



Research paper

Architectural house design with sustainable environmental architecture approach with emphasis on maximum natural light efficiency in mountainous climates

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ABSTRACT

With growing population and increasing construction rates, demand for new materials in the building industry has also increased due to limited resources and consumables. With development in the field of materials and also the methods of inventive construction, the move to better economical and environmentally friendly buildings is imperative. One of the great new technologies of the present century is the optimization of energy consumption in architectural spaces that can be used to meet the needs of the building industry. The benefits of using this technology include energy savings and consequently economic savings. The green building approach that works to improve the environment in the building, while industrialization of construction activities, provides important savings in the water and energy sector, which is a valuable contribution to the economic goals of the countries. This attitude, which comes from the concepts of sustainable development, is one of the basic human needs in the current industrial world, following harmonization and coordination with the environment. There are controversial issues in architecture, the issue of living and sustainable development, in which a variety of ideas and strategies have been presented. In this paper, the design of an architectural house with a sustainable architecture approach based on the maximum use of natural light in mountainous climates which, in turn, it can be used to achieve sustainable architecture as a symbol of lowering energy consumption and enjoying natural light within the site, namely, the city of Kermanshah.

Keywords: Architectural house, Environmental sustainability, Natural light efficiency, Mountainous climates.

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1. Introduction

Today, the demand for achieving successful environmental protection strategies and preventing the waste of energy resources is one of the most important challenges facing urbanization professionals due to the current crises and the intensity of energy consumption, especially in cities, to achieve sustainable urban development. Numerous problems such as high average per capita energy consumption, waste generation and hazardous waste, climate change and global warming have all led to acute environmental crises and ultimately environmental instability and depletion of available resources and the search for a versatile, flexible and practical model has made it inevitable. One of the most important goals of sustainable development is to preserve the nature and look at it, and the manifestation of sustainable development in the built environment is called sustainable architecture. Sustainable development seeks reconciliation between human and his environment in order to have the least harmful effects on himself and the natural ecosystem of the earth, to guarantee the survival of his life and life. Sustainable development, in the context of its defined goals, pursues most of human interests and is a human-centered approach. Sustainable development is the process of improving social life without growth beyond the capacity of ecological carriers. It should be noted that, given the decisive extent of environmental issues, social and economic sustainability are also strongly desired. Sustainable development means social sustainability (with the aim of social justice) and economic sustainability (with the aim of economic survival) and environmental sustainability (with the aim of ecological balance). Sustainable development is a type of development that can balance the three factors of economics, society and the environment in the functional domain. Sustainability can be seen as a local, participatory and equilibrium process, operating in an environmental area. Sustainable development means integrating economic, social and environmental goals to maximize the well-being of the current human being without harming the ability of future generations to meet their needs [1-4].

Along with the public interest in sustainability, architects along with other thinkers have been seeking new ways to secure human life. Without exaggerating all human activities, from eating and sleeping to working and worshipping in places designed by architects, and since environmental strengths and weaknesses will have a direct impact on environmental quality, social relationships and cultural relationships, the science and art of architecture plays a fundamental role in achieving the goals of sustainable development. In other words, energy experts estimate the cost of unnecessary and inappropriate energy consumption in the country to be over \$ 5 billion annually, with the residential and commercial sectors being the most important consumer. Today, with the prevailing conditions in the world and the country, it is worthwhile to use non-renewable resources in its own special place, with minimal waste, and to think of providing energy in sustainable ways. These issues and realities emphasize the importance of the issue in preventing energy waste and its optimal use in architectural spaces and necessitate the collaboration and intervention of architects and urban planners in the community.

Therefore, the first step in achieving sustainable architecture is to optimize energy consumption, analyze precisely the climatic data, and use all the tools that make it possible to understand the climate [5]. Since the number of detailed climatic data in each climate is very high, climate diagrams should be used to identify a climate. Energy efficiency through optimization of energy consumption and maximum use of daylight, as an innovative energy saving method, is a parametric method that studies the effect of different architectural indicators on the energy consumption of buildings. In this method, the focus is on energy dynamic modeling to determine the optimal amount of architectural indicators in terms of energy consumption. Applying these approaches to energy efficiency in building architecture design can save energy without dramatically increasing the executive costs of the building. Therefore, it can be argued that the use of daylight in architectural spaces is an effective way to reduce resource consumption as well as building costs and ultimately to achieve sustainable architecture. In this paper, the design of an architectural house with a sustainable architecture approach is based on the maximum use of natural light in mountainous climate, which in turn can be used to achieve sustainable architecture as a symbol of the reduction of energy consumption and the use of natural

light.

