

UNDER FLOOR AIR DISTRIBUTION SYSTEM: A NEW STRATEGY TO ACHIEVE SUSTAINABILITY IN THE BUILDING

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ABSTRACT:

Since the issue of global warming has become an important matter, scientists strongly have been seeking alternative energy resources for fossil fuels which are the main cause of global warming and in consequence researchers' efforts have been increased to reduce energy consumption in the buildings. In this regard, a new method named underfloor air distribution has been proposed that is widely used in the commercial buildings. The main purpose of this investigation was to introduce underfloor air distribution system as a new mechanism to achieve the sustainability in the buildings. In order to achieve this goal, firstly, the library and analytic methods have been used to define some concepts include sustainability, the under floor air distribution system and the advantages of this system. Then, in order to prove this hypothesis that it can be achieved the suitability by using this system, the effect of under floor air distribution system on sustainability dimensions was evaluated and finally a solution was presented to use this system properly.

KEYWORDS:

Sustainability, Sustainability Dimensions, Under floor Air Distribution System

INTRODUCTION

Nowadays, one of the most important problems that people face the environment crisis is. Due to the massive and dangerous effects that man has on the environment, the sustainability is a solution that need to its presence increasingly is growing. Furthermore, since the architects form the Collective and individual life scene of human, they are heavily responsible for human habitats and other living beings. On the other hand, with regard to the issue that architecture and sustainable urbanism are not only a fashion or style but quick and vital reaction to the loss of habitats of living organisms and also they have fundamental position and role in education at all levels [1].

Simultaneously with urbanization development and the trend to environmental degradation, the application of the concept of sustainability in architecture has created a discussion called the sustainable architecture; in this type of architecture, the building with location, climate and natural of its surroundings creates interaction and reciprocity. So it can be pointed that the most important achievements of the sustainable architecture are the reduction of the natural resource and energy consumption with regard to the building harmony and its surrounding context, and the use of renewable energy as well as maximum protection of nature and the environment [2]. Not only saving and optimization of energy consumption (which more is linked to non-renewable energy) is very important because the resources of energy are limited but also they can cause to reduce environmental pollution.

Because of the destructive effects of non-renewable energy (it means environmental pollution) the man has decided to reduce this effect with an approach to using of the renewable energy. Using renewable energy can be very effective in reducing the consumption of non-renewable energy. By considering that the energy is obtained from fossil fuels are finished, it is so much developed using the energy properly and deliberately, modifying energy efficiency and optimizing the energy consumption. In order to increase energy efficiency, it is important to ensure using appropriate energy type for a particular purpose [3].

One of the consequences of the energy crisis of the 1970s in the world was a general understanding of the importance of saving energy. Increasing growth of the use of fossil fuels, limitations and growing price of this type of energy source, and increasing environmental pollution are the main factors in the formation of a new attitude toward energy consumption in the current situation.

In the meantime, the share of buildings in energy consumption has become increasingly important. On the other hand, the application of sustainability concepts has opened a new discussion that all of them implicate on the sustainable development, architecture compatible with the environment, and urban sustainable development. This paper explores the concepts of sustainable development, under floor air distribution system and the impact of this system on the dimensions of sustainability.



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MATERIALS AND METHOD

This study utilizes content analysis method based on a review of relevant literature and specialized resources. The first, it is expressed the fundamental definitions of sustainability, the under floor air distribution system and the sustainability dimensions. Then, the researchers match this system with the sustainability aspects by using a logical argument based on the inferences from these definitions. Finally, based on the gotten results, it will be presented some recommendations for more use of these systems.

RESULT AND DISCUSSION

The concept of sustainability

The 1990s can be called the awareness of the environmental crisis that in the world created reactions; one of them is the sustainable development which is the result of a deep understanding of the surrounding environment [4]. The generally accepted definition of sustainable development is the definition which is cited in the Brundtland Report; based on it, the sustainable development means providing the needs of the present generation without compromising and regardless of the ability of future generations to fulfill their needs [5].

