch pine, fir, oak, beech, and platform section is manufactured using woo types such as plywood, coated fiber or chipboard.

As wood-panel elements; artificial wood is generally used in these elements, which are included in the structure in the form of dry-wall, floor and roof panel. Known as filled, porous and cellular system, wood panel systems are advanced construction materials of present-day that meets any requirements in terms of building physics.

4. WOODEN APPLICATION SYSTEMS in the STRUCTURES

Wood is one of the most commonly used materials, that spring to mind when it comes to pre-production and naturally renewable construction materials. The wood is a natural construction material, which is possible to be used without exposing to extensive processes, that is renewable and producible without creating much waste, it does not contain materials harmful to health, the amount of fossil energy utilized in its production is low and it stores CO_2 in itself [4]. Besides, it is somewhat available for heat and sound insulation and its fire activity is proper although it is a flammable substance [5]. The elements with wooden raw material may be reused following the end of their lives, they may be eliminated biologically and utilized as energy or raw material. Production of wooden structures is fast, light parts may be easily stored and transported.

In brief, wood has the potential to meet all prevalent trends in construction sector, which are theoretically stated above. Therefore; technological attempts gradually increase considering the use of wood in wood-base systems of multi-story residences.

In widespread application, all mentioned systems are generally used together. It is common to use massive walls with beam-and-slab floors or framing systems with massive floors; or application of wooden systems with steel and reinforced concrete systems. Their use in base system is preferred in low-rise residences, adding stories and in densely populated urban areas in particular. Their use in residential construction is widespread in Scandinavian countries and North American continent.

Solid/massive plates are also used in modular ready cellular systems as they are easily installed despite all of their transport challenges. Projects performed with massive wooden panels range from suspended roofs to industrial structures. Their lightness is a very significant advantage in terms of earthquakes. Wooden base system is the only construction material that can be tested on earthquake table [6].

Wooden construction systems are collected under 4 titles;

4.1. Wood Masonry Systems

Wood masonry systems can be defined as a system created by superimposition of wooden trunks. In accordance with masonry construction guidelines, walls formed by superimposition of wooden elements constitute base systems. It is not required to perform coating on the surfaces of walls, created in this system. Used for traditional construction building either in Turkey or in the World, this system is generally used in weekend houses today.

4.2. Wooden Framed Systems

Wooden framed systems are those in which single-dimension wood components assume role of bearer and wood is used more economically in comparison to masonry systems. In framed systems, while single-dimension wood components constitute the base system, walls turn into the elements which are not carrier but used only for separating spaces and surrounding the building. Wooden framed structures are in fact a frame system. Spaces remaining among the pillars are either filled with a component such as adobe, brick, gas concrete then mortar is applied thereon, or surfaces of pillars facing outwards are coated with wooden boards and desired insulation and protection is ensured against external factors [7].

4.3. Wooden Panel Systems

Wooden panel system is especially appropriate for single-story buildings (schools, offices etc.). This system is also applicable in residences with single or double storey. Wooden panel system is constituted by gathering together the elements, produced as panels. Pillars are used in corner joints of wooden panels. Panel elements are produced based on their compositions and functions as bearing or non-bearing; with or without ventilation. These elements are gathered under four groups as small bearing panels, wide bearing panels, room units and non-bearing small and wide panels [8].

4.4. Systems Formed with Glued Laminated Elements

Glued, laminated wooden elements are the wooden construction elements, generally created by gluing and combining separate wooden plates with different sizes under controlled industrial conditions and by means of special connectors. Fiber directions of all plates are parallel in longitudinal direction. Single plates have a thickness of timber. Plates are composed of parts which are attached from heading joints and that create long length; the parts, which are glued one after another and that create wide cross-sections or from the parts which are bent to obtain curved forms during gluing. This technology has gained an exclusive place in the world of architectural design since it has a very good combination and completion characteristic with other construction elements in all processes as regards rough and fine finishing of the building.

When Utopia Pavilion, Expo Lisbon 1998 is considered as an example of this system; laminated wooden construction system is thought as it was understood that this large building, located in an area of 2000m^2, which is one of the major meeting areas of Europe with an auditorium for 5000 people, could be built within a short time by combining different construction elements. Utopia Pavilion is a natural, fire-protected, ecologic construction model, which does nor create pollution, and functions of which were completed.The length of this structure, consisting of wooden frame arcs is 120m [9].

5. SEVERAL EXAMPLES of WOODEN MATERIAL BASED ARCHITECTURAL STRUCTURES

Wooden materials have gradually started to replace steel and concrete in developed societies as it used to be in the past. Now, buildings with impressive sizes and forms, even sky-scrappers other than small and specific houses are being built with wooden materials.

Below we will analyze structures built with wooden-based materials in different societies for different purposes.

5.1. Examples of Structure 1: Wood Bridge / Anaklia Georgia / 2012 / Peter Walz

When the 540-meter-long bridge over the Inguri in the Georgian town of Anaklia was put into operation, the locals have decided that this is only a temporary structure, and opposition to the authorities even the media were quick to announce that it has taken down after the first heavy rain. And all because the construction of the bridge was made entirely of wood.

Figure 1. Wood Bridge / Anaklia Georgia [URL 1]

Nevertheless, the bridge from the German architect Peter Walz is a capital structure. Moreover, he became the longest wooden object of this kind in the whole of Europe, as well as one of the symbols of the new Georgian resort called Anaklia built on the border with Abkhazia. Serving as a vital link across the Enguri River to the Black Sea resort town of Anaklia, Georgia, the Anaklia-Ganmukhuri Pedestrian Bridge is considered longest cable-stayed timber bridge in Europe and possibly the world.

Originally conceived as a 500-metre-long steel bridge, cost challenges proved to be prohibitive. Fortunately, a Georgian contractor with a keen interest in timber construction stepped forward and engaged HESS TIMBER of Germany to assist in providing a more economical timber solution [URL 1].

5.2. Examples of Structure 2: Wooden Headquarters Tamedia in Zurich / 2014 / Shigeru Ban

Pritzker Laureate 2014 Japanese Shiregu Ban is the bully on the architecture. It creates structures of materials that are less bold and imaginative his colleagues believe quite unsuitable for the job. As an example, the Church of cardboard tubes or multi-story office center of the timber.

In the latter case, it is the headquarters of the Swiss media corporation Tamedia in Zurich. The best traditions of the construction of the real masters of this wooden building was built without a single nail. To seal part of the structure, Shigeru Ban used the traditional connection type gear notching.

Figure 2. Wooden Headquarters Tamedia in Zurich[URL 2]

The result is an elegant five-storey building with a total area of 9000 square meters, it is absolutely safe in terms of seismic and protected from the fire by means of impregnation of wooden construction elements with a special solution [URL 2].

5.3. Examples of Structure 3: Globe of Science and Innovation– wood science museum at CERN/2004/ T.Buchi&H.Dessimoz

The most famous object in the campus of the European Organization for Nuclear Research (CERN) is the Large Hadron Collider – particle accelerator ring with a length of over 26 kilometers. But there is in the territory of another outstanding institution building – Museum Globe of Science and Innovation.

Figure 3. Globe of Science and Innovation–wood science museum [URL 3]

This domed building was discovered at CERN in 2004 as a museum of modern technology, as well as a platform for showcasing the latest advances and research results of scientists working in this organization. Design and exterior design of this building are made of wood that looks very unusual in the territory of one of the largest and most respected in the world of academia.

Interestingly, the height of the Globe of Science and Innovation is 27 meters long and 40 that the size of the second dome of St. Peter's Basilica in the Vatican.

A symbol of sustainable development; several remarkable species of timber were used in the Globe's construction: Scots pine, Douglas pine, spruce, larch and Canadian maple, and these enable the building to act as a carbon sink.

To produce a cubic metre of wood, a tree absorbs a total of one tonne of carbon dioxide (CO_2). It releases approximately 730 kg of oxygen (O_2) and stores 270 kg of carbon (C).
Thus, the approximately 2500 m^3 of timber taken from the Swiss forest that supplied the varieties used in the Globe absorbed 2500 tonnes of CO_2 and released 1825 tonnes of oxygen (O_2) during the trees' life time [URL 3, 4].

5.4. Examples of Structure 4: Metropol Parasol – giant wooden umbrellas in Seville/2011/J.Mayer H.

In many small and large Spanish cities in the central squares have a special place where you can relax in the shade. This can be a balcony overhanging the ground floors of houses, or individual designs – giant umbrellas in the middle of the square. And the largest object of this kind appeared in 2011 in Seville.



Figure 4. Metropol Parasol – giant wooden umbrellas[URL 5]

Metropol Parasol – a giant canopy of unusual shape, which resembles a cloud hovering over one of the squares in the center of the capital of Andalusia. The length of the roof of the wooden building is 175 meters, width – 50, making it the largest wooden object in the world.

Under the Metropol Parasol were equipped with not only a place for walks and get-togethers, but also a small farmer's market, a restaurant and an observation deck, which offers a wonderful view of the historical part of Seville [URL 5].

5.5. Examples of Structure 5: Cathedral of Christ the Light – the cathedral made of wood and glass in Auckland California / 2008 /Craig W. Hartman & Skidmore, Owings and Merrilll

In the old days almost all the churches were built of wood. Reached this tradition and to our times. And, from this material not only erected a small rural churches and chapels, cathedrals and even in large cities, for example, in the California Oakland.



Figure 5. Cathedral of Christ the Light –
the cathedral made of wood and glass in Auckland California [URL 6]

Majestic, modern Cathedral of Christ the Light was built primarily of wood and glass. And at night, it seems as if it is of divine light that justifies the name of the church – Christ Church Cathedral – Light of Light.

The Cathedral of Christ the Light employs state-of-the-art technologies to create lightness and space. The 1,350-seat cathedral incorporates a highly innovative use of materials, including glue-laminated timber, architecturally exposed reinforced concrete, high-strength steel tension rods, aluminum, and glass to provide lightness and luminosity within an efficient structural form. With a building life goal of 300 years, it utilizes a base isolation system along with superstructure materials that allow the structure to resist strength and ductility demands beyond the maximum considered earthquake levels [URL 6].

5.6. Examples of Structure 6: Canadian Timber House Uses Salvaged Wood From Nearby Elk Reserve Canada /2011/ Scott M. Kemp

The use of salvaged wood is just one of many impressive features of this timber home in British Columbia. Designed by Architect Scott M. Kemp, the home serves as a residence for him and his family and has achieved a LEED Platinum rating from the Canadian Green Building Council. Salvaged wood, geothermal heating and cooling, green materials and an energy efficient solar passive design set the home apart.

Figure 6. Canadian Timber House Uses Salvaged Wood From Nearby Elk Reserve [URL 7]

Located on the banks of the Fraser River near the village of Ladner, this eco residence takes full advantage of its river site for views as well as the relatively constant temperature of the water. A closed loop geothermal system hanging in the river below the dock works in tandem with a heat pump to provide hot water and radiant floor heating and cooling for the home. Solar passive design and high performance glazing reduce energy use along with a tight thermal envelope made from SIPs [URL 7].

5.7 Examples of Structure 7: WISA Wooden Design Hotel/ Finland /2009/ Pieta-Linda Auttila

Architect Pieta-Linda Auttila has completed a prototype holiday home in Helsinki, Finland, featuring a sculptural, wooden trellis between two box-like ends.

Called the WISA Wooden Design Hotel and created for Finnish forest products brand UPM Kymmene, the building is made of pine, spruce and birch grown in Finland.

The two solid volumes house sleeping and living areas, with large windows in each end overlooking the sea on one side and the city on the other.

The curved panels of the wooden trellis shelter a central patio from wind and filter the light. WISA Wooden Design Hotel is an architectural gem of wood situated in the maritime heart of Helsinki, capital of Finland. Around it lie the city and 200 years of architectural history.

Figure 7. WISA Wooden Design Hotel/ Finland [URL 8]

The work was designed by interior architect Pieta-Linda Auttila. She hopes to spark interest in wood and highlight its role in building and interior design [URL 8].

5.8 Examples of Structure 8: Haydar Aliyev Life Area in Airport / Bakü / 2014 / Autoban

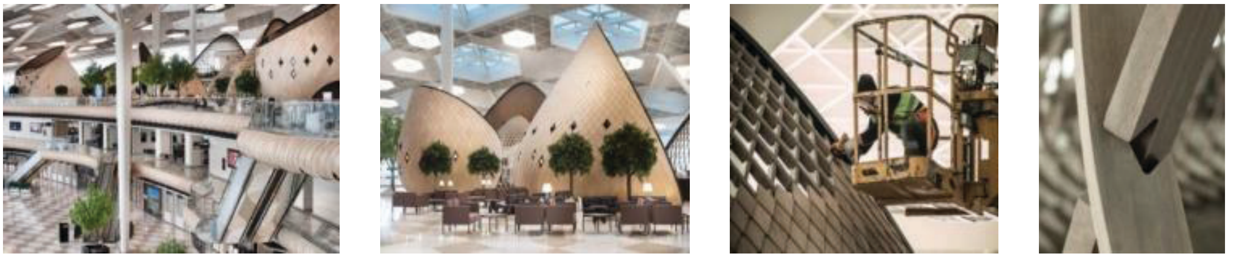

Figure 8. Haydar Aliyev Life Area in Airport / Bakü [URL 9]

Istanbul-based architecture studio Autoban creates a wooden village to encourage wandering in a vast terminal.

Baku, Azerbaijan, burns in a hot landscape-literally. In recent years, swaths of land in the country's capital have ignited in spontaneous fires due to shallow-lying natural gas and oil. Since the country gained its independence in 1991, the government has sought to elevate its design stature, illuminating HOK's three Flame Towers with 39-story animations of flames, and building Zaha Hadid's Heydar Aliyev Center [URL 9].

5.9. Examples of Structure 9:Kaeng Krachan Elephant Park Shell / Zurich/ 2014/ Markus Schietsch

Zurich design firm Markus Schietsch Architekten crafts a complex, freeform roof for several unusual occupants.

The Kaeng Krachan Elephant Park compound at the Zurich Zoo is capable of withstanding the 15-ton force generated by a charging occupant, but that didn't stop local firm Markus Schietsch Architekten (MSA) from imparting an aesthetic delicacy to the structure. Completed in 2014, the 90,900-square-foot structure currently hosts eight Asian elephants, each weighing between 2 tons and 5.5 tons, in a nature-inspired habitat topped by a 73,200-square-foot shell roof made primarily from wood [URL 10].

