The Sustainability Effects of Choosing Adobe in Contemporary Buildings

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ABSTRACT
Many reasons such as the increasing need for buildings in the face of the increasing population after the industrial revolution, various global problems, decreasing resources and cost increases in production are taking away the choice of people to have their own buildings or living spaces. In addition, unconscious construction, intense resource and energy consumption; it poses a threat to biodiversity by causing waste generation.
As a solution proposal to all these problems, sustainable building formation and sustainable building material production, which considers the protection of the environment and the continuation of vitality, gain importance.
With the right material selection in the projects to be created, it may be possible to build a more sustainable world by minimizing the carbon footprint. The choice of material that does not lose its properties for many years plays a major role in reaching the goal of sustainable construction by extending the life of the building. In this regard, adobe can be preferred as one of the materials with zero carbon emission in its production, life and disposal.
In this study, it has been evaluated that, with the successful combination of adobe, which is a natural building material, with contemporary techniques in a modern building, environmentally friendly and energy efficient structures can be created. Through the examples of contemporary mudbrick structures selected by the literature review method; The suitability of adobe for sustainable architecture has been interpreted in terms of economic, social and ecological aspects.

Keywords: sustainability, sustainable architecture, adobe, ecology, local

1 INTRODUCTION

Ensuring the continuity of the ecosystem without damage and not being affected by the negativities of future generations can only be possible by ensuring social, economic and ecological sustainability. For a sustainable architecture; Minimizing the carbon footprint and going for energy efficient solutions will lead to the most accurate results in the design and material selection of buildings. In this regard, the buildings built with the choice of natural materials take their place as examples of sustainable architecture, that are environmentally friendly by their origin. As it is known, more than 30% of the world's population lives in adobe structures produced with local soil. Adobe structures have a breathable, hygroscopic property that provides thermal comfort with an intense thermal mass property that has a minimum environmental impact. When built with the right techniques, adobe structures that have survived for many years; It ranks first in the sustainable building category with its energy conservation, comfort, non-flammability and ability to mix with nature again due to its origin.

As a result of the need for sustainable and environmentally friendly buildings, interest in adobe structures as an alternative to expensive construction techniques has started to increase. Especially soil structures built in arid regions where natural resources such as wood and stone are limited, have been updated and integrated with modern techniques and have started to be preferred again.

2 USE OF ADOBE IN ARCHITECTURE AND ITS EFFECT ON SUSTAINABILITY

In areas where stone and wood resources are limited, human beings have produced adobe blocks by mixing various binders such as clay-containing soil, water and straw in suitable proportions, pouring them into molds and drying them in the sun. We encounter adobe blocks, which are the first building materials produced and shaped by human beings in history, and examples of adobe structures that have survived from the early ages to the present day. Today, mud-brick structures, which are simple, primitive, poor people's choice and are not resistant to earthquakes, are challenging time and these discourses with examples reaching today from thousands of years ago [1].

Adobe is a natural material that is produced from local soil with local labor without the need for any facility and used in building construction. Thanks to the natural and environmentally compatible materials it contains, adobe; It does not cause waste for production, use and after its service life and can be recycled back to its source. It is a healthy and sustainable material with its climatic, thermal, acoustic and natural comfort properties that it offers to its user. It has the feature of protecting its service life and all its sustainable properties without losing its service life when precautions are taken for its sensitivity to water and humidity and when it is maintained during use. As with all other building materials, it is also resistant to earthquakes when built with the right construction techniques [1].

Today, the correct management of ”resources, energy and waste" constitutes the main decisions in terms of ensuring sustainability. For these reasons, the interest in natural building materials and especially adobe is increasing as an alternative to today's unhealthy construction problem. It is in question that the production and construction of adobe material is updated, harmonized with contemporary materials and techniques and brought to the construction sector. While faster and mass production is required in the face of increasing construction demands, alternative solutions can be produced for increasing maintenance and durability. Considering that the energy used for heating and cooling in our country is more than one third of all consumed energy, the preference of natural materials such as adobe, which can breathe and have thermal and climatic comfort properties, is of great importance.