2. Sustainable architecture

2.1. Sustainable architecture design principles

- 1- Controlling the environmental conditions using natural systems.
- 2- Reduce energy consumption during the construction phase of building materials.
- 3- Deployment of low power installations during the operation period.
- 4- Use of non-polluting and replaceable energies (solar energy, wind energy, sea wave energy, etc).
- 5- Reduce energy loss by applying proper insulation.
- 6- Recovery of energy from building exits (chimney, hot air outlet, energy stored in heavy building materials such as rubble, concrete, etc).
- 7- The use of natural light and ventilation and the use of non-harmful materials to the extent possible.
- 8- Using green space in the building.

2.2. Concept of green and sustainable buildings

Green and sustainable titles are, in fact, traits that characterize the existence of environmental sustainability in a subject or artifact, such as a building, assuming that the entire complex of the Earth can be sustained by the sustainability of its constituent and constituent parts. Therefore, the design and construction of the building should be done in a way that makes it one of the most desirable and exemplary buildings, an environmentally friendly, sustainable and intelligent building that can be exploited with the use of the most advanced technologies. A sustainable and green building is not only against nature, it is also shaped to take advantage of the environment and to provide human comfort. Accurate architectural design, selection of suitable materials and use of advanced electronic systems are characteristics of such buildings that should be used to achieve sustainable architectural goals. On this basis, the building uses climatic elements in line with the latest technological developments in the design and construction of large buildings around the world with the help of equipments such as air chimneys, mirrors reflecting sunlight, greenhouses, heat exchangers and more. For this purpose, the angle of sunshine, wind speed and direction and other climatic factors in different seasons are completely measured and modeled on the building design.

In sustainable buildings, materials are selected using the latest technologies in a cycle of production and operation, lower energy consumption and greater savings in fossil fuels, while minimizing the damage to the environment. A green and sustainable building can also be a smart building that utilizes various advanced systems including heating and cooling, lighting systems, security and safety systems, etc., in addition to saving on energy (fossil fuels), comfort Increase the physical, mental and psychological well-being of the users to a very high degree [7]. The outer shell of the building can be intelligently designed and operated using the most advanced technologies similar to human skin. As the human skin responds to cold, heat, moisture. Building shells using sensors in double glazed windows, shutters and removable heat insulation are susceptible to such things as the amount of sunlight, shade and other environmental conditions and it is responded to and controlled by a computer system.

2.3. Saving and energy storage

The building is designed with the overall aim of preserving non-renewable energy sources, preventing local, global and atmospheric pollution and reducing the cost of energy consumed in the building by using energy efficient and inexpensive energy. In this way [8]:

- Low power systems and more efficient to be selected, these systems are: heating and hot water systems are cooling systems.
- Lighting system, audio, telecommunication, video and office and protective machines.
- Ventilation system.
- Choosing mechanical and electrical installations that minimize waste of energy, heat and cold.
- For higher standards, costs will be spent to pay less at the time of operation.
- Observe the rules in design and implementation of buildings for energy conservation.
- In principle for energy saving, the insulation in the manufacturing operation should be thoroughly observed.

2.4. Architecture and environment

The process of ecosystem degradation has become more intense in the present century, and we now see dangerous aspects of it in different parts of cities and villages. Architecture has had a significant impact on this process. Architecture can invent some form of adaptation to the environment. In fact, architecture has tried to define its production within the ecosystem, and in fact its building is part of the ecosystem and moving to enhance and improve it. Notable but costly activities have taken place this way, but we are still on the first steps. There is no doubt that with the right orientation of technology and knowledge in the present century we will witness tremendous developments in this field. With the arrival of the 21st century new interpretations have come into the category of "architecture and the environment". Biological architecture deals with the relationship between nature and architecture, environmental considerations, environmental protection, climate considerations in buildings, energy loss prevention, consideration of biological, ecological, economic and social conditions, etc. [9].

