

A Review of Nader Khalili Shelter Design Thoughts from the Sustainability

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Abstract

Contemporary architecture exists in Nader Khalili's creative designs, including house designs in the USA and Iran, combined with the traditional architecture of Iran. His designs are founded on four characteristics, first is the inspiration from nature, and the other three focuses on low-cost, self-help, and eco-friendliness. The purpose of this study is to demonstrate his architectural thinking and the design process that leads to a rapid and sustainable shelter. In addition, this shelter can be built-in critical conditions or can be long-lasting in any crucial situation. The methodology used in this study is analytical based on qualitative and quantitative approach. The method, which is used to collect the data, is based on literature review and observation. The study concludes that Khalili's designs are reasonable at low prices and quickly built and sustainable.

Keywords: Modernism, Nader Khalili, Traditional Designing, Housing, Sandbag.

1. Introduction

A house is a content dwelling or an essential structure for living that can take many forms, such as nomadic tribes' huts or tents (Sykes, 1900). Moreover, it could have a more complex structure, like towers and complexes (Flórez de la Colina, 2004).

Architecture plays an essential role in the occurrence of environmental crises (Gaston, 2003). Buildings alone produce one-sixth of the world's water resources, one-fourth of the world's wood, and two-fifths of the world's fossil fuels. Once built, the building leaves a lasting impact on the environment (Folke et al., 2007; Gobbens et al., 2010; Mitchell, 2003; Sobin & Olgay, 1963; Young, 2002).

However, sustainable architecture harms the environment, and it seems that paying attention to the features of nature-oriented architecture and the use of natural energies such as sunlight, wind, water systems, and soil energies with the use of technology and intelligent management can complete their application. In this type of architecture, the building adapts to the climatic conditions of its area and interacts with them (Candelaria et al., 2012; Folke et al., 2007; Islam et al., 2015; Jiang et al., 2017; Lyubomirsky et al., 2005; Young, 2002).

The design elements of modern architecture are not exorbitant. Every aspect of the design represents clarity. Modern architecture bases home design on criteria that must be kept to a minimum. When designing a house, architects have to

pay close attention to things like the layout, location, and function. Louis Sullivan, who was Frank Lloyd Wright's teacher (Krier, 1983), said, "*Form follows function.*"

There are no unreasonable components in contemporary architecture. Moreover, this style is complexity-free. Nowadays, in residential home design, architects focus on the space and not on minor details related to the decoration or insignificant details of the overall design. The powerful idea in this style is based on Ludwig Mies van der Rohe's famous sentence, one of modern architecture's foundation sentences, "*Less is more*" (Bustelo, 2013; Cervilla, 2018; Fayos et al., 2018).

Minimalism is an important part of the foundation of modern design. Still, others combine these characteristics with their style and touch to create a unique modern style that belongs to the designer himself (Kang et al., 2021).

Nader Khalili is one of the famous architects who lived in the modern period. The architectural style Nader Khalili chooses for his design is a combination of modern style and the traditional style of Iranian architecture. He invented a bright style in the modern period. His style was creative. "*There are more than 800 million people who live in shantytowns made of scraps of tin and wood or have no shelter at all,*" says Nader Khalili from his office in Hesperia, California. "*It has become my dream to find a solution to house these people.*" This is also the speech of Nader Khalili (Hart, 2008).

2. Modern Architecture

Modern architecture is a term used to describe an overarching movement, with its exact definition and scope varying widely (Brandt, 2020). The term "modern architecture" was often used at the start of the 20th century, with efforts to restate architectural design principles with rapid technological improvements and the modernization of society (Nia & Rahbarianyazd, 2020). Esteban-Maluenda et al (2020) says that for this classification to be fair, different movements, architectural styles, and schools that teach design—some of which are even opposites of each other—would have to be mixed together a lot.

The concept of modernism is an essential theme of the 20th century. It became popular all over the world, especially after World War II. Many architects liked it, and it remained the most popular style for institutional and corporate buildings into the 21st century (Burrell, 1988).

Characteristics of modern architecture (Hillier & Hanson, 1984):

- Use of traditional materials in new different ways
- Emphasis On the reality of the texture of the materials which is used
- High usage of natural light
- Use of natural light of the sun and shading to enhance human comfort

3. Nader Khalili Housing Design

There is a substantial and necessary call worldwide to house 17 million refugees and displaced persons who were the victims of different problems such as war or natural disasters (Sarmiento et al., 2020).

