

A Study on the Coverage of Vertical Green Spaces in the Control of Energy Loss Form Walls in Cultural Centers and High-Rise Buildings

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Abstract— In this paper, according to the urban development plans in our country in order to promote green spaces and condominiums and converting the complex and horizontal structure of city which has been aggregated by adequate traditional principles with related regions to vertical texture of city with the approach of high rise building, in cultural centers or others, is in the agenda of relevant authorities. So, according to converting horizontal to vertical lines, we'll maximum heat loss in the walls of building. Therefore, transmission of central courtyard in urban compressed texture that is requirements of related climate considerations to the vertical courtyards located in front (vertical green space) has been studied as one of guiding principles with the goals of energy conservation in our country. Because it has the most important share in controlling and reducing fuel consumption, especially fossil fuels, and ultimately taking advantage of the natural and renewable energy available in the environment without causing additional pollutants that cause environmental pollution. In this study, similar samples which have been proposed from recent decades in some of the internal and external projects, have being analyzed.

Index Terms— Urban Texture, High Rise Building, Green Spaces, Controlling Energy Loss.

1 INTRODUCTION

DURING more than a century that tall construction has become typical in modern way and urban development plans have been provided with an approach of high rise building and increase of green space capitation and condominiums and have been used to solve some today problems of communities such as lack of housing arising from the increase of population, but it has always been along with new problems and failures. The buildings were constructed at the beginning in order to optimum use of the land in large city centers, but gradually, along with the expansion of cities, more necessities were created for the construction of these buildings in other urban areas. Although high-rise buildings have complexity in terms of architectural design and urban issues, but due to the cultural, social and economic issues, such as dealing with technical and structural items are considered of their design and construction necessities [2]. On the one hand, considering cultural aspects and the way of space usage by people [16] and on the other hand, distinctive elements and components and human activities that could give the character and spirit to a space [12] and various forms make social cohesion crystalized in the space. [17].

Thus, urban area is a basic element of the construction of the city which is concerned with the heart and center of the social strategies [18]. Unfortunately at the present, we have been observing the growth and spread of tall buildings in Iran's major cities while these buildings have being dealt as the conventional and short ones [1].

Although the appropriate use of long buildings can effectively

help to solve problems and create a favorable and proper environment, but neglecting the specific issues of the buildings would be resulted in negative and adverse results including the increase of energy consumption.

In this article, after a brief description of the historical evolution of high-rise building in the world and in Iran, the advantages and disadvantages of the relevant buildings will be studied, and finally according to the goals and criteria of design in relation to a number of affecting factors on the formation of high-rise buildings by providing a case example, the factors that affect reduction of energy consumption would be dealt.

2 RESEARCH BACKGROUND

On growth issues and vertical development in the megalopolis of Iran, there are no specific and direct studies done, but some researches have been done regarding the effects of high-rise building as a habitable pattern of vertical growth in cities. "Mahmoud Golabchi" in the article "criteria for the design and construction of high-rise buildings in Iran" titles problems in relation with the operation of high-rise buildings and the bugs arising from design, construction and maintenance of such buildings; that have more emphasis on social and economic aspects [2]. Anthony Wood in 2007, in his article titled as "sustainability; a new example of vernacular high-rise building" compared flaws and merits of high-rise building with an adaptive method. His approach in comparative review between the two horizontal and vertical growths is so important due to his emphasis on the categories, such as open space, land and urban landscape, representing important emphasis. But with all these design components and criteria, the open spaces and the lands use in the sky have not being clearly evaluated as the two main layers in urban design and planning based on the requirements of modern cities. Some of the

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items that can be found on the advantages and disadvantages of the vertical growth of cities, would be offered in table (1):

