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Comparison of egyptian innovation in affordable housing with global models

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Comparison of egyptian innovation in affordable housing with global models.

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In these work Survey about different types of affordable housing was done with the advantages and disadvantages of each type. The comparability of each type with sustainable in construction according to national and international standards was considered. The risk assessment related to this type of construction was evaluated. The Egyptian innovation in the affordable housing which is registered as patent in the Egyptian patent office is studied. The new building has one floor with spherical external shape for energy conservation, it consists of multilayers movable walls moving on the streams. The metallic structure is installed in the soil surface by fixation elements, it is equipped with sensors which is controlled automatically to detect climate changes. the movement of successive layers can be controlled manual or automatic according to climate changes, The movement of insulated layers is done by sliding on dedicated channels, It is equipped with upper and lower ducts located on several axes positioned at the top and bottom of the ball so that the upper and lower positions are located on one axis. The unit has conical top contain the layers folded to the top and prevent the accumulation of dust and water. The layers can be stored inside the conical top. The Egyptian patent model is compared with the common global models of affordable housing to explain its advantages and disadvantages

Keywords: Affordable Housing, Risk, Sustainable Building, Innovation



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1. Introduction

Affordable housing is a set of building models which is considered as type of low-income housing primarily by providing residential products that are within their reach and difficult living conditions. The models of affordable housing are often linked to rapid and constructive housing in the face of disasters.

Recent studies reveal that green buildings with good overall environmental quality can reduce the rate of respiratory disease and enhance worker performance,(1). The green buildings measures include building shape and orientation, passive solar design, and the use of natural lighting(2),(3). **The conservation of energy is main topic in green buildings design and codes. Affordable housing** is defined as housing which is deemed affordable to those with a median household income or below^[1] as rated by the national government or a local government by a recognized housing affordability index. In other words housing for poor people specially incase of emergency. The hard and critical question in the construction field is how to achieve the balance between affordable housing and green buildings. Figure (1) shows the main elements in green building and affordable housing.

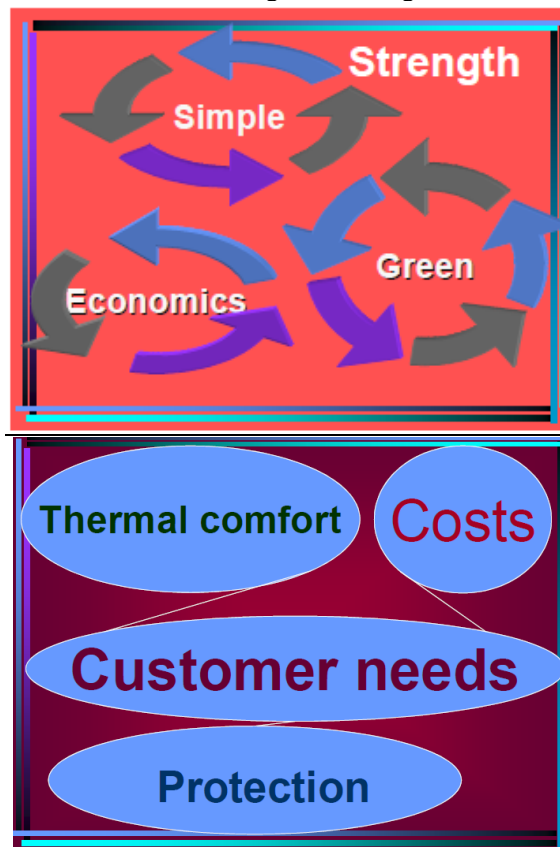


Figure (1) The main elements in green building and affordable housing
Technical problems with affordable housing constructions

1. Construction time is relatively long and not appropriate for emergency situations and disaster situations
2. The insulation layers in the buildings are fixed and do not suit climate change and temperature difference between different seasons of the year
3. Energy conservation increase in buildings have sharp edges. Figure (2) shows the rate of energy conservation according to the building shape.
4. affordable housing with conventional techniques is relatively expensive and take long time so green buildings in the future technique for thermal comfort in low cost energy-efficient buildings.

