Advantages of Adobe Structures In The Design of Zero Energy Building

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ABSTRACT

The majority of the energy consumed in today's building designs is provided by fossil fuels. The energy consumption of buildings corresponds nearly 40% of the total energy consumption. That amount creates approximately 74% of the electricity consumption. Therefore, it is still unclear what rate of this need will be compensated by fossil fuels in the future with the increasing energy requirement. The climate change in progress, daily increasing greenhouse gases (methane, ozone, carbondioxyde, nitrogen oxyde, water steam, etc. gases) reduce the energy consumption in buildings and makes it compulsory to increas the energy efficiency and using renewable energy resources. The global climate change caused rapid increase of the energy demand and in order to solve the problem of buildings having the largest share in energy consumption, priority must be given to passive house, zero energy building designs. Design of "zero energy buildings" gain importance by minimizing costs related with energy consumption in buildings. Adobe material is an important structure material with heat insulation, energy storing and ecological aspects. Adobe building materials are envisaged as the most important building material of the future due to its structural characteristics. In this study, zero energy building designs, amount of energy consumed in zero energy buildings, applicability of adobe building material in zero energy buildings and studies in this area for our country will be researched.

KEYWORDS; Fossil fuels, climate change, energy consumption, passive houses and zero energy buildings, adobe material

1. INTRODUCTION

The natural damage created by the use of fossil fuels indicates that we will be facing with an important climate change problem in coming years. Discussions about that issue initiated after 1979 but scientific researches reveal that the current situation is not adequate for solving the problem (URL-1).

Figure 1 : Non-renewable energy sources

After the Intergovernmental Panel on Climate Change (IPPC) held in 1988, the first intergovernmental negotiations started in 1991 and the UN Framework Convention on Climate Change, which was signed in Rio-Brazil in 1992, entered into force worldwide in 1994. Recognizing that, with this convention, all countries should cooperate in the widest extent appropriate to their common but different responsibilities, opportunities, social and economic conditions, and participate in effective and appropriate international studies; The aim was to stop the effect of greenhouse gases accumulating in the atmosphere of countries on climate change at some level. In the reports published in the Intergovernmental Panel on Climate Change (IPCC), held by the UN Environment Program (UNEP) and the World Meteorological Organization (WMO) in 1988, the seriousness of the situation is shared with scientific studies.

Along with the global climate change, extreme weather events have been experienced in Turkey in recent years. Excessive and instantaneous precipitation, temperature and flood disasters as a result of overheating of the air increase the use of energy along with the collapse of the urban infrastructure.

70.2% of the energy consumption in 2012 is due to the building heating, cooling and lighting needs. This consumption is equivalent to 440 million tons of carbon dioxide equivalent greenhouse gas emissions. (one). Due to our high dependence on foreign energy, our primary energy consumption has increased by 64% between 2000 and 2015. (Fig. 2). Researches conducted in 2015 show that the rate of energy consumption from imported energy sources has increased and reached 75.9%. The energy consumption used in the building sector was 32.8%, even more than the industrial sector (URL- 2) (URL-3)

