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ARCHITECTURAL SOLUTIONS FOR SAVING ENERGY IN RESIDENTIAL BUILDINGS

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ABSTRACT

Nowadays, the world of architecture faces crucial changes in the designing process of buildings along with the increasing tendency of designers to the approach of optimizing energy consumption. On one hand, fuel crisis and on the other hand, environmental pollutions and global warming are the situations that human has never experienced before. Hence, the proper design of buildings which are the most vital energy consumers and producers of greenhouse gases can be an effective step in order to improve the existing situation. Since there are numerous intervener factors to increase the quality and efficiency of the building, considering all the factors simultaneously seems very difficult. The current paper is based on the crucial designing decisions which determine the amount of final consumed energy by a building, are taken by architects in initial levels of designing. Therefore, we try to help architects to obtain the designs which are compatible with the environment in order to reduce the energy consumption by understanding the climate and designing solutions.

INTRODUCTION

Architecture and urban design styles based on decreasing energy consumption study the fact that how it is possible to reduce the amount of building's energy consumption by only having appropriate design and choosing the correct factors of architecture and urban planning which affect the amount of consumed energy by the buildings for each climate and dedicated to the same area while they can prevent using the unit schemes for every constructions. Architecture and urban planning methods based on decreasing the energy consumption are sustainable and costless methods; additionally, comparing to the other methods, these are affordable, environmentally and economy in case that the energy fees rise [1].

According to the presented statistic, between 15% to 20% of the total energy consumption is used in the building and residential spaces in particular; moreover, this issue results in higher costs, eradicating natural resources, the loss of fossil fuels, and destroying the environment in a wide range [2]. The necessity to optimize and save energy is a must at the current time. One of the solutions for this matter which worth considering is architecture design that tries to offer saving energy solutions and patterns in order to saving and optimizing it [3]. At the recent decades, the new housing design approaches are considered in many countries and since the housing pattern is adapted from the human thinking, costumes, traditions, economy and technology, vast changes can be seen through the time. Architects along with scientists try to find the new approaches to supply the desirable life for humans. It's obvious that life, work, leisure, rest and so on are the activities that are held in the designed spaces by architects. Hence, as the strengths and weaknesses of a building directly influence the ecosystem of the world, architects have a vital duty for that [4].

Architecture and Climate

Understanding every region's architecture in each era needs to gain knowledge about the ways that each of its details adapts to the certain climate. The architecture is not able to be separated from the conditions that its surrounding environment has, either naturally or artificially. Therefore, according to the climatic conditions of every environment, every geographical location asks for its special architectural method and construction [5]. The obtained experiences from using the residential buildings lead us to witness forming the various types of structures in different climates by considering every region's climatic need which is known as traditional structures. Hence, we find out that urban texture and the material's kind in every zone are in a perfect adaption with the climatic conditions which reach to their best functions [6].

Nowadays, one of the most important concerns of human is protecting the world's natural sources because of the consequences of industrial world. Therefore, architects and designer's attention to create the conditions which the most beautiful and beneficial plans can be designed while they have the least harm to in the environment is one of the hottest and main topics in the architecture [7-9].

By increasing population in the cities, the qualitative and quantitative housing crisis in urban societies began in such a way that quality issues in housing are the main subjects for researches, surveys and comments of cultural officials along with different subjects such as architecture, urban planning, sociology, economy and even politics for several years. Therefore, one of the outcomes of these researches is designing the house by paying the extreme attention to the climatic conditions [10].

One of the issues that human faces inevitably since the primary civilization is how to locate in order to make settlements. Since human naturally demands safety to counter different situations, peace, and a

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place to keep him safe from any vulnerability, providing a house has become a vital matter for the living of humans. On the other hand, housing as one of the subjects of architecture precisely has the strongest links to the most delicate forms, heritage and the cultural- environmental features and is exclusively important [11].

The issue of limited available energy resources, more or less, is a common problem for every country including industrial, developed and developing nations. According to the industrial activities in different countries, between 30% and 35% of the total energy consumption is dedicated to construction consumptions; moreover, up to 50% to 60% of this amount is consumed for cooling and heating the internal spaces of residential buildings. Therefore, the actions that are taken into improving the quality of the buildings by considering thermal exchanges will result in saving considerably total energy consumption [8].

Climate design

Designing the building is the first shield against the climatic factors out of a building. In every climate, the buildings built according to the principles of climate design reduce the necessity to use the mechanical cooling and heating systems and use the natural energy sources around the buildings in exchange. Designed buildings based on the climate operate well against the unpleasant weather conditions; also, they provide a healthy and beautiful living environment for humans. Tools for practicing the climate design are followed as: windows, natural light, green house, covered porch, and court yard. These tools provide an environment all together which leads in creating the balance among the inhabitants and the surrounding world. Therefore, it can be concluded that the climate design is a method to reduce the costs of building's energy [11].