Designers and architects are always looking for designs that can create a more comfortable environment for humans. The importance of this is becoming increasingly apparent. For today's man lives with the least flexibility in soulless buildings, despite countless advances. A space that is by no means appropriate to his spiritual and physical needs. In addition, issues such as the environment, energy saving, avoiding over-utilization of non-conversion industries, recycling of waste, and so on, which today's human society is involved in, make the need for such research even more important. Because nature has these valuable features we are looking for, including: compatibility, optimization, efficiency, economy, diversity, and so on. So studying and modeling these endless resources can be very useful for architects.

2.5. Architectural environmental horizons in relation to sustainable development

In today's architecture, environmental debate plays a key role. In the construction of buildings, the process of procuring materials, as the beginning of construction activities, plays a significant role in the emergence of environmental crises and, with the impossibility of renewal and recycling, destroys natural resources [10]. Architecture should first of all preserve the environment so as not to damage the environment around it by building. On the other hand, the important issue after architecture and construction is to create the energy needed to provide human habitation within the architectural spaces which, if not properly implemented, architects will face many problems in the future in responding to human habitation needs. Lack of space for development, especially in the middle and dense textures of big cities like Tehran, is one of the major challenges of urban planning. In space scarcity conditions, utilization of all available capabilities and optimization of space utilization is an essential element in the context of endogenous development [6]. With the proper and efficient use of energy in sustainable architecture, the

interrelationship of sustainable development and environmental protection is raised. The two principles of reducing energy consumption and ensuring human health should be among the hallmarks of sustainable architecture. In this study, the direct impact of sustainable development strategies on reducing environmental pollution and protecting the environment is stated. Outdoor design is less of a priority for designers and the main focus is on the interiors of buildings apart from what happens between them [11]. Sustainable architecture is a logical response to the problems of the industrial age. Architecture as a design is not just for man rather, it is important because it is formed on the earth's bed. The rapid development of technology and human industry has led to the rapid and unnecessary growth of cities and the expansion of suburbanization and destruction of green spaces. Therefore, it is only by achieving principles relating to architecture with humans and nature that architecture can, with nature, lead man to perfection.

Today, the interaction of the artificial environment with the natural world remains a complex issue. Designing buildings that have the potential to save energy as well as conserve natural resources is one of the main responsibilities of architects. In terms of energy savings, man is in a position that has never been so critical. It is crucial to enforce permanent energy-saving standards and standards, and to accurately determine and control the energy consumption of buildings [10]. Based on the two-way relationship of sustainable development and sustainable tourism, in order for tourism to contribute to the sustainable development of the city, its impacts on the city must be identified and considered. Residents' perceptions of the impact of tourism and their satisfaction with its various aspects is one of the important indicators of achieving sustainable urban development [12].

3. Physical planning of the plan

3.1. Office

Based on the population calculated in the demographic program and the administrative areas required by the center, the administrative sector is predicted by the following areas.

A - Department of headship and Supervision

Includes sections of the headship and educational and research assistants. **B- Finance**

Includes accounting departments, research credit fund. **C - Administrative Affairs**

Includes sections of the Secretariat, Archives, etc. **D- Service Affairs**

Includes support spaces and services such as teachers' resting place, buttry, Toilets and more.

3.2. Scientific and research department

Most of the functional areas of this section are divided into two parts: scientific and cultural. Academic spaces include libraries, computer sites, laboratories, classrooms, discussion rooms, and cultural departments such as advertising, publishing, audiovisual and more. Research educational spaces with a capacity of 120 people per discipline is foreseen for different groups. Laboratory spaces in which the capacity of the laboratories is divided into two groups of 6 persons based on their specialty. There are separate rooms for professors from different groups. For this center, a library has been selected based on population and research needs. The spatial diagram of the scientific - research department is shown in Figure 1.