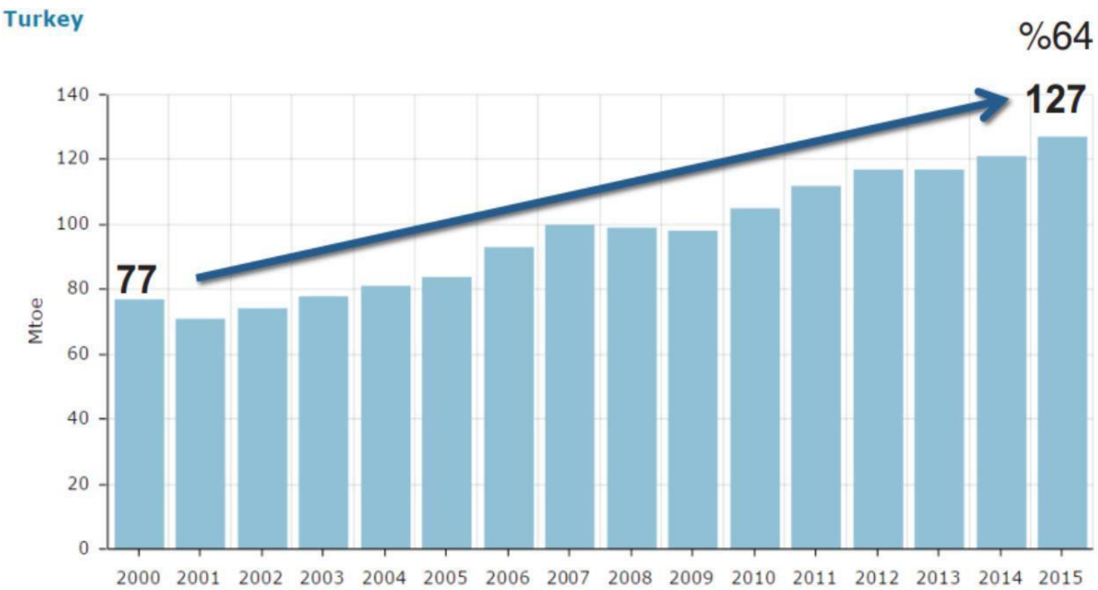

Figure 2: Turkey's energy consumption between 2000-2015

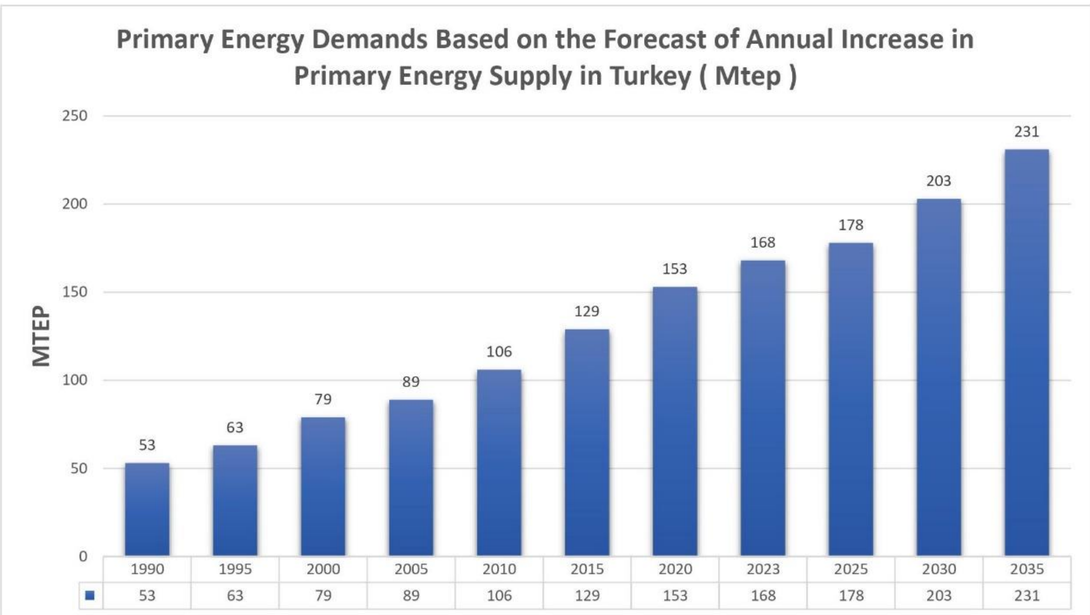

Figure 3: Turkey B. Energy Supply Demands (mtoe) Based on Primary Energy Annual Growth Rates Estimate (Source: EIGM/MENR General Energy Balance Tables 3)

Figure 4 : Clımate Change

With the signing of the Paris Climate Agreement, until 2053, Turkey entered the period of determining Net Zero Emission targets in climate policies. In this period, however, it became imperative that achieving the targets required a total transformation for the transition to 'Zero Energy Buildings' with regulations and incentives.

In the Eleventh Development Plan (2019-2023) of the Presidency of the Turkish Office of Strategy and Budget, the "Zero Energy", which has become mandatory in the EU as of January 1, 2021, for a healthier and more livable world by expanding the efficient and self-generating buildings. The decisions to transform into Buildings have been included in the action plan, which includes Turkey.

The use of energy consumption in the world and in Turkey is 35-40%[4]. The portion of energy use in buildings used for heating, cooling, air conditioning and hot water supply is approximately 80%[5]. The effects of gas emissions thrown into the external environment on climate change are gradually increasing. The results of these effects are shown by scientific studies.

The high amount of energy used in the housing sector requires re-examination of the energy systems used in building designs and innovations in the building materials used. Along with the important problem caused by the energy shortage, the designs made under the concepts such as "Green Building" and "Zero Energy Building" have increased the efficiency of energy use and the orientation towards renewable energy sources. "Net zero energy buildings" discussed in this context are defined as buildings that consume less energy compared to the houses built today, that minimize the interaction with the climate and environmental conditions outside the building, that provide the energy they need from renewable energy sources, that can work integrated with the national energy distribution lines, that are environmentally friendly, sustainable and at the same time aiming for zero CO_2 emissions. is defined.

When the features that make up Zero Energy Buildings (NSEB) are listed, the building should be placed in appropriate directions to benefit from sunlight and energy savings during the layout, and this process should continue with thermally insulated windows. By insulating the building envelope, heating/cooling losses from the external environment should be minimized, panels or wind turbines for electricity generation and solar collectors for hot water should be used.

Buildings with zero energy efficiency are given different names such as "Energized Buildings (ZEB)", "Near Energy Buildings (NZEB)", "Passive House", "Green Energy Buildings". It is aimed that the energy used in these structures is low and the energy resources are used less.

The goals of the European Union in the building sector for 2020, 2030 and 2050 in terms of energy efficiency and reduction of emissions are given in Table 1 below (URL-4) (URL-5).

2020 Target	• 20% reduction in greenhouse gas emissions compared to 1990 levels • Meeting 20% from renewable energy sources • Increasing energy efficiency by 20%
2030 Target	• 40% reduction in greenhouse gas emissions compared to 1990 levels • Meeting 27% from renewable energy sources • Increasing 27% energy efficiency
2050 Target	• 80% reduction in greenhouse gas emissions compared to 1990 levels

Table 1: Energy Related Goals of the European Union

Figure 5 : Beach House

The declaration prepared by ZeroBuild Summit'22 includes the responsibilities and approaches of all stakeholders of the issue. The attitude that all countries that have signed this declaration expect from the Central Government is to determine the decarbonization roadmaps in the housing sector and make legal regulations regarding the energy savings targeted until 2053. In Turkey, it is an important necessity to carry out a standard study on this issue.

