962121212

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

Earth Architecture in Syria between the Past Heritage and The Contemporary Experiences

Nadia Kandakji [a*]

[a] *Department of Architecture & Environmental Planning, Faculty of Engineering & Petroleum, Hadhramout University, YEMEN*

ARTICLEINFO

Article history:
Received 31 August 2017
Accepted 30 November 2017
Available online
15 December 2017

Keywords:
Earth building; Sustainability; Adobe Cob; Domes; Sustainable Architecture; Green Architecture, Earth construction.

ABSTRACT

Earth is one of the oldest building materials known to man that was used widely in the building in different parts of the world, and it has been developed through many different techniques. It has been an ongoing tradition in Syria since 11 thousand years as one of the important architectural styles in Syria. This form of architecture has been neglected in cities and even rural buildings because of many factors. This paper examines the feasibility of reconsidering this form of architecture since it emphasizes the importance of earth as a building material and it provides some local residential models that reflect the culture of adopting with nature and the economic and social aspects. Besides, this paper highlights the most important modern works in Syria that were considered as conservation and revival measures of this form of architecture. The paper concludes that earth building should be reconsidered and relied on in rebuilding the residential units in the countryside areas in Syria, by depending on both traditional experiences as well as modern techniques in this field.

1. Introduction

Earth architecture in Syria is a part of the culture; it depends on community participation and achieves environmental and economic efficiency as well as cultural heritage in the memory of society. This architecture has been neglected in cities and this neglect has extended to rural architecture due to the reliance on modern construction methods and materials, while many of the buildings in the Syrian countryside have been destructed because of the war. This research paper examines the feasibility of restoring earth architecture by adopting it to improve the growing housing rate in the countryside. This enables one to reconstruct the destroyed areas, using the local experience and the methods and techniques used in modern earth architecture.

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.

2. Literature Review

The following sections provide a survey of theoretical literature including earth architecture in the world and its advantages and disadvantages and methods of earth architecture in the world in general and in Syria in particular.

2.1 Earth Architecture in the World

Through the study of the history of human architecture across ages, it can be emphasized that earth architecture was the most widespread form of building throughout history and in various periods. Earth construction has spread in harmony with the environment in the civilizations of Egypt, Mesopotamia, Arab and Islamic civilization, India and Mexico, and in diverse civilizations in Africa. This architecture dominates the world, and according to United Nations statistics, one-third of the world's population still lives in earth-built houses, and earth is a major component of building material. Recently, earth architecture has been considered one of the most important approaches and methods to solve the problem of housing; to achieve sustainable development; to reduce the problems of manufacturing building materials, and to reduce environmental pollution in both industrial and developing worlds. Thus, there has been a great interest in earth as a major building material and in carrying out relevant studies and research.

2.2 Characteristics and Disadvantages of Earth Architecture

Earth architecture has many characteristics:

- Availability: earth is available in most areas except mountainous ones and its widespread availability leads to the low cost of transporting it for construction
- Earth architecture is an organic form of architecture that is closely related to the environment. The earth material has responded to the great variation in climate, environmental conditions and all social and cultural influences through the distinctive forms of each society
- Earth architecture is clean; it does not cause any pollution at the different stages of construction or demolition process. Disposal of the old earth building products does not cause pollution. These products can be recycled into arable soil or re-used in earth construction
- Earth architecture provides the requirements of all social segments; it is a housing architecture, in cities and the countryside, that is suitable for simple and luxurious dwellings
- The earth construction technique allows for popular participation in the construction process, which contributes to the provision of suitable employment opportunities for local community members
- Fire safety: earth is fireproofing.

Despite the advantages of earth, there are disadvantages that cannot be ignored, summed up in

the following points

- The difference of the basic components of soil from one area to another and hence different ways to deal with it
- The weak resistance of earth material to the effect of water resulting from rain or rising from floors, which leads to loss of hardness
- The large-volume change of earth products, especially those with a high percentage of silt, causing cracking when exposed to successive cycles of different weather factors: moisture and drought and so on. This requires continuous maintenance to prevent corrosion
- The ability of earth to be a shelter for rodents and insects, as a result of cracking and thermal properties that characterize it

2.3 Methods of Earth Construction

There are many methods of earth construction in former and modern times. An investigator of earth architecture can count more than 15 construction methods of this widespread material in different countries of the world Figure (1).

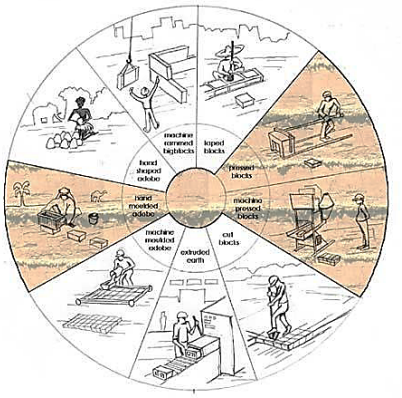


Figure 1: Methods of earth construction in the world (Houben & Guillaud, 1994)

These methods range from the full use of earth in all elements of the building to the use of earth bricks in the construction of the entire building, i.e. walls and roofs. Between these two methods lie many earth building methods and techniques, which use this material either alone or in combination with other materials to build walls in different parts of the world.