Figure 9. Kaeng Krachan Elephant Park Shell [URL 10]

5.10 Examples of Structure 10:Yogav Studio/ New York /2015/ German Rodriguez Sergio Hidalgo

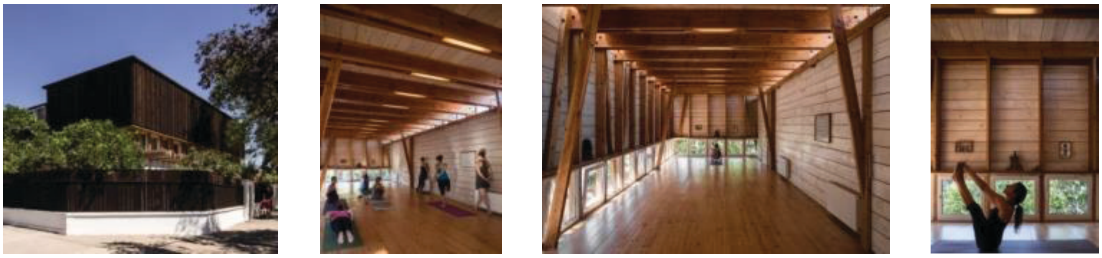

Figure10. Yogav Studio [URL 11]

Chilean studio DX Arquitectos has added a timber-framed roof extension to the home of a yoga teacher in Santiago, providing a studio where she can teach classes. Santiago-based DX Arquitectos designed the studio for the director of Ashtanga Yoga Chile – the oldest school in the country specialising in this method of yoga. She wanted a studio that would allow her to integrate and at the same time separate her home life from her work life, "architect Germán Rodríguez told Dezeen". It needed to satisfy all the conditions for the comfortable practice of yoga – good ventilation, good acoustic and thermal insulation, and a spiritual atmosphere. The architects built the studio entirely with timber, using pine for the exterior and interior surfaces. Outside, the pine is finished with carbonileo – a protective finish commonly used in Chile that gives the extension its blackened appearance. Inside, the pine is left raw for the flooring and whitened for the walls to accentuate its grain. We also chose wood because it is suitable for absorbing the moisture generated during the practice of yoga, and it contributes to the calm atmosphere of the studio, he added [URL 11].

6. CONCLUSION and RECOMMENDATIONS

The approach "to know the nature of material and adhere to such" has revived as a reflection of positivist thinking, which has taken shape since seventeenth century when architectural information was divided into two as "artistic" and "scientific".

When wood is compared with steel and concrete; it is a superior material in all respects thanks to its heat conductivity, naturalism, aestheticism, acoustic properties, cost, and because it is recyclable and requires low-carbon.

Today building designers call for with an increasing pressure in order to reduce carbon footprint of structured frame and balance cost targets and functionality with gradually decreased environmental impacts. Wood is a low-cost and biggest renewable source that is compatible with such a call and that can help to ensure such a balance.

It is important to consider life cycle and environmental impacts of a material when stating any material. Wood is raised naturally, and it is proved to be superior than other materials with its following characteristics to have a lesser solid energy, to create lower air and water pollution, to provide oxygen for nature during production phase and thanks to its carbon-ponding feature.

In order to determine correct cost of a construction material, environmental and financial characteristics of such material during its life cycle should also be; considered. When such characteristics are considered, it is apparent that wooden material provides better performance than steel and concrete in terms of manufacture, transport, installation, usage, maintenance, recycling, air and water pollution, energy and carbon footprint.

In the analysis conducted, it was observed that wooden materials were mainly used in religious buildings, training buildings, hotel buildings, airports, bridges, residences, museums and in many areas such as these in developed countries all over the world and its proliferation increases day by day. That they are living and alive materials makes wooden products always one step ahead in our living spaces. It is a natural outcome of our historical development to be nested with wood in every places we live in; from hand tools we use, houses we live in, from our gardens to external coating materials. That it is a natural, environmentally-friendly, recyclable, protectable, healthy and sustainable material may be considered as significant values of wood and such may be listed among the most important characteristics of wood. Today it is essential that construction industry should develop in a manner to reduce harmful factors, arising during production stage so that ecological problems, it causes, could be resolved.

In order to provide solutions, many studies are conducted mainly in developed countries regarding ecological building and support is provided thereby developing recent approaches aiming to extend the use of wood, as a natural construction material in the field of residence.

Human beings are dependent upon nature with the air they, intake; water, they drink and vegetable-based and animal nutrients. In this respect, they should interact with nature as other creatures. When it comes to select materials, if our materials of choice are the ones which consumes less energy in either during its production or utilization process, which are easily transformed by nature when they complete their life cycle, which also do not pollute environment during both of their production and destruction stages and do not lead to emergence of carcinogens, we would have contributed to protection of natural balance. Wooden material, which is available and offered to us by nature with its excellent internal structure, is the best example for this.

REFERENCES

[1]Tönük, S. 2001. *Bina Tasarımında Ekoloji*, YTÜ Basım –Yayın Merkezi, İstanbul.
[2]Akman, A. 1999. Ekolojik ve Biyolojik Yapı Uygulamaları, *Yapı 213*, 1999(8), p.91-102.
[3]Ünal, O. 2014. *Yapı Malzemesi Ders Notları,* İstanbul. (basılmamış)
[4]Herzog, T. 2003. *Holzbauatlas, Institutfürinternationale Architektur-Dokumentation*, Münih,p.48, 74-75.
[5] Affentranger, X. 2000."*Bautenund Fassaden mit Holz", Prix Lignum,* BaufachverlagAG, Zürih,p.18, 55.
[6]Sandhaas, C. 2009. "*Waspassiert mit meinemHaus, wenndie Erde bebt?*", Zuschnitt-Holzstapelthoch, proHolzAustria Yayını, Dornbirn, p.21-23.
[7]Türkçü, Ç. 2000. *Yapım*, Birsen Yayınevi, İstanbul.
[8] Avlar, E.& Limoncu, S. 2001. Yapı Malzemesi Olarak Ahşap ve Ahşap Yapı Sistemleri, *Yapı 241*, 2001/12,p.87-90.
[9] Tokyay, V. 2001. Modern Mimarlık ve Modern Ahşap Sistem-2, *Tasarım Dergisi 117*, 2001/12, p.42-48.

ONLINE REFERENCES
URL-l. http://architizer.com/projects/anaklia-ganmuhkuri-pedestrian-bridge/)
URL-2.http://www.archdaily.com/478633/tamedia-office-building-shigeru-ban-architects
URL-3.http://www.fondationglobe.ch/index.php?id=5&L=1
URL-4. http://public-archive.web.cern.ch/public-archive/en/Spotlight/SpotlightGlobe-en.html
URL-5. http://www.dezeen.com/2011/04/26/metropol-parasol-by-j-mayer-h/
URL-6.
ttp://www.som.com/projects/cathedral_of_christ_the_light__structural_engineering#sthash.0c2JXt8V.dpuf
URL-7. http://inhabitat.com/canadian-timber-house-uses-salvaged-wood-from-nearby-elk-reserve/
URL-8. http://www.dezeen.com/2009/08/06/wisa-wooden-design-hotel-by-pieta-linda-auttila/
URL-9.http://www.architectmagazine.com/technology/detail/innovative-detail-autoban-weaves-a-network-of-wood-finishes-into-cocoons-in-azerbaijan_o
URL-10. http://www.architectmagazine.com/technology/detail/kaeng-krachan-elephant-park-shell_o
URL-11. http://www.dezeen.com/2015/11/28/dx-arquitectos-ashtanga-yoga-chile-teachers-house-extension-blackened-timber-studio-santiago/

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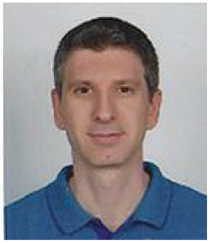
Yığma Kagir Tarihi Camilerde Deprem Yapısal Güvenlik Değerlendirmesi: Ampirik ve Sayısal Yöntemlerin Karşılaştırılması

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Özet: *Malzeme, geometri, yapım sistemi, tarih boyunca yapılan ekler ve müdahaleler bakımından karmaşık olan tarihi yapılarda; yapısal değerlendirmede çeşitli yöntem ve yaklaşımlar mevcuttur. Bu tür yapılarda, yapısal değerlendirme; yeni yapılacak binalardaki değerlendirmelerden; yöntem, amaç ve beklenen sonuçlar bakımından farklıdır. Bu nedenle gerçekçi sonuçlar elde etmek için doğrulanabilir araç ve yöntemler kullanılması oldukça önemlidir. Karmaşık olan tarihi yapılarda, ortaya çıkabilecek bölgesel hasarlar ya da zayıflıklar nedeniyle yapılacak yapısal değerlendirme, yapının zayıf bölgelerinin tespitine odaklanmaktadır. Bu çalışma; tarihi yapılarda yapısal değerlendirme için ampirik ve sayısal analiz yöntemleri kullanılarak elde edilen sonuçların karşılaştırılması ve buna göre tarihi yapılarda yapısal değerlendirme yöntemlerinin değerlendirmesini kapsamaktadır. Çalışma kapsamında, örnek olarak, Tiran Ethem Bey Cami incelenmiştir.*

Anahtar kelimeler: *Tarihi yapı, yığma kagir yapı, yapısal güvenlik, sayısal analiz*

Earthquake Safety Evaluation of Historic Mosques: Comparison Between Empirical and Numerical Methods

Abstract: *Historic structures exhibit complexity based on materials used, geometry, structural system and its elements and according to this complexity, safety evaluation procedures vary. The methods, aim and expected results of safety evaluation of historic structures are rather different than new buildings. In order to obtain realistic results it is an important necessity to use tools and methods that could be verified. The focus of safety evaluation procedures of complex historic structures is to find possible weak parts of the structure. The aim of this study is to compare empirical and numerical evaluation methods and their results for historic structures by making safety evaluation of Tirana Ethem Bey Mosque as a case study.*

Keywords: *Historic structure, masonry structure, earthquake safety evaluation, numerical analysis*

1. GİRİŞ

Malzeme, geometri, yapım sistemi, tarih boyunca yapılan ekler ve müdahaleler bakımından oldukça karmaşık olan tarihi yapıların değerlendirilmesi uzmanlık gerektiren hassas bir konudur. Bu nedenle bu yapılarda yapısal kararların alınması için güvenlik değerlendirmesi de oldukça karmaşık olup çeşitli yöntem ve yaklaşımlar ile yapılmaktadır. Tarihi yapıların; yönetmelik ve yönergelerle sınırlandırılamayıp, yapısal değerlendirmenin tek bir kurala bağlı olmaması durumu güçleştirmektedir.

Yapısal değerlendirme için seçilen yöntem ve yaklaşıma göre işlemin karmaşıklığı hatta sonuçlar da farklılık gösterebilir. Bu durumda bir yöntemi diğerine tercih etmek ya da karmaşık olanın basitleştirilmiş yönteme göre daha güvenilir olduğunu söylemek mümkün değildir. Önemli olan yapısal değerlendirmenin hangi amaçla yapıldığı, hangi bütçe ile yapılacağı, çalışmanın yapılması için zaman sınırlamasının ne olduğu ve çalışmanın amacına uygun bir yöntem seçimidir [1, 2].

Bu çalışmanın amacı; Tiran Ethem Bey Cami örneği ile tarihi yapılarda yapısal değerlendirme için kullanılan ampirik ve sayısal yöntemlerin karşılaştırılmasıdır. İncelenen yapı; Balkan ülkeleri içinde aktif deprem kuşağında yer alan Tiran, Arnavutluk'tadır ve bu nedenle yapısal değerlendirme özellikle deprem riski göz önünden bulundurularak yapılmıştır.

2. TARİHİ YAPILARDA YAPISAL DEĞERLENDİRME

Büyük bir bölümü taş, tuğla, harç gibi parçalı blok malzemelerle yapılmış tarihi yapılar; sünekliği az, gevrek, basınç dayanımı yüksek ve çekme dayanımı olmayan yığma kagir yapılardır. Bu tür yapılarda, yapısal değerlendirme; yeni yapılacak binalardaki değerlendirmelerden; yöntem, amaç ve beklenen sonuçlar bakımından farklıdır. Bu nedenle gerçekçi sonuçlar elde etmek için doğrulanabilir araç ve yöntemler kullanılması oldukça önemlidir. Yapısal değerlendirme, malzeme ve geometrisi bakımından karmaşık olan tarihi yapılarda, ortaya çıkabilecek bölgesel hasarlar ya da zayıflıkların tespitine odaklanmaktadır [3].

Modern yapım teknikleri ile yapılacak binalarda olduğu gibi yapıya ve yapı elemanlarına gelen yükler ile bu yüklere göre yapı elemanı kesitlerinin kontrolü; tarihi binalarda kullanılan yapı malzemelerinin özellikleri ve yüzlerce yıllık ömürleri göz önünde bulundurulduğunda tam olarak uygunluk gösterememektedir. Tarihi yapılarda, karmaşık bir işlem olan yapısal değerlendirmede karşılaşılan güçlükler genel olarak;

- Yapı geometrisine ilişkin bilgiler eksik ya da mevcut değildir,
- Yapı elemanlarının iç yapısı ve yapım biçiminin ayrıntılarına ilişkin bilgi yoktur,
- Malzemelerin mekanik özelliklerinin belirlenmesi güç ve pahalı bir işlemdir,
- Mekanik özellikler; işçilik, kullanılan malzemenin çeşitlilik göstermesi ve zaman içindeki değişimler dikkate alındığında karmaşıktır,
- Zaman içinde yapılan müdahale ve değişikliklerin belirsizlikleri,
- Zaman içinde yapının geçirdiği müdahaleler, uğradığı hasarlar ve yapıldıysa tadilatlara ilişkin kesin bilginin olmaması,
- Yeni yapılacak binalar için hazırlanmış olan yönetmeliklerin tarihi yapılarda kullanılmaya elverişli olmaması gibi konulardır [4, 6].

Yapısal değerlendirme; analojik, analitik, nümerik gibi çeşitli analiz modelleri ile yapılmaktadır. Bu analizlerde; tarihi yapının tarihsel gelişimini, olası yapısal ve malzeme sorunlarını ve yapı ile malzeme davranışının dikkate alınması oldukça önemlidir. Geometri, malzeme ve davranış yönünden karmaşık yapıları nedeniyle tarihi yapılarda, modern yapı yaklaşımındaki gibi net ve kesin tanımlar kullanılamamaktadır. Bu nedenle; tarihi yapılarda yapısal değerlendirme yöntemleri genel ve daha esnek yaklaşımlara dayalı, yapıya has özellikleri (tarihsel süreç) dikkate almaktadır.

Genel olarak tarihi yapıların yapısal değerlendirmesinde; tarih boyunca yapılan müdahaleler, afet gibi geçirilen büyük olaylar, malzeme özellikleri, yapım tekniği, yapının bulunduğu zemin özellikleri gibi yapıya ait temel özelliklerin araştırıldığı, yapısal analiz modeli için nitel ve nicel verilerin elde edildiği çalışmalar teşhis olarak adlandırılmaktadır. Teşhisin ardından yapısal analiz yapılarak yapının zayıf bölgeleri ve olası deprem gibi büyük etkilerden zarar görecek yapı elemanları ya da yapı kısımları tespit edilmeye çalışılır. Teşhiste belirlenen hasar/bozulma ve nedenlerinin yapılan sayısal hesaplar ile örtüşmesi oldukça önemlidir [6].

Modern analiz yöntemleri; yönetmelik kriterlerine bağlı güvenlik değerleri ve bazen belirli bir bölgeye/detaya odaklı olan çalışmalardır. Buna göre, tarihi yapıların karmaşık durumu için doğrudan kullanılması sakıncalı yöntemlerdir [7]. Bu nedenle tarihi yapıların yapısal değerlendirmelerinde kesin bir hesap yöntemi belirlemek mümkün değildir. Ancak varsayımlar ve kabuller ile uzmanlık tecrübesine göre nitel ve nicel veriler bir arada değerlendirilerek yapısal değerlendirme yapılmaktadır. Bu tespitlerin amacı; zayıf bölgeleri ve yapısal elemanları tespit etmektir.