2. SUSTAINABILITY, SUSTAINABLE ARCHITECTURE, ZERO ENERGY BUILDINGS AND ADOBE STRUCTURES

2.1 Sustainability

The Industrial Revolution, which first emerged in the United Kingdom, continued in Western Europe, North America and Japan and spread all over the world. The energy problems, also known as the Industrial Revolution or the Industrial Revolution, which continue to increase with the effect of new inventions on production in the 18th and 19th centuries in Europe and the creation of mechanized industry by steam powered machines, the increase in unplanned and rapidly developing industries today. With the increase in population around the world and the uncontrolled use of natural resources, the decrease in natural resources, the more use and production of non- renewable energy and materials, along with environmental pollution and many problems that threaten humanity. The concept of sustainability has emerged to reduce these problems, which emerged with the realization of the industrial revolution in the 1970s and continue to increase until today.

The concept of sustainability has gained more importance in recent years due to the decrease in natural resources, increasing population and non-renewable energy problems. The concept of sustainability is defined as "the evaluation or use of a resource in a way that the resource is not consumed or permanently damaged" (Kımilli, 2006). The generally accepted meaning is the definition made by the Brundtland Commission in 1987 as "Sustainability development is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs, that is, without harming the lives of future generations". This definition is accepted as the most comprehensive definition of the concept of sustainability (Haştemoğlu, 2006) (URL-6).

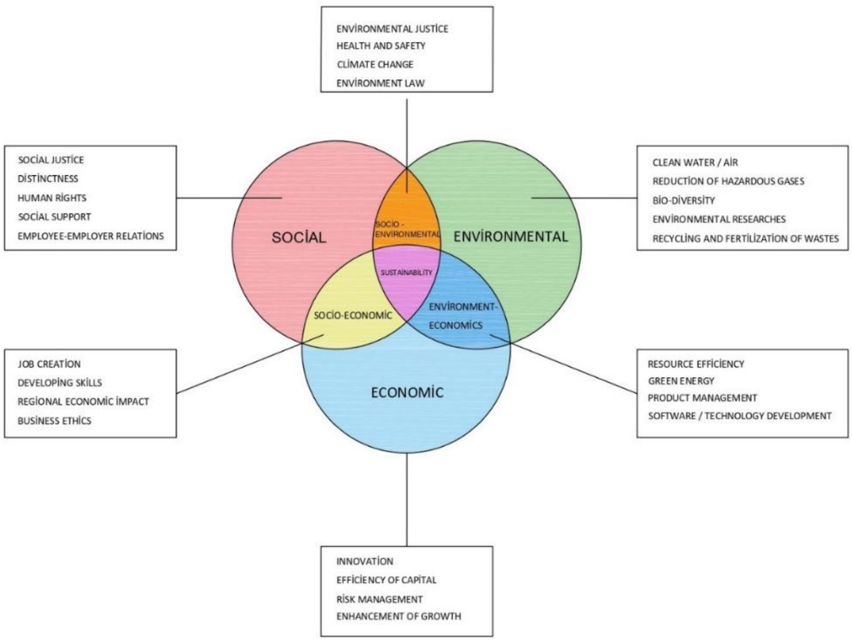

Figure 6 : Components of sustainability

2.2 What is sustainable architecture?

In its simplest form, we can call "sustainable architecture" an architectural approach that uses the least amount of natural resources, uses more renewable resources, does not create environmental pollution and is designed in harmony with nature.

Established in 1994 by the United States Green Building Council, this standard, created for the dissemination and preference of sustainable architecture, is called LEED Standards (Leadership in Energy and Environmental Design). Since 1994, certain updates and standards have been formed in the construction and design of nature-friendly and green buildings, which can be measured in the design. These standards and criteria aim at the basis of an efficient use of energy approach.(URL-7)(URL-8)