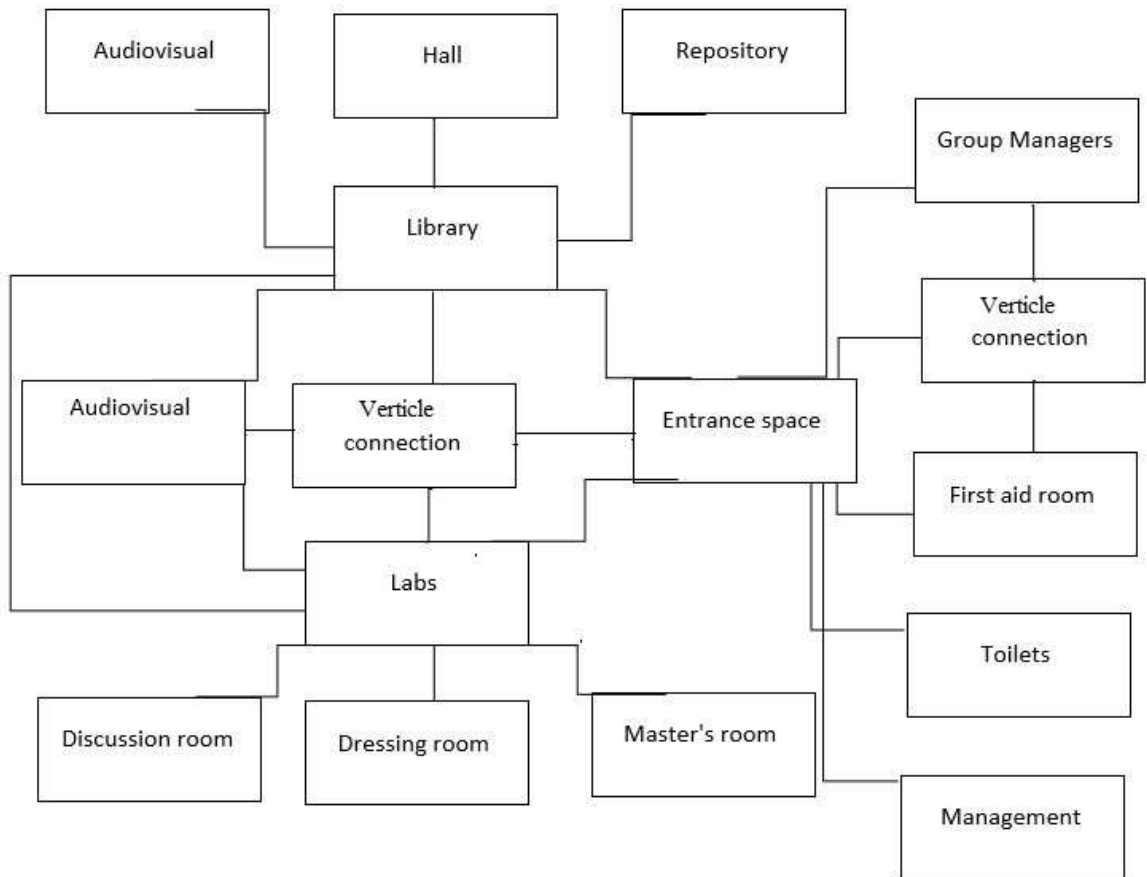


Figure 1: The spatial diagram of the scientific - research department

3.3. Residential complex

Accommodation is a must-have for camps in preparation for international competitions as well as extra-provincial professors and special guests attending classes and special events. Suites with capacity of 1, 2 and 3 persons serve the scholars. The spatial diagram of the residential sector is shown in Figure 2.