When the physical and mechanical properties of adobe are examined, it is concluded that in the direction of the findings obtained, there is no need to use any vehicle to provide cooling in soil structures in hot periods and that appropriate comfort conditions can be provided in soil structures with a fuel consumption of 1/4 of the fuel consumption used in concrete structures in cold periods [2].

Thanks to the correct integration of adobe with technology; Contemporary and sustainable structures that are subject to nature, life and culture emerge. With the inclusion of renewable energy solutions (such as photovoltaic panels, wind turbines, heat pumps), passive energy solutions (design according to the sun), water conservation and recycling in designs, it provides great economic, ecological and social contributions to the societies in which it is made.

3 THE SUSTAINABILITY EFFECTS OF CHOOSING ADOBE IN CONTEMPORARY BUILDING EXAMPLES

Adobe structures provide a physical environment in which a person can live comfortably that other materials cannot provide. Since it uses less energy: it does not pollute the natural environment, protects the family budget and the country budget. Although the building housing the largest number of people in the world is made of earth, it is not included in engineering and architecture education since there has been no industrial production in this area in the last hundred years [3].

Adobe has begun to be forgotten due to the fact that experts do not know adobe material well enough, that they do not receive support at the point of application, and that today's other building systems are preferred. Today, when looking for healthy and comfortable natural materials that can meet the needs of societies in terms of ecological, economic and cultural; adobe emerges as a material that attracts attention again and is updated in contemporary buildings and brought to the sector.
In the contemporary building samples examined within the scope of the study, the preference of adobe; communities, ecological and economic effects were evaluated and tried to be interpreted in terms of sustainability.

3.1 Aknaibich Preschool

In 2014, a low-cost preschool was built using adobe and rattan in Aknaibich, Morocco, under the direction of Architect Frank Stabel, with the participation of a group of architecture students from the University of KU Leuven (Belgium) and local workers 'Fig. 1' (Url 1).

Figure 1. Aknaibich Preschool, Plan and Section (Url 1).

It is inspired by the traditional earthen architecture of the old city in the area where the city has a dense concrete structure. The preschool building was built with local materials and typology, with a contemporary look. Concrete beams supported by vertical bars were used in the building, which was built with mudbrick blocks on a local stone foundation and plastered with straw-mixed earth mortar, considering the earthquake risk. In the design of the building, small and deep window openings were left on the thick walls in the south façade direction in order to use the sun effect indirectly in the interior lighting, and also benefited from the thermal comfort feature of the thick mudbrick wall. At the school, an outdoor area with a pergola has been created, which can be described as an external classroom that can be used for storytelling and other activities, where children aged 3-6 can play outside the classroom 'Figs 2, 3 and 4' (Url 1).

Figure 2, 3, 4. Aknaibich Preschool Garden and Rattan Details (Url-2)

The adobe structure consisting of a single classroom; It is concluded that it is a sustainable structure in terms of using community dynamics with local workers, observing the bioclimate, incorporating and protecting the three existing argan trees in the treeless area in the city, and being an architectural design that combines today's modern school infrastructure standards with local style (Url-2).

3.2 Burkina Institute of Technology

Local materials clay and eucalyptus wood were used in the construction of the Burkina Institute of Technology, designed by Francis Kéré in Burkina Faso, Africa 'Figs 5 and 6'.