There are four main methods that are the most prominent in the construction of earth; they are widespread in the world and of great interest because of their characteristics and being widespread. These methods can be described briefly as follows:

2.3.1 Adobe Construction

Bricks are prepared by mixing soil, which often contains a high percentage of earth, with water and chopped straw. It is mixed well with feet or using oxen or cows; then earth is formed using a wooden mold without a bottom, containing one or more empty spaces to make adobe. The dimensions of this mold and the number of spaces it contains vary from one area to another. The

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

mold is filled with an earth mixture and pressed by hands to make sure that all the blanks in the mold are filled and to get a homogeneous block. The mold is then removed, leaving an earth block formed on the ground, which is left for a few days to dry. The mold is cleaned from earth stickers with dry soil or a wooden tool. The brick manufacturing process continues in compact rows, separated by a slight distance and left to dry in the sun, together with turning the sides of the bricks, to ensure their drying thoroughly before use in construction (AlJadeed, 2003, p.139).

This method is still prevalent in the manufacture of brick in most countries of the world that adopt this method of construction, but in some developed countries, the United States in particular, the mechanization of mixing and manufacturing of earth was introduced to produce earth brick in commercial quantities.

2.3.2 Cob Construction:

The method of earth construction is very similar to adobe construction, regarding preparation and mixing of earth, noting that the cut straw is added to the earth mixture in larger quantities in this method to avoid cracks caused by dry silt material, which is often in large quantities in the soil used in the preparation of cob. The importance of silt being fermented with straw is that this material is responsible for the interconnection between the soil components used, because this method of earth construction requires a degree of plasticity and cohesion, so that it can be made. The importance of earth fermentation with straw lies in the melting of some cellulosic materials in the mixed straw, which gives it better resistance to rainwater effect (AlJadeed, 2003, p.140)

The earth in this method is prepared by cutting it from the mixture in the form of spherical pieces so that the worker can handle it manually and hand it to the builder who takes these blocks, and presses them next to each other in a tier of about 30 cm high. Then the builder trims and forms these blocks manually to form a continuous layer along the wall, left about two days to dry before starting to build the next tier. In spite of the widespread use of this method of earth construction in the past, and the strength it provides, it has not received great development at present.

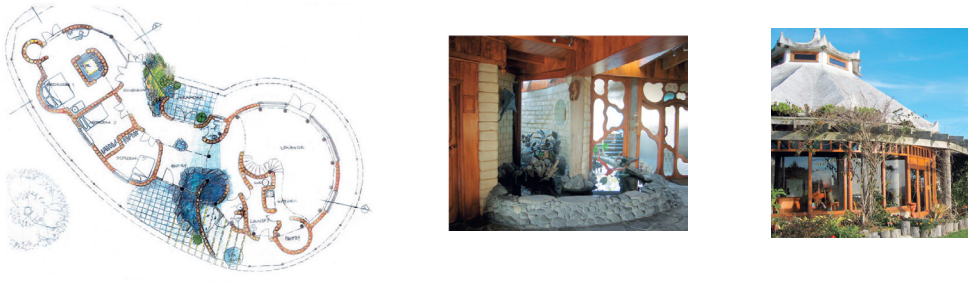
2.3.3 Rammed Earth Construction:

This method of earth construction is different from the previous two methods in that little water, not exceeding (10%), is added to soil, which gives the soil wetness and plasticity, contributing to its good compression. The wet soil is then moved and placed in molds similar to the molds in which the concrete is poured. These molds are installed on the base of the walls to be constructed, and the soil is well pressed in these molds, whether using special wooden pieces, as in developing countries or using some simple mechanisms, as in developed countries (AlJadeed, 2003, p. 141). When the molds are filled with compressed earth, they are removed and moved horizontally until a continuous layer is completed from that compressed earth on the entire wall, and then the molds are vertically raised to form another layer, and so on up to the roofing level.

2.3.4 Compressed Stabilized Earth Block Technology CSEB:

Stabilized earth blocks are the post-World War II version of compressed earth. This method of

earth construction combines the method of construction with earth and the method of construction with compressed earth. This method of earth construction is one of the most widespread methods at present, due to its many advantages, the most prominent being the ease of construction and the availability of appropriate techniques(Correia, et al., 2014, p. 4).



Residence, HelensVille, New Zealand –Recycled timber, Adobes by hand from local soil. Completion: 2005-Area: 180 m^2 (Minke, 2013, p. 170-171)

Residence and studio, Gallina. Canyon, New Mexico, USA.
The two-story residence of sun-dried unsterilized and local Adobes. Completion: 2001-Area: 390 m^2 (Minke, 2013, p. 160)

Kindergarten, Sorsum, Germany-Exterior walls, plinth: Porous bricks. Roof: Mud brick domes, timber structure, covered by 15 cm mineral wool, water and rainproof plastic-covered fabric, 15 cm earth, wild grass vegetation. Completion: 1996, Area: 595 m^2 (Minke, 2013, p. 176-177).