TABLE 1
COMPARATIVE REVIEW OF HIGH-RISE BUILDING ADVANTAGES AND DISADVANTAGES - RESOURCE: THE AUTHOR

High rise building and vertical growth of city	
Disadvantages of high rise building	Advantages of high rise building
High loads resulting from wind at altitude (impact on the size and dimensions of the structural elements and the view)	More compressed cities = reduction of traffic
The negative impacts on the urban scale (storm wind, broad shading, creating shading barrier)	More wind speed at altitude (more potential for efficiency of wind energy)
High population density in specific and special location, (lack of open spaces, recreational areas, etc.)	Less inner-city trips = less wasting of time
Closed and isolated spaces at altitude (more need to space ventilation)	The potential and the possibility of creating a building with various functions [14]
Safety and security problems at altitude (while constructing; for user)	Low width and altitude stretched classes, the potential the possibility of natural shading in space
High consumption of energy and materials to build at altitude	Space in the sky = the possibility of creating cozy and quiet spaces far from overcrowding of city; the urban landscape
High energy consumption for fork-lift trucks (up to 15% of the total energy consumption of the building)	The optimum use of land, according to the focus of the population, reduction of the urban suburb development, and reduction of damage to the environment
High energy consumption for maintenance and cleaning of buildings	Focus cities = reduction of the size of urban infrastructure network

3 TALL BUILDINGS IN IRAN

Construction of buildings with modern method was begun in large American cities first and then Europe and after a few decades it was also common in developing countries. About half a century ago, constructing high-rise buildings was begun in Iran and the first high-rise buildings in Tehran were built at around 1950-1960. Constructing high-rise buildings Iran was not resulted from the necessity of social operation and urban development at first, and it was performed by the imitation of the world's great cities [3].

In recent decades, the construction of high-rise building with habitable use was into consideration to help solve the housing problem. But according to the maximum heat loss in such buildings and due to its quick growth, the fundamental solution to reduce this problem is needed.

3.1 Theories about the Vertical Growth of City

In relation to the vertical development of cities, some theories have been raised that we briefly explain them.

Proponents have known constructing tall buildings a kind of realism according to conditions that has been created in the present century, and put an emphasis on the benefits of their use of high-rise buildings [1]. The majority of proposers of this prospect, while agreeing with the construction of tall build

ings, believe that items such as lack of urban lands, controlling city development, the need to accommodate and available demand led to propose design and implementation of high-rise buildings as a necessity in the current communities. Opposition believes that tall buildings have caused quality degradation of urban life in different ways and with contravening values and traditions, have provided adverse conditions in terms of living in cities and it's been merely obligated to construct the buildings in large cities.

The middle theories, in relation with construction of high-rise buildings, accept using it under certain conditions. While this group opposite the two previous perspectives, shift the construction of building at altitude to certain conditions.

3.1.1 Vertical Growth in Cultural Centers

Considering cultural aspects and the way of using the space by people and the specific elements and components and human activities that can provide a space with character and spirit have significant impact in the form of high-rise building architecture. Therefore, many similarities could be found between the disadvantages and advantages of high-rise buildings in the cultural centers.

3.2 High-Rise Building Problems

Due to the increase of vertical buildings, though we'll ob-

serve more open spaces around the high-rise buildings, but private green space capitation will be reduced for any resident. On the other hand, according to previous researches and

studies performed in this research, way of controlling the adopted proposed volume will signify of thermal exchange rate of building with surrounding environment.

