

Using Modern Technology to Conserve Human Indigenous Knowledge

Analysis the nomad house (Black Tent) structure's, Case study: Qashqai nomad Black Tent, Fars province, Iran

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Introduction

This article is intended as a retrospective onto research and abstract of the author's PhD thesis, Typology and comparative analysis of Black Tents built in the tradition of Iranian tribes, at Gdansk University of Technology.

The aim of this topic was the conservation of the oldest and the primary human lifestyle and culture. Recognition, study, collecting data and valuation are the base of conservation. In this regard, culture and way of life of nomads were examined but their homes (Black Tent) structure were of interest.

The thesis explored the construction of the Black Tents and the way of shaping the space in which family life takes place. It concerned the architectural forms of tents, structures and materials from which they are erected, as well as interior furnishings and objects that determine their character. For more details about architectural aspect could referring the article (Hassas. 2020)

Due to the area of Iran and the dispersion of the tribes, seven of them were selected, wandering in different topographic and climatic conditions. These conditions were analysed in detail and made it possible to determine the extreme and average weather phenomena for the summer and winter where about of the seven tribes. Comparisons were made between their tents. Needless to say, this article is rather general and is focused on one structure of these seven Black tents structure's. First case study was Black tent of the Qashqai tribe from the Fars province in Iran. However, researcher is interested in formulating some information onto the tent structure by using the new and modern technology such as some software, thus triggering discussions based on some general references and some specific research to be able to understand values and potentials. This can be so important for the next step, towards protecting and conserving this native architect.

The methods used in the research include descriptive analysis and graphical presentation of the test results. The inquiry was conducted in libraries, archives and institutions and using official websites,

also conducted drawing and photographic inventories of tents and everyday life of nomads. Participation in the migration (participant observation) and conducted interviews with representatives of the nomadic community. Laboratory tests of the next phase of work have been documented with printouts and presentations of the sets of devices used in the research. The laboratory tests conducted for the first time concerns the physical and mechanical side of solutions used in the tents.

As a result of macroscopic studies, it turned out that the fabric with which the structures are covered (chador), which is woven by women, is the same for all tribes. Women also erect and dismantle tents before and after the journey and so have an influence on their construction. The analysis of the dimensions and forms of the discussed seven types of tents from different parts of the country showed large differences, which is evidence of creativity and engineering thinking.

The next step of the research was to check to what extent the stability of each tent is adjusted to the climatic situation in which it is used. Further analysis was carried out using advanced software computer programmes, such as 3DMax, Ansys, finite element software ABAQUS and other professional engineering digital tools. For this purpose, models were created in the ABACUS program. Their responses to wind and rain loads have been studied. It has been confirmed that the tents are strictly adapted to the conditions in which they are used. Their diversification is the result of the experience of many generations of nomads: observing the routes they travelled and the materials they could use. Tests of tent models covered with hand-made goat hair fabric showed that it is more useful for strengthening the structure of the tent and protecting its interior than fabrics used today for a similar purpose.

Nomad Life

The great expanse of East and Central Asia, the Middle East and North Africa witnessed many forms of coexistence of peoples, including nomadic tribes. Wandering is the basis of the life of such groups that have existed since the beginning of mankind. Many studies point to geographic, political and socioeconomic factors as the reason for the formation and development of this way of life in the Iranian Highlands. Among them, the geographic factor had a decisive influence on the fact that breeding became the main occupation of people (Feilberg. 1980). Many nomadic tribes still live in Iran today. During their journey, they take their houses with them, moving them from summer to winter stay and back. The houses were adapted to their lifestyle and geographic conditions. Hence it can be concluded that this portable and flexible structure has been used by nomads from the earliest times.

Iran is located in the Middle East and its large area is characterized by a very varied topography. The climate is similarly diverse, so the nomadic tribes occupy territories with very different conditions. Various natural environments meant that the tribes, adapting to the conditions for generations, differentiated the ways of building tents and arranging them. Tribes that make a living by raising cattle go with herds to areas where fodder can be found. They have few items to handle because of the necessity to move. The tents in which they live are simply furnished, and each item that is there usually performs several functions. The tents themselves, called Black Tents, are made of cloth woven from long black goat hair. Tent constructions have been refined over the centuries, therefore they differ in different parts of Iran. They represent high craftsmanship and contribute to the cultural heritage of Iran. The tribes of nomads also developed their own system of beliefs and rituals resulting

from them. Costumes, products and ornaments constitute an important and varied element of Persian culture.

For a few decades, due to political, safety and welfare reasons more permanent settlements for the tribes were set in villages or around the cities. This resettlement policy implemented in some regions of Iran has not yielded any results, and the migration culture is still very active and mobile in some places (Moeni. 2008).

Black Tents structure and Modelling

Tent is a tensile shell that is supported by columns or arches. Nomads' tent is a specific kind of cable structure with double curvature and its roof surface is covered by a continuous cover made of strips of woollen fabric.

Fabric covers require pressed and bending elements to keep them upright and transmit their load to the ground. The tent's shell is carrying a part of the loads. Nomadic tents are covered entirely with fabric and are kept upright by the central row of columns and side pillars.

