

## Designing a building form to utilize Renewable energies

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### Abstract

Designing correct architectural buildings has great impact on reducing energy consumption and its waste. The building forms are one of the issues that should be considered in order to achieve sustainable architecture. This study aimed to introduce architects the methods and principals to achieve sustainable regional architecture through analytical-descriptive approach. The principals and characteristics used in this study include: the form volume, form stretching, form height, place and ratio of empty and filled places in the form, materials used in constructing the form, and the facilities place in the building form. Proportionate to the analysis in each place, the example of historical and current architecture were used to better understanding of the topic and sometimes comparative comparison was done as well. Some solutions were also introduced in order to get appropriate form.

**Keywords:** Renewable energies, regional architecture, historical architecture, current architecture, building form.

### Introduction

Using renewable energies in architecture dated back to long time ago. Human being appropriate to the equipment available in each era tried to utilize natural factors more in order to provide their comfort and welfare. One of the signs of human's attention to the issue is the architectural works remained. Architecture has always been the reflection of nature impact on human life and their understanding of how to use and control the natural factors.

Unfortunately, in the current time along with finding the renewable energies and numerous uses of them in architecture and urbanization, people have gradually forgotten the old experiences in using renewable energies and nowadays the architecture forms show less the relationship of the building and its surrounding environment. However, human being recently has understood the harms and problems of irregular uses of renewable energies. The problems such as environmental pollution of none renewable energies waste, limited renewable energies resources, renewable energies resources not easily obtained anywhere made human beings think of new solutions to apply renewable energies in different fields of life. Unfortunately, the Iranian building forms have been currently designed based on beautification principals and the effects of the form on reducing the energy waste or save has been less regarded. In this regard, the current study aimed to introduce the principals in designing building form so that architects can use renewable energies optimally in the buildings.

### Significance of the study

Complete investigation of the relationship between building form and building energy consumption needs widespread study that this article is an introduction for the future researches. The significance of the study includes:

- Increase in the cost of building energy consumption in Iran due to omitting the subsidy in energy;
- Limited none renewable energies resources;
- Environmental pollution resulted in irregular use of none renewable energies;

- The potential use of various renewable energies in different parts of Iran;
- The needs for considering regional characteristics of the region in order to identify the architectural buildings.

### **The principals of designing forms**

In order to achieve a form compatible with the climate of a region and provide the inhabitants comfort and welfare some qualities and properties mentioned in the following should be considered.

Selecting volume is one of the importance factors in designing forms and it sometimes causes volume and form vocabularies considered as each other equivalent. The volume of the building has significance impact on the building energy waste. To explain this case it should be considered that some volumes with fixed capacity may not have the same external area which has direct relationship with the effects of inner temperature of that volume from the environment temperature. In other word, the more external area of a building, the more effects of inner temperature of that volume from the environment temperature. As it can be seen in figure 1, there are 3 volumes with the same capacity (3200 unit of volume) and it was attempted to be similar to the popular buildings around us. The first volume represents three story buildings, the second volume represents villas, and the third volume represents buildings with tiled roof. Although they have the same capacity but the second volume has the most external area and the third one has the least external area. Therefore, based on the given information, the second volume has the most energy waste and the third volume has the least energy exchange with the environment in the same temperature.

In general, among the volumes the one with the least external area in relation to the volume capacity is circle volume. Therefore, if it is intended to have a building with the least energy waste, it is better to modify the building form into the circle as far as possible and since circle has the least supporting point with the earth, it should be done in the form of semicircle. There are some houses and buildings in circle everywhere in the world (figure 1).



**Figure 1: House in circle in New York**

There are problems in building semicircle houses including:

- Problems in building the details of semicircle roof and structures;
- Creating unused spaces in the building due to less or more height of spaces appropriate to the distance to the center of semicircle (figure 2);
- There are unused spaces between circle buildings in a neighborhood and makes the urban design difficult.



**Figure 2: Unused spaces in circle houses filled with vases and some other stuff**

The examples of circle forms in historical bathrooms in Iran are the good examples in this field. The circle roof in the bathrooms prevents high energy waste (figure 3).



**Figure 3: Ali Gholi Agha Bathroom in Isfahan with circle roof**

The volume of buildings can be effective in directing the regional winds and using renewable energies. One of the examples of this kind of design can be seen in the world trade center in Bahrain (figure 4 & 5).