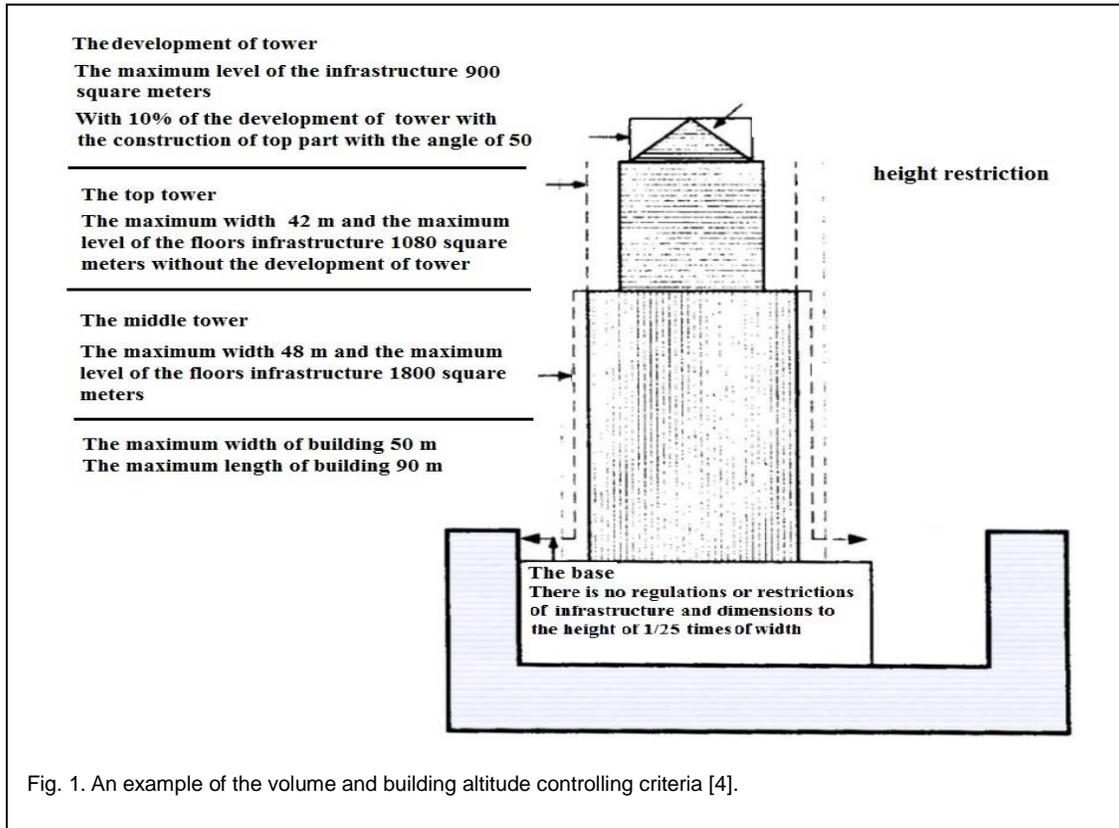


Fig. 1. An example of the volume and building altitude controlling criteria [4].

Thus, with a review of energy consumption average in household sector, half of it is consists of heating and cooling

share which has itself a significant share in energy consumption.

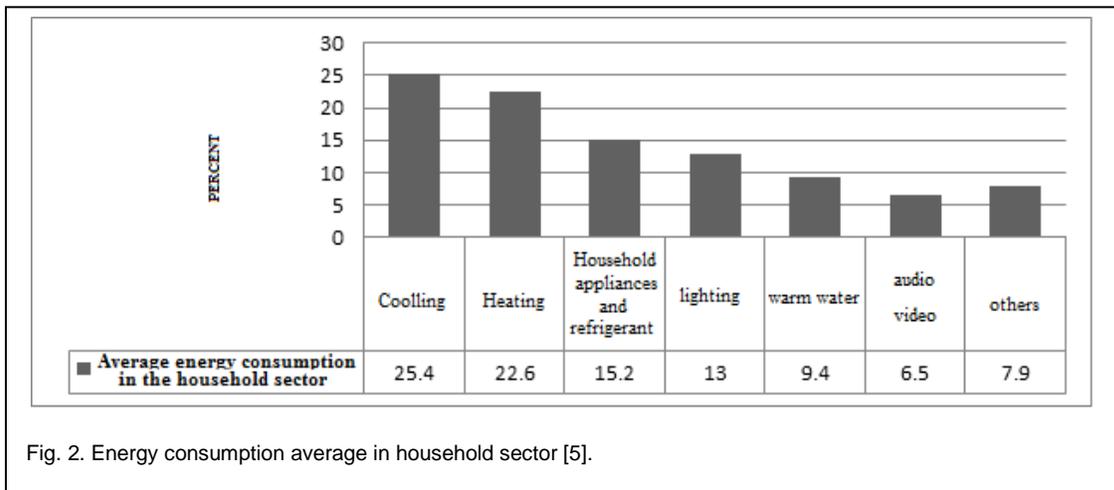


Fig. 2. Energy consumption average in household sector [5].

4 SMART BUILDINGS

With the creation of smart buildings against the energy, the energy production equipment in living environment can be reduced about 50% compared to the old buildings [6].

Smart buildings with Energy saving greatly help in reducing costs of building. Statistics show in 2000 the amount of wasting energy in a traditional building has been 39207 calorie which is close to half in a smart building. A smart building, according to the definition of "smart buildings institute" is a building that creates the proper environment with the econo-

my saving by using a few basic elements: structure and systems and services and management and their internal relationships [7].