Figure 5. Burkina Institute of Technology (Url- 3)

Figure 6. Burkina Institute of Technology Plan, Section and Roof Ventilation (Url- 3)

The 2100-square-meter structure, consisting of classrooms, a conference room and other complementary areas, consists of a decoupling of repeating modules. Classroom modules, with a

rectangular courtyard at their centre, were constructed by pouring a concrete-clay mixture into classroom-sized demounted molds.
Considering the abundance of clay in the environment and the thermal comfort effect, the use of soil was preferred in the building to help cool the classrooms. The walls, which are formed by pouring in-situ molds with a mixture of cement, aggregate and clay, provide more flexibility and a faster construction process compared to the use of traditional clay bricks. An entire class-size formwork was used to build each module in situ. This method is cheaper and more sustainable than concrete. Wooden curtain facades made of eucalyptus trees protect the clay walls of the building from rain, while shaded corridors help cool the classrooms 'Fig.7'. The roof openings provide ventilation by allowing the rising hot air to be expelled.
With a special landscape design in the building area, which is located on the flood plain, it is planned to store the water in an underground tank and use it to irrigate the trees on the campus. At the same time, the building is protected against water in rainy seasons (Url- 3).

Figure 7. Interior of Burkina Institute of Technology (Url- 3)

3.3 Puntukurnu Aboriginal Health Service

The use of compacted soil was preferred in the 970m2 Puntukurnu Aboriginal Health Service structure, the construction of which was completed in 2020 in the driest Newman region of Western Australia 'Fig. 8'. Kaunitz Yeung Architecture, who realized the design, aimed to solve the difficulties that local Aboriginal communities have in terms of transportation and financial expenses to the city of Perth, 1400 km away, in order to receive health care, with the use of local materials and the support of the local people. With the realization of the building, access to health services has ceased to be a privilege for local communities who are experiencing impossibilities (Url-4, Url-5).

Figure 8. Puntukurnu Aboriginal Health Service (Url-6)

Economy has been provided in terms of materials and transportation expenses to be brought from Perth with the choice of local materials. The building consists of two parts, the health center and the administrative 'Fig. 9'.

Figure 9. Puntukurnu Aboriginal Health Service Plan and Section (Url-4)

The courtyard in the middle provides visual communication between the departments and creates an area to shelter in the harsh wind and sun of the desert climate. The courtyard with the landscape created with endemic plants is an outdoor waiting room. In addition to all these features, the photovoltaic panels placed on the roof make the building sustainable by meeting more than 85% of the electricity need of the building, which is located in a sunny area, during the day 'Fig.10'(Url-6).

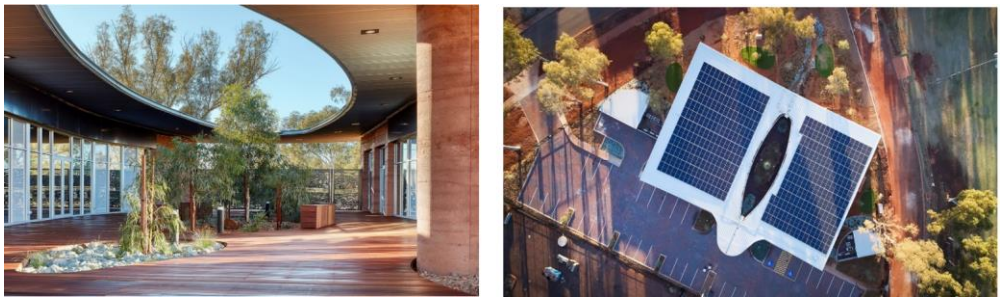

Figure 10. Puntukurnu Aboriginal Health Service Courtyard and Roof (Url-6)

The intended success of the project was achieved, and the need for local residents to leave their families in Newman at great costs, go to another city and undergo a negative psychological process was left behind. Cultural ties between local Aboriginal communities and other communities living in the region have been strengthened and a work of art has been put forward in which cultural beliefs and a sense of community ownership representative of dreams have developed with the use of decamped land (Url-6).

3.4 Muyinga Library

The 1,500-square-foot Library of Muyinga was established on the campus of a boarding school for deaf children in northeastern Burundi, with the aim of providing social interaction and educational support to children in this group without exclusion 'Figs.11 and 12' (Url-7).