Tarihi yapılarda yapısal değerlendirme için kullanılan sayısal yöntemler çeşitli idealleştirme ve kabuller içermektedir. Genel olarak analizler; yapı ve malzeme davranışında yapılan idealleştirmelere göre elastik davranış, plastik davranış ve non-lineer yapı davranışına dayanmaktadır. Non – lineer analizler; yapı davranışını, çatlakların ortaya çıkması, ezilme ve tümüyle yıkılma safhalarını görmek için en etkili analiz yöntemidir. Ancak; yüzlerce yıl ayakta kalan ve zaman içinde pek çok değişiklik geçiren tarihi yapıların, gerek malzeme ve birleşimlerinin kesin ve net olarak tarif edilemeyecek kadar karmaşık olması gerekse günümüz yapısal analiz programlarının yeni yapılacak binalar için geliştiriliyor olması tarihi yapılar konusunda non-lineer analizlerin yaygınlaşmasını engellemiştir.

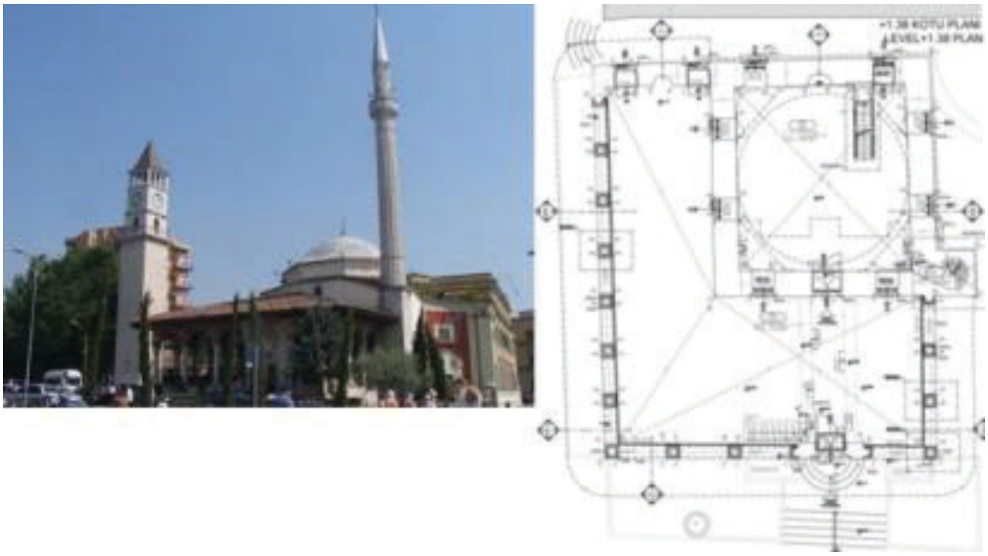
Sayısal modellemenin amacı; yapının tamamının, belli bir bölümünün ya da taşıyıcı sistem elemanlarının yük altındaki davranışını belirlemektir. Tarihi yapılar karmaşık olduğu için sayısal modellemede pek çok sadeleştirme yapılması zorunlu hale gelmekte ve yalın, basit ve doğru bir model elde etmek için yapısal elemanların, malzeme ve mekanik özelliklerinin doğru tanımlanması büyük önem taşımaktadır [1, 8].

3. ÖRNEK ÇALIŞMA - TİRAN ETHEM BEY CAMİ

3.1. Mimari Özellikler ve Bina Geometrisi

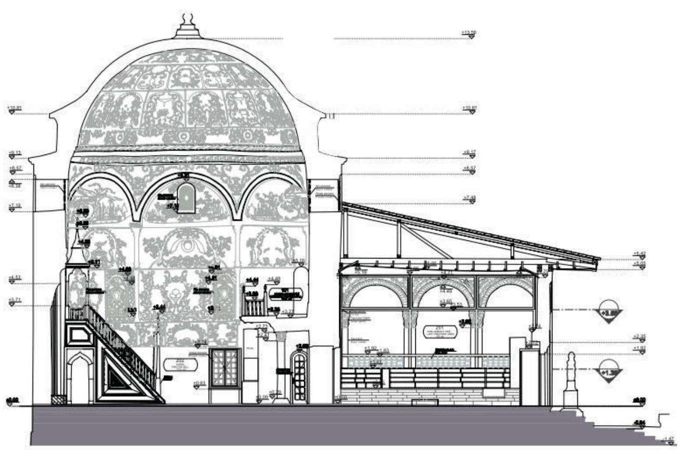
Ethem Bey Cami; Tiran - Arnavutluk'ta konumlanmış, 1793 yılında inşa edilmiş ve 1822 yılında esaslı bir onarım geçirmiştir [9]. 1967'de müzeye dönüştürülmüş ve 1990'larda yeniden cami olarak kullanılmaya başlanmıştır [10].

Ethem Bey Cami, tek kubbeli, kare planlıdır (Şekil 1). Ana mekanda yer alan, iki dairesel kesitli sütuna oturan ve ulaşımı minare ile ortak merdivenden sağlanan kadınlar kısmı; asma kat olarak düzenlenmiştir. Son cemaat yeri, caminin kuzeyi ve doğusunda konumlandırılmış, camiye bitişik ve L biçimindedir. Minare, caminin batı duvarına bitişik olarak inşa edilmiştir.



Şekil 1. Ethem Bey Cami fotoğraf: Meltem Vatan, çizim Ekol Mimarlık.

Kubbe; çapı 822 cm, yüksekliği 453 cm (ölçüler iç mekandandır) olan yarım küredir. Kesiti; tepede 38~40 cm olup eteklere doğru artmakta (Şekil 2) ve kareye geçiş; sekizgen kasnağa oturan, arkaları dolgulu, tromp elemanları ile sağlanmaktadır.



Şekil 2. Ethem Bey Cami kesiti [11]

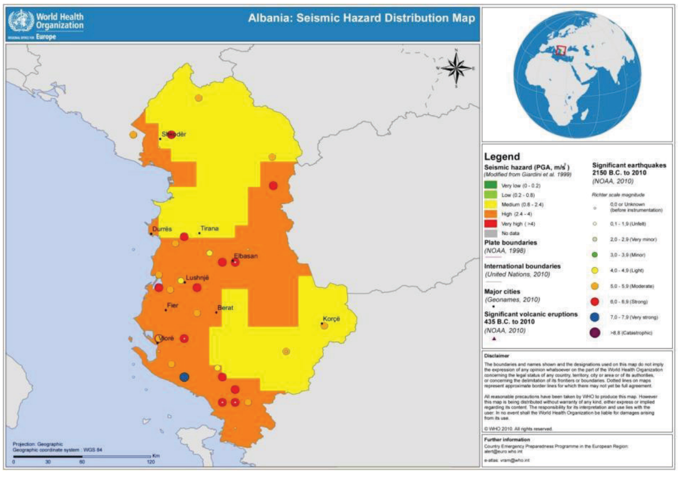
120 cm kesitinde olan beden duvarları kil taşı ve kireç taşıdır [12]. Ayrıca kadınlar mahfilinin altında, beden duvarına bitişik, 40~44 cm çapında taş sütunlar mevcuttur.

Ethem Bey Cami minaresi; ana cami kütlesine bitişik, kare kaideye oturan, +10 kotunda kare kaideden daireye geçerek, +27.3 kotuna kadar minare çeperinin kesit kalınlığı 12 – 16 cm ve çapı da 140 cm - 110 cm olarak düzenlenen minarenin kesit ölçülerinden de anlaşılacağı gibi yükseldikçe çapı daralmaktadır [11]. Malzemesi taş olan minarenin sadece külah bölümü ahşaptır. Yapıda tam bir bodrum katı olmamakla birlikte sadece son cemaat yerinin altında, daha geç bir dönemde abdesthane ilavesi yapılmıştır.

3.2. Yapısal Değerlendirme

Adriyatik ovasında, 100–140 m deniz seviyesi üzerinde konumlanan Tiran ve yakın çevresine ilişkin sismik veriler oldukça sınırlıdır. Tiran'da meydana gelen ve yerel olarak kaydedilen en önemli deprem, Rihter ölçeği ile 5.4 (ISC) büyüklüğünde ve 7-8 (MSK – 64) şiddetinde olup 9 Ocak 1988'e tarihlenmektedir. Deprem süresi 6 sn'yi geçmemiş ve en büyük ivme kaydı A_{max}=0.4g olarak ölçülmüştür [13].

Balkan ülkeleri içinde aktif deprem kuşağında yer aldığı kabul edilen Arnavutluk'un, deprem riskine göre bölgeleme haritası Şekil 3'te gösterilmiştir. Haritada; Tiran şehrinin yer aldığı sarı renk, orta riskli alanlara işaret etmekte ve deprem ivmesi 0.8 – 2.4 m/s^2 olarak verilmektedir [14]. Tiran'da, 100 yıllık deprem tekrarı için ortalama 7 (MSK – 64) şiddeti öngörülmektedir [13].



Şekil 3. Arnavutluk deprem haritası [13]

Bu çalışmada; Ethem Bey Cami için ampirik hesap ve sayısal analiz yapılmış ve elde edilen bulgular karşılaştırılarak tarihi yapılarda yapısal değerlendirme yöntemleri değerlendirilmiştir.

3.2.1. Ampirik Hesaplar

Yapılan ampirik hesaplarda; taşıyıcı duvar alanı toplamının bina ağırlığına oranı ($\Sigma A_{dvX,Y}/W$), taşıyıcı duvar alanı toplamının bina brüt taban alanına oranı ($\Sigma A_{dvX,Y}/\Sigma A_{bina}$), deprem yükü doğrultusundaki duvar kesme kapasitesi için eşdeğer deprem yükü ($FR_{dX,Y} = \Sigma A_{dvX,Y} * \tau$), duvarların uzunluk ve yükseklik narinliklerine ($L_{i\,dv.} / t_{i\,dv.}$; ve $H_{i\,dv.} / t_{i\,dv.}$) bakılmıştır [15,16].

Bu bağıntılarda; $\Sigma A_{dvX,Y}$ dikkate alınan deprem yükü doğrultusundaki taşıyıcı duvar toplam alanını, W bina ağırlığını, ΣA_{bina} binanın brüt (toplam) taban alanını, $FR_{dX,Y}$ dikkate alınan deprem yükü doğrultusundaki duvar kesme kapasitesi, V_t eşdeğer deprem yükünü, $L_{i\,dv}$ duvar uzunluğunu, $t_{i\,dv}$. duvar kalınlığını, $H_{i\,dv}$ duvar yüksekliğini, W bina ağırlığını ifade etmektedir.

Yapılan hesaplara göre elde edilen sonuçların karşılaştırılması için uygunluk ölçütlerinin değerleri Tablo 1'de verilmiştir [15].

Tablo 1. Bina değerlendirme ölçütlerinin uygunluk koşulları [15]

Ölçüt	**Uygunluk koşulu**
ΣAdvX,Y/W	≥ 1,2 m²/MN
ΣAdvX,Y /ΣAbina	≥ 0,1
FRdX,Y / Vt	> 1
Ldv. / tdv.	≤ 18
Hdv. / tdv.	≤ 9

Bina kare formlu olup taşıyıcı elemanları her iki doğrultuda aynı olduğu için yapısal değerlendirme hesapları X ve Y doğrultusu için birbiri ile aynı değerlere sahiptir. Duvar hesapları Tablo 2'de, deprem hesapları Tablo 3'te verilmiştir.

Tablo 2. X ve Y yönü duvar hesabı (Wall calculations - X and Y direction)

		H	**t**	**L**	**L_b=Σl**	**L_{net}=L-L_b**	**A_{dv}**	**V**	**W**	**L/t**	**H/t**
	DUVAR	(m)	(m)	(m)	(m)	(m)	(m^2)	(m^3)	(kN)		
X ve Y Yönü	D1, D3	9.16	1.2	10	1.8	8.2	9.84	90.13	2163.23	8.33	7.63
	D2, D4	9.16	1.2	10	1.8	8.2	9.84	90.13	2163.23	8.33	7.63

Taşıyıcı duvar alanı toplamının bina ağırlığına oranı: $\Sigma A_{dvX,Y}$ / W = 2.27
Taşıyıcı duvar alanı toplamının bina brüt taban alanına oranı: $\Sigma A_{dvX,Y}$ /ΣA_{bina} = 0.20
Duvar uzunluk narinliklerinin değeri her iki doğrultu için: $L_{dv.}$ / t_{dv}. = 8.33
Duvar yükseklik narinlikleri: $H_{dv.}$ / $t_{dv.}$= 7.63 olarak hesaplanmıştır.

Tablo 3. Ethem Bey Cami deprem yönünden yapısal değerlendirmesi

ΣW	**A bina taban**	**ΣFR_d**		**V_t**	**ΣA_{dv}/W**		**$\Sigma A_{dv}/\Sigma A_{bina}$**		**$\Sigma FR_d/V_t$**	
(kN)	(m^2)	(kN)		(kN)	(m^2/MN)					
		X	**Y**		**X**	**Y**	**X**	**Y**	**X**	**Y**
8652.90	100	19680.00	19680.00	6057.03	2.27	2.27	0.20	0.20	3.25	3.25

Vt=W*1.4/2

V_t eşdeğer deprem yükünün hesabı; bina ağırlığı, spektral ivme katsayısı ve taşıyıcı sistem davranışı katsayısından yararlanarak yapılmıştır (V_t=W*A(T)/R).

Literatür araştırmasına göre, lineer sınır ötesi davranışı temsil eden, taşıyıcı sistem davranış katsayısının değeri R=2.0 olarak alınmıştır. Bu değer; yığma yapı malzemesi, doğası gereği gevrek özellik gösterdiği için malzeme davranışına uygun olarak, hem deprem yönetmeliğinde hem de literatürde verilen değerlere göre alınmıştır [17]. A(T) spektral ivme katsayısının değeri bina önem katsayısı ve binanın bulunduğu deprem bölgesinin etkin ivmesine göre hesaplanmıştır: $A(T)=A_0*I*S(T)$. Anıtsal yığma binalarda kullanmak üzere, I bina önem katsayısı Deprem Yönetmeliği (DBYBHY) Tablo 3'e göre, 1.4 ve S(T) = 2.5 alınmıştır [18]. Deprem Yönetmeliği'nde bina önem katsayıları tablosunda (DBYBHY - Tablo 3) anıtsal binalara ilişkin belirli bir tanım yapılmamıştır. Ethem Bey Cami'sinin yapısal durum değerlendirmesi yapılırken, dikkate alınacak bina önem katsayısı değeri, "insanların uzun süreli ve yoğun olarak bulunduğu ve değerli eşyaların saklandığı binalar" kategorisi dikkate alınarak, I=1.4 olarak alınmıştır [18]. Zemin özellikleri ve yapı periyodunu ifade eden spektrum katsayısı, S(T); ampirik hesapta güvende kalmak için Deprem Yönetmeliğinde kabul edilen en büyük değer olan 2.5 olarak alınmıştır. Narin ve uzun periyotlu minare dışında ana yapı, büyük duvar kesitleri nedeniyle rijit ve genelde kısa periyotlu bir yapı olarak ele alınmıştır [18]. Yapılan hesapların sonuçları, Tablo 1'de verilen sınır değerleriyle karşılaştırıldığında Ethem Bey Camisi'nin yapısal olarak güvenli olduğu tespiti yapılmıştır (Tablo 4).