5. All Green building codes and techniques which are environmentally compatible are very complicated and expensive.

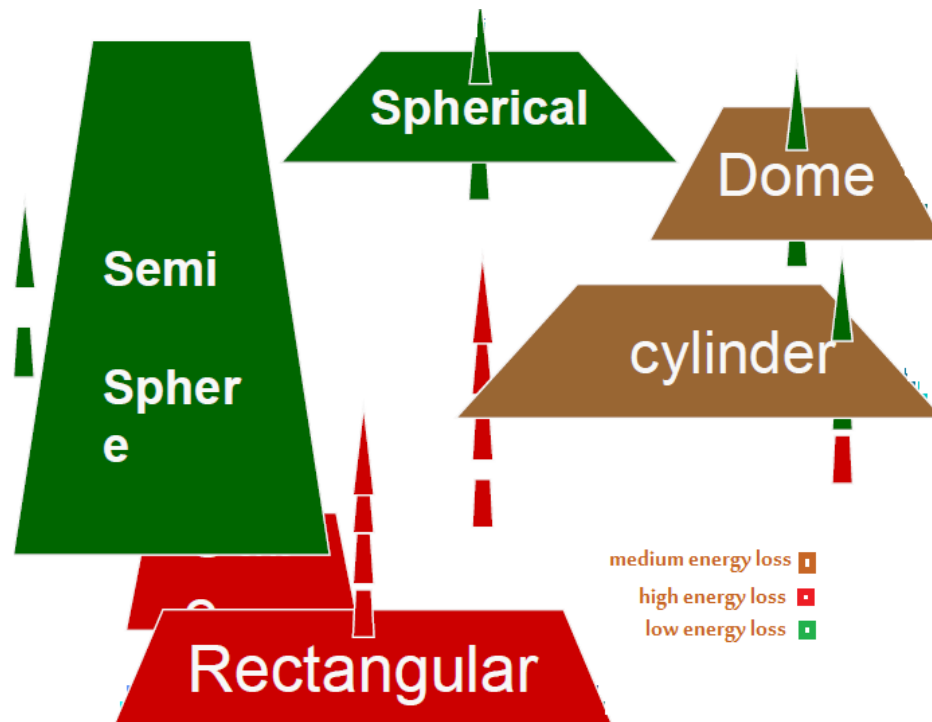


Figure (2) the rate of energy conservation according in different building shapes.

6. The conventional building consists of only one layer and fixed walls that lack the ability to cope with climate changes

7. Prefabricated buildings are suitable only for very limited types of soil

8. Connections of electricity, water, sanitation and communications are part of the building and are adjacent to the walls, which causes the building to be rapidly damaged and difficult to maintain

9. Insulation layers, doors, windows, coatings and protections are connected to the main building body.

2. Methodology

2.1 Egyptian innovation technique in affordable housing

The Egyptian green building for affordable and low income housing is patent registered and granted from the Egyptian patent office. patent number is 27118/2015. The invention is a design for building element in the form of incomplete sphere, The design save energy. It consists of multiple layers on moving streams equipped with sensors, The movement of the working layers were controlled automatically or manually according to climate changes in the surrounding atmosphere. The top and bottom of the layers are installed on several axes centered together. The movement of insulated layers are done by sliding on the certain channels. Figure (3) The section elevation for main elements in the building.

