

# The Contrastive Study of Geodesic Domes in Modern Cappars

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## Abstract

*The modern Cappars are considered as the most stable, simplest and cheapest architectural designs. The Cappars were the primitive accommodation for primitive human beings when they left caves and before they constructed villages. Cappars are the first social institutions which have existed along with the development of villages and cities for 40000 years without destroying the ecosystem while observing all factors of sustainability. The Cappars built in the past had a desirable function since they were set up with regard to the principles of Iran's climatic conditions, and protected human beings from heat and cold naturally. The renovation of Cappars with regard to preserving their architectural values by using new constructional materials not only helps revive apart of Iran's history but also assists human being to have an impermanent accommodation. The plan of the modern Cappar based on designing accommodation units with geodesic domes which look like the domes of ancient Cappars is the typically live architecture in Iran. The geodesic domes used in modern Cappars are very efficient due to having high performance structures to cover small integrated spaces without pillars. These domes physically have the most efficient resistance against exterior forces like strong winds in Iran. Moreover, this kind of cover is light and can be manufactured easily and installed quickly. In this study, we will focus on studying the sustainability of Cappars, the most resistant structures, and then the modern local designs of such structures are studied by taking the climatic capabilities of environmental architecture into consideration by using the climatic technics and modern technology which correspond with the local architecture so as to provide more convenience for the residents.*

*Keywords: Modern Cappar (the primitive shack with dome-shaped cover), Iran's climate, Geodesic domes, Climate technics, and Modern technology.*

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## **1 Introduction**

Lodging has been the most essential requirement for man since the creation of human beings. The primitive humans instinctively chose caves as their lodging and shelter against climatic changes and as a safe place to be secure against savage animals. The increase of population forced humans to think about solving their lodging requirement by using jungle trees and stone to some extent. The further increase of population and its dispersion in different geographical places enforced humans to build proper houses consistent with the climatic conditions of their regions. The first houses humans made after they had come out of caves and before settling in villages were the primitive lodging called Cappars. In fact, the first institution which was still used along with the development of villages and, later on, cities in Iran was the designing of Cappars for accommodation. This style of life has a longer background than history of having a fixed settlement to build up society. The history of settlement in Cappars goes back to 40,000 years ago. Living in Cappars based on stockbreeding economy which is accompanied with learning different skills of exploiting natural facilities and ecosystem was formed by domesticating and breeding animals [1]. The main houses of nomads in Iran, which can be easily setup or packed are Cappars used based on economic and social ecology. It has its own hierarchy which is based on family as the main core. Family in larger scales includes group, tribe and clan. Nomads are tribal groups in Iran, who cannot have a fixed location for accommodation because they need to migrate frequently or seasonally in order to find forage and pasture for their livestock. Since pastures are limited, they face some problems with staying in one place. Therefore, these problems force them to design Cappars with regard to their facilities. These Cappars should be easily movable. They should be capable to be setup in the shortest possible time, or packed and carried easily in the time of migration, while they should strong, and resistant against climatic factors like strong wind, rainfall, snow and earthquakes; moreover, they should be usable in summer or winter. Consequently, nomads managed to design lodging with some materials like wood and sheep wool available to them, which met all their accommodation requirements [6].

## **2 The Climate Conditions of Iran**

In regard to the climatic divisions, we can locate Iran in the dry climate of the world. Based on the climatic effects on the civil structure, the form of houses and the kind of constructional materials, some common features can be observed in the following four regions: the southern bank of the Caspian Sea, the northern bank of Persian Gulf and Oman Sea, mountainous regions and plateau and Flat plains [5].

Each of these regions has its own climatic conditions. Consequently, in today's modern buildings, the builders have tried to fight with climatic differences by using

modern technology and mechanical installations. However, in the past, there were not such mechanical installations; thus, the traditional builders had to fight climatic conditions by using local facilities and available materials and, to provide the residents with comfort, they took important climatic features such as sunlight, wind, rain, temperature changes and so on into their consideration. The usage of Cappars and bowers was more common in eastern regions of the Caspian Sea and southern regions of Iran, especially near Bandar Abbas and Chabahar. The poor people settling in these regions build straw houses with domed ceilings called Cappar near the regions where reed and date trees grow in north and south of Iran respectively, Cappars and bowers are used as accommodation by a high percentage of villagers in these regions. The materials used in building Cappars are the reeds growing in lakes or ponds and the leaves of date trees. These Cappars are used as houses beside lakes and ponds, but they are used as barns in villages. Cappars are economically suitable in such regions because they do not save heat and provide shade; in addition, ventilation is done easily and naturally. Thirdly, Cappars function better than muddy walls when the level of water rises in the region due to sudden rain falls since water and rain destroy mud bricks and walls gradually and preserve moisture for a long time, while walls made of straw or reed are not easily destroyed with water; furthermore, their moisture is easily dried. Besides, straw or reed walls are stronger and more resistant against earthquakes than mud-brick walls when earthquakes happen frequently in Iran.