Tablo 4. Ethem Bey Cami ampirik hesap sonuçları uygunluk karşılaştırması

Ölçüt	**Hesap sonucu**	**Güvenlik durumu**
$\Sigma A_{dvX,Y}/W$	2,27 ≥ 1,2 m²/MN	GÜVENLİ
$\Sigma A_{dvX,Y} / \Sigma A_{bina}$	0,20 ≥ 0,1	GÜVENLİ
$FR_{dX,Y} / V_t$	3,25 > 1	GÜVENLİ
$L_{dv.} / t_{dv.}$	8,33 ≤ 18	GÜVENLİ
$H_{dv.} / t_{dv.}$	7,63 ≤ 9	GÜVENLİ

3.2.2. Üç Boyutlu (3B) Sayısal Analiz

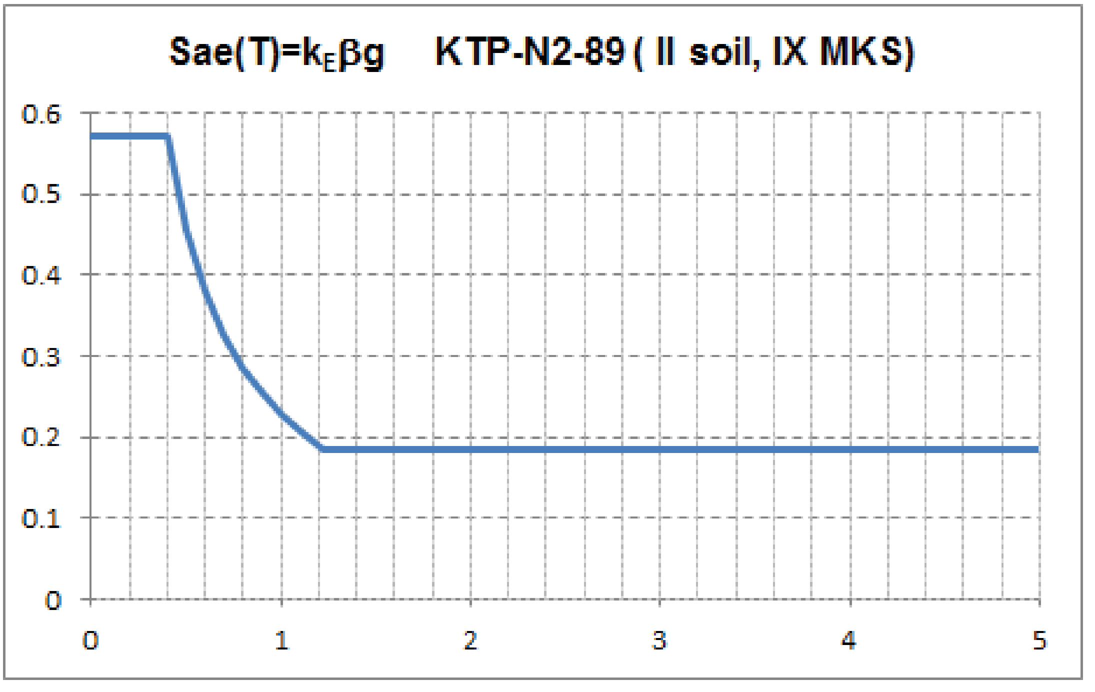
Ethem Bey Cami için yapılan sayısal hesaplar SAP 2000 programı ile gerçekleştirilmiştir. Analiz modelinde yığma yapı elemanları için makro model özellikleri tanımlanan, yığmayı oluşturan taş ve harç özelliklerinin birleşiminden oluşan kompozit eleman olarak ifade edilen [8] elemanlar kullanılmıştır.

Çalışma sırasında temel kazısı yapılamadığı için Ethem Bey Camisi'nin yüzyıllardır ayakta kalması göz önünde bulundurularak, zemin sıkışmasını tamamladığı ve yükleri yapıdan zemine güvenle aktardığını kanıtladığı kabul edilmiştir. Temellere ilişkin gözle tespit yapılmış ve yapı oturmasından kaynaklı olabilecek herhangi bir çatlak gözlenmemiş ve yapı temellerinin iyi durumda olduğu kabul edilmiştir. Ayrıca, Çamlıbel'in yaptığı çalışmalarda belirtmiş olduğu, "tarihi yapılar rijit yapılar olduğu için rijit temellere oturur" kabulü yapılmıştır [19].

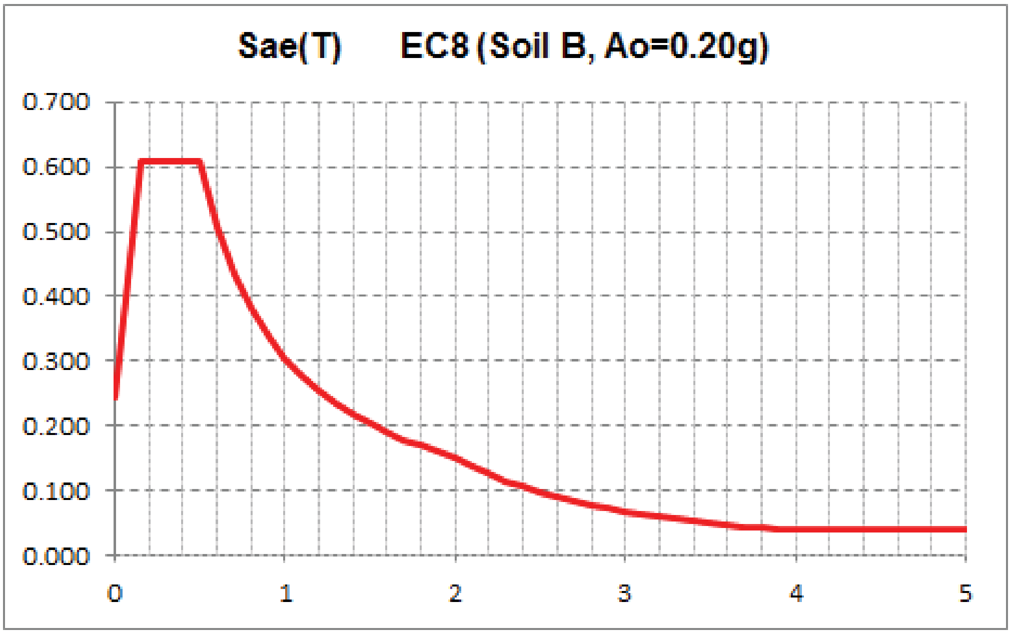
Ethem Bey Camisi için yapılan malzeme deneylerinde elemanların taşıyıcı özelliklerine ilişkin bir inceleme yapılamadığı için, deneylerde belirtilen diğer sonuçlar da göz önünde bulundurularak, literatürde belirtilen değerler kullanılmıştır [10, 17]. Literatür araştırmasında taş duvar ve kemerlerde taşıyıcı eleman özellikleri elastisite modülü değerinin 500~10000 N/mm^2 arasında değişen değerlerde dikkate alındığı görülmüş ve Ethem Bey Camisi'nin taş duvar elemanlarının mevcut durumunun iyi olduğu göz önünde bulundurularak analizilerde; elastisite modülü 5000 N/mm^2, Poisson oranı 0.20, birim hacim ağırlığı 24 KN/m^3 olarak dikkate alınmıştır. Duvar basınç dayanımının 12MPa olabileceği ve emniyet katsayısı 3 alınarak; emniyetli duvar basınç gerilmesi 4MPa, duvar çekme emniyet gerilmesi 0.5MPa, duvar çatlama emniyet gerilmesi τo=1Mpa olarak kabul edilmiştir. Tuğla kubbede; elastisite modülü 3000 N/mm^2, Poisson oranı 0.20, birim hacim ağırlığı: 22 KN/m^3 olarak kabul edilmiştir. Duvar basınç dayanımı 4.5MPa ve emniyet katsayısı 3 alınarak; emniyetli duvar basınç gerilmesi 1.5Mpa, duvar çekme emniyet gerilmesi 0.5MPa, duvar çatlama emniyet gerilmesi τo=1 MPa olarak kabul edilmiştir.

Sayısal analiz hesabı yapılırken eleman zati ağırlıklarına ilave olarak iklim özellikleri dikkate alınıp, deniz seviyesinden 100~150 m yukarıda olan yapı için güvenli tarafta kalmak üzere, 1kN/m^2 kar yükü ve ahşap çatı ve kiremitler için 1.5kN/m^2 sabit yük dikkate alınmıştır.

Deprem yükleri için Arnavutluk Deprem Yönetmeliği [13] ve Eurocode 8 [20] yönetmeliğindeki parametreler kullanılmıştır. Buna göre; ikinci zemin kategorisi ve Ke=0.285 kullanılmıştır. Ethem Bey Camisi zemin durumu için Eurocode 8/B grubu zemin ve A_{max}=0.203g yer ivmesi kullanılmıştır [13, 19]. Tarihi yapılar için önem katsayısı, Eurocode 8 esas alınarak I=1.2 kullanılmıştır. Arnavutluk deprem yönetmeliği ve Eurocode 8 elastik ivme spektrum grafikleri Sekil 4 ve Şekil 5'te gösterilmiştir.

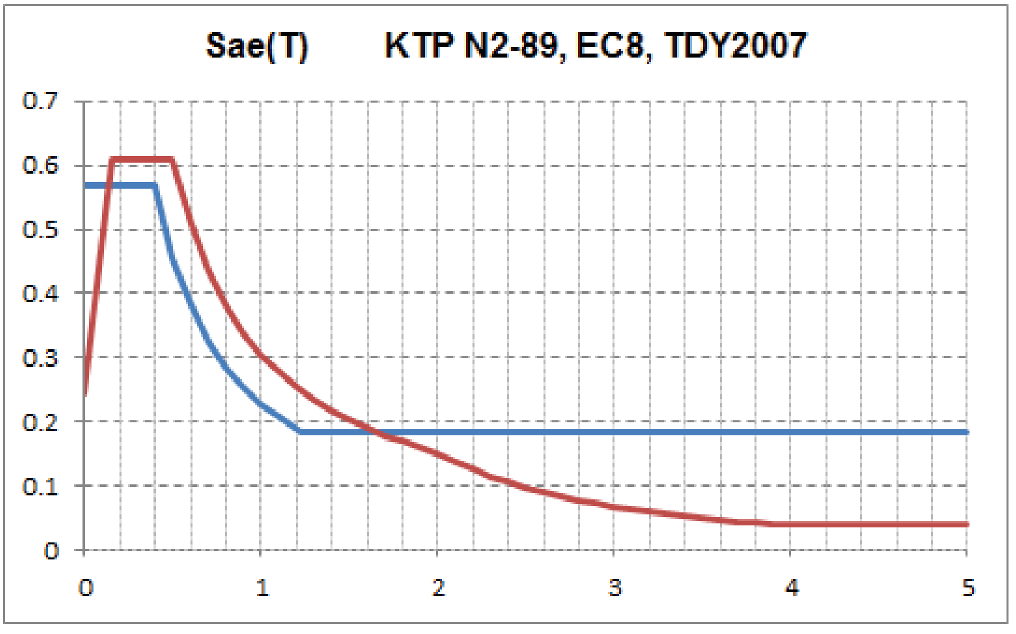


Şekil 4. Arnavutluk deprem yönetmeliği elastik ivme spektrumu



Şekil 5. Eurocode8 deprem yönetmeliği elastik ivme spektrumu

Şekil 6'da gösterilen Eurocode 8 ve Arnavutluk Deprem Yönetmeliği zarf elastik ivme spektrumu analizde kullanılmıştır.

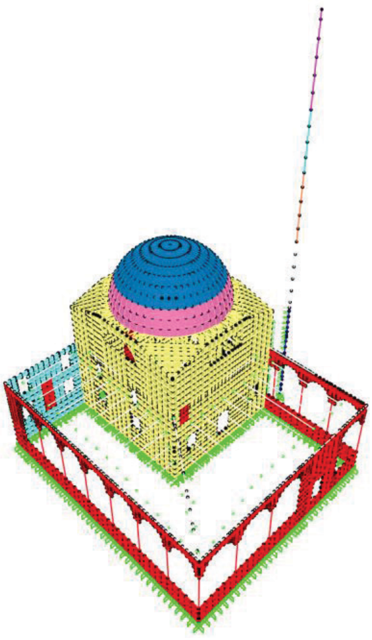


Şekil 6. Zarf elastik ivme spektrumu

Deprem yükü hesabında, deprem yükü azaltma katsayısı olarak bilinen taşıyıcı sistem davranış katsayısı için R=2 kullanılmıştır [17]. Yapının temelleri için literatür araştırmasına dayanarak, rijit temel varsayımı yapılmış ve ankastre mesnet olarak hesaplarda dikkate alınmıştır [19].

Sayısal Analiz Modeli – Matematik Model

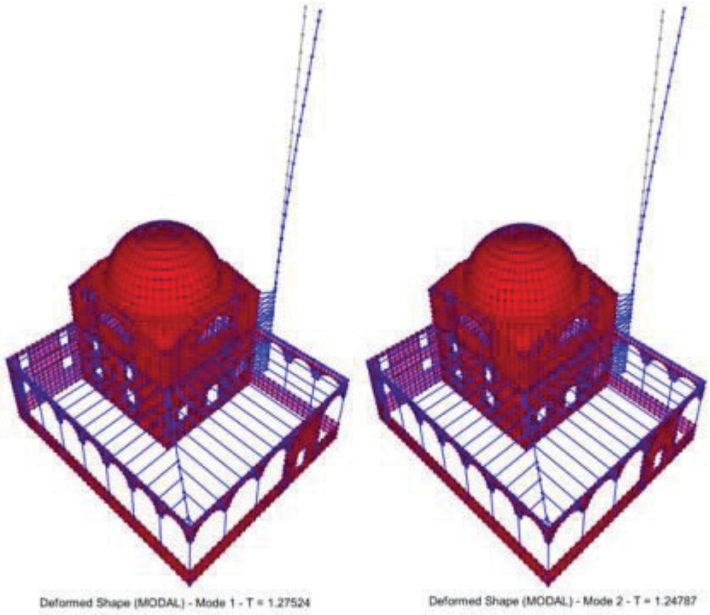
Ethem Bey Cami sayısal analizleri için Shell, Frame ve Joint elemanlardan 3B yapısal model kurulmuş ve düşey yükler ile deprem yükleri için analiz yapılmıştır. Modelde 4471 Shell, 4880 Joint ve 363 Frame eleman kullanılmıştır (Şekil 7). Analiz modelinin sadeliği ve yapı davranışını yansıtmada yeterli bulunduğu için bu çalışmada frame ve shell (çubuk ve kabuk) elemanlar kullanılmıştır. Daha kapsamlı; daha uzun süre gerektiren Solid elemanlar ile yapılan çalışmalar literatürde yer almaktadır, ancak bu yapı özelinde gerekli görülmemiştir. Tüm kaynaklarda olduğu gibi, bu çalışmada da basit yöntemler ile başlanması ve gerekli görülürse karmaşık yöntemlere doğru gidilmesine karar verilmiştir.



