A Review on the efficiency of using natural ventilation in traditional architecture (Case study: northern Iran, Qajarieh era houses)

ABSTRACT:
One of the main problems in human life is achieving an inexhaustible source of energy. One of the most important renewable energies is wind and human being has been always thinking about application of this energy in industry and construction of buildings. Oldest method of using wind energy is documented in returns to ancient Iran. For the first time, Iranians succeeded to invent waterwheels by using wind force and send water from their water wells to farms. In Iranian traditional architecture, natural ventilation was the main part of building design that came to existence by creating natural air current into buildings. Native architecture reached to a phenomenon of stable architecture. For example, in North of Iran (Gilan, Mazandaran and Golestan Provinces) architecture in humid and moderate weather, as a sample of native architecture mixed with nature, has an ancient history in which a soothing space compatible to climate was created by considering nature. This architecture guaranteed its stability by using ecological buildings and proper storage of energy resources that one of the main samples is in Qajarieh era and has considerable importance in art and architecture history of Iran because in that period, based on architecture of their ancestors heritage and also intercommunication with west, salient revolutions and innovation produced in domain of art and architecture. This review was aimed in identifying stable architecture and useful alternatives that were used for utilizing air current in humid and moderate climate.

Keywords:
Wind energy, Natural ventilation, Stable architecture, Native architecture, Qajarieh era
INTRODUCTION

Since the origin, humans received help from the nature for securing themselves from natured forces and had shelter in caves and, trees and among stones (Ahmadpour, 2015). He did invariable initiatives for organizing environment around himself to meet his primary needs (Shoaee and Arabesmaili, 2013) and gradually learned to make his shelter more stably and then the world's different civilizations used their special methods by considering special conditions of climate and human was always looking for creation of biological environment to meet his emotional and physical needs and used environmental conditions for his interests and made more comfortable houses by using sun, wind and water. Four decades prior to BC, Aristotle and one decade press to BC, Marcus Vitruvius Pollio, a Roman architect, talked about the method of using wind in architecture and construction. Among them, Iran's traditional architecture was one of the best examples of climatic architecture which had the most desirable solutions for survival of biology and human welfare and desires using natural energies. Iran has enormous resources of renewable energies because of its proper geographical location (Tabriz et al., 2012). One of the renewable energies is wind. So in the past, Iranian architects used wind factor for moderating heat inside houses, salons and reservoirs. They could make the best coordination with environments by natural resources and pure energies in different climates and provided the best biological requirements with limitations and equipment’s (Shahamipour and Farzanmanesh, 2015; Utaberta et al., 2012). North
of Iran architecture is one of the successful samples of native architecture that has mixed with nature in such a way that is pure of natural context and environment around it (Peirov and Farivar, 2015). The purpose of this view is identifying ecological elements used in natural ventilation of Qajarieh buildings in humid and moderate climates.

**Alternative Energy**

Alternative energy i.e. renewable energy for producing these kinds of energy resources without carbon is used. These kinds of energies don’t have disadvantages of fossil fuels like increase of carbon dioxide concentration and finally increase of earth temperature, weather changes and environmental pollution. In addition, the resources of their production are inexhaustible limitless.

Fossil fuels like coal, oil and natural gas are currently the world’s primary energy sources. The heavy dependence on the fossil fuel in 20th century largely reduced the natural reserve of it (Bhandari et al., 2015). The issue of energy and the ways of taking the advantage of natural and renewable ones are the most important which attract attentions nowadays (Kalantari et al., 2015).

**Kinds of renewable energies used at Qajarieh**

**Wind Energy**

At the present time, we are able to predict wind current position and their effect on all structural collections by using architecture aerodynamic science. With the help of this science, one can investigate wind currents by using wind tunnel or using theoretical methods and mathematical calculations and impose required corrections before designing.
Architecture in Qajarieh era (1796-1925 AD)

Totally, architecture of Qajarieh period is divided into two general periods.

The first period (Agha Mohammad Khan’s monarchy to the end of Mohammad Shah’s monarchy)

In this period, dominant look on architecture was on introvert look and based on Isfahan style and its accomplishment such as St. Masoumeh shrine in Qom and Soltani mosque (http://arktourism.ir).

The Second Period (Naseroddin Shah monarchy to the end of Qajar dynasty government)

In this period, an architectural style began in the effect of Naseroddin Shah based on his posterity trips and also sending some Iranian students to Europe and being affected by government parties and elites of society. This architectural style is a compound of native and western architecture (Qasemi et al., 2015).

Qajar architecture is divided in the Isfahanian method, but in this period, a new method was made in architecture that was again based on Isfahan style and Tehran style, is a compound of Iranian noble architecture with western architecture. (Qasemi et al., 2015).