Therefore, Cappars, which are the traditional buildings in Iran, are said to have no harms to environmental conditions, but they have co existence with virgin nature and ecosystem by using natural conditions appropriately, whereas most of the temporary and modern buildings are not nature friendly [4].

### **3 The Design of Ancient Cappars**

In nomadic life, the routine affairs are divided between men and women. Men are responsible for the protection of sheep in their temporary residential area, while women take the responsibility of setting up their Cappars. It is easy task which is done collectively [6]. In their residential region, a smooth and flat land standing almost 10 centimeters higher than the adjacent area is chosen; of course this height includes clay and straw plaster used to level the ground; consequently, it prevents from the penetration of rain and wind into the Cappar, when there are strong rainfalls and wind. This height, also, prevents from vermin's. In uneven regions with hills, some other factors such as canals conducting water from the hill top should be considered. The orientation to set up the Cappar is important as well to enable the Cappar to receive enough sunshine, while it provides a safe shelter against disturbing wind. The main building material of Cappars is reed, which can be set up and packed easily in the shortest time, and comprises some interconnections. The lower part of the Cappar is cylindrical with 2 up to 2.5 meters in radius formed of

crisscross wooden interconnections, and the upper part includes a dome-shape made of tens of arched wood pieces [6].

Picture 1: Ancient nomadic Cappars



## 4 Geodesic Domes

The application of domes to cover an integrated residential space without pillars is an easy and economical way. The design of such a dome has its own advantages and beauties. Domes have been used in Iranian architecture since the ancient times. The carved paintings and designs of cheribo Castle remaining from Ashuri Dynasty show that domes were constructed with sharp point peaks and arched hemisphere. The development of domes in ancient Iran was accompanied with pieces of stone gradually replaced with brick works. Later on, in the modern age, Iron was used to form the structure of domes, and then concrete was extensively used, which provided desirable resistance against pressure, in the implementation of modern domes. The addition of Iran bars to arm the concrete against the pulling forces created a new method in structural engineering which led to constructing modern domes by using strengthened concrete. The inclination to use harnessed domes and their progress which was begun by an American engineer named Buck minister, Fuller in the second world war in Europe have become more widespread; it has led to the construction of geodesic domes, the most effective domes [2].

### 4.1 The Designing and Construction of Geodesic Domes

The development and progress of this kind of domes which were innovated by Buck Minister, Fuller in Europe in 1954, began a turning point. The ideal construction of domes based on a few elements which are connected with simple interconnecting fittings and are the same for all connections is carried out. These domes enjoy noticeable sustainability and balanced distribution of forces due to specific geometric forms and the concentration of deferent forces is not seen at any point of its surface but the posing points because the length of strong and heavy profile constructing the structure has a few modules. There is no need to use strong, heavy profiles [2]. These domes are usually divided into three classes namely steel domes, aluminium

and wooden domes. The design of the geodesic dome, having numerous advantages, is applied in the ceiling of temporary modern accommodations in Iran.

## 5 The Modern Design of Cappars

The modern Cappars are considered as the strongest, simplest and cheapest houses. This design is also used to build temporary mosques, mobile hospitals, local health centers, weather forecast stations and telecommunication stations, resting places for mountain climbers, road maintenance bases, red crescent bases, police stations, nomadic camps, refuge bases, traditional restaurants, greenhouses, villas, farm houses and so on. Modern Cappars can be set up at any places like flat land, hills, and even on netted foam floating on water.