Şekil 7. 3B analiz model görüntüsü

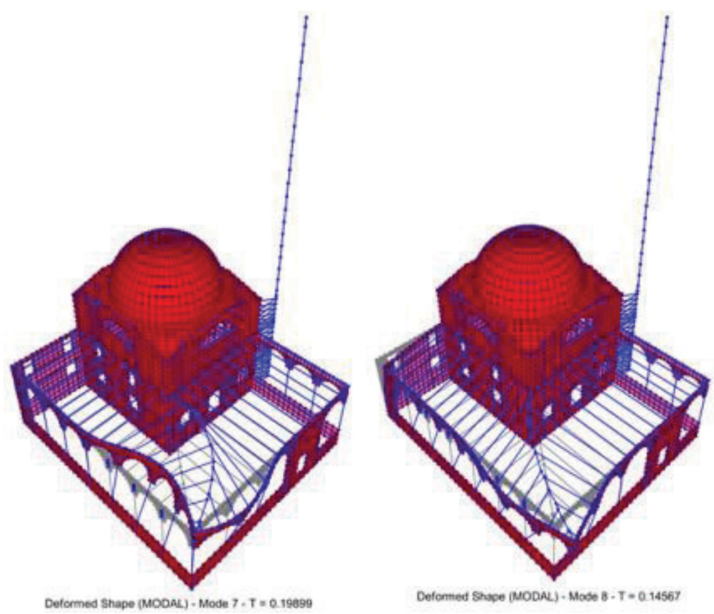
Sayısal analizde 150 mod dikkate alınarak %99 katılım sağlanmıştır. Yapının deprem durumu ağırlığı W=17380 kN ve deprem taban kesme kuvveti 4520kN olarak hesaplanmıştır.Cami ana kütlesine ek olarak, sütun ve kemerlerle oluşturulan, L biçimindeki, ahşap çatılı son cemaat yeri ilave edildiği durumda; düzgün geometrili, kare planlı bir bina olmaktan çıkan Ethem Bey Camisi’nde yatay yük etkisinde (deprem yükü) asal ekseninde dönme hareketi oluşmaktadır. L biçimindeki son cemaat kütlesi nedeniyle yapıda, X ve Y eksenlerinin diyagoneli doğrultusunda (45 derece dönmüş eksen takımı) ve ona dik doğrultu dışında titreşim ve sonuçlarda iki eksende de değerler ortaya çıkmaktadır.

Yapının hesaplanan ilk iki modu minareye ait olup periyotları; Ty=T1= 1.27 sn ve Tx=T2=1.25 sn'dir (Şekil 8).



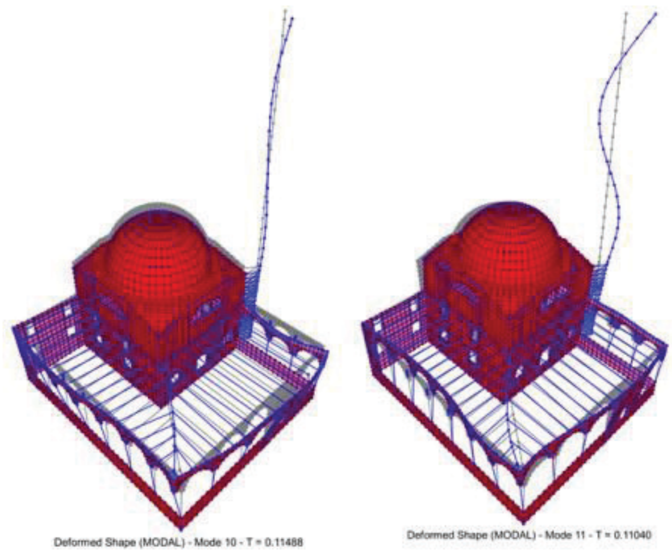
Şekil 8. Mod 1 ve Mod 2 (Mod 1 and Mod 2)

3B sayısal analizde, minareden sonra 7 ve 8 inci modlarda son cemaat yerinin yapısal elemanları olan sütun ve kemerler, 0.20 sn ve 0.15 sn periyotlar ile katılım göstermiştir (Şekil 9).



Şekil 9. Mod 7 ve Mod 8 (Mod 7 and Mod 8)

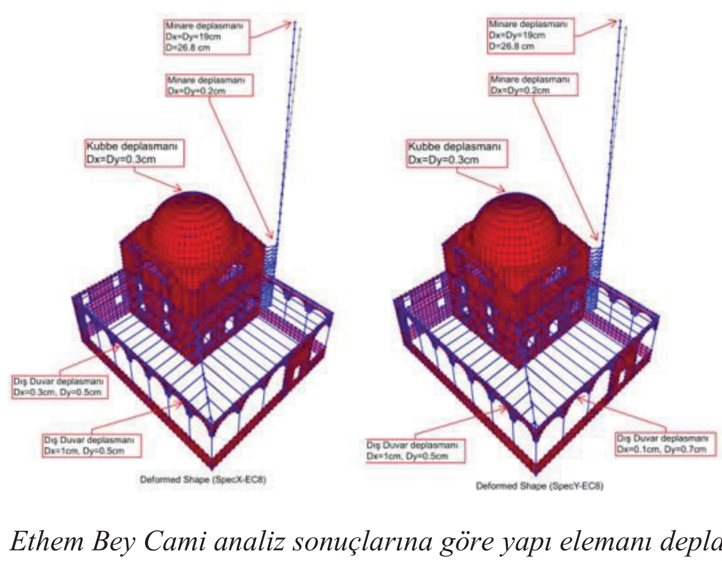
Yapı ana kütlesi olan, kubbeli cami kısmı, 10 ve 11. modlarda 0.11 sn periyot ile katılım göstermiştir (Şekil 10).



Şekil 10. Mod 10 ve Mod 11 (Mod 10 and Mod 11)

Yapılan 3B sayısal analizde, deplasman kontrolünde; ana bina olan cami kütlesinde kritik bir durum saptanmamış, narin olan minare kritik olarak değerlendirilmiştir. Minarede, deprem durumunda 26.5 cm mertebesinde, yatay elastik deplasman (R ile azaltılmamış) hesaplanmıştır (Şekil 11). Yapılan hesap; Türkiye Deprem Yönetmeliğinde deplasman kontrolü için belirlenen, deprem durumundaki elastik deplasmanın (Δ*R) yapı yüksekliği ve 0.020 (H/50) sınır değeri kontrolüne dayanmaktadır [18]. Eurocode 8 de deplasman sınırını değişik yapı özellikleri için 0.010(H/100) - 0.020(H/20) benzer şekilde vermektedir [20].

Ethem Bey Camisi için deplasman limitini sınırda karşıladığı kabul edilmiştir.



Şekil 11. Ethem Bey Cami analiz sonuçlarına göre yapı elemanı deplasmanları

Ethem Bey Cami minaresinde basınç gerilmeleri izin verilen emniyet gerilmesi değerlerini sağlarken, çekme gerilmelerinde emniyet gerilmesinden ziyade taşıma, eleman kapasite değerlerine ulaşmaktadır. Buna göre hesap sırasında yapılan kabuller doğrultusunda olası bir deprem durumunda minarede hasar beklenebileceği sonucu ortaya çıkmaktadır.

Cami kubbesinin yükü, sırasıyla; yük aktarma ve geçiş elemanı olan tromplara ve beden duvarlarına aktarılmaktadır. Trompların duvara yük aktardığı noktalarda ve duvar boşluklarının (pencere) etraflarında yoğunlaşma olmakla birlikte duvarlar taşıma açısından uygun olarak değerlendirilmiştir. Bu yüklerin, duvar altında daha geniş kesitli sürekli temel ile taşındığı kabul edilirse, zemin etüdünde belirtilen 200~250 kPa zemin emniyet gerilmesi değeri için yapı güvenli kalmaktadır [21].

Düşey yüklerle birlikte X depremi durumunda duvarlar oldukça güvenli olarak değerlendirilmiştir.

3.3. Bulgular

Bu çalışmada incelenen Ethem Bey Camisi'nin güvenlik değerlendirmesinde; yapılan deney sonuçları ve literatür kaynaklarına dayalı kabuller yapılmıştır. Basınç dayanımı ve elastisite modülü için literatür bilgileri kullanılmış; bölgeye ilişkin deprem bilgileri için 2010 tarihli, güncel olarak değerlendirilen "Data on the Seismic Danger in the City of Tirana, Republic of Albania Parliamenti, 2010" raporundan yararlanılmıştır. Sonradan ilave edilen abdestlik kısmının temele etkisi bilinemediğinden yaklaşık kabul yapılmıştır.

Ethem Bey Camisi'nin yapısal durum değerlendirmesi için ampirik hesap ve sayısal analiz olmak üzere iki yöntem kullanılmıştır. Yapılan analizler sonucunda ortaya çıkan bulgular aşağıda sıralanmaktadır:

- Ampirik hesap sonuçlarına göre bina geometrisinden kaynaklı bir kusur görülmemiş, sadece minare narin bir eleman olarak tüm anıtsal yapılarda olduğu gibi olası deprem durumunda en riskli yapı elemanı olarak gözükmektedir,
- Sayısal analiz sonuçlarına göre, olası bir deprem durumunda bina güvenlidir, minarede hasar oluşması beklenen bir durumdur,
- Her iki hesap yönteminin sonuçları yapının mevcut durumu ile karşılaştırıldığında örtüşmektedir. Yapının mevcut durumunda görsel olarak gözlenen yapısal hasara rastlanmamıştır,
- Ethem Bey Cami, yüzlerce yıl ayakta kalan tarihi yığma kagir bir bina olduğu için olası hasar; deprem ve malzeme özellikleri, zaman içinde çevresel etkiler vb. pek çok unsura bağlıdır,
- Tiran bölgesinin deprem durumuna ilişkin literatür kaynaklarının incelenmesi ve yapı için yapılan; görsel verilere dayalı ampirik hesaplar ile sayısal hesaplarda; olası deprem sonrasında, somut değerler ile binanın hasar durumuna ilişkin veriler ortaya koymak olanaklı değildir,
- Yüzlerce yıldır ayakta kalan Ethem Bey Camisi için yapılan hesaplar sonucunda; hasarın mertebesi, onarılabilir olup olamayacağı, göçme riski gibi durumlar nicel verilerle ortaya konulamaz.
- Yapılan incelemeler ve hesaplar sonucunda; Ethem Bey Camisi'nin bakım ve onarımları periyodik olarak ve doğru yöntemlerle yapıldığında yapı güvenli bir biçimde ayakta kalmayı sürdürebilecek potansiyele sahiptir.

4. SONUÇLAR VE DEĞERLENDİRME

Tarihi yapılarda gelişmiş analiz yöntemleri kullanmak; analizin yapılmasının mali boyutu, deneyimli uzman gereksinimi, sonuçların ve kullanılan yöntemin doğrulanması gibi zorluklar barındırmaktadır. Bu tür binaların yapısal davranışını belirlemek için yapılan çalışmalarda birçok ölçüt eş zamanlı değerlendirilmek zorundadır. Yapının geometrisi, malzeme, yapıya etkiyen yükler, geçiş elemanları, yapısal elemanlar arasındaki ilişki ve yük aktarma biçimi, zaman içinde geçirilen onarım ve müdahaleler olabildiğince ayrıntılı araştırılmalıdır. Burada en önemli konu, yapılan sayısal güvenlik değerlendirmesinin doğrulanabilmesidir. Karmaşık modele dayalı sayısal analizin sonuçları, alanda yapılan gözleme dayalı çalışmalar ve elde edilen bulgular ile örtüşmüyorsa anlamını yitirecektir. Sayısal analiz ile elde edilen sonuçlar yapının yapısal davranışını anlamak için kullanıldığında anlamlı olmaktadır.

Yapısal özellikleri bakımından pek çok belirsizlik içeren tarihi yapılarda, yapısal değerlendirme için özel yöntemler kullanılmakta ve farklı yaklaşımlar uygulanmaktadır. Non – lineer analizler karmaşık yığma kagir yapılar için olmazsa olmaz ve tek doğru yöntem olarak değerlendirilmemelidir. Gelişmiş ve karmaşık sayısal analizlerin karmaşık yapıların davranışı ve olası hasar durumunu anlamak için kullanılabilecek bir yöntem olduğu ve uzman gerektirdiği unutulmaması gereken en önemli konudur. Öte yandan basitleştirilmiş yöntemler, daha yaygın kullanılabilecek ve ön fikir verebilecek yöntemlerdir.

Yapısal değerlendirme için yöntem seçilirken; değerlendirmenin amacı, süre, donanım, sonucun nasıl ve niçin kullanılacağı, yapıya etkiyen yükler, yapısal riskler gibi ölçütler iyice kararlaştırmalı ve en uygun yöntem seçilmelidir. Sayısal analiz gerektiği durumlarda; yığma kagir olan, anıtsal tarihi yapıların kullanılan malzeme ve yapısal elemanların büyük kesitleri nedeniyle düşey yükler altında lineer davranış sınırları içerisinde kaldıkları düşünülebilir. Sadece, deprem gibi ilave tesirler ortaya çıktığında; oluşan iç kuvvetlerde, belirli bölgelerde lineer sınırın aşılması söz konusu olabilir. Lourenco; basitleştirilmiş yöntemlerin gelişmiş yöntemlere göre daha tercih edilebilir olduğunu ve en önemlisi, yapılan analizde elde edilen sonuçların doğrulanabilir nitelikte olmasının gereğini vurgulamaktadır.

Ampirik hesap yapmanın amacı; özellikle bina geometrisinden kaynaklanabilecek bina kusurlarının ortaya konulmasıdır. Bu hesapta dikkate alınan ölçütler; taşıyıcı duvar alanı toplamının bina ağırlığı ile olan ilişkisi, taşıyıcı duvar alanı toplamının bina brüt taban alanı ile olan ilişkisi, deprem yükü doğrultusundaki duvar kesme kapasitesi ve duvarların uzunluk ve yükseklik narinlikleridir.

Sayısal hesapta; düşey yükler altında lineer statik analiz ile genel yük dağılımı ve olası zorlanan bölgeler incelenerek, deprem durumunda lineer olmayan davranış, yük azaltma katsayıları ile temsil edilip lineer analiz yöntemi uygulanabilir. Günümüz yapı yönetmelikleri, hem düşey yük hem de deprem durumuna ait yükler için belirli güvenlik düzeyleri hedefleyen hesap yöntemleri içerdiğinden yük azaltma katsayıları kullanılarak analiz yapılabilir.

Bu çalışmada ele alınan ve bir örnek ile incelenen, tarihi yapılarda yapısal değerlendirme konusu oldukça karmaşık ve kesin bir yöntem ile tarif edilemeyecek bir iştir. Geometrisi, malzemesi, geçirdiği onarım ve müdahaleler yönünden çok karmaşık olan ve pek çok belirsizlik içeren tarihi yapıların güvenlik değerlendirmesi, yapıya özel unsurlar içermekte ve değerlendirme sırasında her yapının kendine has gereksinimlerinin olacağı dikkate alınarak amaca göre en uygun yöntem belirlenmelidir.