The concept of sustainable development is to provide the solutions against the traditional pattern of physical, social and economic development that can prevent problems such as the destruction of natural resources, the degradation of ecosystems, the pollution, and the indiscriminate increase of population, the prevalence of injustice and the low quality of the human life [6]. The environmental sustainability emphasis on the following cases with the purpose of keeping the environment:

- Reducing waste and energy distribution in the environment
- Reducing the production of the influences on human health
- Using reversible materials to the cycle of nature
- Removing the toxins in materials

Architects have investigated to find new strategies to provide a favorable life for humans, like the other scientists. Application of sustainability concepts in architecture has opened the new discussion which can be called sustainable architecture, ecological architecture, green architecture and ecological architecture; all of them have similar concepts and implicate on the architecture compatible with the environment [7]. Hence, sustainable architecture is based on the fact that building is a small part of the surrounding nature; it should act as a part of the ecosystem and place in the life cycle. Consequently, the aim of designing the sustainable buildings is to reduce the damage of buildings on the environment, energy

resources and nature. The sustainable architecture has its own principles, like the other categories of the architecture and generally encompasses three principles: [6]

- The savings of resources
- Designing for the return to life cycle
- Designing for humans

In the discussion of sustainable development and therefore sustainable architecture, it is obvious that each building must interact with its substrate and surrounding natural environment. The controversial and considerable part of it is how to create an interaction between the building and its surroundings, and what kind of measures they are taken to achieve this interaction. These measures are evident not only on the environmental dimension but also on other sustainability dimensions such as social and economic aspects. In attitude of sustainability, the design is done such a way that these three cases interact with each other to make a perspective of world environment is called "a dream with needs of present era without compromising the resources for future generations".

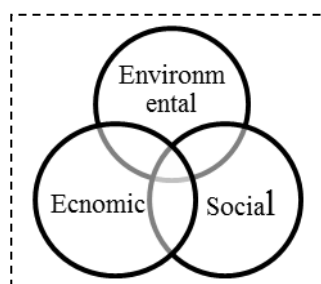


Figure 1: Display of Sustainable Development Aspects

SUSTAINABILITY DIMENSIONS

The sustainability is a manipulation in the environment that tries to invent solutions with the environmental, social and economic purposes at a holistic and integrated look (as shown in Figure 1) to achieve a balance for providing a superior quality for the current generation and an appropriate heritage for future generations [8]. It means that the sustainability is needed to investigate in all dimensions of environmental, social and economic; in the following, the significance of each of these issues are discussed.

Environmental sustainability

Environmental sustainability emphasize on reducing the use of natural resources and non-renewable energies, preventing the waste of energy resources, reducing the waste production and emphasizing on the reuse and recycle of waste, using reversible materials to the cycle of nature and decreasing the pollution production in the industries and agriculture. Environmental sustainability in relation to architecture is so important to achieve the goals of sustainable development and the environmental issues that have endangered the human future,



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architects have been forced to remedy. It can be said that briefly the principles of sustainable development include the followings: regards to the use of renewable resources such as wind and solar energy, less use of non-renewable energies and pollutants, such as fossil fuels and considering future generations, environment and pollution reduction. According to these principles, the architects and urban planners have sought to define the sustainable architecture and urbanism; many definitions of sustainable architecture and urbanism have made that some factors are very important in most of them, such as considering the urban environment, creating healthy and ecological cities, and less polluting cities [9].

Social sustainability

Humans and human societies are main indicator of sustainable development. As said above, the goal of sustainable development is the comprehensive development which is not possible without social development. The social sustainability emphasize on the aims such as cultural identity, social solidarity, organizational development, citizen participation, human empowerment and the possible of social displacement. So it can generally be said that the goal of sustainable development is to achieve a dynamic and lasting community that it will not be possible unless the environment is preserved [9].

Economic sustainability

Economy and economic capital are clearly understood as financial resources and are in the center of the world political system 155 years ago. An indicator of economic capital is considered as a success criteria until the government is able to make certain reforms through controlling interest rates for improving economic efficiency. A mount of economic capital depends on the exploitation of resources (land, people and resources) and also the basic concept of sustainable development challenges [10]. However, the economic sustainability means maintaining and promoting the current economic situation without damaging to the natural resources; economic activities should cause population growth with justice and efficiency [9].

The use of innovative technologies is one of the ways to achieve sustainability in the building construction; among the technologies, it can be noted to under floor air distribution system for heating, cooling and air conditioning in the buildings that is the main purpose of this paper. In the following, this system has been explained.