**Figure 4: Using wind turbines between the towers of world trade center in Bahrain**

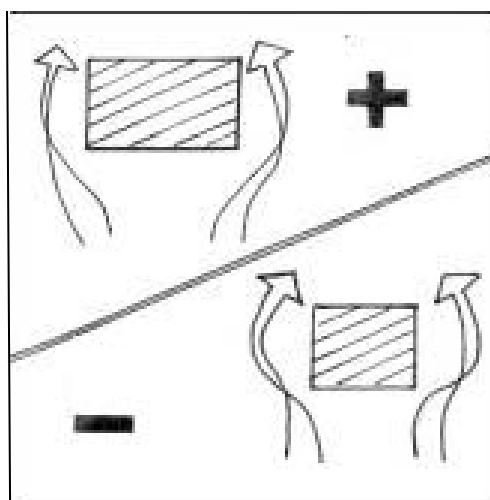


**Figure 5: ANARA tower in Dubai**

Therefore, determining the form volume has great impact on the building energy waste and absorbing wind energy and architects should be careful in choosing the building forms in order to reduce the building needs to heat and coldness resources.

### **Form stretching**

Selecting the form stretching can be highly effective in absorbing or wasting renewable energies. If building stretching is in Eastern-Western direction the possibility of absorbing solar energy is more than the state that the building stretching is in Northern-Southern direction. The blowing direction of desired or undesired wind should be regarded in order to control the amount of absorbing or wasting the wind (figure 6).



**Figure 6: The above building stretching is in a state that absorbs the most desired wind**

If it is possible to absorb desired winds, small wind turbines can be used to generate electricity in the buildings (figure 7).



**Figure 7: Applying wind turbines on the roof of the building**

### **Form structure**

Selecting a structure in constructing a building can be done by considering the approach of using the region climate condition. In this field, the civil engineers cooperation to design structures that have the potential of using clean energies is necessary (figure 8).



**Figure 8: Alternatives in construction of moving tower in Dubai**

### **Determining the place and the ratio of empty and filled spaces in the form**

In Iranian historical architecture it can be seen that the places of empty and filled spaces are appropriate to the climate and environmental conditions of the regions.



**Figure 9: Pirnia house in Naein**



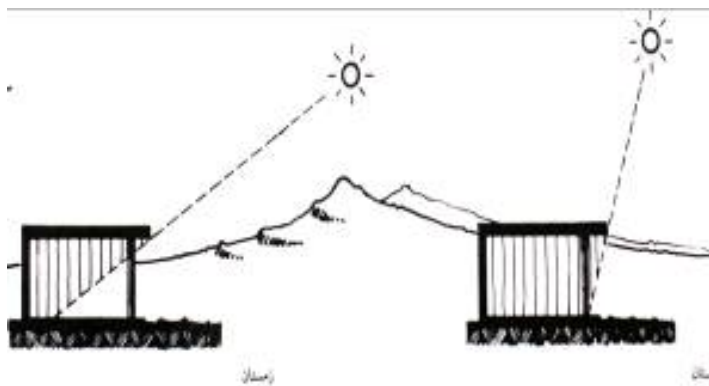
For example in central parts of Iran due to the hot weather, the empty space (yard) is located in the middle of filled spaces and some elements like water and trees are put there which literally called central yard and overall form of the building was called “Introvert” (figure 9).

The presence of yard in the center of the building was due to the fact that they could use the moisturized humidity of the pond and also the trees leaves and the green space in the yard and to stabilize the hot and dry weather. But in the northern parts of Iran the empty spaces were located around the filled spaces and the buildings were literally called extrovert (figure 10).



**Figure 10: An extrovert house in Astara**

The reason that the houses designed with open spaces around them was to create a passage of air around the building and to avoid the humidity staying inside the buildings. On the other hand, using the semi open spaces like porches (Gholmgardesh) in the old architecture as regional elements is significant. Porches in central parts of Iran prevent sunrays getting into the houses in summer and let them shine in to the houses in winter (figure 11).



**Figure 11: The effect of porches on the amount of sunrays getting into the houses in different seasons (Ghobadian, 2010)**

Gholamgardesh (porches around the building) in the architecture of northern parts of Iran provides situations in which makes the air circulate and prevents humidity bothering the residents (figure 12)

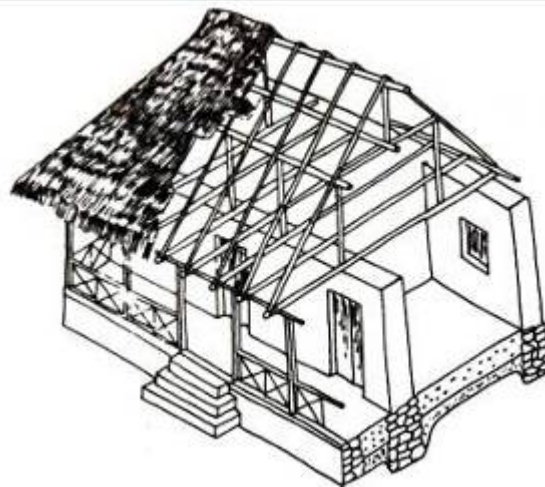


**Figure 12: The position of Gholamgardesh around the building**

Although Iranian historical architecture has indicated the mentioned solutions to maximum uses of the environment but unfortunately today's urbanization and architectural principals are different from these solutions and resulted in buildings throughout Iran without considering the climate and environmental characteristics.