Architecture and urban design styles based on decreasing energy consumption study the fact that how it is possible to reduce the amount of building's energy consumption by only having appropriate design and choosing the correct factors of architecture and urban planning which affect the amount of consumed energy by the buildings for each climate and dedicated to the same area while they can prevent using the unit schemes for every constructions. Architecture and urban planning methods based on decreasing the energy consumption are sustainable and costless methods; additionally, comparing to the other methods, these are affordable, environmentally and economy in case that the energy fees rise [1]. One of the advantages of reducing the energy consumption by using architecture design is its high potential of saving energy. According to the studies, due to climatic conditions in Iran, the impact of architecture design on the amount of energy consumption of the buildings is great. Energy optimization can be simply accessible as a result of using energy efficient methods of architecture and urban planning which their functionality is very high [12].

Climate design is gone beyond of being a construction profession and more noticed by common people. The outstanding matter of understanding the value of each era's architecture understands the adaption of building to the certain climate of each region. How a building benefits from sun, breeze, and the green space and how an architect creates a small climate are the signs of a designer's skill and knowledge. Generally, understanding the climate is not difficult. Human's physical comfort in the building is a result of the balance which is between the building's thermal energy and its environment. When a designer recognizes the climatic conditions of the site, he can choose the principles of climate designs which are special for each weather and compare them [5].

According to the aforementioned issues, we will study some solutions of climate design in the following which considerably lead to decreasing the energy consumption in the residential buildings. These solutions are followed as:

Building's direction

Providing the heating energy: according to the studies, the least heating energy consumption of a building occurs when the building is directed to 170 degree (10 degree from south to the east). As the building's direction differs from the given measures, either to the east or west, the amount of heating energy consumption increases. The maximum amount of heating energy consumption of a building occurs in 40 degree (northeast) and 320 degree (northwest) [12].

Providing the cooling energy: the cooling energy consumption of buildings reaches its minimum when building is directed to the north. The maximum amount of cooling energy consumption occurs when a building is directed to 110 and 260 degrees. By rotating the building from east and west directions to north and south directions, the amount of cooling energy consumption reduces [13].

Building's stretch

Building's direction has a significant impact on the amount of building's energy consumption. Building's direction is one of the most important factors among the architecture's factors related to the energy saving. Energy consumption for a building's cooling and heating systems is operated in order to have a balance between the wasting and receiving energy by the building's heat shield. Therefore, every changes in the area of this heat shield or its components which are located in different geographical directions, alter the amount of wasted and received energy by this shield which results in changing the cooling and heating energy consumption of a building. Building's stretch affects the heating and cooling energy

consumption of buildings. Also, changing the depth of a building leads to changing in the amount of daylight penetration in the inner spaces of buildings. Hence, this will have impact on the consuming electricity for providing the building's light. As it's said, the building's stretch is one of the effective factors for building's energy consumption [12].

Number of floors

A building's number of floors is one of the factors that affect the amount of building's energy consumption. A building's number of floor has impact on the ratio of surface to the building's volume and consequently the amount of wasting energy through the building's heat shield which subsequently influences the amount of heating and cooling energy consumption of a building. Also, the building's number of floors affects the ratio of the ceiling's area to the infrastructure area of the building which is a significant factor in the amount of wasted and received energy of a building. Ceilings as the horizontal thermal shield surface compared to the walls are more important due to the receiving the great amount of the radiation in cold days and low radiation in warm days. This item can increase the amount of cooling energy due to receiving a great amount of radiation in summer which results in increasing in received thermal energy by the last floor. Increasing or decreasing of the amount of cooling energy by increasing the area of the ceiling is an issue which is related to the climate, building's usage and the hours which a building is used. Ceiling can cause increasing in the amount of heating energy of a building by wasting energy in the winter. Changing the number of floors can change in the ratio of floor area to the infrastructure area of a building; furthermore, this matter can change the amount of the building's need for cooling and heating energy [12].

Natural ventilation

The natural ventilation can reduce the need for cooling energy by removing the extra heat from the internal spaces and create a healthier conditions by providing the fresh air for the users. During the process of natural ventilation, the natural pressure differences between the inner air and external air leads to providing the external air into the inner spaces and expelling the inner air in to the outer space so that results in exchanging the external and internal air. The pressure difference can be a result of the air flow or the thermal differences between the inside and outside of a building [12].

The natural ventilation can effectively reduce the need for cooling energy in the buildings. Reducing the need for cooling energy by using the natural ventilation is a simple and economy way in order to optimize the energy in the buildings which does not need any special material or tools. This method can provide the pleasant and fresh air for the residents and help to save the energy and reduce the capacity of the cooling system.