Figure 7 : Sustaınable Archıtecture

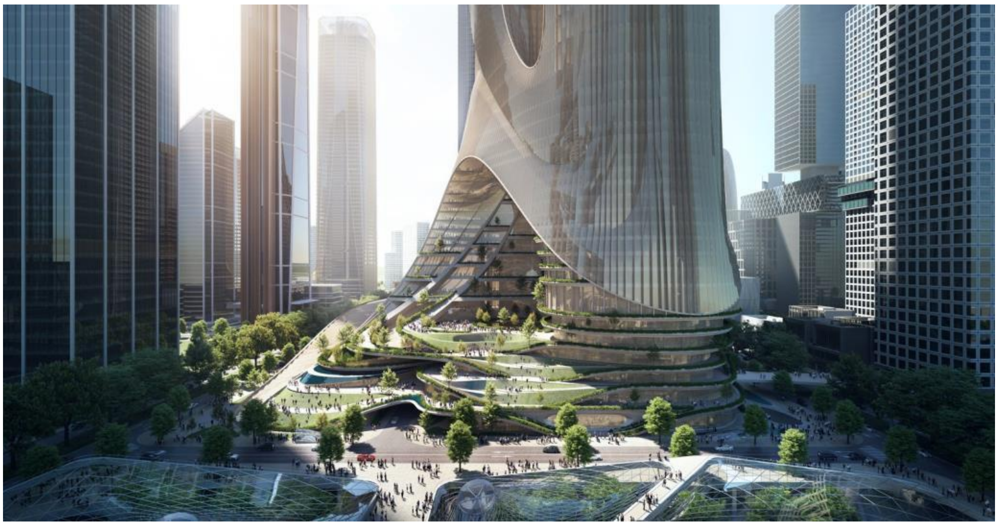

Figure 8 : An Ecological Podium Skyscraper: TOWER C / Zaha Hadid Architects

2.3. What is the purpose of sustainable architecture?

The main purpose of Sustainable Architecture is to ensure continuity by incorporating renewable resources into the transformation by enabling people to connect with the ecosystem. Sustainable architecture aims to meet the amount of energy needed without polluting the surrounding natural area and by using the power of the natural environment. For example, when we look at the features of newly built sustainable buildings, attention is paid to the fact that they are capable of meeting their own energy needs. In order to benefit from solar energy in the building, it is important to find environmentally friendly technologies such as solar panels or wind turbines that will save energy. Thanks to these designs, energy resources such as natural gas, water and electricity are also saved.

It is one of the important objectives to ensure energy efficiency as long as the use of the structure continues. Building materials used in sustainable housing are also very important. These materials need to be selected in a way that does not have negative effects on the environment. Adobe material is an important building material due to its thermal insulation, energy storage and ecologicality. It is predicted that the mud brick building materials will be the most important building material of the next period due to its structural characteristics(URL-9)(URL-10)

Figure 9 : Cultural Center Osoyoos, Canada

2.4. Principles of Sustainable Architecture

All the work done in the field of sustainable architecture and architecture aims to leave a more livable world for the new generations without posing a threat to the future of the world. However, innovations in architectural building materials are prioritized to be compatible with social, economic and ecological sustainability. Another important issue can be called the need to analyze the natural resources and environmental conditions in the areas where architectural designs will be implemented and to participate in the design phase.

3. ZERO ENERGY BUILDINGS

3.1 Zero Energy Buildings

In today's designed buildings, the energy used in air conditioning (heating-cooling-ventilation), lighting, and household appliances is inadequate to meet the energy needs despite the energy systems installed in the buildings. As a solution to meet this energy needs, which continues to increase rapidly, "Zero Energy Buildings (ZEB)" is proposed. To define zero-energy buildings, it is right to say that buildings that use efficient energy building techniques that provide the energy used from renewable energy sources and energy-efficient technologies.

At the heart of zeb design is the idea that all energy needs of buildings are met from low cost, locally available environmentally polluting and renewable sources. (Torcellini, Pless and Deru, 2006). In the EU Directive on Energy Performance in Buildings, it says: zero-energy building (ZEB) must demonstrate low primary energy (fossil-based energy) consumption and high energy performance (URL-11). It has important proposals that solve problems such as reducing the use of fossil energy fuels, eliminating the threats posed by carbon emissions, generating as much energy as needed, and combining energy efficient construction techniques with renewable energy technologies.

Sustainable, environmentally friendly, ecological, green, zero energy defined under different concepts such as zero energy buildings are designed in accordance with nature, sensitive to the environment, starting from the settlement of the land where it will be built, taking into account environmental and social criteria. In this sense, taking into account land conditions and climatic conditions, they are structures that use renewable energy sources correctly, do not produce waste with the use of natural and recyclable materials and consume only as much energy as they need (Environmentally Friendly Green Buildings Association, 2019). In summary, zero-energy buildings are buildings that aim to produce as much energy as they consume throughout the year and are built to equal the consumption of their annual production. Since the buildings cannot produce the energy they need when the appropriate weather conditions cannot occur, they get it from the national electricity grid and send the excess energy back to the National electricity grid during periods of high energy production. In this way, it sends back the energy it uses from the grid when it cannot produce the energy. In this way, two different types of design are formed. In cases where overproduction exceeds consumption, "positive energy building" is defined as "buildings with near zero energy" (NZEB) when production is lower than consumption.

Freiburg Zero-Energy Building application is one of the exemplary structures of zero energy building design. Designed with climatic conditions in mind, the building has gained passively from solar energy thanks to large surfaced windows on the southern façade. Transparent insulation supported walls on the façade prevent heat loss and at the same time the solar heat stored in the walls is transferred to the interior. Thanks to the modules added to the roof, electricity is generated from solar energy and hot water production is also carried out. As such, the building is a zero emission building (Figure 10, 11)(URL-12).

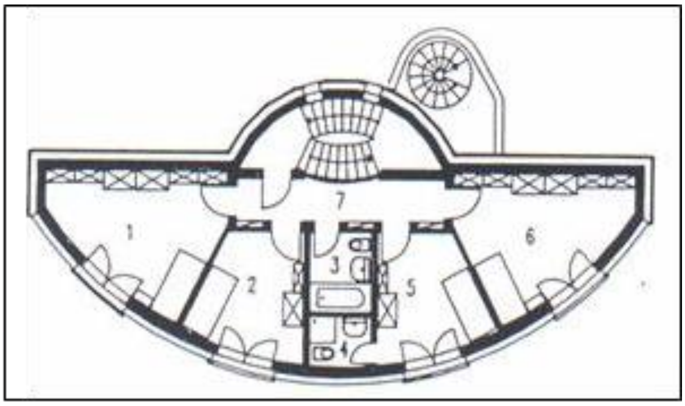

Figure 10: Freiburg Zero-Energy Building View

Figure 11: Freiburg Zero-Energy Building Plan

3.2. Passive House Standards

The "Passive Home Standard", which is formed by the development of low energy-use home design standards, can also be done with the use of design, building materials and technology. Passive houses form the building group that provides internal climatic conditions suitable for human health in summer and winter without the need for a traditional air conditioning system. The three main elements that make up the passive home standard are expressed as follows.