Qajar architecture promoted the principles and old patterns of Iranian architecture and made innovations specially. Locality and degree of Qajar architecture in history of Iranian past architecture (before new period) can be arguable and deliberative. Spaces reach to dilation and old patterns of Iran architecture are accomplished for dilating space. In summary, if we consider architecture development, dilation, transparency and levitation of spaces, architecture of this period is proposed as a development stage of Iranian old architecture. We should consider that, the end of Qajar era was coincident with the time origin of modern architecture which was established in Europe and some typical constructions of modern architecture became viable. In fact, Qajar architecture promoted principles and old patterns of Iranian architecture and created some innovations spatially (Figure 2) (http://www.islamicartz.com)

Macro characteristics of architecture in Qajarieh period

- Using purple or red color in seven-colors of adobe tiles
- Using crenation beside castles roof
- Decorative elements and facing influenced by western elements
- Construction of huge and high "Iwan" (balcony) in entries
- Construction centrality with columns and capitals
- Constructions in elevated form showing grandness and power
- Stone, cement and iron materials
- Interior decorations
Construction of staircases in main axis
Respecting hierarchies
Alteration of three valves to two valves
Housetop roof and construction of fields

Residential constructions in Qajarieh Period
Including central room, Iwan with two columns in front of it, small rooms around central room in a simple and ample form
Plans extended across construction
Construction of widespread landscape by windows
Springhouse shebang
Common funnel for construction of space
Construction of capitals and columns in entries
High "Iwan" porches
Construction of two-ways staircase in main axis
Alteration of three valves to two valves and entrance of direct light into construction
More variety and levity and dilation of spaces
Gradient roof and housetop
Mix of Iranian and European architecture (http://www.islamicartz.com)

Native architecture in Northern Iran
Humid and moderate Climate

Design and construction with climatic attitude for saving energy, using natural materials like wood, plant fibers, stone, soil, etc., providing requested energies for ease with proper design of dilations and extraversion of buildings with proper orientation, using technology and native methods of making and creating desirable environments with natural energies and minimization of fossil energies are some ecological patterns in native architecture of northern Iran. Native constructions of this area not only damage to their context but also play a role for improvement and its quality. Construction is used as a member of natural cycle and for development of this cycle (Peirov and Farivar, 2015).

North of Iran native architecture
Gilan, Mazandaran and Golestan Provinces

Native architecture of northern Iran has the following characteristics. For preserving building from extra moisture of earth, houses were made over wooden legs, but moisture is less in foot of mountains. Houses were usually established over stone and mud feed and sometimes over the "Gorbeh ro" (catwalk)

- For preserving rooms from rain, small and wide Iwan were made around rooms.
- Most buildings were established with materials of minimum thermal capacity.
- In all buildings of this area, without exception draught or natural ventilation are used.
- Buildings were decentralized and sparse.
• Plans of this area is widespread and open and this skeletal form is lengthy and narrow and with geometrical shapes.
• Because of much rain, roofs were made gradient (Kasmaei, 2012).
• Buildings have lengthy and narrow geometrical shapes and are extended east-west.

Natural Ventilation

Natural ventilation means the movement of fresh air inside building outside without using mechanical systems that ends in saving fossil energies. In this process, air inside the building was heavy due to, skin inspiration, cooking, smokes and similar cases and is replaced with fresh and light air from outside (Tahbaz and Jalilian, 2011; Schiller and Schille, 2000).

The main advantage of utilization of natural ventilation in building design is not only reducing energy consumption and cost, but also providing acceptable, comfortable, healthy and productive conditions (Moosavi et al., 2014). Provision of fresh air with a connection to the outdoors, which are the main requirements of natural ventilation, can be achieved by openable windows, double facades, ventilation stacks, balconies, patios, terraces, atriums and gardens in a tall building (Irwin, et al., 2008).

Using wind energy in architecture

In climatic architecture, wind current is used for natural ventilation and renewal of air inside the buildings. In addition, in hot regions and hot climate, wind current is used for cooling environment and internal space of buildings from one side, avoiding from undesirable and intruder winds and their control are the main subjects that should be considered (Tahbaz and Jalilian, 2011).

Investigating sustainability elements in ecology using renewable energy of wind in natural ventilation of Qajarieh buildings in northern Iran

In north of Iran’s traditional architecture, each part is a member of a regular and stable macro environment that plays a role in reacting with each other. Present material, structuring methods, kind of buildings and their relation with design bed, all of them indicate balance and dynamics of this architecture. Sustainability elements which played a role in natural ventilation of buildings by using wind energy is as follows:

Dispersion and extroversion of building

Dispersion and extroversion of construction of building was the best way in using wind current and air ventilation in building (Figure 4). So, the building had to be opened from two sides or four sides.