One of the climatic components of the indigenous buildings in Iran is wind tower (Badgir). Wind tower is one of the significant samples of natural ventilation in a building as a dynamic cooling system. Wind tower provides the pleasant ventilation by using the renewable energy, Wind. This structure has a vital role in providing the thermal comfort for the residents by using the nature's energy in order to reach the thermal adjustment [7].

The gray water

One of the ways to provide the water requirements is using the gray water as an alternative for water in some consumptions [14]. The Gray water is produced from the wastewater such as washing, bathing and so on and comparing to the black water which is extracted from the fecal sewage has better quality. By using a management perspective, we can bring back this water in to the consumption circle and use it as an alternative for the purified water with the higher quality in some usages such as watering the green spaces, fountains and so on. Therefore, using the gray water can reduce the building's water consumption and its following costs [15-16].

Greenhouse

Greenhouses can be connected to the southern front of building as a glass chamber or some part of this chamber can penetrate in to the building and the outer part can penetrate outside of the building. Also, it can be also closed inside the building which receives the sunlight through the ceiling. Generally, the ideal orientation for glassing in a greenhouse should be directed to the south. However, the orientation with 30 degrees west or east to the south is acceptable as well. For having maximum energy absorption, the glass should have a slope with 50-60 degrees to the horizon [3]. Solar Greenhouse System absorbs the solar energy directly and stores it in its walls in order to transfer the energy to the adjacent spaces [10]. A designed greenhouse can provide more than 50% of a need for home heat. In this case, it is better that the living place is located to the south and spaces such as bedrooms should be located in the north [3].

Canopy

By decreasing the amount of absorbed solar energy, canopies are one of the greatest source of the absorbing heat in the building which has effective usage in reducing the need for cooling energy. The dynamic canopies are the simple and cheap tools which their cooling functions are not dependent on the setting by users. However, this item can reduce the received solar heat in the winter which results in decreasing the demand for heating energy. Therefore, the beneficial canopy can be defined as a canopy that reduces the amount of solar absorption to the least in the period of winter days while it would not

reduce the amount of the solar absorption during the summer days. If the horizontal canopies which are built for the southern windows create the most shadows during the winter and the least shadows on the windows during the summer, effectively will reduce the building's demand for energy [12].

Solar reflectors

Using the solar reflectors as a passive heating method can reduce considerably the amount of demand for heating energy by receiving the radiation through the northern windows. According to the energy supply, the northern façade of a building is the most important part because the receiving thermal energy from the sun through the fluorescent surfaces of this front is very less during the heating period. Employing this solution can reduce the demanded energy consumption for the building's heating considerably [12].

Green Roof

Using the green roof in the buildings can reduce the unpleasant thermal effects, particularly in the summer and increase the roof's stability. Due to the sun's high altitude angle in the summer, horizontal surfaces receive much more radiation energy than vertical surfaces. The absorbed radiation by the roof transfers to the heat which increases significantly the temperature of the external surfaces of the roof. Some parts of the external surface's heat of the roof penetrate in to the building through the ceiling's conductivity. Moreover, the heat enters into the spaces through the internal surfaces in a form of movements or radiation which increases the air and radiation temperature of the space. This matter increases the amount of cooling energy consumption considerably. Additionally, it reduces the level of thermal comfort because of radiation heat on individuals through the ceiling's surface [17].

CONCLUSION

Urbanization According to the conducted researches, we find out that the amount of energy resources in the world such as fossil fuels, coal and so on are increasingly over and in the close future we will face the crucial crisis of lacking the energy. This is the fact that can cause harsh consequences for every human beings due to being not understood by managers and decision makers of each nations.

On the other hand, the most consumed energy in the construction is dedicated to the housing. Therefore, the architects' roles to bring up the topic of assimilating the structures with the existing and future situation and creating the balance between the demand and supply of energy will become more highlighted day by day. Hence, by considering to every aspects and existing problems, we should recommend some solutions in order to reduce the energy consumption in this sector. The following solutions are suggested: determining the proper direction for the buildings, having a proper stretch in order to reducing the need for artificial light, the number of floors and calculating the amount of wasted or saved energy, using the natural ventilation to reduce the demand for cooling and heating by using electronic facilities, reusing the gray water for non-drinking consumption, creating the canopies for decreasing the amount of extra thermal energy received from sun, benefiting from the solar reflectors in order to reduce the demand for thermal energy in some seasons, using the green roof to prevent from wasting energy and also receiving the heat energy from the sun through the used materials in the roof, and also to prevent them from being damaged by cooling and heating during the day and night. All together can be considered as a great step in order to maintain and protect the energy resources for the future generations and natural environment.

CONFLICT OF INTEREST

There is no conflict of interest.

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