Figure 2

The appropriate soil is prepared and mixed, while dry, with some improved materials such as cement, tar, lime or other improved materials to increase strength or resistance to water. The soil is wetted in the same manner as compressed earth and then it is pressed in special molds or presses. The compressed bricks are then taken to dry and be processed before use in construction. The bricks are then used in construction like the adobe construction method, using and mixing the soil. Some machines and presses have been developed to facilitate soil preparation, mixing and compressing.

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

2.4 Earth Architecture in Syria

Earth architecture in Syria goes back to 11,000 years. The characteristics of this architecture vary depending on its history, place, and the surrounding economic, social and climatic environment.

2.4.1 The Geographical Spread

Earth-built houses are currently in the centers of large cities such as Damascus, Homs and Hama and in most of the Syrian countryside. This architecture is no longer alive in the large cities, and the earth dwellings in the historical centers of these cities have turned into archeological monuments. In contrast, this architecture is still alive in the Syrian countryside and is still used to build new earth dwellings, where the people have construction experience and maintain and spread this architecture although it is in marked decline Figure 3.

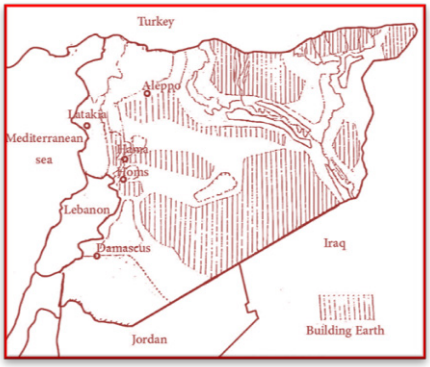


Figure 3: Earth architecture in Syria

3. Methodology

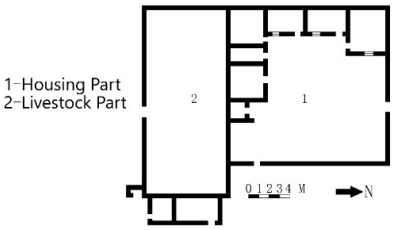
This research has been conducted according to two axes:

- The documentary approach was used by adopting the relevant sources and references. The importance of earth architecture in the world in general and in Syria, in particular, was examined together with some modern studies and experiments applied in the world that focus on the positive aspects of earth as a building material, in addition to documenting the local experience in earth architecture as organic and sustainable architecture.

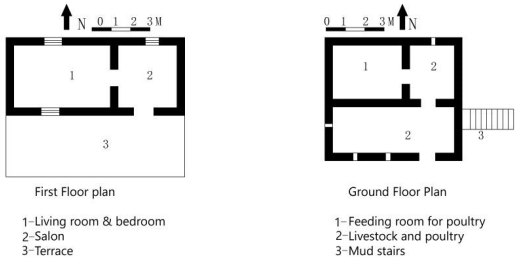
- The analytical method to monitor the current situation of earth architecture in Syria was used, and the newly implemented experiments were highlighted.

4. Analysis and Findings

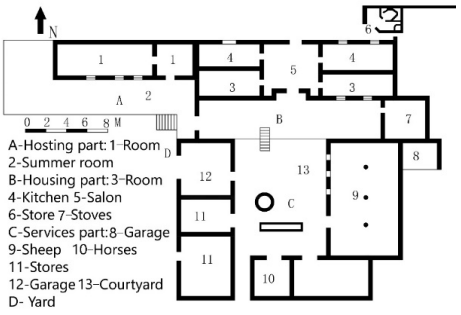
Earth architecture in Syria reflects the culture of dealing with nature to provide suitable living conditions. It varies according to the characteristics of each area, type of building, materials used and climatic conditions. This difference is evidence of a new and flexible architectural language that has produced different architectural patterns as they interact with the overall economic, social and climatic factors and spatial environment. In the following sections, some examples will be analyzed in order to demonstrate the sustainability factors of architectural patterns.



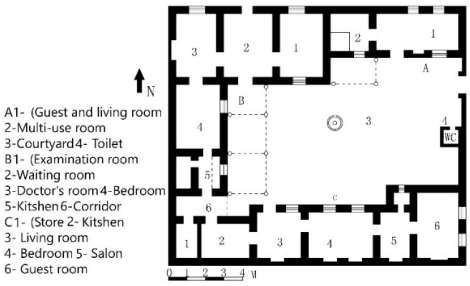
A plan of a dwelling. At the same level, the living and the livestock sections have been separated from each other (Azad, 2010, p. 272).



A plan of a two-story dwelling of a simple villager, the ground floor for the livestock, and the first-floor for living (Azad, 2010 p. 233).



A dwelling of a well-off villager, accommodating a place for livestock, feed, and a garage. Upper Mesopotamia Countryside (Azad, 2010, p. 230)



A plan of a doctor's dwelling, built in three stages 1944-1957 to suit the needs of the population (still existing) – the section of consultation and waiting – Al-Qamishli City, Syria. (Azad, 2010, p. 187)

Figure 4

Maardis Village - Hama Countryside

Northern Syria - Aleppo Countryside.