4.1 The Results of Research on Smart Building Saving Potential

Assumption in case we can save the following:
Lighting: up to 30 % / of 100 % = 09 %
Heating/Cooling: up to 20 % of 100 % = 14 %
Total saving: = 23

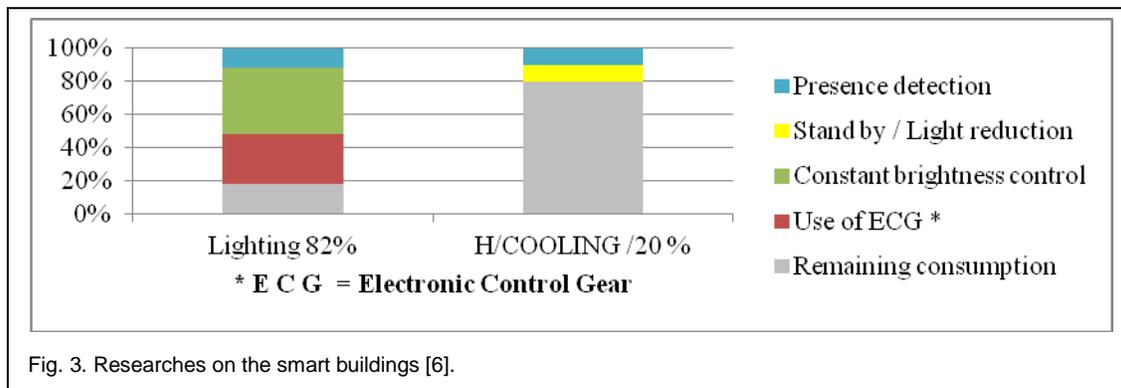


Fig. 3. Researches on the smart buildings [6].

4.2 Considerations for Smart Structures against Energy

The following three basic points, guide us towards significant reduction of required energy instruments inside the building to pick up:

1. Reduction of wasting heat
2. Increase of saving energy, through the use of the Sun's radiation
3. The conscious efforts by users to improve the energy balance

Choosing right location, can lonely reduce wasting the energy. In the area of a region, the aspects are very different, and on other words, temperature and wind aspect will be changed due to the altitude of a building location. The shape of the building plays an important role in creating right conditions to save energy. The external surface of the building is in direct contact with the outside air and pass out valuable energy to the outside air.

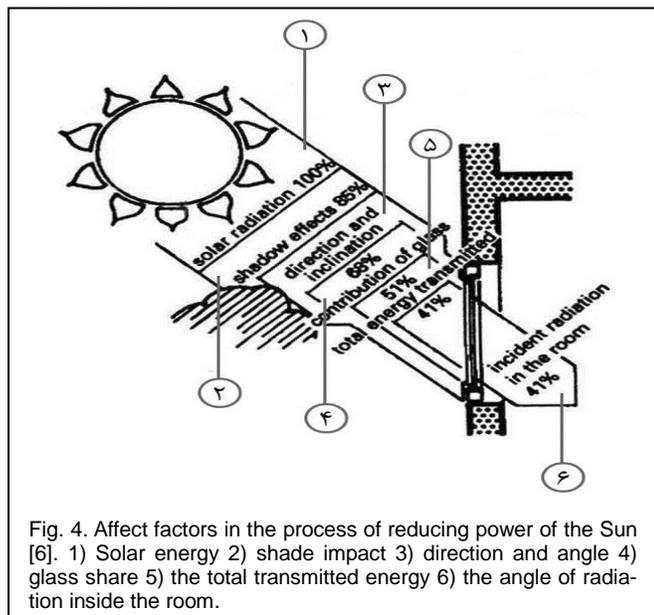


Fig. 4. Affect factors in the process of reducing power of the Sun [6]. 1) Solar energy 2) shade impact 3) direction and angle 4) glass share 5) the total transmitted energy 6) the angle of radiation inside the room.

5 ENERGY CONSUMPTION IN IRAN

Most of available buildings in the country have no technical criteria and no arrangement have been set to avoid wasting heating and cooling energy. At the present, the capitation of energy consumption in the country is annually equal 3.4 oil barrels and his amount is about 3 times of energy consumption of industrial countries in the world.

Iran has the highest energy consumption capitation in the world, which of course is not a feather in its cap, because the same amount of energy could be useful and effective for the circulation of the country's economic wheels. According to the estimates of oil and gas findings that have lasted for about 300 million years to be saved and provided, the greater part of it is spent less than 150 years [5].