Tarihi yapılara ilişkin tüm çalışmalarda her zaman soru işaretleri ve belirsizliklerin olacağı unutulmamalıdır. Bütün çalışmalar; bilimsel yöntem ve yaklaşımlara dayalı olduğu halde uzmanlık bilgisi ve tecrübe ile şekillendiğinden her zaman için belli bir düzeyde sübjektif kabul edilmektedir. Yapılan hesap ve değerlendirmeler sonucunda ortaya çıkan yapısal durum hakkında verilen kararlar, ancak yapıda gözlenen hasarlar ile örtüşüyorsa geçerlilik kazanabilir.

SEMBOLLER

MSK: Mercalli ölçeğine göre deprem şiddeti
A_{max} : Max. İvme
A(T): Spektral ivme
S(T): Spektrum katsayisi
$A_{dvX,Y}$: Deprem yükü doğrultusundaki taşıyıcı duvar alanını
ΣA_{bina} : Binanın brüt (toplam) taban alanı
W: Bina ağırlığı
$FR_{dX,Y}$: Dikkate alınan deprem yükü doğrultusundaki duvar kesme kapasitesi
V_t : Eşdeğer deprem yükü
$L_{i\ dv}$: Bir doğrultudaki duvar uzunluğu
$t_{i\ dv}$. : Bir doğrultudaki duvar kalınlığı
$H_{i\ dv}$: Bir doğrultudaki duvar yüksekliği
γ : Malzeme birim ağırlığı
R: Taşıyıcı sistem davranış katsayısı
I: Bina önem katsayısı
T: bina periyodu

KAYNAKLAR

[1] Lourenço, P. B., 2001. "Analysis of historical constructions: From thrust-lines to advanced simulations", 3rd International Seminar on Structural Analysis of Historical Constructions, Guimarães, 7-9 Kasım.

[2] Sinha, R. ve Goyal, A., 2004. A National Policy for Seismic Vulnerability Assessment of Buildings and Procedure for Rapid Visual Screening of Buildings for Potential Seismic Vulnerability, Report to Disaster Management Division, Ministry of Home Affairs, Government of India.

[3] Lagomarsino, S. ve Reseminia, S., 2009. "the Assessment of Damage Limitation State in the Seismic Analysis of Monumental Buildings", Earthquake Spectra, Vol. 25, No. 2, 323-346, Mayıs 2009.

[4] Lourenço, P. B., 2002. "Guidelines for the analysis of historical masonry structures, em: Finite Elements in Engineering and Science", Eds. M.A.N. Hendriks et al, A.A. Balkema, Rotterdam, The Netherlands, 241-247.

[5] ICOMOS, 2003. Guidelines for the Analysis, Conservation and Structural Restoration of Architectural Heritage.

[6] Roca, P., 2007. "Recommendations for The Analysis, Conservation and Structural Restoration of Architectural Heritage", International Symposium on "Studies on Historical Heritage" - SHH07, Antalya, 17 – 21 Eylül (key note speech).

[7] Binda, L., Drdacky, M., Kasal, B. (Editors), 2006. In-situ evaluation & non-destructive testing of historic wood and masonry structures, Institute of Theoretical and Applied Mechanics of the Academy of Science of the Czech Republic.

[8] Ünay, A. İ.,2009. "Tarihi Binaların Yapısal Davranışı ve Performansını Anlamak için Sayısal Analiz Yöntemleri", Koruma Sempozyumu – Taşınmaz Kültür Varlıklarını Tespit ve Belgeleme Yöntemleri, Mersin Üniversitesi Restorasyon ve Koruma Merkezi, Mersin, 105-111, 1-3 Ekim.

[9] İbrahimgil, M., Z., 2014. Tiran, Ethem Bey Camii Sanat Tarihi Raporu, Gazi Üniversitesi, Edebiyat Fakültesi, Sanat Tarihi Bölümü, 34-44.

[10] Eskici, B., 2014. Tiran Ethem Bey Camisi Malzeme Koruma Raporu, Gazi Üniversitesi, Güzel Sanatlar Fakültesi, Kültür Varlıklarını Koruma ve Onarım Bölümü.

[11] EKOL Mimarlık, 2013. Eskişehir, Ethem Bey Cami Rolöve çizimleri.
[12] Arnavutluk, Tiran Ethem Paşa Cami Yapı Malzemeleri Arkeometrik Analizleri Raporu, 2014. Ankara Üniversitesi Yer Bilimleri ve Uygulamaları Araştırma Merkezi, Ankara.
[13] Aliaj, S., Duni, L., Kuka, N., Çollaku, A., 2010. "Data on the Seismic Danger in the City of Tirana, Republic of Albania Parliament", Ekim.
[14] Aliaj, S., Adams, J., Halchuk, S., Sulstarova, E., Peci, V., Muco, B., 2004. "Probabılıstıc Seismic Hazard Maps for Albania", 13th World Conference on Earthquake Engineering Vancouver, Kanada, 1-6 Ağustos.
[15] Vatan, M., 2010. "Anıtsal Yığma Binalarda Risk Düzeyinin Tespitine İlişkin Bir Öndeğerlendirme Yöntemi", Doktora tezi, Yıldız Teknik Üniversitesi Fen Bilimleri Enstitüsü, Mimarlık – Yapı Programı.
[16] Vatan, M., ve Arun, G., 2012. "Anıtsal Yığma Binalarda Ön-Değerlendirme Yöntemine Dayalı Risk Tespiti Anıtsal Yığma Binalarda Ön-Değerlendirme Yöntemine Dayalı Risk Tespiti", **MEGARON,** 2012: 7-2, 79-93
[17] Lourenço, P. B. ve Roque J. A., 2006. "Simplified Indexes for the Seismic Vulnerability of Ancient Masonry Buildings", Construction and Building Materials, 20: 200 – 208.
[18] Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik, 2007. Türkiye
[19] Çamlıbel, N., 1992. İstanbul'daki Tarihi Yapıların Depreme Karşı Dayanıklılığının Artırılmasına İlişkin Bir Sistem Araştırması, YTÜ Yayınları, Yayın No: 242.
[20] EUROCODE 8, 2002. Design of Structures for Earthquake Resistance.
[21] Altea Geostudio, 2014. Geological report for Ethem Bey Mosque.

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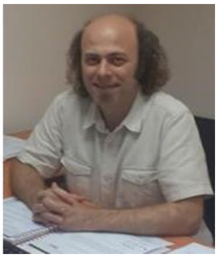
Studying Tabriz Elgöli Park in the view point of accessibility, safety and conveniences

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Abstract: *The urban problems caused by the industrialization have led to a decline in the quality of life in urban centers and a decline in urban spaces suitable for child development, this situation has increased the importance of urban parks as recreational areas where people can breathe, relax and enjoy their longing for nature. Accessibility to all recreational areas, which plays an important role on urban open space, should be arranged in such a way that people of all age groups can easily use them regardless of disability. The parks meet the needs of the people by leading them from the urban center to open areas. This study examined the functionality and accessibility of the zones in Elgölii Park in Iran Tabriz. Design and regulation principles of facilities and landscapes were evaluated in the context of the standards in Turkey, which would lead to the development of the park in the future.*

Keywords: *Urban parks, accessibility, Tabriz Elgöli Park.*

Tebriz Elgöli Parkının Erişilebilirlik, Güvenlik ve Konfor Kriterleri Çerçevesinde İrdelenmesi

Özet: *Sanayileşmenin beraberinde getirdiği kentsel sorunlar, kent merkezlerinde yaşam kalitesinin düşmesine, çocuk gelişimine uygun nitelikli kentsel mekanların azalmasına yol açmış, bu durum insanların nefes alabileceği, dinlenebileceği ve doğaya olan özlemini giderebileceği rekreasyon alanları olarak kent parklarının önemini arttırmıştır. Kentsel açık alan olarak önemli bir işlev üstlenen tüm rekreasyon alanlarının ve bu anlamda parkların erişilebilirliği, engelli ya da engelsiz farkı gözetmeksizin her yaş gurubundaki insanların rahatça kullanabileceği şekilde düzenlemelidir. Parklar kent halkını, kent merkezindeki yaşantılardan uzaklaştırarak, çeşitli ihtiyaçlarını karşılamaktadır. Bu çalışmada, İran Tebriz'deki Elgöli Parkının işlev alanlarının fonksiyonelliği ve erişilebilirliği incelenmiş, donatıların ve peyzaj öğelerinin tasarım ve düzenleme ilkeleri Türkiye'de geçerli olan standartlar bağlamında değerlendirilmiş ve parkın geleceğe yönelik gelişimine yol gösterebilecek çıkarsamalarda bulunulmuştur.*

Anahtar kelimeler: *Kent parkları, erişim, Tebriz Elgöli Parkı.*

1. INTRODUCTION

Dense housing, concentration and rapid growth of population in urban centers following the industrial revolution have caused increase in number of people living in urban centers. Today, parks make a big contribution to move people away from the urban center's adverse conditions, bring people close to nature and to eliminate of longing for nature and meet recreational requirements. Arrangement of parks, which are located in urban open spaces, in an accessible and freely usable way by people of all age groups whether handicapped or not, has importance. As such, functional areas like entrance of parks, pedestrian circulation paths, stairs, ramps, children playgrounds and parking lots as well as the floor coverings and urban furniture in foregoing areas should be arranged by taking into consideration the access and usage of all individuals. Elgöli Park is the biggest and most intensively enjoyed urban park of Tabriz. There are no works in the literature as to accessibility of people without handicap to this park. Accordingly, Elgöli Park of Tabriz/Iran, chosen as an example in this study, was evaluated in terms of accessibility by referring to widespread standards in Turkey determined through TSI 12576, Prime Ministry Department of the Administration of the Disabled (ÖİB), Ministry of Family and Social Policy, General Directorate of Services for Persons with Disabilities and the Elderly (ASPB) and Additional Technical Specification for Physical Environment and Constructions Accessible and Useable for Everyone (IMM).

Yıldızcı [1] states that open spaces can be utilized both as areas having a specific function such as agricultural areas and forest areas outside the city or as parks, gardens, squares and etc., which meet specific functions within the city. According to Özdengiş [2], open spaces can be divided into two main groups in terms of functionality as active and passive. They are also classified as urban green spaces and rural spaces areas according to the locations of their suitability for recreational activities, density of their green texture or their relationship with the city [2, 3]. Urban green spaces are grouped as green areas at the level of building, neighborhood unit, quarter unit and city while green areas at the urban unit level comprise urban parks and sports facilities [2, 4, 5, 6].

2. URBAN PARK CONCEPT

Urban parks consist of large green areas compared to neighborhood parks, equipped with some group units which are significant physically, psychologically and in terms of health for the city people [6]. Urban parks must be bigger than neighborhood parks and accessible and usable for healthy or disabled individuals in all age groups and include functions not covered by the neighborhood parks according to Aygün (2005). Moreover, urban parks are open green spaces which have to be located in focal points of the city in order to preserve the ecological balance of the city and meet the active-passive recreational needs of the city from all age groups [7, 8]. Adult individuals need areas of activity for relaxation and entertainment offered by urban parks in order to reduce the effects of exhausting daily routine, renew themselves, relax and become powerful spiritually. There must be integration between the functions included in the urban parks and visitors must be enabled to utilize the whole area of the park [2]. Urban parks are areas which are typically located centrally and a part of the city visually. They have to be situated in easily accessible locations for people's everyday use and ensure individual or collective activities such as walking, jogging, sitting outside, picnicking and playing games [8].

Urban parks provide opportunities for recreational activities and social and cultural interaction while eliminating the longing for nature for all members of the society suffering from the effects of daily routine. Morever, they provide space for furnishing game and education facilities for junior users in addition to opportunities such as exhibitions, shows and concerts for young people while creating healthier environments for middle aged and senior users. Furthermore, urban parks enable the cities to increase their tourism revenues by contributing to the development of the city's fauna-flora, protecting the ecological balance, contributing to the city's identity acquisition and promotion. Urban parks help to arrangement of human and vehicle traffic and ensure the creation of safe open spaces [8]. As such, urban parks should be arranged in an accessible and freely usable way by people of all age groups whether handicapped or not.

3. ELGÖLİ PARK AS A FIELD WORK SPACE

Tabriz is the largest city located in Iran's north-west and the administrative center of East Azerbaijan Province. Official population of Tabriz, with an area 324 sq km, is 1,494,998 as of 2011 while Tabriz is Iran's fifth largest city in terms of population after Tehran, Mashhad, Isfahan and Kerej (Figure 1) [9].

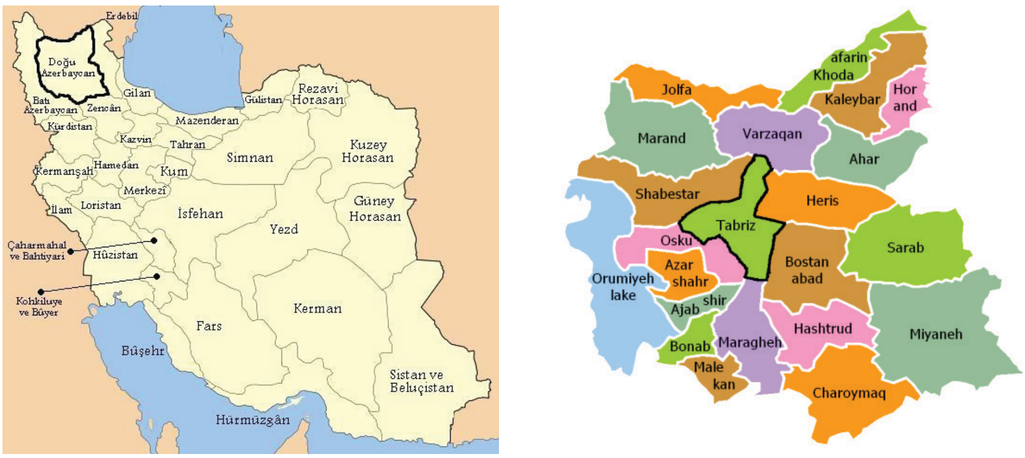

Figure 1. Iran's provincial map (left) and map of Eastern Azerbaijan (Right) [10]

Elgöli Park, situated in the south-east of Tabriz, is one of the city's largest parks and most important places with an area of 70 ha [11]. In Iran, the districts are named with numbers. The map showing the districts of Tabriz, which consists of ten districts, is seen in Figure 2. As it can be understood from the map, Elgöli Park is located in the south of the 2nd district and close to the borders of the residential neighborhood of the city.

Figure 2. District borders of Tabriz metropolitan area and location of Elgöli Park (indicated by red stain) [12]

Elgöli was built during the Aq Qoyunlu period (1378-1508) and expanded during the Safavid period (1501-1722). Elgöli was utilized as a reservoir for provision of water to big gardens surrounding Tabriz before the Safavid period [10]. In the Qajar period (1789-1925), following the Safavid period, a summer pavilion was built for the Qajar crown prince due to the beautiful, clean and cool air of the region and a street was built around the lake and various trees and roses were planted (Figure 3). Elgöli or the Shah Lake in the name of that period was planned to be converted into a public park in the Pahlavi period (1925-1979) and there for Elgöli was assigned to Tabriz municipality. Tabriz Municipality made some restorations around the lake's coast around to convert Elgöli into an open park for everyone in this period, [13].