Figure 5: Domed Dwellings.

4.1 Earth Architecture is Sustainable

4.1.1 Architectural Patterns and Social and Economic Factors

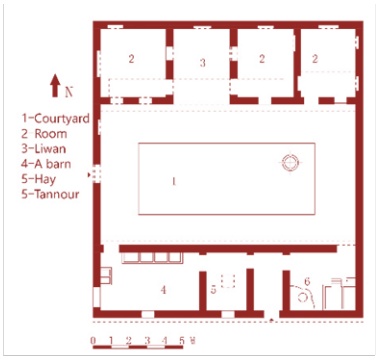
The architectural patterns of earth architecture have absorbed the type of social life of each area. The shape, pattern, size, functional characteristics, the degree of development, building materials and decorations of each dwelling were defined. Thus, design forms are various and have a mechanism of accommodating the various social needs. The dwellings are flexible and grow according to the increase in family members. Besides, the design form can be added to and modified continuously. In different areas, we distinguish between dwellings of wealthy families, middle-income families, low-income families, and poor families, Figure 4.

For example, in poor areas in northern and central Syria, domed dwellings are widespread,

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

where poor families, do not have enough money to use wood or build their dwellings using adobe on a high base of stone. According to a square plan topped by a circular dome that can be up to five meters high, having a door and small ventilation openings below. On the outer side of the dome, protruding flat stones, called *da'wasat*, are installed at regular intervals between adobe tiers to enable access to the higher parts of the dome for the periodic repair of the external mortar and for whitewashing the domes, Figure 5.

A large dwelling, Damascus Countryside, Arbin. (Doughman, 1995, p. 23)



A middle dwelling, Damascus Countryside, Eastern Ghouta. (Doughman, 1995, p.35)

Figure 6: Courtyards in dwellings

4.1.2 Architectural Patterns and Climatic Factors:

Climate factors have influenced the design of dwellings in the Syrian countryside. Different treatments can be observed to deal with the nature of climatic zones

1. Using the inner courtyard in different areas, which is surrounded by rooms, provides a space for family activities, and works to achieve a thermal balance of the dwelling through the presence of plants and a water pond. Figure 6.

2. Dwellings face south, in general to be protected from the cold winter winds and to take advantage of sunrays.

3. The difference of roofing method according to the climate of the area:

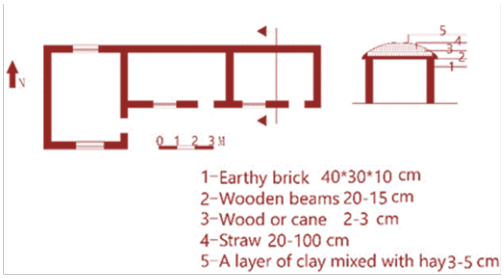
- The double-slope (gable) surface is used in the northeastern areas of the Syrian Upper Mesopotamia and in the Ghouta of Damascus, where there are wet climate and high rainfall rates.
- The convex surfaces are used to place a thick layer of straw over a horizontal wooden structure in areas of heavy rainfall. The convex shape helps to drain rainwater as well as providing thermal insulation.
- Flat surfaces are flat or slightly domed in areas of lower rainfall rates. Figure 7.

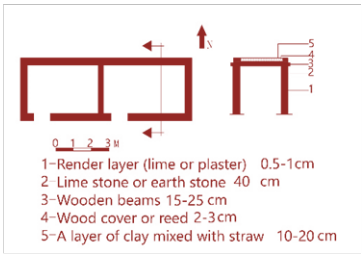
4. Roofs are insulated with a layer of plastic foil. Metal gutters installed on the earth façade are used to drain rainwater

5. Using stone material to insulate and protect eastern walls from rain when wind is eastern in winter.

6. Using horizontal umbrellas by raising the last roof one meter at least toward the outside to protect against rain in winter and sunrays in summer.

7. The difference of window size in dwellings according to the climate of the place. Windows are large in dimensions, ranging from 80-100 cm to 110-180 cm in the countryside of Upper Mesopotamia, and are narrow and small in domed dwellings in the north and center of the desert of Upper Mesopotamia, and in the center of Syria in the countryside of Homs and Hama.





The convex surface (Azad 2010, p. 249) The flat surface (Azad, 2010, p. 285)

Figure 7: Methods of roofing according to the environment and climate

4.1.3 Architectural Patterns and Spatial Environment (Construction Materials)

This architecture depends on unfired earth, that is, the earth that is only dried in the sun. It is soil mixed mainly with water and straw. It also depends on the stone and timber available in the area.