Building orientation or direction

It is one of the main works in buildings of Qajar era and also Pahlavi era in north of Iran for ventilation and cooling by air, construction of north oriented buildings and behind southern buildings was preferred. Because in north of this area, there is the Caspian whose...
air flows from north to south and this causes natural ventilation of air. Also in winter, the southern side has more sunshades and as a result it is heated and north side is shaded and is cooler.

**Plurality and exposure of openers**

In the north of Iran’s traditional architecture, openers are used more in front of each other, in order to flow air well into building. Of course it should be mentioned that the number of higher or upper floor openers was usually more than lower floor ones (Figure 5)

**Height of the building roof**

It was the main principle that was considered more by most of the architects of that time. Height of down floors was made less than upper floors (Figure 6). As an example height of the ground floors was made about two meters and these rooms were called winter-setting rooms. Because of shorter roof and also fewer number of openers, airflow was less and thermal exchange was less in open spaces and as a result, internal space became warm earlier and height of upper floors were made about four meters and they were called summer-setting rooms. Because of roof height and also more number of openers and as a result using better airflow, space became cool earlier (Dashti, 2013).

**Construction of a small room between rooms around**

In many buildings of that period, a small room was made between other two rooms for cooling space more especially in warm months of year in upstairs. In fact, it was the coolest room of house because there were two corridors in front of each other that one of them was in north side and the other in south side and air moved into this space with more pressure from north to south and moved out of this space with more pressure. As a result, this part of house had more air current and natural ventilation was better.

**Construction of stairs in mid-space of building**

In many buildings of Qajar era and also Pahlavi, stairs were made in mid-space of building because of more air current to have natural ventilation (Figure 7). In other words, a kind of air movement was from up to down and from down to up (Dashti, 2013).

**Kalagh Neshin**

In traditional constructions with humid and moderate climate, a reticulated valve was made for entering air outside in to the space. As seen in Figure 8, "Kalagh Neshin" was the highest part of building and airflow directed from outside into buildings and caused natural ventilation between spaces of house, like Bâdgir operation in dry and hot climates. Fixing and repairing roof cracks were other applications of "Kalagh Neshin" (Dashti, 2013).

**Gorbehro**

As seen in Figure 9, Gorbehro is a canal made under building and taking moisture from foundation of
building and direct towards up and removes moisture. "Gorbehros" have a main role in lowering degree of moisture and hence flowing wind inside the space of house causes cooling air inside (Dashti, 2013).

**Iwan**

In Persian language, Iwan means 'portico, open gallery, porch or palace' and the word Iwan in Arabic covers the Persian concept (Reuther, 1967). Iwan is one of the historical elements of Iran’s architecture that is considered as a main innovation in native architecture. This element was designed by climatic method and was known as a ventilating system and provides pleasant ventilation by using renewable energy (Mirhadi and Sanaee, 2014). Also it is the semi-open space of house that is the main and most applicable space which has multiple operations (Diba and Yaghini, 1993). Iwan is in the middle and semi-open space in hierarchy and is available from open to close space (Armaghan and Gorji, 2009). This element was in Safavi architecture but less common in Qajarieh era because of fewer limitations but in Pahlavi period, this element was considered more and adjoins over Qajarieh buildings, as it is shown in Figure 10 (Dashti, 2013).

**CONCLUSION**

North of Iran’s traditional architecture was mixed with nature by using native materials and self-sufficiency. This architecture is a proper sample of mixing and coordination of building with nature. Those days, architects used some techniques that nowadays engineers neglected or forgot them. By the development of modern architecture and extra dependency of human on technology, native architecture and in following native oriented architecture are less argued. Also progressive utilization of fossil energies put the world into crisis of finishing energy resources and this case caused inexpiable damages to our environment. Traditional architecture while energy consumption has not been defined as today, have utilized some passive design methods by attending to the potentials of the region and made them highlight. Air conditioning and mechanical ventilation have been for decades the standard method of environmental control in many building types. Global warming, pollution and dwindling energy supplies have lead to a new environmental approach in building design. Innovative technologies along with bioclimatic principles and traditional design strategies are often combined to create new and potentially successful design solutions. In Iranian traditional architecture, natural ventilation was the main part of building design, but nowadays optimal utilization of wind energy was neglected very much. Therefore, according to this fact that wind energy is more economical than other pure energies, it is necessary to apply the solution for decrease of using fossil fuels and using stable patterns according to climates as a step for preserving our environment.

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