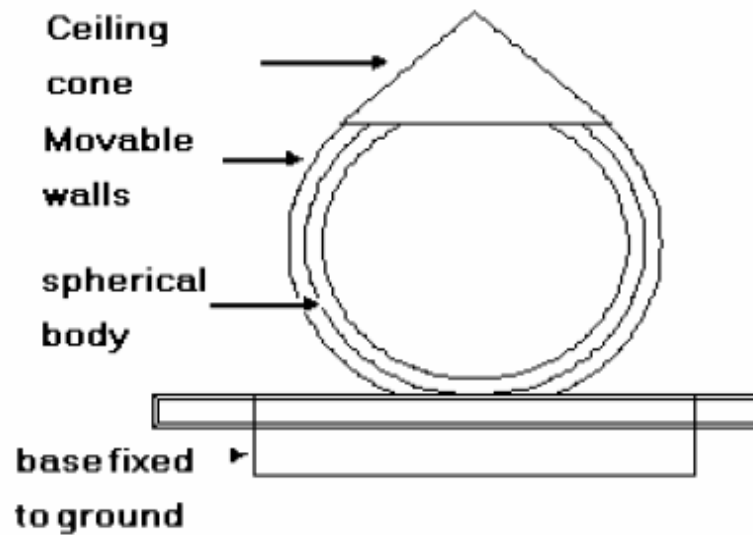


Figure (3) The main elements in the building

2.2 Green building design

In this work green building is designed in spherical shape with moving walls. figure (4) and Figure (5) show the main construction of the new green building . Figure (4) shows the exterior shape of the building, while Figure (5) shows a building block showing the general structure which are a general shape of a semi-spherical structure