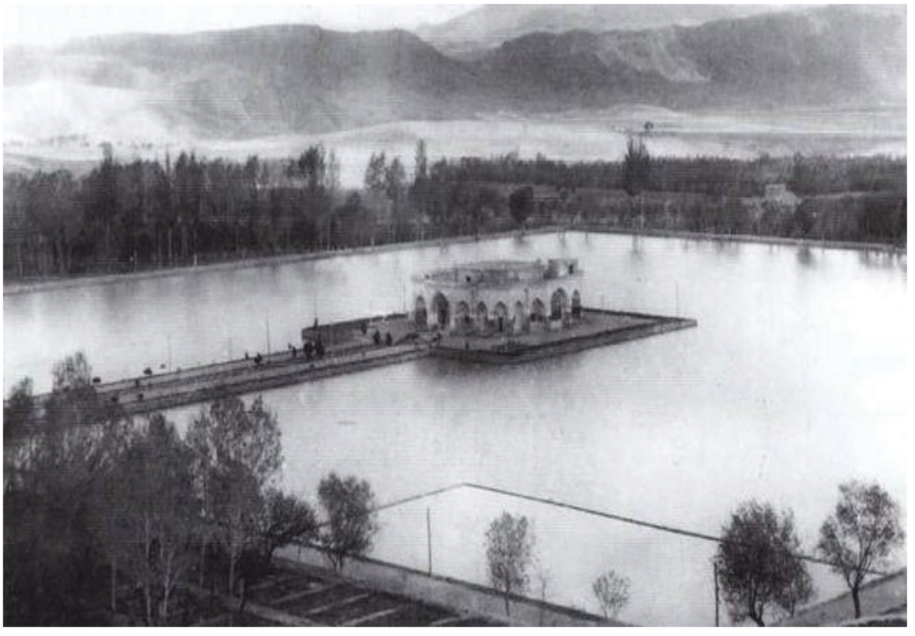

Figure 3. Elgöli kiosk during Qajar period [14]

The large octagonal building located at the center of the lake is known as the Elgöli kiosk. The building was made of adobe material and as a single-storey building in the Qajar period (Figure 3) and was reconstructed in Pehlevi period in 1945 through Tabriz Municipality as a two-storey building due to its being worn out (Figure 4). Today, this building is used as a big reception building [15].

The lake with an area of 5.5 hectare and with a depth of 12 m holds 720,000m³ of water. The lake was named as "Shah Lake" prior to the Iranian revolution however it was renamed as Elgöli Lake (People's Lake) subsequent to the revolution (1979). The title "Shah" has been used for Iranian kings since ancient times. However, the word "Shah" used for the Shah Lake has not been taken from the Shah word used for Iranian kings but has presumably been named because the lake is grandiose and gorgeous (Figure 5) [16].

Figure 4. Elgöli kiosk constructed in 1945 [17]

Figure 5. Elgöli park subsequent to the Iranian revolution [18]

Elgöli Park, layout plan of which is provided in Figure 6, is surrounded by a traffic way. There is a large hotel, indoor sports hall and football field at the south side of the park. In addition, there is also a large theater building on the east side of the park which is close to the main entrance. Elgöli Street, on the west side of the park hosting the 2nd, 3rd and 4th entrances, has a dense traffic flow with a giant traffic jam most of the day. This situation leads to difficult access to the park and it also affects the park's utilization negatively by causing noise pollution. The park's being crowded and noisy prevents users to spend their leisure time in a quiet and peaceful manner in open air. Opening of the subway station, construction of which is going on at the same street as well as taking measures to lower the effects of noise-caused adversities will be important steps for access and in order to reduce noise pollution.

3.1. User profile and utilization manner of Elgöli Park

Much as intensity of pedestrian utilization of Elgöli Park may vary within the day and in particular in summer and vacation days it has a very intensive utilization since it is the biggest urban park and one of the most important places of Tabriz. Elgöli Park is used more intensively in the afternoon and evening and many users are observed to enjoy the park also in the morning and at nights particularly in the summer season. Users utilize this park mostly as a place for picnicking and outdoor hiking along the coast of the lake. Inasmuch as Elgöli Park is a park open to public, it houses a variety of recreational activities fit for people of all ages, however teenager and children population group has a significant part compared to other park users. The reason why it has a higher usage in the evenings is that most of the users of Elgöli Park are working people who spend time with their families in the park after the working hours while their children play in the park. Various festivals are organized at the eastern part of the lake (close to the main entrance of the park). Families show a protective attitude for their children since the park is very crowded due to intensive use. Accordingly, it is observed that the children in the young age group cannot find efficient size of space to move freely.

4. PHYSICAL ASSESSMENT OF ELGÖLİ PARK

Elgöli Park is the biggest urban park of Tabriz city bearing also historical and cultural values. As mentioned in the introduction of the study, Elgöli Park was examined in titles by referring to the standards in Turkey and the physical accessibility thereof has been evaluated.

4.1. Entry points

Arrangement of entry points which enable access to the parks are of great significance for both pedestrian and car users. Elgöli Park has numerous entry points from different directions. Entries to the park have been arranged for pedestrian and vehicle entrances. The Second (main pedestrian entry), Fifth and Sixth entry points are employed only as pedestrian entries while the First (main entry), Third and Fourth entry points are utilized for both pedestrian and vehicle entries (Figure 6).

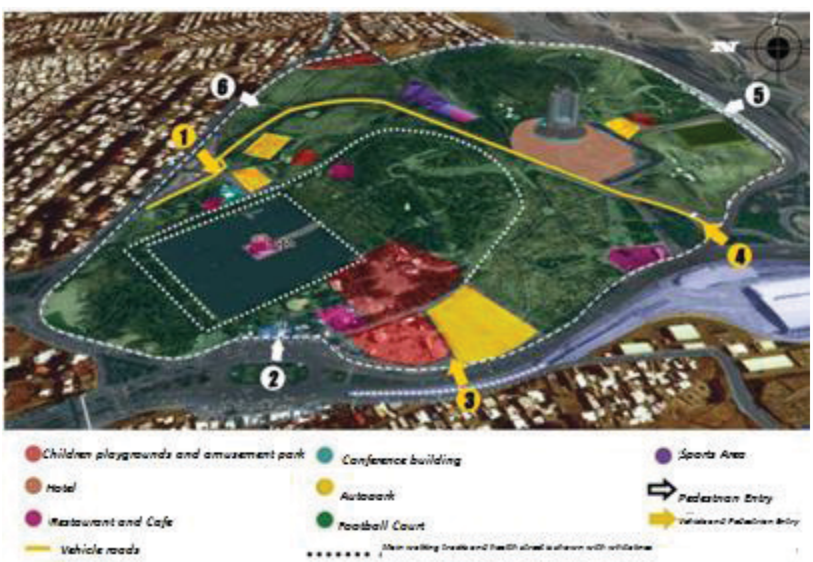

Figure 6. Layout of the Elgöli Park

Inasmuch as all entrances save the second entrance are far from the public transport stops, individuals using public transportation experience issues accessing the park from other entrances. As such, the second entrance, which is the main pedestrian entrance of the park, is the most used pedestrian entrance utilized by people using public transportation vehicles. Width sizes of all entrances of the area are sufficient and a ramp regulation is applied for the entrances with slope differences. There are ramps in all entrances to the park in order to reach the walking area along the lake. Furthermore, the Health Street, connected to the main entrance to access the upper parts of the park, is employed as a low-slope pedestrian path (Figure 7).

Figure 7. Health Street providing access to the upper parts of the park (left) and ramp at the main entry (right) (Aysan Danesharasteh's personal archive)

4.2. Pedestrian ways

The main goal is to provide a clear surface without obstructions with sufficient width in pavement design for safe access of individuals with limited mobility and especially for the disabled in the society. These principles should be taken into account in the design of pavement and ramps in all urban open spaces such as pedestrian roads recreational areas and squares [19]. The ideal width for an obstacle-free pedestrian walkway should be at least net 1.50 meters while the optimum is 2.00 meters. The pavement width should be minimum 3.00 meters at bus stops and 3.50 meters in front of the shops [19]. The sidewalk width must be designed in order that a disabled person with wheelchair can turn with angles of 90 °, 180 °, 360 ° and make "U" turn [20]. The slope of the section of pavement should be kept less than 2% by ensuring that wheelchair users can move without any problems [19] and there should be no manhole grilles on the pedestrian crossings [21]. All walkways and sidewalks allocated to pedestrians in Elgöli Park are above the standard of 1.5 m. Movements of disabled people using wheelchairs are ensured more than adequate for their turns (Figure 8). The bicycle riding area and sports area are separate from the normal walkways of the park. The area where the sportive actions are performed is called Health Street. Banning of bicycle riding and playing soccer applied on the lake side is not valid for the health road. This street is utilized more intensely in the morning hours of the day. There are numerous passages at the eastern and western sides of the lake for disabled people to come to the lake coast from the entrance areas (Figure 9).

Figure 8. Lakeside walkways [22]

Figure 9. Access routes in walkways for people with disabilities (Aysan Danesharasteh's personal archive)

Vehicle usage is prohibited on pedestrian roads. There are also pedestrian sidewalks on the roads allocated to vehicles. However, this creates a great deal of risk both to the people walking and especially the disabled and those who want to park their vehicles due to the depth of the water channels on the sides of these roads and the lack of grills in these channels (Figure 10). Plants, lighting elements, garbage cans and etc. on pedestrian paths do not have different texture and color contrasts to ensure that the disabled feel their surroundings and be alerted for it. This situation creates danger for visually impaired individuals. Furthermore, concrete pots and barriers placed in order to prevent vehicle access to walkways and especially to the Health Street, limit the width of the road thereby making passage difficult and dangerous for such visually impaired individuals. There are safety guards on the walkways near the lake. The height of the railings is suitable for protection of all age groups.

Figure 10. Roadside water channels (Aysan Danesharasteh's personal archive)

4.3. Stairs

Stairs are typically employed to connect spaces with spaces having elevation difference in open areas in the shortest way. However, some requirements have to be met as to design and usage of stairs in open areas, taking into account the disabled, elderly and other individuals with restricted movement within the society. Furthermore, the step height must be at least 15 cm while the step width must be at least 30 cm. There must be no difference in height between the steps and all steps should be at equal height in the step group in the stairs [23]. If the height difference is more than 1.8 m on the ways with stairs continuing in the same direction depending on the topographical structure of the land there must be a stairhead of 2 m between the stairs and at the beginning and at the end of the stairs there must be a surface with a flat and different texture in the length of 1.2 m for the visually impaired people. The sensible surface should be at least 60 cm wide and must be different with its different color and texture. This surface should start at the bottom just before the first step and be placed after leaving a space same with the width of the staircase at end of the stairs at the top [21]. There must be handrails on both sides of the stairs and, if there is a wall on the sides of the stairs then a railing must be placed. A rail guard should be placed with a maximum height of 45 cm between the railing and the step floor [23].

Going of stairways in different regions of the Elgöli Park have a width of 30-40 cm and while their height is 12-15 cm. So, it is observed that both riser and step measurements of stair units are suitable(Figure 11). When the staircases in the Elgöli Park are examined generally, it is observed that their material types are suitable, their surfaces are rough, stable and non-slippery and well maintained and in this respect they are fit for disabled people. Although there should be coating material with a length of 1.2 m with flat and different texture at the beginning and end of the stairs for the visually impaired people, this is not present in any staircase in the Elgöli Park. There are parapets made of stone on both sides of the stairs (Figure 11). Inasmuch as the stairs on the southern side of the lake have many steps, the stairheads are quite wide and many stairheads have been designed in connection with the sitting areas and walkways (Figure 11).The lighting elements around the staircase provide sufficient light for the staircase.

Figure 11. Lakeside stairs (left) and stairhead sample (right) (Aysan Danesharasteh's personal archive)

4.4. Ramps

Ramps are utilized on the sidewalks, at crosswalks, at the entrances of the buildings, briefly, to eliminate the height differences on the walking ways of the pedestrians or while they partake in an activity. The main target, when designing ramps, should be to provide ergonomically required conditions while wheelchair users, people with baby carriages and visually impaired people when they have to eliminate height differences [19]. Much as the ramp size may vary due to elevation difference between two levels, the intensity of use, it is stated in the guide of the United Nations (2004), titled "Accessibility for the Disabled: A Design Manual for a Barrier Free Environment", that the width of the plain ramps should be at least 90 cm and 140 cm in turn ramps [19]. There must be a stairhead at least with an area of 2.50 meters for resting in ramps that are longer than 10 m and exceeding the elevation difference of 50 cm. If there are more than one successive ramps the same rule should be applied [21]. The slope should be maximum 8% in ramps up to length of 10 meters and maximum 6% on ramps longer than 10 meters. The standards determined by Prime Ministry Department of the Administration of the Disabled (ÖİB) are partially different. The cited values are provided in Table 1.

Table 1. Dimensions of a ramp [19]

Maximum Slope	Maximum Length	Maximum Elevation Difference
1:20 (5%)	-	-
1:16 (6%)	8.00 m	0.50 m
1:14 (7%)	5.00 m	0.35 m
1:12 (8%)	2.00 m	0.15 m
1:10 (10%)	1.25 m	0.12 m
1: 8 (12%)	0.50 m	0.06 m

For wheelchair users, a protection border of at least 5 cm height should be made on the sides of the ramps which do not have guard rails [21]. Furthermore there should be a flat space 150 cm in length and different texture at the beginning and end of the ramps for the visually impaired persons. The surfaces of the ramps must be covered with hard, stable, non-slip and very less roughened material. The roughness on the surface should not create differences more than 0.2 cm [21].

The length of the only ramp at the first entrance area of the Elgöli park which attracts attention in the park is 18 m while its slope is 6% and width is 1.5 m (Figure 12). This ramp is within the appropriate limits according to the TSI (Turkish Standards Institution) however it slightly exceeds the limits of Prime Ministry Department of the Administration of the Disabled (ÖİB). It is observed that there is a protection border on the sides of the ramp. The surface of the ramp is fit for use of walking-disabled individuals. However, there is not a flat surface in length of 1.5 m with different texture for visually impaired persons at the beginning and end of the ramp. There are no ramps on the sides of the stairs inasmuch as the stairs around the lake area of the park are long and the slope of the land here is not suitable for making ramps. As such, the street in the south-east of the park is utilized as a pedestrian way for disabled people to reach the upper parts of the park, and functions as a low-slope ramp for disabled people (Figure 12).

Figure 12. Health Street going to the upper parts *of Park (right)*
(Aysan Danesharasteh's personal archive)

4.5. Pavement flooring

The material to be used for covering the pavement and walkways should be slip resistant and make walking easy. There must be no sudden level changes on the road surface, manhole covers must not protrude while there must be continuity at ground level. [21]. In addition, guide marks should be formed consisting of embossed surfaces that can be felt along the way in order that visually impaired people can easily find the route [19]. In this way, texture differences must be created on the surface of the equipments in order that locations of equipments can be felt by visually impaired persons [21]. The color of the guide marks must be selected in such a way as to contrast with other surrounding surface colors, while the embossed surface height of the material used should not pose an obstacle for wheelchair users [19].