1- Controlling the energy used in air conditioning,
2- Ensuring indoor thermal comfort in accordance with ISO 7730 norms,
3- Providing energy needs and adequate indoor comfort with the help of cost passive system designs.

There are 5 important principles that should be applied in structures built in accordance with passive house standards. These are the ones that are going to

1- Heat Insulation: The outer shell is very well insulated,
2- Windows with high thermal insulation resistance: Insulation of opening gaps in the façade, i.e. window frames,
3- Waste Heat Recovery: Saving energy required for healthy indoor air quality,
4- Building shell airtightness (Sealing): In terms of air tightness of the exterior, compliance with air exchange norms should be ensured,
5- Blocking heat bridges: All edges, corners, connections and transitions should be carefully planned and made.

The representation of 5 important principles that should be applied in structures designed in accordance with passive house standard is as follows;(URL-13)

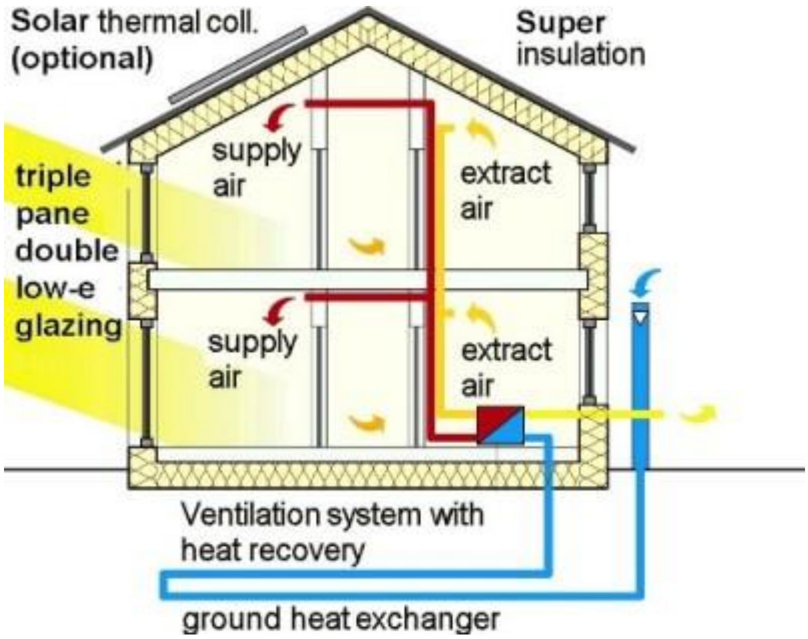

Figure 12 : Schematic representation of the main principle of zero energy (Passive) house standard 5

Darmstadt Passive house was built in 1991-1992 and insulation in the building is very well planned. The building, which does not use traditional heating systems, has also benefited from passive solar energy by providing insulation of the outer shell, low-temperature windows and a south-facing orientation. At the same time, the conservatory, which is defined as a buffer on the north side, supports the structure in a different respect by supporting the soil heat with the waste heat recovery system in the reduction of heat losses and ventilation (Figure 13-14)(URL-14).

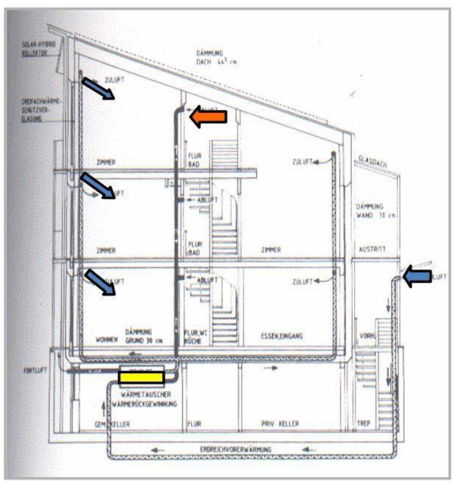

Figure 13 : Darmstadt – Passive home appearance (Wolfgang Feist, Passivhaus Institut, 1992)

Figure 14 : Darmstadt – Passive house section, (Wolfgang, (Wolfgang Feist, Passivhaus Institut, 1992)

3.3. Advantages of Zero Energy Buildings

Compared to existing buildings, zero-energy buildings save 50%-70% energy. By reducing carbon emissions, they release less emissions into the atmosphere. By reducing dependence on fossil fuels, they reduce their ecological footprint. Considering these characteristics, it is foreseen that it will play an important role in creating a healthier future without energy problems.