Under floor air distribution system (UFAD)

Air-conditioning systems have been used in many parts of the world. The purpose of most systems is to provide thermal comfort and an acceptable indoor air quality (IAQ) for occupants. With the improvement of standard of living, occupants require more and more comfortable and healthful

indoor environment. People spend 80-90% of their time indoors, and indoor environment has important effects on human health and work efficiency. The factors affecting indoor environment mainly include temperature, humidity, air exchange rate, air movement, ventilation, particle pollutants, biological pollutants, and gaseous pollutants [11].

In this trend, a relatively new approach of air distribution, under floor-air-distribution system (UFAD), has been widely used in new commercial buildings [12]. UFAD systems use an under floor supply plenum located between the structural concrete slab and a raised access floor system to supply conditioned air through floor diffusers directly into the occupied zone [13]. Underfloor air distribution system (UFAD) is a mechanical air distribution strategy in which the conditioned air is primarily delivered to the zone from a pressurized plenum through floor-mounted diffusers. It has several potential advantages compared UFAD systems have several potential advantages over traditional overhead systems, such as layout flexibility, improved energy efficiency in suitable climates and reduced life cycle costs [14]. This system was first introduced in the 1950s to cool a computer room and is emerging as a leading ventilation system design in modern commercial buildings [15].

In UFAD systems, two distinguishing characteristics combine to change the dominant heat transfer dynamics related to energy balance in the conditioned space under cooling operation. These are: (1) room air stratification, in which comfortable air temperatures are maintained in the occupied zone near the floor but warmer air exists near the ceiling; and (2) underfloor air supply plenums, through which cool supply air is distributed to floor diffusers. The underfloor plenum creates a relatively cool reservoir of air extending across the entire building floor plate and establishes large-area pathways for heat to enter the supply plenum (1) through the slab in multi-story buildings from the warm return plenum below, and (2) through the floor panels from the room above and incident radiant heat loads. Thermal decay, defined as the temperature rise of the conditioned air due to convective heat gain as it travels through the underfloor supply plenum, is the result of this heat transfer process and is the subject of this paper [13].

In addition, an UFAD system induces an efficient ventilation pattern in a room, producing good indoor air quality and cooling efficiency.

This system improves the ventilation rate as a result human efficiency increases. And also the thermal desirability improves and in terms of commercial, the value of the buildings rises; it is because of the increased flexibility and energy savings. Of course, the UFAD system has negative points which can be noted such as the primary costs in its implementation.



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According to Louder milk two major advantages of this system are:

- Ventilation cool air is certain to reach the occupants (as it is introduced within the occupied zone).

- Convection heat gains that occur above the occupied zone are isolated from the calculation of the required space supply air flow.

The displacement-type flow that occurs in the upper zone serves to convey heat efficiently to ceiling based exhaust openings, resulting in better cooling efficiency and indoor air quality in the lower, occupied portion of the space, than those of the traditional mixing type systems. Bauman and Webster show that well-designed UFAD systems can provide such benefits as:

- Reduced life cycle building costs;
- Improved thermal comfort;
- Improved ventilation efficiency and indoor air quality;
- Reduced energy use;
- Reduced floor-to-floor height in new constructions;
- Improved productivity and health [15].

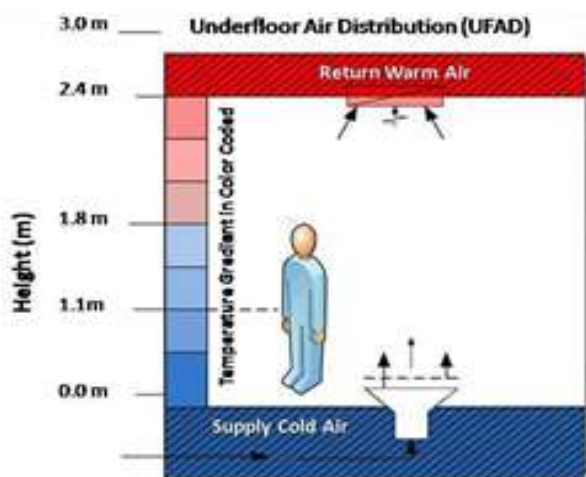


Figure 2: Air pattern flow for UFAD [12]