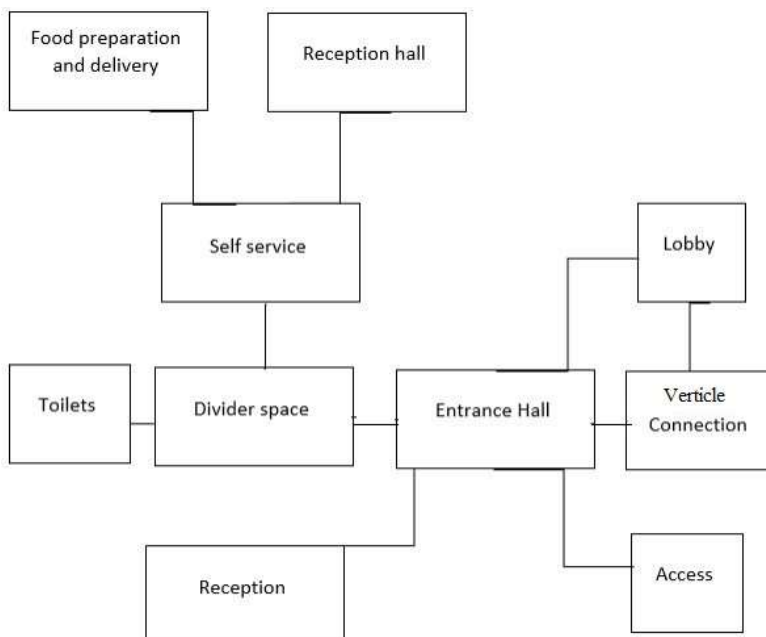


Figure 2: Spatial diagram of the residential sector

3.4. Service areas

The service spaces included in this complex include meeting rooms, self-service, chapels, installation, coffee shops and parking, etc., which support and provide services to the complex.

4. Climatic studies and topology of plan

4.1. Climatic divisions of Kermanshah province

According to studies by Koppen, a narrow area of western Zagros, which contains almost plains and mountains between Kermanshah and Shiraz, has a climate with characteristics of dry summers and temperate winters as well as Precipitation is low. The average rainfall in different regions of the province varies between 300-900 mm and in general the average rainfall in the province can be considered as 400-500 mm [13]. According to the Koppen classification, Kermanshah province has four major climates:

- A) Cold winter and cool summer.
- B) Semi-arid and steppe-cool.
- C) Semi-arid climate and warm steppe.
- D) Mild winter weather and hot and dry summer.

In general, Kermanshah province can be divided into two regions: tropical and Cold (Qeshlagh and Yilagh).

Comfort conditions are a set of conditions that are thermally suitable for at least 80% of people, or in other words, humans do not feel cold or warm in those conditions. Another term is thermal neutralization. It is in these conditions that the human organism can maintain its thermal balance to the best of its ability without deficiency or surplus energy. From the climatic point of view, four elements, including temperature, humidity, wind and radiation, play a key role in shaping human comfort. Among these climatic elements, temperature and humidity have the greatest impact on human health and comfort and most of the indicators and models of human comfort are based on these two elements. Human biomedical studies are nowadays the basis of many planning, especially in the areas of urban and residential, architecture and tourism. The results of such studies will be applied to human settlements in new areas as well as to the development of existing settlements.

4.2. Introducing and analyzing the site for design

The area of the site is 26000 square meters and includes the main communication axis of the city and the most important tourism axis leading to the Taq-e Bostan and Khosrow Parviz hunting ground (Shahid Beheshti Boulevard). In this area, there are landmark sites that have had a great impact on site selection. Cultural and tourism heritage and crafts organization, 14-hectare forest park, parsian international hotel, shahid motahari higher education center, master rashid yasimi library, Kermanshah amusement park, coastal park and Gharasoo River are prominent uses of this area. The project site range is shown in Figure 3. The route to the project site is also shown in Figure 4.



Figure 3: Project site range



Figure 4: Entrance to the site

4.3. Alternatives for building design

- 1- Kermanshah Traditional Architecture Concept.
- 2- Bird Flight (Soar).
3. The idea of transformation and motion.

Out of the ideas presented, the third idea was selected as the main alternative and design idea for the following reasons: Research is a conscious, systematic, and purposeful effort to reach the unknown and the facts. The principle of research is to reveal and come to the truth. The facts around us that we are unaware of because of some limitations, and we try to discover them. The Architectural house is a very modern institution in which technology is used to design a space whose main organization is based on information and in the field of architecture and urban planning. Science in the field of architecture is the originator of technology in this field and for this reason the global and futuristic dimension of it is of particular importance and its architecture must present a modern image with a prominent role in technology.