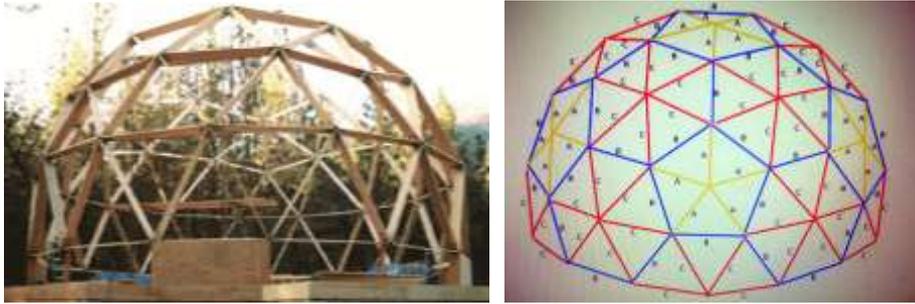
Picture 2: Geodesic dome used in the construction of a green house in mashhad, Iran.



### 5.1 The Geometry of Plan

The plan of this space is comprised of a circle or multiangular shapes, on which numerous triangles( normally 40 triangles) form a domed space. The formation of this structure may be made of wood, aluminium or steel. The triangles are pre-made pices which are screwed together to form the main structure of modern Cappar. The structure of building is formed by putting two kinds of triangles together. The first kinds are equilateral and the second ones are isosceles. The following pictures show how these triangles are assembled. In fact, the invention of modern Cappars depends on the kind of structure and the way are performed, which is registered in General department of Industrial ownership [6].

Picture 3: Geometrical Geodesic domes with triangles and isosceles



## 5.2 The geometry of plan

Some material like woven straw, tar covered materials, wood different kinds of glass, ceramics, stone, kinds of tile with different traditional colors, polymerie concrete, kinds of foam, glass wool, and mud and straw. Their application depends on their plentifulness and climatic conditions.

Picture 4: The construction of a villa based on geodesic dome in Mashhad, Iran.



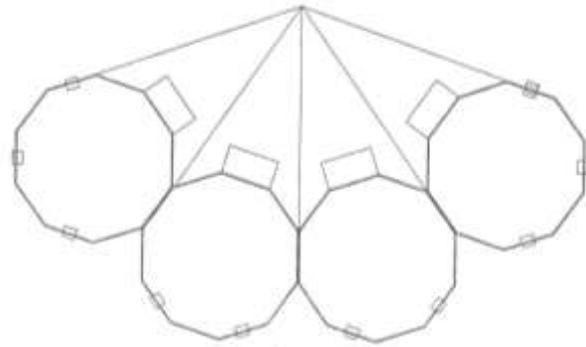
## 5.3 The Diversity of Designs in Plan and Volume

The modern Cappar can be designed based on desirable geometric divisions which are changeable based on their applicability; therefore, their performance have great diversity. Moreover, they have harmony, and beauty because of their geometric shapes and being spacious. These designs are more adaptable with the individual's spirit, and provide human beings with peace and comfort in our modern world. Using desirable colors is possible in this kind of architectural designs to cover the ceiling. Furthermore, they provide the possibility of having different shapes in regard to using fake ceilings designed within the structure, balcony construction as well as the possibility of putting different units together and instituting an interconnected network with different applications.

Picture 5: A Villa in Velenjack, Mashhad, Iran.



Picture 6: Structural development of site plan based on constructing Geodesic domes



## 5.4 Security and Convenience

Wind and earthquakes are of special significance in different parts of Iran. This structure can resist against earthquakes at 8 richter scale being experimented in computerized models, and wind at 200 kilometer per hours cannot break it down, due to the aerodynamic feature of such structures. This structure can even be designed in such a way that it does not need fixing in the earth can be slightly displaced without any tension. Its material can be resistant against fire and provide insulation against moisture, heat and sound.

Picture 7: Kavir accommodation, Kavir Mesr, Farahzad, Iran.



## 5.5 Economy and Ecosystem

The modern Cappar is more economical and its construction does not add anything to constructional wastes. Its structure is easily moveable and its application can be easily changed. All comprising parts are easily recyclable. Its capability to use the sun's energy and not having energy waste reduce its energy demand to the minimum level. Moreover, using air conductors on the top provides natural air conditioning and a hanging light reflector in the upper part of the dome can provide enough light for all its area. Using modern designs in houses provided with intelligent

system, the designer can make the optimal use of environmental conditions of sustainable ecosystem in such units.

## 6 Designing and Using Modern Cappars in Mashhad, Iran

Designing and constructing modern Cappars are used in private villas in Mashhad. These Cappars have some architectural designing advantages as follows;

A. The Implemented Projects in Mashhad are used as one or two floor villas including complete equipment and facilities. Due to not having pillars in the inner space, the divisional capability and creative setting of furniture provide peace and convenience for the residents.