Zero-energy buildings produce the renewable energy they need when viewed in the form of annual periods, thereby reducing the energy use needed and ungenerated by the building industry. In order to reduce energy use in buildings, appropriate building materials are used first, and renewable energy sources are included to meet the remaining energy needs. These buildings, which are compatible with the environment, provide economic benefits as well as meeting the energy needs throughout the life of the building.

Zero emissions, minimum waste, high indoor quality, unplanned consumption of natural resources, making important contributions in the prevention of environmental pollution, reducing greenhouse gas emissions and, most importantly, being environmentally friendly structures are prominent features in solving the problem created by non-renewable energy sources.

Today, the zero-energy buildings designed are constructed with important objectives such as minimum emission, minimum consumption, minimum waste, efficient human-nature relationship, maximizing indoor quality, healthy indoor conditions, ensuring an efficient working environment, efficient use of natural resources and keeping adverse environmental conditions to a minimum. The problem posed by non-renewable energy sources is that they are environmentally friendly structures with benefits such as reducing energy consumption and therefore reducing greenhouse gas emissions, as well as effective use of rainwater, waste management and waste amount reduction, and protection of air and water quality and natural resources.

Another goal aimed at these buildings is to limit the damage to the ecosystem and to prevent environmental pollution. It is aimed to increase the number of zero-energy buildings (ZEB), reduce environmental pollution and make great contributions in the long term to improve energy security.

3.3. Zero Energy Building Design

Some of the most important criteria that zero-energy buildings consider are the correct and effective energy use of energy efficiency. Zero energy buildings are of great importance in order to minimize the damage to the ecological environment and to save energy.

Energy efficiency and sustainability are of great importance during the design phase of zero energy buildings. To achieve this, some systems that can be integrated with the structures are shown on the sample building in Figure 15 (Yöntem, 2016:5).

Figure 15 : Ankara, Xinjiang and Etimesgut TKGM Building energy efficiency applications, Ministry of Environment and Urbanization Ankara, Sincan ve Etimesgut TKGM Bina enerji verimliliği uygulamaları, Çevre ve Şehircilik Bakanlığı

In zero-energy buildings, some of the energy needed by the structure is provided from renewable energy sources within the structure. All heating and cooling energies used by the building and some of the electrical energy consumption are provided by these systems. Good building insulation and solar heat gain (Passive Energy) are important points to consider. Apart from these, the energy to be used is provided from renewable energy sources (Figure 16) (Berberoglu, 2009).

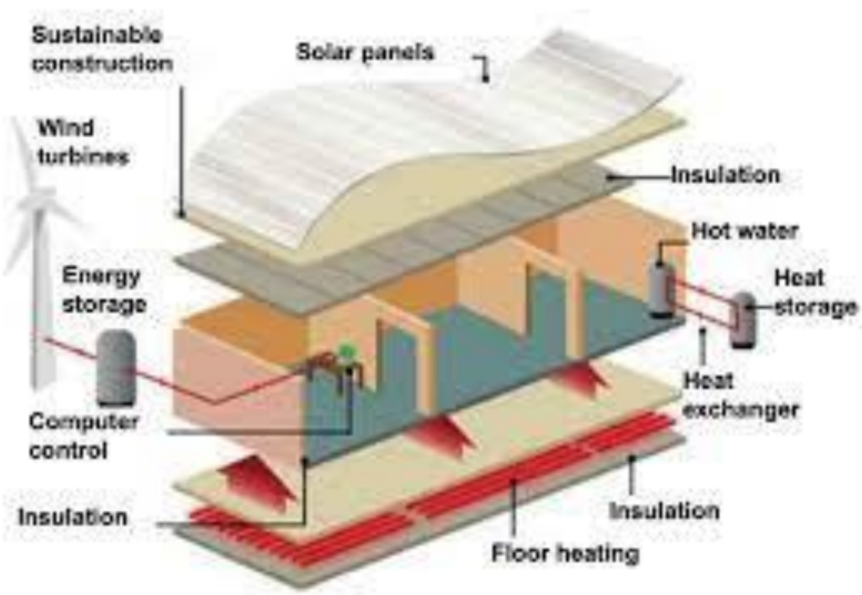

Figure 16 : Example of zero-energy building

4. ADOBE STRUCTURES

When we look at today's building materials, we see that soil structures remain the healthiest and best thermal insulation material. Besides, it's breathing, so it balances the humidity of the environment. The construction of a soil structure is quite economical as it is made entirely with the materials in that region. From here, it is possible to make structures that are compatible with nature and recycled.

In human history, soil and production go back to 9000 B.C. In Anatolia, the settlements of Aşıklı Mound in 8000 B.C. and Çatalhöyük in 7500 B.C. are the places where the first soil structures were seen. Built in 1300 B.C., II Ramses' vaulted earth grain stores are still standing. This shows that the soil still remains the healthiest and best thermal insulation material. And because he's breathing, he's balancing the humidity of the environment. At the same time, it saves energy with its thermal insulation feature. The construction of a soil structure is quite economical as it is made entirely with the materials located in the place of that area. Moreover, like concrete-produced houses, they are not high energy consumption structures.(URL-15)

Figure : Windhover Contemplation Center, Stanford University

Today, designers make earth structures by combining traditional methods with modern techniques. Especially developed countries are working hard to investigate and implement these techniques to make more identity structures. In these days of energy problems, it is extremely important that soil structures are improved and reuse of them by taking advantage of today's technologies.