#### **Materials of constructing the form**

In order to construct a building with optimal condition in consuming energy, the materials should be used which are compatible with the climate of the region. Historical architecture of Iran is full of the successful experiences indicating the old architects' attention to the materials compatible with the climate of each region (figure 13).



**Figure 13: Applying local materials in constructing houses in the northern parts of Iran (Fateh & Daryush 2010)**

Iranian architects believed that buildings should be the product of the place where the building is being constructed (Pirnia, 2005). But in current architectures it can be seen that choosing the materials for buildings is done only based on the outer beauty of the buildings and respectably the conditions of the region are less considered. As an example applying glasses facing in central parts of Iran like European architecture is one of the current architects' mistakes because in these places sunshine is high and the number of cloudy days is small and this situation is different from Europe and following this facing causes high sunshine in the buildings and bothers the residents.

### Form height

In historical architecture of Iran, the height of building forms is also determined based on regional conditions. As an example in Maymand Village in Kerman it can be seen that the buildings are short in the earth instead of being tall (figure 14).



**Figure 14: the way to build houses in Maymand Village**

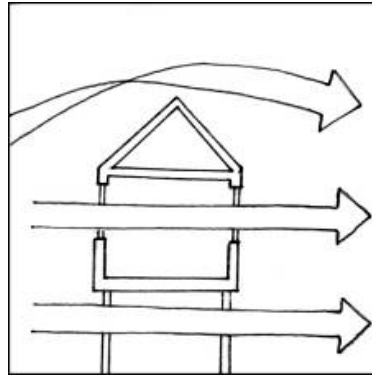
This method is used in the current architecture of the world and is literally called buildings surrounded in the soil. In this method, some parts of the building or the whole parts are covered by soil in order to lessen thermal exchange between buildings and outside weather. This method is also used to cool the building as well (Ghiabkuh, 2011). The main problem in this method is impossibility of using sunrays. To solve the problem the building is constructed in a way that half of the building is put under the earth for the activities that need less light and the other half is located above the earth. In the northern parts of Iran the past architects with regards to this fact also constructed buildings on the hills and established pilots or Gorbero under the buildings (figure 15).



**Figure 15: Building located on Gorbero (the museum of village heritage in Rasht)**

Establishing pilots or Gorbero causes the buildings located in higher places over the level of the earth and free winds can create air passages in the buildings (figure 16).





**Figure 16: Air passages in the building located on the pilot**

### **Facilities in the form**

One of the tendencies in modern architecture is known as “unique style”. The architects confirm that this style in technology is a breakthrough and the most important factor in development in 20th century. According to them the characteristics and signs of each era are shown in their architecture (Ghobadian, 2005). They believed that the facilities and technology used in the buildings should be designed in a way to be used in beautifying the buildings and prevent covering them due to lack of beauty. With a look at the historical architecture in Iran it can be seen that regional issues followed by the past architects led to the buildings beautification and were considered as the beauty factors of the buildings. The examples of windward, shoal, sash etc. are a lot in this architecture (figure 17).



**Figure 17: Windward is an element of facilities as well as the beauty of the building (Aghazadeh house in Abarkuh)**

Unfortunately the current Iranian architecture does not pay attention to this background and today's buildings facing have changed into a chaos of coolers and facilities parts (figure 18).



**Figure 18: Chaos in building facing due to lack of designing facilities spaces**

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Iranian architects should plan to apply facilities systems with the least energy consumption and avoid being indifference to the architecture by considering their historical background (figure 19).



**Figure 19: The difference between current and historical architecture in utilizing energy and designing facilities places in buildings (Ayatolahi, 2006)**

### **Conclusion**

Designing building form has significant effect on the rate of energy consumption and architects should regard beautification factors as well as regional and climate factors in designing building forms. In order to achieve sustainable architecture compatible with the climate it is needed to consider the form volume, form stretching, form height, place and ratio of empty and filled places in the form, materials used in constructing the form, and the facilities place in the building form. Iranian architects can rely on their brilliant historical background in architecture and promote the principals in the architecture appropriate to the today's life. Following the principals brings about comfort for human being with the least energy consumption as well as creating identity in architecture and evokes the sense of belonging and diversity in the followers.

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