6 ENERGY SAVING

In recent years, along with fossil resources, the subject of using a variety of thermal insulation in order to save energy has been raised seriously [11] and the high costs of energy have organized wide activities in the field of efficient use of energy and this importance have been along with dramatic developments in science engineering and construction industry. Selecting the location of the building determines the climatic conditions in which building is located, and building coverage determines the effects of environmental conditions upon building residents. This coverage is, in fact, a porous shell that passes the energy, light and gases and water vapor between the two sides of the building and its surrounding environment. [5]. Therefore, due to the vertical expansion of buildings and more relationship of building with the surrounding environment, that climate changes will have the most impact on the building shell, the creation of a process to reduce this energy exchange from the inside to the outside and vice versa would be needed.

6.1 Energy Loss from the Walls

Parts of the building from where the most of energy is exchanging, and in better words, they include the most of energy loss, from the outer walls, are roof, walls and floor.

6.2 Saving Energy

Available insulation in the walls, roof and floor of rooms, would decrease the energy consumption, up to 25 percent [8].

6.2.1 Roof, Wall and Floor

The roof construction in the past has been in a way that they brought up around the roof and created a kind of yard on the roof. Also these walls with shading on a part of roof in different hours of a day on the roof have also a secondary climate role. In contemporary period, the attention to the environment and nature has been converted into a criterion that is more pervasive every day [9].

7 GREEN SPACES

Today, the concept of cities without green space in its various forms is inconceivable. The expansion of cities have led to intensify unstable and irregular complications of urban development that that environmental pollution intensification is considered as the most important complications which underlies loss of green spaces within the city and change the use of such lands. Based on the studies and survey of the minister of urban development affairs and housing, common and acceptable capitation of urban green spaces, in Iran's cities is between 7 to 12 square meters per person that compared with the specified index by department of environment (United Nations) 20 to 25 square meters per person, is a less figure [10].

Spatial distribution of green space has to be in such a way to access it easily. Some estimate the access time for 10 minutes, which is equal 400 to 500 meters away from habitable areas.

7.1 At-Grade Green Spaces

Places that have enough spaces for green spaces, including parks, cultural centers areas, etc

7.2 Non-Coplanar of Green Spaces

There is not enough space and walls, columns, canopies, etc. covered with green spaces are used.

Its most important function is the reduction of energy absorption in a rate of 50% in summer and saving energy in winter. Municipalities have considered discounts on reconstruction and rehabilitation in order to protect grade separation of green spaces in our country. With these facilities we'll observe the growing of green spaces capitation in our country.



Fig. 5. At-grade green spaces [10].



Fig. 6. Non-coplanar green spaces.

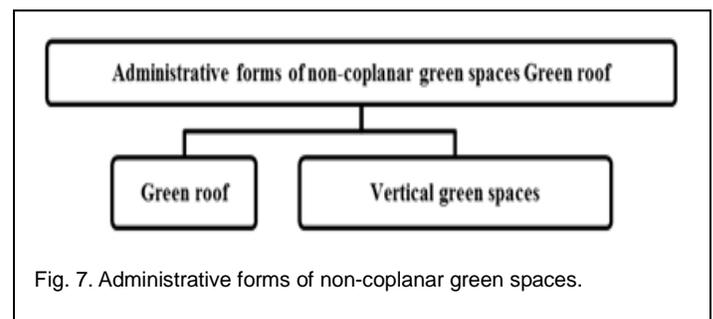


Fig. 7. Administrative forms of non-coplanar green spaces.

7.2.1 Green Roof

Constructing a green roof has a long antiquity which back to 7 and 8 centuries before Christ. Green roof is considered as applying new technology in construction. The roofs of plants are a layer of plant, which is located and grown on the special infrastructure on the structure of flat or slanting roof. The use of green roof will cause the reduction of thermal conductivity utilization of the structure of roof and more stable Interior temperatures [9]. The use of green roof will reduce thermal exchange at the rate of 50%. Dealing with this technology can be considered as the greatest positive environmental developments in cities. Green Roofs are greens spaces which are created via adding layers that are capa-

ble to grow and develop plants, on the rooftops of homes. Generally constituents of a green roof could be shown in the following figure:

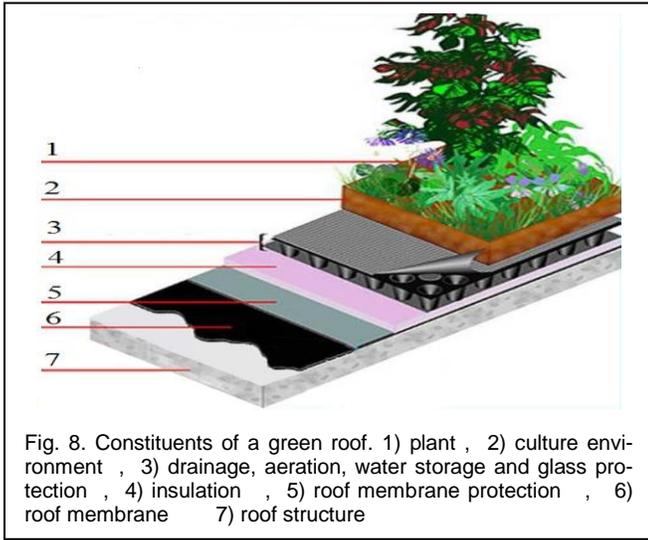


Fig. 8. Constituents of a green roof. 1) plant , 2) culture environment , 3) drainage, aeration, water storage and glass protection , 4) insulation , 5) roof membrane protection , 6) roof membrane 7) roof structure

Some of the advantages of green roof:

1. Supplying conditioned and compatible space for building users due to the placement of yard and patio
2. The possibility of cultivating fruits, vegetables and flowers
3. The reduction of heating and cooling load of the construction
4. The reduction of heating effects and urban climate changes
5. The increase of living zone
6. The reduction of flood
7. Air ventilation and the reduction of air co2

8. The reduction and adjustment of the intensity of sounds that enter building up to up to 18db arrived and go out of it the amount of 3db or more.

9. The improvement of landscapes around the building with providing a beautiful green space

10. Raising the roof membrane lifetime with protecting it against harmful UV rays and weather damages

11. Increase the value of property

Some of the disadvantages of green roof:

1. The need to strengthen available roofs structures for the establishment of a green roof and the fact that most of these roofs are not prepared for the human presence.

2. Sometimes, matching design of the roofs with climate conditions of working area is difficult.

3. Green roof requires acceptable structural criteria (due to soil and plant requirements weight load).

7.2.2 Vertical Green Spaces

Vertical green spaces are predicated in parts of space including fences, columns, canopies, windows and all non-coplanar spaces in which plant could be grown and developed. Even a small vase that can be put in the platform of window is also considered as a part of green spaces.

8 REVIEW OF EXTERNAL AND INTERNAL SAMPLES

8.1 Analysis of One of the External Designs with the Approach of Non-Coplanar Green Spaces

Constructed commercial project in southern Japan, located in Fukuoka, Japan which is built on a hill with gradient of 2%, and has absorbed the attention of many nature lovers [8].

International Hall ACROS, "Asian Crossroads Over the Sea," Fukuoka Prefectural.