Nader Khalili, a supporter of using earthly potentials to help serve these people, noted that applying this theory is the only way out of this problem. After deep research into earth-friendly methods, Khalili created several prototypes and eventually came up with the sandbag or "superadobe" system. Khalili's concept explains that people can build their shelters by efficiently gathering whatever the earth offers; for example, people in the desert can collect sand in bags, pack them, and then stack them into dome forms held together by barbed wire. According to Khalili, such structures are quite strong and can withstand natural disasters such as fires and earthquakes. His concept is exceptionally inexpensive, quick, and easy to apply and build. By adding the necessary ancillary spaces, these shelters can be converted into permanent structures. Such structures can reduce energy use by consuming solar energy, shade, and gravity. They can also be easily altered and changed in size, material, and formation. This concept is easily applicable in the road and infrastructure construction industries. Cal-Earth Institute (1992) says that these shelters give people more economic power by letting them build their own homes and communities. These developments are sustainable because they combine traditional building materials with modern materials and technology. This aided in the creation of comfortable living spaces that met modern safety standards (Hinning & Saad, 2015).

Nader Khalili started his career as a modernist, and he was successful and highly regarded because of his designs that surprised the world of architecture. In 1975, he shut down his offices in Los Angeles of USA and Tehran of Iran and decided to go on a solo trip through the Iranian deserts. He was convinced that the only way poor people could afford homes was to build with whatever earth there was. He spent most of his time researching traditional ways of mud construction in Iran and began to work on ideas for using earth's resources as a modern building material as well as developing a new concept for a "Ceramic House," constructed from sun-dried mud and then fired to create a ceramic

structure that could resist all types of natural disturbances (Kamal & Rahman, 2018). The type of ceramic house built by Nader Khalili in Iran is shown in Figure (1) (Khalili, 2011).



Figure 1. Ceramic house of Nader Khalili in Iran (Khalili, 2011).

The basic construction method entails filling sandbags with earth's sand and laying them in a circular pattern. The circles created are tied near the top to form a dome. Barbed wire is laid between these circles to prevent the sandbags from moving and give them earthquake-resisting power. Hence, these materials used for war (sandbags and barbed wire) were finally used for peaceful goals, mixing traditional earth architecture with global safety requirements (Hart, 2008). The sandbag house of Nader Khalili, which he built in Kuwait, is shown in Figure (2) (Khalili, 2011).



Figure 2. Sandbag house of Nader Khalili in Kuwait (Khalili, 2011).

Several prototype domes were created using this technology, and vaults were built and tested under various conditions, including shelters for refugees, well-built tiny houses called "Eco-Domes," and a conventionally planned four-bedroom home (Khalili, 2011). This type of dwelling is shown in Figure (3) (Khalili, 2011).



Figure 3. An Eco Dome designed by Nader Khalili (Khalili, 2011).

The system is particularly suitable for providing shelter for a short period of 5–10 years. It is cheap and allows buildings to be quickly elevated by inhabited caves with little training. Khalili found the inspiration for the structure's design in the principles of Iranian architecture and Sufi philosophy: the unity of the elements of earth, water, air, and fire. Each shelter is made up of one central, circular space for the roof and some additional spaces for cooking and sanitary services. This system is highly flexible and efficient. The material—lisan, alonglay, and sand with straw and water—used to make traditional sun-dried bricks for prosperity are not always available. Even these inhabitants do not always have the time or space to make these blocks and store them. With the technique of filling bags directly from the land and empowering them with barbed wire, almost any land can be used to create a shelter, keeping in mind that building speed is much faster. You can use the structures as a temporary solution or make them last longer by adding a layer of mud or another finishing material. Additional supplements, such as ovens and animal shelters, can also be provided to create a more permanent status. The shelter itself can be expanded or minimized according to individual needs. The technology can also be used for building infrastructures such as roads, retaining walls, and landscaping elements (Cal-Earth Institute, 1992).

This system takes advantage of the timeless forms of domes, arches, and vaults to create single and double structures that are strong and appealing. Using these compressed forms of sandbags to talk about the ancient mud-brick architecture of the Middle East and the different ways barbed wire is used as a bendable element suggests that this is how ancient nomadic cultures built their homes. The result is a highly safe structure. By adding barbed wire to the compressed structure, earth wire resistance is made. The aerodynamic shape made by this design makes the structure resistant to hurricanes. The use of sandbags helps with flood resistance, and the earth itself provides insulation from fire. The sand used to fill the sandbags is taken from the exact place where shelters are built, and makeup at least 90 percent of the filling material; stabilizers such as cement and asphalt may be added. Materials research showed that most sandbags made of both natural and artificial materials could be used. The best solution is an artificial ultraviolet-resistant degradable material. In a short-term building, the bags can degrade, and the building returns to earth. The artificial bags are covered over for long-term structures to provide an erosion-resistant layer. Because the structures use local resources collected directly from the earth and human hands to build them up, they are entirely viable. Men, women, old, and young people can build since the maximum weight to lift is just a few kilos which will be poured into the bags. Barbed wires and sandbags are supplied on-site, and the stabilizer is also usually locally sourced. The shelters are also continuously efficient in terms of

energy: the wind and the sun provide continuous cooling and heating, and the sandbags provide wide walls that resist temperature changes (Khalili, 2011).