Cables are important elements of tensile fabric structures as they play a vital role in the stability, resistance to loads and shape of the structures. The Black Tents' ropes are made of goat's hair or sometimes hair mixed with wool and act as structural cables.

In modelling for civil engineering structures the software like Robot, Etub, Sap and Ansys programmes are used for structural load analysis. Due to the complexity in the case of structural behaviour of the tent shell, not each of them was suitable. Thus, after conducting a survey, Abacus programme proved to have the potential in this kind of modelling.

The first step was a simulation of the fabric of a Black Tent. Due to the tests carried out on the samples of the fabrics, it was confirmed that the fabric warp and woof stress and strain reaction is non-linear and that it should follow non-elastic materials in modelling software, in order to secure consistency of the results of the simulation with the reality.

Method of the Black Tent structure modelling

Main structure of the tent includes wooden structure (such as columns, ridge carrier beam and post), ropes and wooden stakes. Firstly, the structure is modelled in solid works software and then inserted the model in Abacus software and the other piece of the structure as fabric is modelled in these software as *SHELL*. The modelling of the tent fabric surface is done through the mesh or net-work. One of the most important mechanical properties is tensile strength. The simplest scientific method to study its features is to examine the reactions against imposed forces and the consequences of the transformation. In order to obtain the approximate elasticity modulus, the diagram of fabric stress-strain value was used. During extension it was computed as an approximate slope line between load imposing moments to maximum load moment before plasticity mode of the material starts. All materials characteristics are included in (Table 1). It should be noted that the total weight of the Black Tent of Qashqai tribe is only 314 kg.

Table 1: Density, elasticity modulus and Poisson's ratio of all materials applied to this structure

Material	Type of elements	Method of modeling	Poisson`s ratio	Elasticity module (pa)	Density (Kgm/m ³)
Wood	8-node linear brick (3D stress family)	Solid-Homogenous	0.3	11e9	500
Rope	2-node linear 3D truss (Truss family)	Wire-truss	0.3	0.9e6	300
Black tent fabric	4-node doubly curved thick shell (Shell family)	Shell-Homogenous	0.41	Planar test data	1.588
	4-node quadrilateral membrane (membrane family)	Membrane Fabric	0.41	Test data	

Exert loads to the Black Tent model

The most important required information in modelling concerns the loads imposed on the structures. Imposing loads is clearly marked in the Iranian Building codes and standards, Standards No, 2800. (National Building Regulation of Iran. 2009)

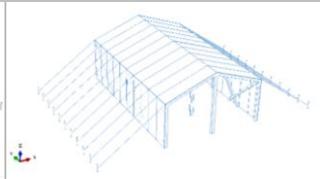
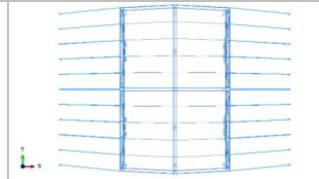
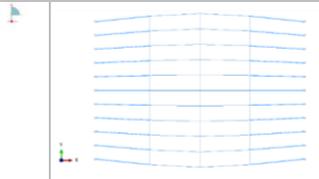
Imposing loads to the Black Tent structure includes three factors. First, the imposing of the tent structure (Dead Load). Then, the initial stress caused by the tension of holder ropes used for the tent stability (Live Load). Finally, rain and snow imposed, such as Gravity load and the lateral loads caused by wind on these structures. For loads like wind (lateral load), the most critical mode must be determined and imposed on the structure. This critical mode is considered because of the low weight of the tent, vast loading area of the tent exposed against the wind and freedom to move the bot-tom of the tent wall fabric.

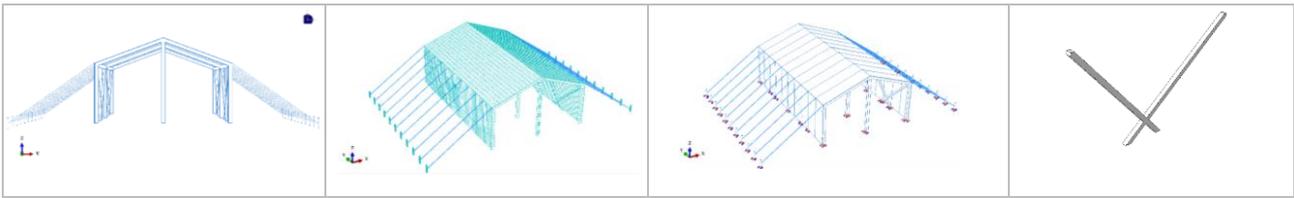
Results of modelling the Black Tent

All fabric elements of the roof structure work on the basis of curvature and tension opposed to the wind pressure. Cables (ropes) are important elements stabilizing the structures. Tensions within the fabric of the roof cover play a focal role in keeping the tent in shape and resisting the blows of wind. Tent structure is a tensile shell, so it is stabilized by strain arches. This is why Black Tents have purposely big curvatures of the roof covers. This is achieved by the roof frames consisting of beams supported by main and lateral posts.