The conformance of under floor air distribution system (UFAD) with sustainability aspects

A UFAD system is a strategy for the air conditioning in which the ventilated air transfers through floor distributors to the considered area. The UFAD system has many advantages in compared with the existing air conditioning system, such as the improvement in providing the favorable heating, indoor air quality (IAQ), the design flexibility, the reduction of maintenance costs and less energy consumption in suitable weather. Considering to what it was mentioned about sustainability, it is concluded that the advantage of this system is proportional to the sustainability aspects; the properties of these systems can be noted in various dimensions of sustainable development, such as:

- In terms of social aspect, individuals can control the environment of their surroundings to improve the thermal comfort; this will improve the health of the residents.

- Economically, the costs related to creating these types of facilities are reduced; thereby the costs of maintenance and repairs are reduced in the buildings. Also new buildings that use this system, height reduction of the service space is seen by reducing the height between floor to floor (10% reduction in the height between floor to floor) that this reduces the cost of energy consumption.

- In terms of environmental sustainability aspect, With regard to these systems are non-mechanical and use renewable energies; they cause less energy consumption in the buildings through improving ventilation and indoor air quality by providing fresh air and thereby cause reducing air pollution and noise pollution.

Because of being clear what mentioned above and also the recommended strategies, the conformance of the sustainable development dimensions with UFAD are cited in table 1:

Table 1: The conformance of the sustainable development aspects and UFAD.

SUSTAINABILITY DIMENSIONS AND DISPLAYING THEM		DISPLAYING IN UFAD SYSTEM
Social sustainability	Attention to human	Improving thermal comfort Improving healthy
	Attention to cultural identity	Attention to previous architecture such as the performance of a cat
Economic sustainability	Maintaining and promoting the economic situation without damaging to the natural resources	Reducing the costs of maintenance and repairs in the buildings reducing the height between floor to floor
Environmental sustainability	Reducing in the use of non-renewable energies	Using renewable energies
	To prevent wasting energy sources	To improve the performance of ventilation
	To reduce pollution	Failure to use fossil fuels



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CONCLUSION

In this paper, it have tried to express that applying mechanical systems in order to create a permanent welfare for the users regardless any conditions or restrictions is a considerable strategy and this strategy is disregarded due to the lack of awareness of the proposed issues of the environment and energy dissipation factor. Also the recent crises in field of energy have been shown the importance of recognizing architecture solutions that try to optimize the use of energy and resources.

A significant portion of fossil energy which heat and cool the buildings is wasted due to the lacked of the environmental design in the contemporary architecture. The UFAD system can be used as an appropriate strategy for enhancing the more quality of the environment and sustainability in the architecture and urbanism. There is the most efficiency in the energy part when the UFAD system is used that is an important issue in saving the consumed energy in the buildings. This project has significant advantages such as savings in energy consumption, the thermal comfort control, the use of clean energies, high reliability, increasing the maintenance and the energy efficiency. As before said, this system reduce the energy consumption. According to the successful experience of other countries in its implementation and the possible increase in the price of energy, the mass housing company are encouraged using these technologies in residential buildings, offices and businesses.

As it were investigated in Table 1, this system can reduce many of the concerns of the urban development and at the same time, provide economic benefits through the reduction of different costs related to the building and the growth building industry. This system also helps to improve thermal comfort and health. So with the mentioned advantages, the UFAD system can be considered as the executive instructions in the building construction.

This new technology provides new methods of construction with less cost and better quality and durability. Alternative energies such as wind and geothermal energy can become widespread in the future. As regards our country has a favorable climate, it can be suitable ground for the spread of this technology in the field of architecture and researching in this context can put the bright horizons for the practitioners in the field. Considering the following points can help us to achieve this goal:

- The users and residents are informed from saving in the energy consumption.
- The users are informed from new optimum systems in the building construction.
- Decisions are based on long-term effects in public and private sectors.
- This model should be placed on the agenda in long-term plans of government and organizations.

- Comprehensive models of this field and their background that are used in the developed countries can be taken advantage.

- The Comprehensive model should be developed by experts and include architectural standards which are completely scientific.

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