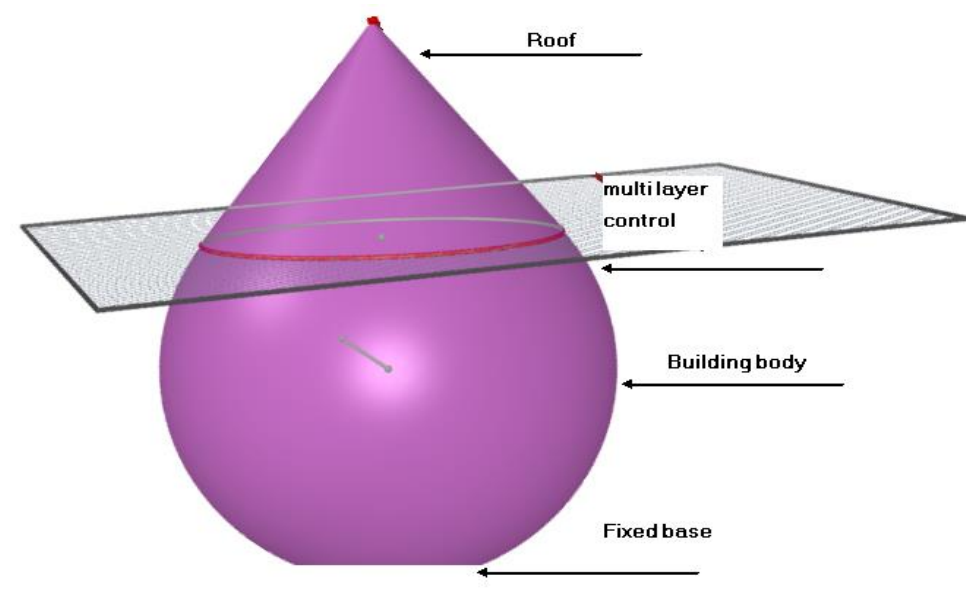


Figure (4) 3D view of the building

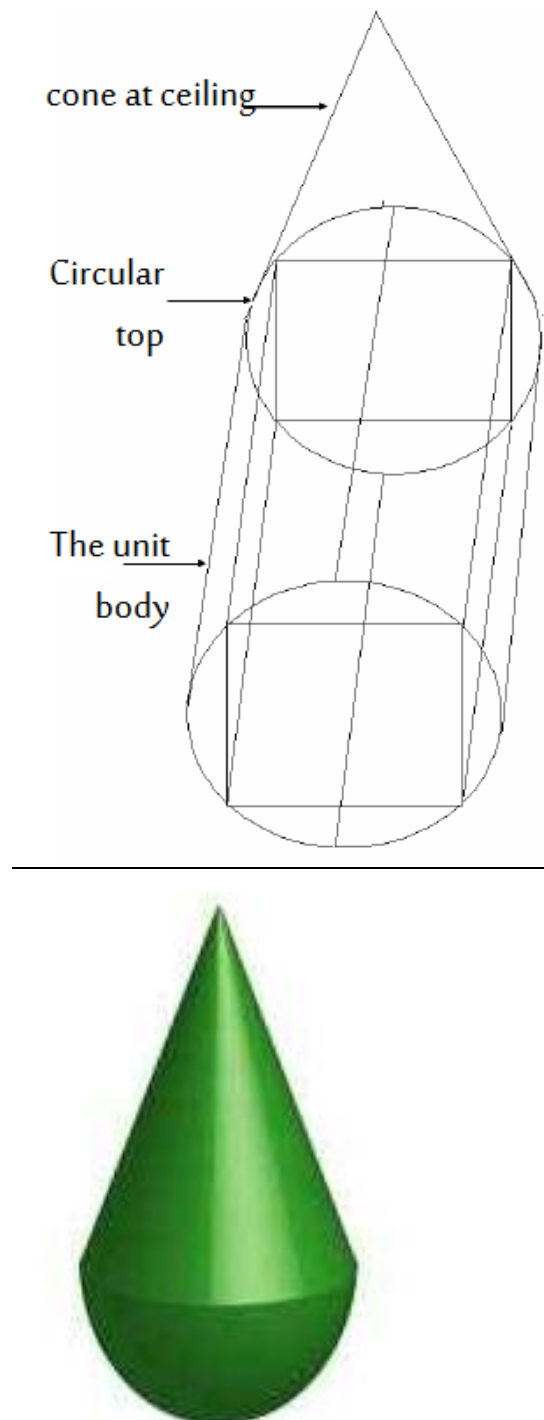


Figure (5) The main construction of the new green building

2.3 Building shape

The shape is in the form of a great ball, the ball is not completely circular. The circular shape is the best engineering shape can preserves energy and prevents leakage, it is also contains the lowest heat transfer rates. The building shape is free from any right angles, it is achieve ideal distribution of energy inside the building. Figure (6) shows the energy distribution inside the structure .