1. **Walls:** walls are constructed in two ways:

- **Earth-block walls:** this is the most common method of building the walls of dwellings. The main material is earth mixed with straw and water, which makes up the basic building blocks (earth blocks) and mortar that will connect these blocks. Earth is brought and mixed with straw, which gives it strength and then is put in molds to form blocks, with dimensions often of 10*20*40 cm. Mortar is made from the same raw materials of earth blocks, but it is sifted to become smoother. After mixing with water and earth, it becomes more viscous and extendable. These walls are built directly on the ground if it is rocky. If the ground is not solid, walls are built on stone foundations with a depth of 50 to 75 cm and sometimes a height of 50 cm or more. The thickness of walls ranges from 60 to 70 cm and is covered from the outside with a layer of earth or limestone.

- **Rammed-earth walls:** they are mostly used to build the fences of dwellings or orchards and sometimes to build the walls of dwellings, which consist of a sequence of relatively large earth blocks. These walls are relatively inexpensive; earth is placed in wooden frames, which are 150 cm high, 80 to 90 cm long, and 50 to 60 cm wide. These walls are built on a stone foundation with a depth of 120 cm and a width of 60 to 80 cm. The surface of the stone foundation is made level, and then the wooden frame is put over it in the corner of the building. The frame is filled with earth that is pressed with a stick to form the first piece of the wall, and then the operation is repeated next to the previous piece, and so on until the wall is built. Small stones are used to connect the wall pieces together. Walls are covered with a layer of earth or lime.

2. **Roofing:** Timber, if available, is used in roofing. The shape and technique of roofing have

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

been affected by climatic factors and the economic level of occupants as well as the nature of materials available in the region. Figure 8 shows the constructional forms used in the roofing of earth architecture in Syria:

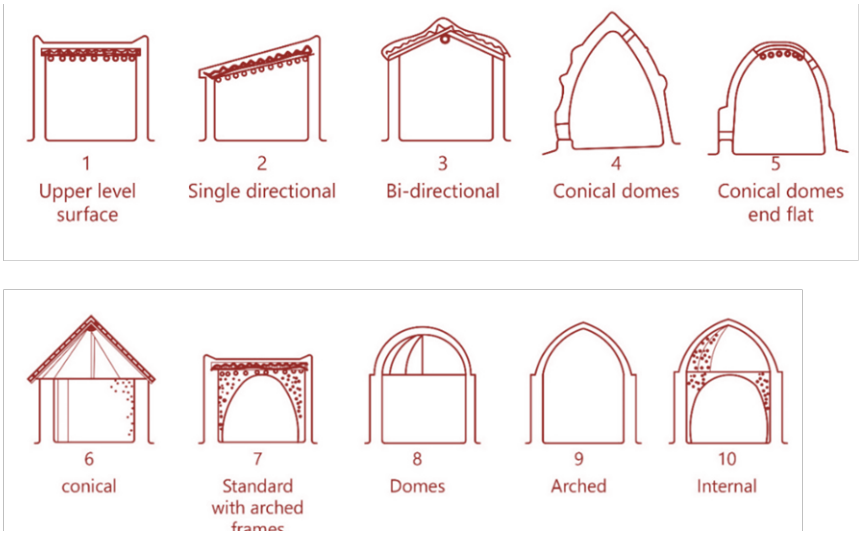


Figure 8: constructional forms (Khezam, 1991, p 240).

4.2 The Current Situation of Earth Architecture in Syria

Earth architecture in the countryside faces face major challenges that can be summed up on several levels

- **At the urban level:** The lack of pre-planning of villages has led to unplanned urban growth dominated by social relations such as kinship and topography of the earth, and has led to a disintegrating fabric that lacks the basic elements of the provision of streets and public facilities. Poor planning was reflected in the permanence and sustainability of earth dwellings.
- **At the design level:** The absence of pre-design of dwellings has led to random design. The gradation of construction, which was related to the development of housing needs, has had a negative impact on the unit size of the dwelling and sometimes has led to the emergence of housing patterns with disjointed and unconnected elements, in addition to the desire of the population to have vast tracts of land. All these factors have led to isolated dwellings that lack design and technical conditions and thus were rapidly deteriorating.
- **At the technical and constructional level:** The occupant who builds his dwelling lacks a comprehensive knowledge of the basic characteristics of earth. He deals with different types of earth material and does not distinguish between them regarding composition and constructional characteristics. This lack of information can lead to weak housing patterns that can rapidly collapse.

4.2 Recent Experiments to Revive Clay Architecture

Despite the unfortunate reality of earth architecture in Syria, there have been attempts to revive it through documentation, studies and the construction of some earth buildings, using new techniques. Among these attempts are:

- Modern construction using the earth architecture in Mary

- Earth building, using old models in Dura Uropos and the archaeological mission house in the archaeological Tell Beydar (Nabada) in Al-Hasakah Governorate.
- Building a kindergarten in Idlib Governorate
- Assigning the historical parts of earth architecture, in major cities such as Damascus, to the list of human heritage, and developing restoration work in these cities
- Earth village to provide disaster shelters for displaced families.

Four examples were chosen to be highlighted:

4.2.1 The House of the Excavation Mission in Tel Baidar, Al-Hasaka (NABADA), Syria. Architect Andre Stevens 1997

Architect Andre Stevens 1997.