5. Approaching the plan

5.1. Structure and installations

A- Structure

The structure for this complex is intended as concrete. The use of concrete beams and columns has provided the possibility of covering the craters up to a maximum of 9 meters. Tubes and tensile structures are also attached to the facade by placing metal plates in the concrete structure. The conference hall is also designed with a concrete structure, with square column modules extending from the main hall to the floor covering slab. The roof of this hall is covered with pre-cast main powders and concrete slabs throughout the main hall opening.

B- Installation

The building is equipped with an intelligent system to control training programs with a computer program and change the heating, cooling, and air-conditioning facilities accordingly. . In fact, much of the mechanical and facility work is controlled by computer programming.

C- Waterworks

Drinking water from the municipal water network and landscaping uses is also provided by drip irrigation. Surface water and wastewater are collected by the municipal sewage system.

D-Fire extinguishing system

In order to prevent fires, fire extinguishing system and the establishment of fire brigades in this center is recommended. The use of portable fire extinguisher capsules to prevent the spread of topical fires and the use of a water network with appropriate storage systems at laboratories, workshops and libraries is also suggested.

E-Heating and Cooling

The center's heating and cooling system includes Air conditioning systems for large spaces and halls and research departments (laboratories and classes) and ceiling and wall fan coils in smaller office spaces using a pressure system and central home engine. These central home engine also supply hot and cold water to various units and toilets in winter. Central water coolers in different parts of the building provide water in the warm season. Central home engine refueling is provided by the urban gas network.

5.2. Using Sustainable Architecture Elements to Achieve an Environmental Sustainability Approach

A-Green roof

Given the unnecessary consumption of non-renewable energy and environmental damage, the state of the world's energy is at a critical stage. The solution in this regard will be to pave the way for survival and preservation of the environment for the next generation. The green building approach to improving the environment in the building, while industrializing the

construction activities, makes significant savings in the energy and materials sector which is a valuable contribution to the economic objectives of the countries. This attitude, derived from the concepts of sustainable development, is one of the basic needs of the modern industrial world in the pursuit of adaptation to the environment. In this regard, one of the elements of sustainable design in ecological design are green roofs that are sustainable, healthy and create a landscape. It can be used to increase per capita green space, improve environmental quality and sustainable urban development. Green roofs have a lot of benefits by being in the urban environment, making cities more beautiful and relaxing, and by reducing their energy consumption [14].

B-smart shell

In general, the body and the architectural space are made of interior and exterior shells. The shell of the building can have different functions depending on its location, short-term and long-term use, its type of users and environmental conditions. Adaptation of each shell to its performance results in the building responding to needs and saving materials and energy. In general, the main goal of most common approaches to smart shells is to be able to sense external stimulus factors and respond appropriately. Smart shell refers to a shell that integrates with the environment, using a combination of active and passive methods to provide users comfort and reduce energy consumption. Therefore, in the areas of the Architectural house that are more heat dissipated, these smart shells can be used to provide the optimum state of energy consumption in the building according to the climate and weather conditions.

5.3. Final design

The final design is shown in Figure 5.



Figure 5: Final design

6. Conclusion

Technological development and the preservation of society's status in modern societies of the world require the provision of purposeful planning based on a deep understanding of the subject. It can be said that the existence of science centers in every region, especially in the modern world, is absolutely essential. The idea of movement and technology, given the type of activity available at the center, can lead to productive interaction among young people, the use of technology in the path of change, and also to be very effective for progress. However, considering the issue of environmental sustainability, which is the approach sought in this paper, some of the ideas underlying the idea in this research relate to the sustainability and endless process of growth and order in nature, or environmental sustainability. In fact, proper adaptation between the form and its context on the one hand and the creation of a sense of movement in space in the other are important issues in this project that can be useful in encouraging users and young people active in the center to produce and acquire knowledge. In this paper, the design of an architectural house with a sustainable architecture approach based on the maximum use of natural light in mountainous climates which, in turn, it can be used to achieve sustainable architecture as a symbol of lowering energy consumption and enjoying natural light within the site, namely, the city of Kermanshah.

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