Fig. 9. Administrative project of vertical green spaces in Fukuoka, Japan

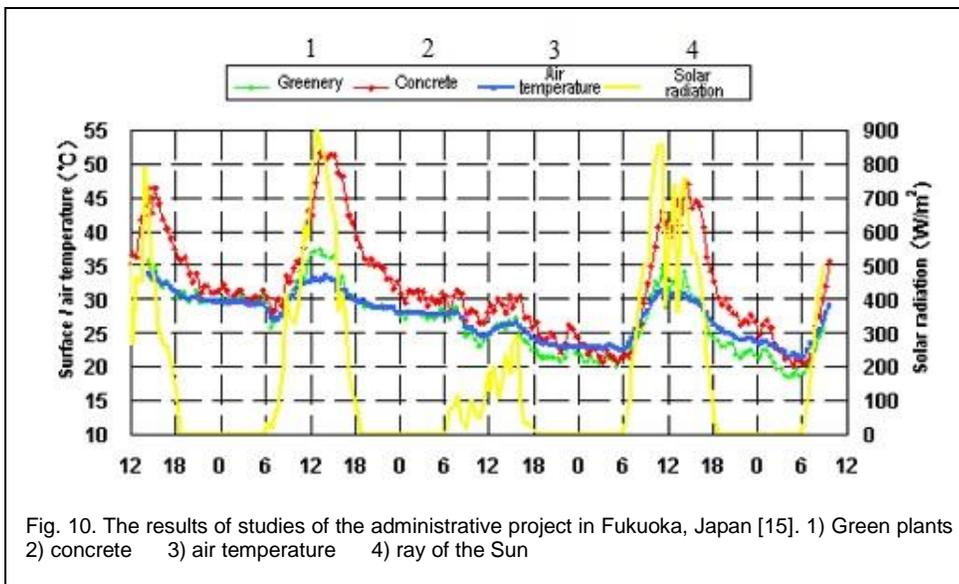


Fig. 10. The results of studies of the administrative project in Fukuoka, Japan [15]. 1) Green plants 2) concrete 3) air temperature 4) ray of the Sun

The results of studies are as following: "the difference of 15 Celsius degrees between temperature levels of concrete"; the results reveal that green spaces and plants stop rising of surrounded air temperature.

8.2 Analysis of One of the Country's Interior Designs with the Approach of Green Space Location Vertical Development of the City

One of the projects which has been formed with this approach in our country is the projects of Ardebil Yademan twin towers that is applied with the approach of energy sustainability on utilization of maximum solar energy.

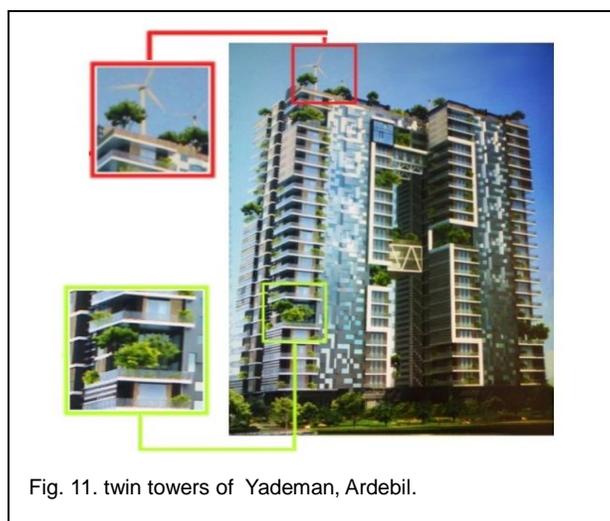


Fig. 11. twin towers of Yademan, Ardebil.

Some of the advantages of twin towers plan of Ardebil Yademan, can be noted as following:

1) In this project, according to vertical growth and expansion and the necessity of increasing the heat exchanges of these two twin towers that are connected together at the end, by embedding vertical green spaces, the energy loss has been largely reduced from the wall.

2) According to the horizontal plans and horizontal growth of the city in previous records, the central courtyards will be considered as one of the climate requirements in such buildings which are replaced with vertical courtyards by the vertical expansion of cities and it plays the most important role on the deficiency of this shortcoming.

3) This would increase green space capitation.

4) Applied wind turbines to take advantage of wind energy and control solar energy in this building by windows with moving canopies and vertical yards will prove the necessity of taking advantage of sustainable architecture requirements.

9 CONCLUSION

The process of urban growth and tendency to high rise building and vertical growth of cities and the need to increase climatic considerations and also the increase of increase green spaces capitation, the necessity to use green spaces even in grade separation is important. Thus, justifiability of green roofs and vertical green spaces with the aims to optimize energy consumption and control thermal exchanges on the one hand and increase green space capitation on the other hand play a significant role. Due to the increase of energy exchanges between the surface of construction shell and surrounding environment in high-rise buildings and also nearly half of the average of household consumption includes heating and cooling system. The need to create smart buildings in order to control and optimize energy consumption that is effective in reducing energy consumption close to 50 percent and also the most available heat loss in roof, walls and floor by applying non-coplanar green spaces that includes green roofs (the reduction of roof thermal exchanges) and vertical green spaces (the reduction of wall thermal exchanges) can be applied as one of the most effective solutions that finally is along with controlling and reducing fuel consumption, especially fossil fuels, and benefiting from natural and renewable energy available in the environment without creating additional pollutants that cause environmental pollution.

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