4.1. Traditional Adobe

According to the TS 2514 (1967) standard; it is defined as "a product that can be used in construction by mixing hay or other vegetable fibers (plants of thatch type, coarse grass, hemp fibers, residual hay collected from barn mangers, dry shrubs, pine needles, tree branches, saws, grater chips) into clayy and suitable soil, and then poured into molds after kneading with water and dried outdoors."

The TS 2515 (1985) standard defined the adobe structure as "buildings with wooden ceiling and floor coverings, the walls of which are made with mud brick and mud mortar".

Advantages of traditional adobe

Adobe material is a construction material that is suitable for modern technology, compatible with the ecological system due to its material feature, providing the comfort and ease of use of the age, breathable, carrying many advantages in terms of design features, workmanship in terms of short construction time and more economical.

Advantages of traditional adobe are:

The availability of soil, which is its main ingredient, in every region;
Its production is done in a short time and there is no need for technical knowledge;
Being an economical material, low cost;
Being an ecological material;
Providing thermal insulation.
Being resistant to fire (Table 2.),

MATERIAL TYPE	**INTENSITY P (kg/m3)**	**THICKNESS D (cm)**	**FLAMING SMOKE**	**FIRE RESISTANCE TIME**
SOLID ADOBE	2000	15-25	-	F 120 – F 180
LIGHT ADOBE	900	25	-	F 180
CONCRETE	2300	20	-	F 180

Table 2: Behavior of adobe materials in fire (Anon., 1993. VKF Vereinigung Kant. Feuerversicherungen, Brandschutzregister, Ausgabe)

Providing sound insulation according to material properties (Table 3.).

MATERIAL TYPE	**INTENSITY P (kg/m3)**	**SOUND İNTENSİTY**	**SOUND İNTENSİTY**	**SOUND İNTENSİTY**	**SOUND İNTENSİTY**
		30 dB	**40 dB**	**50 dB**	**55 dB**
SOLID ADOBE	2000	0,03	0,07	0,20	0,40
LIGHT ADOBE	900	0,04	0,12	0,33	0,73

Table 3: Sound insulation value of adobe materials (Anon., SIA 181, Schallschutz im Hochbau, SIA 381/1 Baustoffkennwerte)

Low energy consumption in construction and use,
Being environmentally friendly,
Easy maintenance and repair work.

Mud brick reinforced with plaster and lime (ALKER)

Alker is a adobe material that is formed by adding certain amounts of gypsum-lime and water to suitable soil and kneading it. Alker is not made with traditional adobe mixing methods (mixing with feet). The soil in the area where the building will be built is examined, and 10% gypsum and 2% lime are added in appropriate proportions and mixed with the help of a shovel or concrete mixer. (Kafesçioğlu R., Toydemir N.,Gürdal E., Özüer B., "Stabilization of adobe with gypsum as a building material" TÜBİTAK MAG 505. İstanbul. 1980.) (Işık, Bilge, Advisor: Ruhi Kafescioğlu, Assistants: A. Akın, H. Kuş, İ. Çetiner İ., C. Göçer and N. Arıoğlu, "Determination of Mechanized Construction Technology and Standards Suitable for Gypsum Additive Adobe Material")

Mechanical and physical properties of alker

It is a type of adobe made by adding 10-20% gypsum to the adobe soil while making alker. In terms of its structure and physical properties, it is more durable than traditional adobe. Thanks to the gypsum added to the soil, rapid setting occurs and provides the necessary strength when being removed from the mold. Since there is no drying process, there is no need for a drying area, no loss of time and labor, and it provides convenience in application.

Thanks to the rapid solidification that occurs in the plaster, it prevents cracking by not allowing shrinkage and deformation in cases where balanced drying cannot occur.

While this situation leads to an increase in strength, it also prevents water from dispersing the soil. Recent studies show that the physical and mechanical characteristics of the alker material have important properties. The properties in Table 4 should be known in order to reach the necessary comfort and safety conditions for masonry structures made using Alker. (Kafesçioğlu R., Toydemir N.,Gürdal E., Özüer B., "Stabilization of adobe with gypsum as a building material" TÜBİTAK MAG 505. İstanbul. 1980.) (Işık, Bilge, Akın A., Kuş H., Çetiner İ., Göçer C., Arıoğlu N., "ADetermination of Mechanized Construction Technology and Standards Suitable for Mudbrick Building Material with Gypsum Carcass" TÜBİTAK İNTAG TOKİ 622, İstanbul, 1995.) (Işık, Bilge, Özdemir P., Boduroğlu H., "Earthquakes Aspects of Gypsum Stabilised Earth (Alker) Construction for Housing in the Southeast (GAP) Area of Turkey" Disaster prevention Management, Workshop, Ankara 11 Mart 1999.)