Since 1982, Nader Khalili has developed and tested the “Superadobe” prototype in California. He has talked a lot about the idea and gave a talk about it at the first Lunar Habitat Symposium Conference held by NASA in 1984. He posed for construction with lunar soil found on the moon itself. In 1991, he founded the California Institute of Earth Art and Architecture, a non-profit research and educational organization that covers everything from construction on the moon and on Mars to housing design and development for the world’s homeless people for the United Nations. Cal-Earth is an institution that has concentrated on researching, teaching, and developing superadobe technologies. The extreme desert environment of California, with summer temperatures usually exceeding 40° C and severe winters with snow and freezing temperatures, floods, extreme winds, and the most dangerous earthquake zone in the United States, has provided the perfect testing ground. The prototypes have not only received California building permits but have also met the requirements of the United Nations High Commissioner for Refugees (UNHCR) for emergency housing. Both the United Nations Development Program and the UNHCR Program have chosen to use the system, which they used to provide temporary shelters in 1995 for a flood of refugees coming into Iran from Iraq. During that period of prototype building and testing, Khalili’s educational philosophy continued to develop. Many people have been trained at Cal-Earth to build using these techniques. They are carrying this knowledge and these concepts to those in need in many countries, from Mexico, Mongolia, and India to the United States, Brazil, Siberia, Iran, South Africa, and Chile (Khalili, 2011).

4. Cal-Earth

Cal-Earth is a non-profit institution dedicated to researching and educating about the four elements: earth, water, air, and fire, and their equilibrium and unity at the service of the arts, environment, and humanity. Nader Khalili supervises the institute. He had come up with simple ideas and technological breakthroughs for housing for poor people especially in rural areas of developed countries. He called his sandbag architecture "Velcro Adobe" when he presented it at a NASA conference in 1984. Velcro bags were meant to be filled with lunar soil and would be used to construct lunar houses in the form of domes and vaults. According to Figure (4) later this concept became more famous under the “Superadobe” sandbag and barbed with wire technologies, or earthbags (Khalili, 2011).



Figure 4. A sample of the sandbag house in California designed by Nader Khalili (Khalili, 2011).

Khalili infers a sustainable solution to human shelter based on timeless materials (earth, water, air, and fire) and timeless principles (arches, vaults, and domes). Every person has the right to build a home for his family out of these common things that can be found anywhere on earth. These principles are the simplest forms of building technology. They've made emergency shelters that can be turned into permanent housing and have passed strict tests and building codes to

make sure they meet the minimum safety standards. Since 1975, Khalili has dedicated his life to researching and developing this eco-friendly, low-cost, and self-help technology that can resist natural disasters and give it free to humanity. The only thing missing is to educate humans on how to use these helpful techniques developed at Cal-Earth Institute to fit their own unique culture and environment (Hart, 2008).

Khalili believes that these techniques will make all houses fireproof and cost 40–60% less than other buildings. He also says that the money he saves on energy by using natural materials to keep heat and cold out of his buildings could pay for the whole house in a few years. He uses the word "*sustainability*" a lot when talking about his buildings to show that they are built with materials and methods that don't put too much stress on simple natural materials (Khalili, 2011).

Sustainable characteristics of sandbag buildings are (Cal-Earth Institute, 1992):

- Think small
- Heat with the sun
- Keep cool
- Use renewable energy
- Conserve water
- Use local materials
- Use natural materials
- Save the forests

5. Conclusion

In the 21st century and modern times, there have been a lot more people on earth, which has led to real estate development. Modern technology is being used more and more, which makes it easy to meet the demand for home improvement. There was a strong focus on using wind, fire, earth, and water as sources of energy in traditional architecture, and modern architectural trends follow this.

Nader Khalili is an Iranian architect whose designs use the four elements of nature to make low-cost, self-sufficient, and affordable housing. Since 1975, Khalili has been working hard to build and set up real estate that can withstand natural disasters. Khalili categorized his architectural ideas as follows: "*Shelter is a basic human right; every human being should be able to build a house for him or herself; and one of the best ways to provide shelter for the exponentially increasing human population is by building with earth.*" Khalili's work used a wide range of materials, methods, designs, and patterns. Modern engineering ideas like base isolation and post-tensioning are just two examples. One of Khalili's innovative ideas was adding barbed wire to sandbags, which allowed home builders to have flexibility in building changeable structures that were culturally acceptable. Putting barbed wire into sandbags, earth domes, and vaults makes them more resistant to earthquakes, which makes them safer places to live. Khalili's invention can and should be spread worldwide to provide more sustainable and safer living conditions to poor people. In future studies on the development of this method, it is better to consider urban facilities in the expansion of residential settlements built with this method.

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