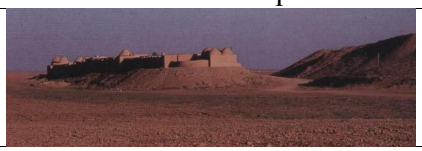
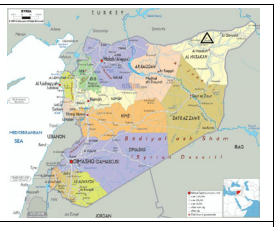
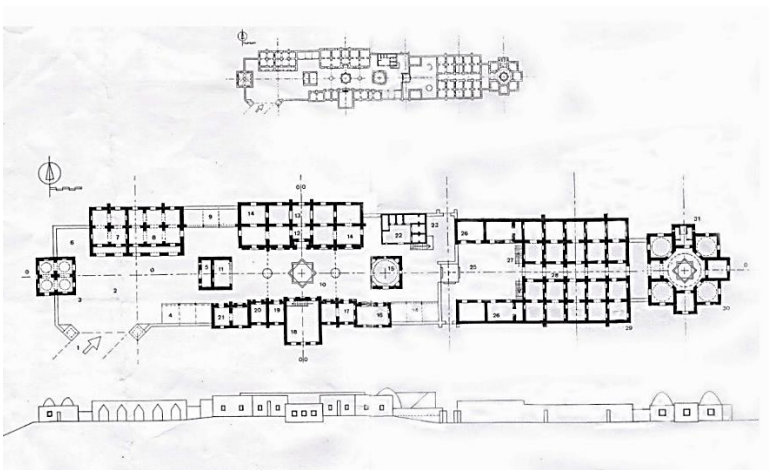
Supporting bodies: the European Archaeological Mission

The project objective: Restoration of a site in Tel Baidar and its use as a complex for the establishment of the European Archaeological Mission in Tel Baidar, Al-Hasaka, Syria.

Functional components: A set of functional spaces with a celestial courtyard.

Construction technique: Adobe construction together with the use of domes in roofing, see Table 1.

Table 1. Construction technique of Tel Baidar.

<table>
<tr><td>  
The excavation site of the Syrian-European archaeological mission dominates the scene as a desert vessel.</td><td rowspan="2"> 
Project Site
 
  </td></tr>
<tr><td> 
Plan of the facade of the excavation mission house, Tal Baidar. (NABADA)</td></tr>
<tr><td>Domes-inside of the central courtyard-courtyard.</td><td>  </td></tr>
</table>

4.2.2 A kindergarten in the Village of Kafr Jalis in Idlib Governorate, Syria, 2007

Supporting bodies: A non-governmental organization in Idlib Governorate.

The project objective: Building an environment-friendly kindergarten with an area of 1000 m2, accommodating about 300 children. The earth material was adopted as a building material to achieve this objective. The project started in 2007 and was completed by the end of 2009 at an estimated cost of about $210,000

Functional components:

- Twelve Classrooms
- Four playing rooms
- a reception hall
- an inner courtyard
- Service facilities

Architectural form:

- The roof contains 10 domes.
- A pyramidal earth roof above the reception hall.
- Stone arches and columns to solidify and maintain the building, and insulating the roof and domes so as not to be affected by weather factors.
- **Construction technique:** in the process of construction was used light and cost-cheap adobe blocks, using a kind of earth with distinctive local characteristics being free of organic and agricultural materials. This earth is mixed with 15% of straw, and after the process of mixing, the mixture is left for a period of 15 days. Then it is poured into special molds in the form of ordinary concrete blocks, and then the molds and emptied and left for about a week. After this, they become ready for construction, and the process for coating the walls is done with earth and straw, with increasing the proportion of straw. Figure 9.

traditional manual method of construction

Courtyard

inside of the classrooms

Project Site

Figure 9: Construction of the village of Kafr Jalis

4.2.3 The Revival of the earth domed dwellings and turning them into an eco-tourism cultural project in the village of Al-Sheikh Hilal, Hama Governorate, Syria, in 2010

Supporting bodies: A local non-governmental organization together with support from the

Swiss Agency for Development.

The project objective: The main objective is to stabilize the local population; to improve their incomes and create job opportunities for them, especially women; and to provide participation for women in promoting tourism. The project has sought women's participation in all aspects of tourism and development of the project through the manufacture of handicraft tools and products for which the village is known.

Components of the project:

- Hotel Suites: Maintenance of earth domed dwellings in the village and using them as suites equipped with all the rich Syrian folklore and heritage. These dwellings become beneficial through renting them form their owners.

- Facilities: a large hall as a multi-purpose cultural center, a popular celebration hall, a lecture hall and tourist facilities, built of earth.

Only 146 domes of the total 348 were completed and the service complex was not completed.