Pavement flooring materials such as asphalt, slate and stone, concrete and paving stones have been employed in Elgöli Park. The slate is geologically composed of mudstone, siltstone, shale and volcanic ash. The layer surfaces of the slate which are separated naturally have a rough structure [24]. These materials are not fit for people with disabilities due to the wide and irregular joints which form between them, especially in the laying of slate stones (Figure 13). Moreover, although asphalt and stone pavement covering generally does not create difficulty in walking, it needs constantly maintenance due to climate of Tabriz and quality of the stone material used on the pedestrian paths of the park is not suitable for the park. For this reason, pavement covering must also be made again at some points in the park. It is important that the pavement covering to be used in the park should be considered as to comply with other landscaping items and urban furniture in color and material so that meaning and value is added to the space. There are no surfaces consisting of embossed surfaces that can be felt along the way on any walkway of the park in order that visually impaired people can easily find the route. As such, various problems are experienced in utilization of the park by the visually impaired people. This is one of the most significant issues of the park (Figure 13).

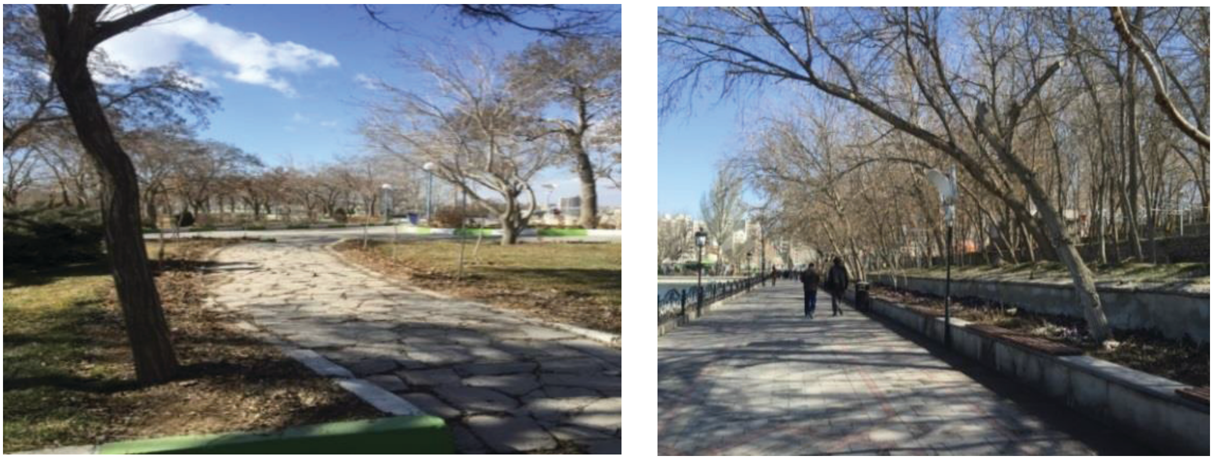

Figure 13. Pedestrian paths made of slate (left) and cobblestone(right) in Elgöli Park (Aysan Danesharasteh's personal archive)

4.6. Children's playgrounds

One of the most substantial design elements is safety. This subject is even more important for juvenile age groups. It is recommended that different age groups should play separately and if they will play in the same place, safety measures must be taken by considering the lowest age group [25]. Furthermore, safety barriers must be provided for children to prevent falls for safety in the playground, and materials having surface safety which will not cause injury such as grass, sand, rubber and etc., should be chosen on the ground for children against risks of falling and injuries [4, 26]. The furnishings should be plain, with little detail, well sanded and with rounded and blunt corners. In addition, the paints and colors used should not give harm to the health of the child. They should be appropriate for the language, intelligence, creativity, body and muscle development of the child ad must be fit for the child's age, development level and height while the child's sense of sharing should be developed. Their maintenance and repair should be easy and they must be cleanable [4]. Accessibility of children with disabilities to the playground is the first important issue to enable them participate in outdoor activities. Arrangement of pedestrian areas in a way that children using wheelchairs can move freely should also bed ensure for children with disabilities while playground equipments in the playground must be fit for use thereof by children with disabilities[27].

Elgöli Park has 4 children's play areas. These are known as First Playing Area, Second Playing Area, Autism Park and Amusement Park (Figure 14).

Figure 14. Playgrounds located in Elgöli Park

The first playground is situated in the south-east of Elgöli Park and is the closest playground to the lake and parking lot (Fig. 14). However, it has a very small area (Figure 15). This playground is built in the living areas located at the lake coast and is suitable for children in the small age group.

The second playground is situated away from the lake and the residential areas in the south part of Elgöli Park. This playground is situated behind the big Pars Hotel in Elgöli Park. This playground is accessed from the entry point on the Kesmai Tehran Highway (Figure 14). It has a very small area for the time being since the construction of the second play area is not yet completed, and as such it has only one game unit. Therefore, it is not preferred by both children and parents compared to other playgrounds. Its location in the park and its being far from public transportation stops are also important factors in its low utilization rate (Figure 15).

Figure 15. First playground (left) and second playground (right) (Aysan Danesharasteh's personal archive)

The first autism park in Iran, designed in line with the needs of autistic children, is situated in the south-east of Elgöli Park (Figure 14). The use of water elements, game elements and the elements made in the form of animals in this playground were made suitable for autistic children. This playground is more suitable for children aged 3-8 in the general sense. The sports elements such as basketball hoop and tennis table in the Autism Park are used for older children (Figure 16). Game groups comprise slides, seesaws, swings, balance elements, sand pools, animal cages and water surfaces. There is a long walking distance to reach this playground because the autism playground is far from the most important areas of Elgöli Park. It is also far from public transport stops. Individuals using public transport have issues accessing this playground inasmuch as Elgöli Park has a very large area.

Figure 16. Autism park (left) [28] and sports elements in Autism Park (right) (Aysan Danesharasteh's personal archive)

The amusement park is situated on the west and south west of Elgöli Park and on Elgöli Main Street. The amusement park can be entered both from the Elgöli Main Street and the south west of the Elgöli Park Lake. The Amusement Park, which is situated close to the lake and other sitting areas, mostly houses units and activities for children in the older age group and adults. Access to the park is quite comfortable thanks to its location. It is close to public transport stops (Figure 17).

Figure 17. Amusement park (Aysan Danesharasteh's personal archive)

The pavement covering of the First, Second and Autism playgrounds consist of a rubber-based material and is appropriate in terms of comfort and security. However, the pit occurring due to stripped playground covering under the swing in the autism park poses a potential danger for children. Moreover in the first game area, no fillings have been used around the tree trunks which create a level difference on the ground again posing a danger to children (Figure 18). Furthermore, the amusement park has been designed to serve not only children but also to adults and its pavement covering is made of asphalt and cast concrete. As such, it does not protect the children against the risks of falling and being injured.

Figure 18. Stripped playground covering in the Autism Park stripped (left) and formation of level difference in the First playground (right) (Aysan Danesharasteh's personal archive)

There is no age group seperation in any playground in Elgöli Park. As such all age groups utilize playgrounds together. This situation causes a risk of negative social and physical effect on children. Particularly in the First and Second playgrounds, the number of equipments is not sufficient and the children are bored and cannot spend much time inasmuch as they are designed only for the children in the small age group. On the contrary, in the Amusement park playgrounds are fit for use of older age groups and there are fewer options for children of younger age groups. The playing equipments comprise completely electric devices which have limited effects on children's physical development.

The materials of all the playgrounds are suitable for child safety in general however the playing elements are not clean and well maintained in the first playground. Especially the deformations in the chains of the swings pose risk, and there is vital risk for children in the second playing field due to the fact that some parts of playing elements are broken basing on lack of maintenance (Figure 19). The most significant issue of the playgrounds within the Elgöli Park is that they do not house special playgrounds for children with disabilities. As such, they are not fit for physically and visually impaired children. Surroundings of the first and second playgrounds located close to the parking lots are surrounded by fences in order to prevent children from running out to the parking lot.

Figure 19. The detail as to the swing in first playground (left) and slide detail posing risk in the second playground (right) (Aysan Danesharasteh's personal archive)

4.7. Parking Lots

According to TSI (Turkish Standards Institution) [21] norms, open car parks must have a smooth surface preventing slipping and there should be orientation arrows on the ground and poles. Parking spaces allocated to disabled persons in the public areas should be at the closest point to the entrance and exit of the relevant facility. In such areas, the sidewalks should be lowered to "0 cm" or "+3 cm" in line with the level of the vehicle way. Furthermore, there must be a disabled parking sign indicating that the vehicles of disabled persons can park in addition to plates showing the way to the disabled parking lot and signs within the parking lot must be illuminated during the night [21].

There is enough lighting in the parking lot for illumination during the night. On the other hand, there are no parking spaces allocated to disabled persons in Elgöli Park. Furthermore, there are no plates or signs showing the entry and exit.

8.4. Other items

Many lighting standards have been established by predicting the height of an adult human standing eye. The eye-line height of wheelchair users is about 1.19 m [29]. Height of the lighting elements must be at least 220 cm, so as to allow the passage of the pedestrians and particularly the visually impaired persons to pass safely and be suitably placed so as to provide a sufficient level of illumination.

The height of lighting elements of the Elgöli Park is 2.30 m to 2.50 m. The level of illumination in the park is extremely sufficient. Elgöli Park has a quite spectacular appearance at nights, making it a center of attraction for everyone. Furthermore, lighting elements in the park have a significant role for safety and comfort of the users.

Elgöli Park is quite rich in terms of plant variety and number. The height of the branches of the plants extending to the walkways of the park does not pose risk. However, there are no surfaces or guard rails visually impaired persons which the can feel on the line separating the walkways and planted areas.

Waste containers should be installed with minimum 90 cm and maximum 120 cm height from the ground and at least 40 cm away from the curb stone at the side of the pedestrian sidewalk in a way not to impede the pedestrians' movements [23]. The waste containers in Elgöli Park are made of metal and are placed on the roadside in a fixed manner not impeding with the movement of the individuals. Furthermore, the height measurements of waste containers in the park are suitable for the standards since their height is 1m. There are sufficient waste containers in the park. However, they are susceptible to visually impaired individuals since there are not areas with different textured materials surrounding them to indicate their presence.

The height of the sitting unit should have a height of 45 cm and the backrest should have a height of 70 cm from the ground, [21]. The height of sitting elements from the ground is 40-45 cm while the backrests have a height of 82 cm from the ground in Elgöli Park the ground. These measurements are in accordance with the standard. The sitting units are made of wood and metal and are sufficient in number in important areas of the park.

5. CONCLUSION

The Elgöli park has issues in terms of accessibility to park from the outside and to certain areas within the park itself. Nevertheless, it is an urban park which is visited extensively by Tabriz people of all ages with or without disability and it is the most important open green area of the city. Although it can be said that the circulation network in the park is relatively convenient for physically handicapped people, foregoing is not true for visually impaired people. Another important issue within the park is observed in playgrounds. The playground has been arranged without taking into consideration children with disabilities and different age groups. There are dangerous points for children as a result of negligence and carelessness. There is also the issue of access to some playgrounds.

The gorgeous park rising over the historical and cultural richness of Elgöli will be a role model in this region of the country in terms of functionality and human values by virtue of the revisions to be made in the light of these evaluations. In this regard, firstly urban administrators and urban planning, urban design and ergonomics specialists have more important duties to carry out.

REFERENCES

[1] Yıldızcı, A.C., Relations Between The Urban Tissue and Green Tissue in Istanbul and a Proposal for the Green Space System Istanbul, PhD Thesis, Istanbul Technical University, Faculty of Architecture, Istanbul, 1978. .

[2] Özdingiş. N., A Research on Evaluation of Istanbul Urban Parks As Regards People with Physical Disabilities, M.Sc. Thesis, Bahçeşehir University, Institute of Science and Technology, Istanbul, 2007.o

[3] Özdemir, B. Evaluation of Some Urban Parks in Konya Province As Regards User Preferences, M.Sc. Thesis, Selçuk University's Institute of Science, Konya, 2013.

[4] Bal, A., Examination of children's playing areas in terms of landscape architecture principles in Zonguldak province's green space system, M.Sc. Thesis, Karaelmas University, Institute of Science and Technology, Bartın, 2005.

[5] Öztürk Levend T., Examination of open and green spaces of Bayrampaşa district of Istanbul province in terms of quality and quantity , M.Sc. Thesis, Selcuk University Institute of Science, Konya, 2008.

[6] Demir, Z., 2004, Bringing in New Functions to Open and Green Areas in Düzce's New Urbanization Process, PhD Thesis, Istanbul University, Institute of Science and Technology, Istanbul, 2004.

[7] Ertekin, N. Studies on Determination, Protection and Development of of Flora of Kültürpark Which Has Importance for Izmir Province as Green Area, Master Thesis, Ege University, Department of Landscape Architecture , İzmir, 1992.

[8] Özkır, A., 2007. Development of Urban Parks Management Model. PhD Thesis. Ankara University, Institute of Science and Technology, Ankara, 2007.

[9] URL-1. https://www.amar.org. is, last accessed on 02 January 2017.

[10] URL-2. http://iranrehberi.net, last accessed on 02 January 2017.
[11] Eslami, F., Tabriz, city of beauties, Iran, Tabriz (Persian) 2009.
[12] URL-3. http://www.ourism.tabriz.ir, last accessed on 02 January 2017.
[13] Maasumi, A., Tabriz province, Iran, Tehran (Persian), 1999.
[14] URL-11. Akharin news, http://www.akharinnews.com , last accessed on 02 January 2017.
[15] Rahnemayeshahsavar, N., Tabriz, the oldest city of History , Iran, Tabriz (Persian), 2003.
[16] Khamachi, B., Tabriz, my city, Iran, Tabriz (Persian), 2007.
[17] URL-4. http://www.citypedia.ir, last accessed on 02 January 2017.
[18] URL-5. http://www.irannaz.com, last accessed on 02 January 2017.
[19] ÖİB., Basic Information Technical Manual on Accessibility for Local Administrations, Prime Ministry Department of the Administration of the Disabled (ÖİB), Ankara, 2010.
[20] Gökçe, D., Usage Opportunity of the Parks by Individuals with Disabilities in Antalya Province's Atatürk Kültür Parkı example, M.Sc. Thesis, Akdeniz University, Institute of Science, Akdeniz, 2012.
[21] TSI., Design Rules for Intracity Roads,Alleys, Streets, Squares and Structural Measures and Marking for disabled people , TSI 12576. TSI Institute Publications, 1999.
[22] URL-6. http://www.tourismonline.com, last accessed on 02 January 2017.
[23] ASPB., Accessibility Implementation Guide for Individuals with Disabilities at Special Care Centers, the Turkish Ministry of Family and Social Affairs, General Directorate of Services for Persons with Disabilities and Elderly People 2013.
[24] URL-7. http://www.sefatas.com, last accessed on 02 January 2017.
[25] Kuşuloğlu, D.D, Qualitative and Quantitative Evaluation of the Children's Play Area in Kadıköy District of Istanbul Province, Master Thesis, Istanbul Technical University, Institute of Natural Sciences, Istanbul, 2013.
[26] Yılmaz, Ş.,, Evaluation of Utilization of Playgrounds by Users Studying Primary School and Determination of Design Principles , Master Thesis, Istanbul University, Institute of Natural Sciences, Istanbul, 2010.
[27] Çetin, G. Examination of Adequacy and Quality of Playgrounds in the Üsküdar district , Master Thesis, Istanbul Technical University, Institute of Natural Sciences, Istanbul, 2003.
[28] URL-8. https://www.nasrnews.ir, last accessed on 02 January 2017
[29] IMM., Additional Technical Specifications for Accessible and Usable Buildings and Physical Environment for everyone .Istanbul, 2012.

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