FEATURE	VALUE
Shrınkage (%)	1,0 - 1,5
Water Absorptıon (%)	Very Low
Heat Transfer Coeffıcıent (W/mK)	0,4
Heat Storage	1,0
Long-Term Water Exposure (Excludıng Surface Impact)	-

Table 4. Physical properties of alker (Kafesçioğlu, R., 1980. Stabilization of adobe as a building material with plaster, TÜBİTAK MAG 505, Istanbul)

Even though the appearance of adobe structures manufactured with traditional methods changes in a short time, Alker mud brick structures are more robust structures due to both the short production phase and high strength. Table 5 clearly shows the differences between traditional adobe and alker. (Işık, Bilge, P.Özdemir ve H. Boduroğlu, "Earthquake Aspects of Proposing Gypsum Stabilized Eart (Alker) Construction for Housing in the Southeast (GAP) Area of Turkey",Workshop on Recent Earthquakesand Disaster Prevention Management, Earthquake Disaster Prevention Research Center Project (JICA), General Directorate of Disaster Affairs (GDDA), Middle East Technical University, Ankara, 10-12 March 1999.) (Işık, Bilge, "The Effect of the Use of Gypsum Mud (Alker) Instead of Brick in the Housing Wall in the Example of New Gözeli in the GAP Region on Annual Energy Use and Air Pollution" GAP Environment 2000, congress, HARRAN)

TRADİTİONAL ADOBE BUİLDİNG TECHNOLOGY	**GYPSUM ADDED ADOBE CONSTRUCTİON TECHNOLOGY**
Cutting adobe : no precipitation – summer	4 seasons production
Drying Adobe : No precipitation – summer	-
Construction period : No precipitation – summer	4 seasons production
Rest is required	-
Large area for cutting adobe	Casting on the wall
¤ Large area for drying	-
Gains strength in 15 -21 days	Gains strength in 20 minutes
30% clay	10% clay
The outside of the wall should be protected from precipitation	Can be left open
Not done in rainy areas	Can be done

Table 5. Comparison of traditional and gypsum-added adobe building technologies (Işık, Bilge., Akın, Alev., Kuş, Hülya., Çetiner, İkbal., Göçer, Caner., Arıoğlu, Nihal. December 1995. Determination of Appropriate Mechanized Construction Technology and Standards in Gypsum Additive Building Material, TUBITAK Research Report. Project number: İNTAG TOKİ 622)

These disadvantages in traditional adobe not only reduce the use of adobe, but also increase the interest in industrial products that are incompatible with the ecological system, do not recycle, do not have natural air conditioning systems, and do not save energy. However, the mudbrick structures built in recent years have suffered very little damage in terms of their lifetime and there is no deterioration on the building surface (Table 6 –7).

Quality	Threshing Brick	Perforated Brick	Concrete Block	Light Concrete Block	**Alker**
Internal Surface Temp. (C)	12,44	13,70	9,68	14,85	16,80
Heat Accum. Capacity (kJ/kgK)	75,24	54,34	110,00	57,60	139,80
phase shift (h)	4,50	4,47	4,03	13,58	29,00
Cooling Period (h)	14,29	12,87	13,97	17,28	66,68

Table 6. Qualifications of various wall types in terms of building climatology (Kafesçioğlu, R., Gürdal, E., 1985. Contemporary Building Material Alker, Ministry of Energy and Natural Resources, Department of Energy, Shell, Istanbul)

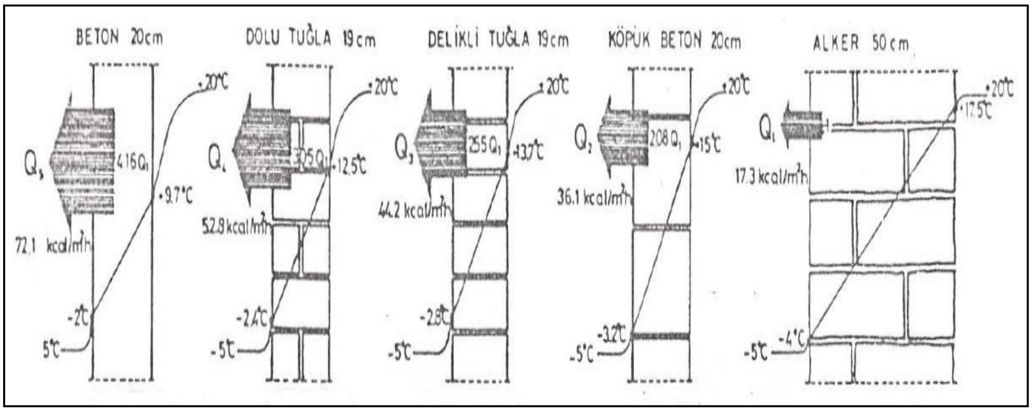

Table 7. Alker malzemenin ısı depolama değerinin diğer duvar malzemeleri ile karşılaştırılması (Kafesçioğlu, R., Gürdal, E., 1985. Contemporary Building Material Alker, Ministry of Energy and Natural Resources, Department of Energy, Shell, Istanbul)

4.1. CONCLUSIONS

With the decision taken by the European Union, it has been emphasized that, starting from 2020, new buildings, including public and residential buildings, will be zero-energy buildings, which will make very important contributions to the solution of the energy crisis and environmental pollution in the coming period. In this sense, it is important to increase the performance of the building envelope, to support the use of new building materials with energy saving and renewable energy sources. In this sense, it is important to increase the performance of the building envelope, to support the use of new building materials with energy saving and renewable energy sources. It is pointed out that healthier structures that produce their own energy, which do not create environmental pollution by minimizing the emission of emissions to energy consumption, by evaluating our solar potential and climatic conditions as our geography, are an inevitable necessity.

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