Figure 11. Muyinga Library (Url-7)

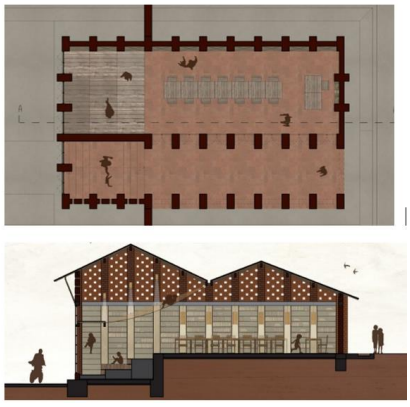

Figure 12. Muyinga Library Plan and Section (Url-7)

Reintegrating deaf and blind communities, who are excluded from education and often isolated in Burundi culture, as intended in this project (community integration) is a very important social movement. The project was implemented with a participatory team including local workforce, young architects and architecture students. The team had a learning and production period by experiencing the processes of the building in the workshops created 'Fig. 13' (Url-8).

Figure 13. Muyinga Library Construction Process (Url-8).

According to the climate, special material selection, volume and facade designs were made in the building. Using compressed earth brick blocks and baked roof tiles; A library structure with high body walls and a porch roof was built. By leaving rhythmic spaces on the façade, a bright image is obtained in the evenings, while cross ventilation is provided against humidity and heat in the interior. The porch corridor, which is included in the local housing typology, is also used in the library structure, playing an important role in providing protection from heavy rain and harsh sun. By keeping the corridor porch larger, it has been tried to obtain a social area where community relations are strengthened. It is tried to provide interaction with transparent doors on the surface facing the porch from the interior. The mezzanine floor created with a large hammock on the street side and the sitting areas made of wood offer the opportunity to dream while reading 'Fig. 13' (Url-9).

Figure 13. Muyinga Library Construction Process (Url-10)

The existing slope is transformed into playgrounds and courtyards with landscaping. The combination of the local materials and techniques used with contemporary sustainable design principles, and the socially unifying feature it provides in the society, is of great importance for Burundi in terms of a sustainable future.

4 CONCLUSION

Although it is part of different communities, one of the things that has not changed for people is the need for a sheltered shell in which they can take refuge. This need, together with the increasing population, has turned into materials and designs that have been processed and used without considering the effects on human health that have arisen after the unconscious consumption of natural resources. This situation appears as a problem today. Sustainable use of materials in

building formation will be the right choice in solving the problem.
In today's conditions when resources are scarce, soil use in contemporary architecture is seen as a good alternative to other natural materials when its sustainable properties are compared. When the examples examined in this context are evaluated in this study, the use of soil as a building material provides many benefits in terms of economic, ecological, social and cultural aspects. Many of the buildings selected as examples are located in areas where communities live below a certain level economically. The choice of land use in the design, by building local materials with local craftsmen and participating individuals; Economy has been achieved in terms of transportation, out-of-town master and qualified team expenses. During the construction process, local people were both educated and part of a unifying community movement as they experienced and learned how to build. While buildings with primary priority such as education and hospitals are brought to the regions; In addition to the comfort features offered by the earthen material, these earthen structures were equipped with contemporary sustainable techniques, resulting in sustainable buildings that are self-sufficient in terms of energy. When evaluated for the whole of the buildings; The sensitivities shown in the designs in terms of adapting to the geography and climate they are in draw attention. Especially in these regions where the sun and wind have harsh effects, solutions with courtyards and landscaping, conservation of water and other resources have led to the emergence of structures intertwined with nature. The strengthening of cultural ties and the development of a peaceful life are witnessed in the communities using these structures.
As a result, in today's conditions, there is a need for comfortable and environmentally compatible structure formations where resource consumption can be kept at a minimum level. In this regard, adobe meets the sustainability criteria with its features of production with contemporary techniques and integration with contemporary materials, while enabling communities to build their own structures in harmony with their own culture and ecology.

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