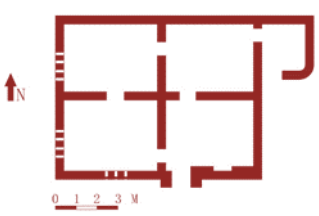
Architectural description of the domed dwellings: The earth dwellings in the village are characterized by having more than one earth dome in each dwelling. The domes open to each other are used for living. They provide occupants with warmth in winter and mild weather in summer. Besides living, they are used for various purposes such as storage. They are polished with soft cement, equipped with sanitary extensions, and most of them are coated with white lime from the inside and outside. These domes have three forms:

The first: An ordinary pyramidal dome, and at the top is a cylindrical stone called colloquially *al-tantour.*

The second: A dome carrying a circular roof 3 meters in diameter, which is lower than the previous one by a meter or two, is covered with timber and earth, and is called *tuza.*

The third: The Sultanic dome. It starts at the height of two meters in a square room, on which is circularly built a dome that has a circular roof of timber and earth, which is up to 3 meters high.

The name comes from the domes being suitable for the residence of sultans because they are the most luxurious type of earth domes, Figure 10.



plan of a dwelling with four domes

domed dwellings

Project Site

"Sultanic"

"Tuza"

" Al-Tantur"

Figure 10: Construction of the village of Al-Sheikh Hilal

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

4.2.4 Earth village to provide disaster shelters for displaced families in Idlib Governorate in 2015

Supporting bodies: Non-governmental organizations in Idlib Governorate, funded by the Qatari Red Crescent.

The project objective: Providing earth housing and accommodation with necessary services for the displaced persons of the war, in the city of Saraqeb in Idlib Governorate

Components of the project:

- 2200 small housing units. Each unit contains two rooms, a kitchen and a bathroom with an approximate area of 24 m^2
- **General services**: A mosque, a school, shops, a cultural center, an educational institute, a cow farm, a poultry farm, and vegetable nurseries around the dwellings as well as the necessary streets and playgrounds for children.
- **Public facilities**: A sewage system, a large reservoir fed by a well to secure water, and an electric generator to secure electricity.

Only 100 housing units were built at the cost of $750 per unit. Compared to prefabricated caravans, which cost about $3,500, these housing units were found to be cheaper. It was planned to build a series of earth villages elsewhere, based on lessons learned from the current project.

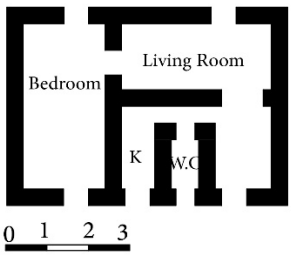
- **Construction technique:** The unit was built on a foundation 50 cm high, of stones available in the region to insulate the floor from the moisture of the earth. Cement render was used to cover the floor of the unit. The method used was of manually manufactured adobe blocks, composed of earth and some straw, to build the walls. The floor was polished from the inside and outside with a cement layer to give it more durability. Wooden panels were used in roofing, placed over them is a layer of earth, protected by a nylon coat, Figure 11.

A roof of rafters insulated by nylon bags

Manual manufacturing of earth block molds

The stone foundation of the housing unit

Project Site



plan and facade of the housing unit

Figure 11: Construction of the village in Idlib.

5. Discussion

1. The importance of the presence of cultural objectives and community participation to ensure the success of the experiment of earth construction. Community participation does not only mean the participation of the people in the process of construction and restoration by providing employment opportunities for the beneficiaries of the project in particular and the members of the community in general, but it also means the adoption and promotion of these projects by a non-governmental organization. Recognizing the importance and advantages of earth architecture and showing it in a modern and acceptable form is a collective responsibility that rests with several parts, including academic, engineering, and architectural ones, as well as organizations and bodies that responsible for culture, heritage, environment, etc.

2. The attempt to benefit from the architectural heritage and to promote its area is a strong response to the possibility of the continuation of earth architecture and its ability to meet various functions (residential, tourist and educational).

3. Construction projects (kindergarten and housing) were carried out with the same traditional construction technique of adobe, with the use of stone, timber and render coating. Advanced techniques were not used.

4. The population's satisfaction with the project is realized if the necessary services are provided for its continuation. This effect was evident in the earth village project. The project was planned to be an integrated complex of housing and basic services. However, the delay in carrying out the services led the displaced persons to a feeling of dissatisfaction with the project in general.

5. There is a widespread belief among the population, especially the urban population, that earth dwellings represent poverty and backwardness. In contrast, there is a kind of nostalgia for the traditional architecture of the past. This difference is shown in the degree of satisfaction with previous projects; recipients were satisfied with the projects except for the earth village project, where it was found that the feelings of the displaced persons about housing varied markedly. While rural residents see housing as appropriate and meet most of their needs, urban internally displaced persons feel contempt for and discontent with the idea of living in earth dwellings. These feelings seem normal due to the lack of public services, as well as the vast difference between the kinds of houses that they were forced to leave and the current level of earth shelter.

6. Results

The research yields the following results:

1. Earth material is one of the oldest building materials known to man; it was used widely in the architecture of the past in different parts of the world, and it has been developed through many different techniques in order to benefit from its advantages and reduce its disadvantages.

2. Earth architecture in Syria is organic architecture, closely linked to the environment and geography of a given place, and has produced different patterns due to the impact of the overall economic, social, environmental and other factors.