The modelling reactions and results were modelled in two situations: firstly, when the Black Tent was supported along the walls by the lateral inclined posts (braces), and then without braces. Both structures were checked for wind loading force. The structure behaviour under the wind load, was observed with assumption of the goats' hair fabric cover (Table 2). It shows the reaction of the Tent structure under wind load with the lateral inclined posts (braces) and without them.

Table 2: Modelling of all elements of the Black tent structure

Wireframe	Hidden	View X-Y, Wireframe	View X-Y, Hidden
			
View X-Z	Meshing of the tent elements	Boundary Conditions	Bracing



The following conclusions can be made, supported by the modelling research: Table 3.

The cross struts (bracing) of the walls play an important role in reduction of the tension of movement in the Tents covers. In roof covers the width of the strips of the fabric determines the distance between the ropes.

Table 3: Modelling results, Model by author

<p>Reaction of the tensions in the tent with lateral vertical posts and bracings (cross struts) and without the bracings</p>
<p>Absolute value of displacement of the cover with lateral vertical posts and bracings (cross struts) and without the bracings</p>
<p>Dependence of the widths of the roof cover strips and the distances between the holding ropes that form the grid (the mesh)</p>

The strips of the covering fabric are 60-80 cm wide and the distances between the ropes are the same. The ropes form a grid (a mesh) responsible for carrying the loads. The load distribution in the two directions must be balanced. If either of them increases or decreases, the stability of the tent is endangered. The mesh network is a technology invented and applied by the nomadic people and it

was formed by a long experience. This is exactly the way in which advanced soft wares analyse and recognize the quality of fabrics.

The main difference in behaviour of the Black Tents fabric and the other fabrics results come from its loose structure – the spaces between the fibres cause less pressure on the fabric from the wind. Thus, the force imposed on the structures is decreased too. Quality of goats' hair fabric shows two significant advantages: it postpones fabric rupture and also it increases the whole structure durability and resistance. Goats' hair fabric shows higher durability in wind, rain and snowfall than the other fabrics used for tents. On a sample that was modelled and analysed this point was significant, as the displacement rate in Black Tent fabric is only 34% of displacement in other non-porous tent fabrics. The most important point is that the maximum stress imposed on the Black Tent fabric is less than 2% of non-porous tent fabrics.

Finally, the displacement rates and Von Mises stress values of the tents surfaces were calculated for wind loading and rainfall pressures they encountered. Due to the lack of snowfall, the snow load calculation was omitted. Nevertheless, the diagrams for such cases were included. According to the climatic situation of the analysed tribe, the displacement rates of the tent proved to be insignificant and stability of the Black Tent is not threatened by the climatic occurrences which they meet in their area.

Conclusion

In the course of the research on the Black Tents built by nomad tribes living in different climatic conditions, physical, mechanical and structural features of their Tents were compared and modelled. Woven covers were checked against wind, storm, rain, snow and local phenomena common for the regions. The Black Tent is a four season dwelling place, modified throughout the country to resist different temperatures, rainfalls, and to provide the conditions necessary for living in it. Additionally, static strength and durability of the Tent is great. All of the result based that Black tent structure is one of the interesting category of vernacular architecture.

The Black Tent acquired modifications necessary for living in different weather conditions. They were adapted to high and low temperatures. Although their structure seems simple, the Black Tents implement interesting heating-and-cooling system due to the covers made of goats' hair and flexibility of the construction. The basic scheme of the Tent remains the same, each tribe modified it to obtain maximum comfort with minimum load to carry on the trail. The structures are made of timber, which varies according to local types of trees. Covers are woven in the same way, but the strips of fabrics joined according to the weather conditions. There are several ways of putting up the Tent and dismounting it. Artistic decorations that through the country, but all of them are prepared with wool: light and re-usable. In the Tents' structures, natural and vernacular materials are used in a way, exposing their technical qualities and craftsmanship of the tribesmen. Comparative analysis of the Black Tents in the different regions of Iran has confirmed compatibility of structural, function-al and aesthetic character of the Tents with the local climate and tribal folklore.

This research is aimed at completing documentation on constructions, methods of transferring the homes and crafts by using the new technology that were developed in the course of the centuries, when many more nomad tribes were on the trail twice a year. This research presents a typology of

the Black Tents of seven Iranian nomad tribes and proves the idiosyncrasy of their achievements in many fields. Unfortunately, this article is just focused briefly on one tent modelling.

Another goal of the research was to create the basis for methods of conservation of historical nomad shelters and passing over this knowledge to posterity. It was also aimed at recognition of the perspectives of continuation of the nomadism in contemporary world, maybe, on a slightly different basis.

The Black Tent is one of the least known elements of Persian culture. Recent decades have not been favourable to the nomadic community, and without support this culture may perish. The first step should be to understand the unique, immense technology and culture that these tribes have created.

The right step, which has already taken place, was to register the Black Tent of Qashqai tribe from the Fars province in 2012 as an intangible cultural heritage of Iran, promoted by author, and hope this thesis will be useful for other levels of conservation and preservation of this cultural heritage.

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