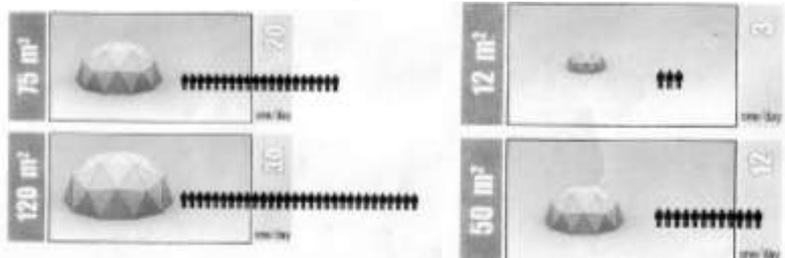
Picture 8: A Villa based on geodesic dome in Manzelabad



B. The constructional frame of this house which is based on geodesic domes is designed in terms of frame person and high speed of construction. These days, with the scientific and technological development in this method compared to the past, the construction speed can be increased fivefold.

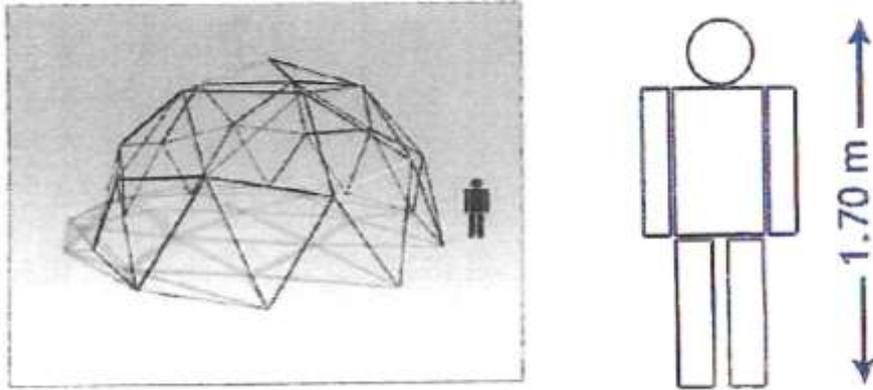
C. The structural space of such buildings can provide functionally useful areas varying between 12 and 750 square meters. The dimensions of such structures are designed in such a way that it has adjustability with the occupants' needs and use, and can be made bigger or smaller at different scales.

Picture 9: The construction of geodesic dome structure based on frame per person



D. The data proportions in terms of dimension per person are presented in the following figures, which can be developed in terms of space ratio per person for different applications and the height scale in terms of plan scale.

Picture 10: The height of Geodesic dome in proportion to the height of a man



E. Triangle which is the most durable form or shape of existence is chosen as the smallest constituent part of the domed building being the persistent and resistant structure due to its technological and estimated justifications.

F. The capability as its installment and packing in the shortest time and its movability as well as its functional change are among the advantages of designing and execution of this spatial structure with a geodesic dome.

Picture 11: The first modern Cappar executed in Mashhad, Iran



G. In regard to the attitude of the 21<sup>st</sup> century to new energies, this structure enjoys the capability to absorb the sunlight completely due to its form; therefore, it can be used to develop the use of the sun's energy and convert it to electricity.

H. In comparison to the other usual structures, this structure provides a radial space with a diversity of plan, which make this structure easily applicable in educational and cultural buildings due to providing a better view in such places. In addition, this spatial structure can be used in accidents to set up a temporary covered spaces for red crescent and red cross's clinics in desert to deliver aid to the injured people

quickly. Because of its easy and quick installment and diverse spaces, it can be applied as urgency basis on roads, the police stations, road maintenance stations, kiosks, watchman's room in construction workshops and road and dam building bases as well as providing a permanent or temporary resting place.

## 7 Conclusion

In this research, the old Cappars and their positions in Iranian architecture are introduced and it shows how Iranian nomads have designed their houses in different climatic conditions, which can be considered as the most perfect residential spaces. These accommodations can be easily set up, collected and carried without taking a longtime. In the modern architecture of Cappars and their construction; some factors such as the construction conditions at high speed and climatic conditions of the region should be carefully considered to have a durable design. The application of multiangularly designed plans for domes, which were used to set up old Cappars manually, is utilized in modern designs of geodesic domes replacing the old Cappars. Using intelligent systems of inner spaces of modern Cappars, now being designed and executed, will be studied in another research.

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