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.
 Volume 8 No.4 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V08/243.pdf.

3. The Syrian earth heritage is extraordinarily rich, but it is suffering day after day from the consequences of the profound changes that have been affecting the Syrian society, such as changes in lifestyles, the desire to modernize, turning the village into a city, rural migration and abandonment of agricultural culture, in addition to the negative effects of the destruction caused by the war in recent years.

4. There are some experiments and attempts that were carried out in order to raise awareness of the importance of earth architecture and to establish the development of this architecture through documentation and some of research studies. It should be noted that the results of these studies have not been applied yet in reality.

5. The attempts related to the construction and maintenance of some earth buildings prove the efficiency of earth material as a flexible material that responds to different stages of development if the planning of its facilities and the design of its components are done well. This confirms the validity of the research hypothesis that there are feasibility and necessity to rehabilitate earth material and its use in rural architecture in Syria.

7. Recommendations:

- The need to develop a participatory scientific strategy in which the pattern of earth architecture is integrated with economic, environmental and cultural objectives. The strategy should include raising awareness of the importance of this heritage; building capacities at all levels to develop it such as establishing specialized institutions that disseminate information about earth architecture; holding exhibitions and lectures and using other means that encourage and contribute to the use of earth construction.

- Introducing the earth construction technique within the curricula of architecture and civil engineering in Syrian universities to familiarize students with the architectural culture related to earth architecture and the necessary information about this material, its characteristics, and seeking ways to develop it.

- Evaluating practical and field experiments in which earth was used in a modern construction method to draw on lessons and avoid defects.

- Communicating with international research and pragmatic centers concerned with this material through a global information network; benefiting from recent studies; and working on translating sourcebooks into Arabic.

7. Conclusion

Earth is one of the oldest building materials in the world used by humans and has been developed through many methods. Earth architecture in Syria is part of the culture; it depends on community participation. It reflects the culture of dealing with nature to provide suitable living conditions. It is linked with social and economic conditions, in addition to the cultural heritage in the memory of society. This architecture has been neglected in cities and this neglect has extended to rural architecture as a result of many factors. The research concludes that it is important to

rehabilitate this pattern, to take advantage of the existing traditional experience, and to communicate it with the latest developments and treatments on how to deal with earth as it is a viable option to ensure the necessary of housing crisis, especially in rural areas.

8. References

Ali, A. A. (2010). *Earth architecture types in Euphrates Island*. Publications of the Syrian General Book Organization. Damascus, Syria.

AlJadeed, M. A. (2003). Earth building in the Arab countries and Western countries, building methods and proposed development axes. *Journal of the Center for Research and Studies of Medina El-mounwara* 8, 107-146.

AlSakkaf, Y. Kh. (2009). *Durability properties of stabilized earth blocks* (doctoral dissertation). University Seins Malaysia (USM), Malaysia.

Correia, M., Carlos, G. & Rocha, S. (Eds.). (2014). *Vernacular heritage and earthen architecture contributions for sustainable development*. Taylor & Francis Group: Boca Raton.

Douhgman, M. (1995). *Earth buildings architecture in the territory of Damascus* (master dissertation). Damascus University, Damascus, Syria.

Doughman, M. (1999). *Documentation and development of building materials for local residences* (doctoral dissertation). Damascus University, Damascus, Syria.

Houben, H. & Guillaud, H. (1994). *Earth construction- a comprehensive guide*. London: Intermediate Technology Publications.

Khezam, A. A. (1991). *Rural agricultural housing earth architecture in the conditions of the Syrian Arab Republic* (doctoral dissertation). Moscow Institute of Architecture, Russia.

Maini, S. (2005). Earthen architecture for sustainable habitat and compressed stabilized earth block technology. Heritage Conservation Program: *Lecture on earth architecture and building techniques with compressed soil.*

Mileto, C., Vegas, F., Garcia Sociano, L. & Cristini, V. (2014). *Earthen architecture: past, present, future*. Taylor & Francis Group: Boca Raton.

Minke, G. (2013). *Building with earth design and technology of a sustainable architecture* (3rd ed). Birkhauser: Basel.

Dr. N. Kandakji is an Assistant Professor of Department of Architecture and Environmental Planning at Faculty of Engineering and Petroleum Hadhramout University, YEMEN. She received her B.Eng. from Hims University. She continued her PhD study at Aleppo University, Syria, where she obtained her PhD in Architectural Design. Dr. Kandakji current interests involve applications of modern architectural design methods for low-income housing.

Note: The original work of this article was reviewed, accepted, and orally presented at the 3rd International Conference-Workshop on Sustainable Architecture and Urban Design (ICWSAUD 2017), a joint conference with the 3rd International Conference on Engineering, Innovation and Technology (ICEIT 2017), held at Royale Ballroom at the Royale Chulan Penang Hotel, Malaysia, during 13-15th November 2017.

*Corresponding author (N. Kandakji). Tel/Fax: +967735020884. E-mail: n_n_alwnan@hotmail.com.