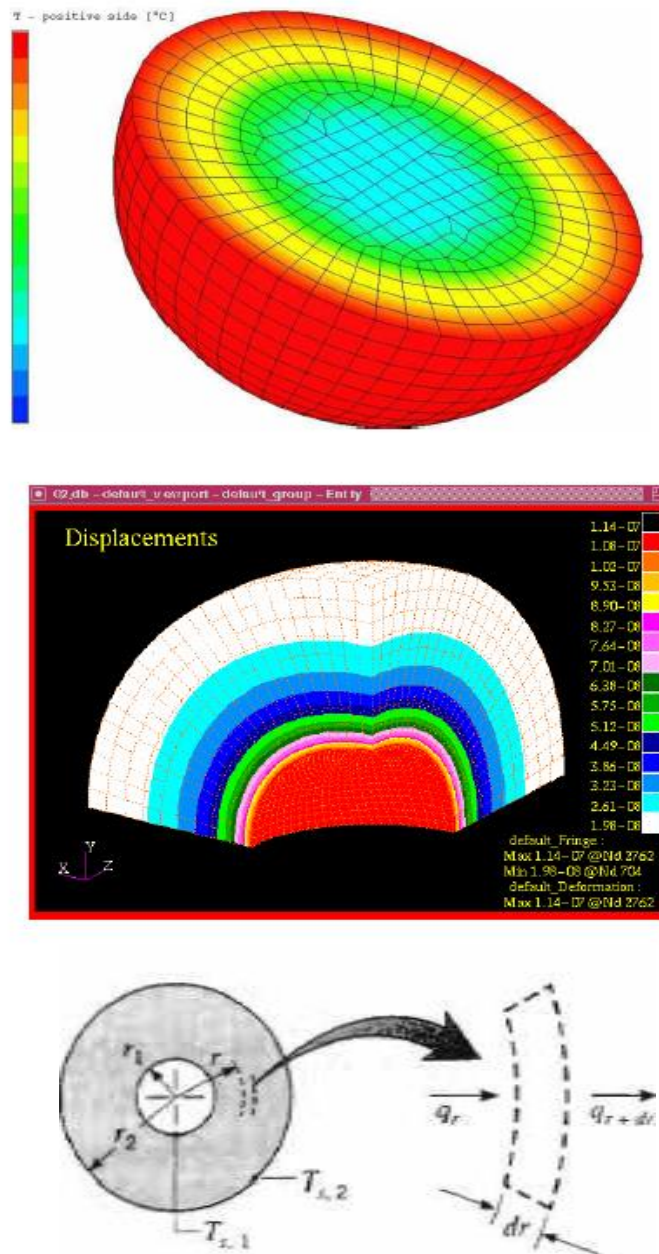


Figure (6) The energy distribution inside the structure

The new building consists of the following main parts:-

1. The conical top
2. The upper cavity
3. The lower cavity
4. The transparent layer
5. Insulating layers
6. Install the unit
7. The upper base
8. Eight fixing bars
9. A layer of heat transfer insulation
10. A layer to achieve acoustic insulation
11. A layer of reinforced plastic with additives to achieve light weight and integration of building elements.
12. An additional layer when isolating lead or radiation for special applications
13. Side places where the layers are combined
14. Bottom base
15. Laying down the layers while folding
16. The window that penetrates the insulation layers

Conical top to prevent the accumulation of dust and water on the roof surface, The upper cavity is regarded as a suspended ceiling for lighting, air conditioning, and other facilities. the upper cavity is used to store the layers of the walls for long periods by pushing the layer (body) up [26]. The upper cavity follows the upper base (7), which contains interlocking circular rings with variable diameters, where the diagonal spacing depends on the required distance between the layers of the movable and folding walls. Each ring fixed to the upper base corresponds to a ring at the bottom base (14)

The lower cavity is considered as raised floor containing cables, water pipes and electricity connections. The upper base is connected to the roof of the building adjacent to the base of the conical top. Fixation of the unit in the soil is done by means of metal columns and anchors, The eight fixation columns extend from the conical top to under ground to fix the building in the subsurface of the soil to achieve stabilization of the building.

The Egyptian patent in affordable housing consists of Spherical structure with conical tops and movable multi-layered walls. The outer layer is transparent layer to allow penetration of sunlight. The Insulating Layers is multi layers all of them are movable and separated from each others. Figure (7) shows the plain of the different wall layers and the windows. One of the building layers can be used and the other layer is folded through side places. In the side places the layers (13) are collected and fixed from the top and from the bottom in the bottom base (14), cross-straps are installed by valves to control the fastening of the layers during the folding (15) and their lengths can be controlled. the size of the folded part and its height can be also adjusted.

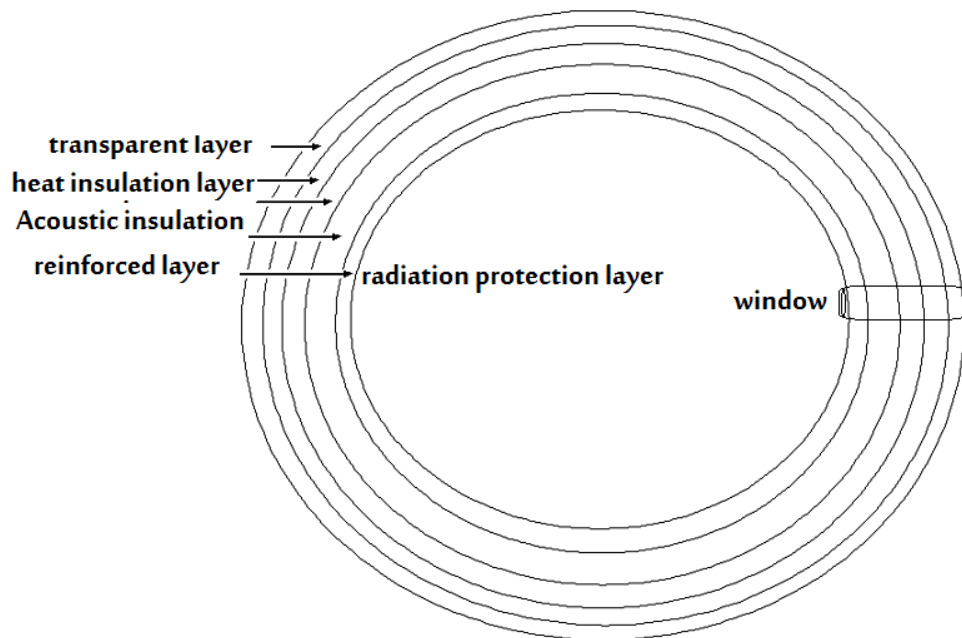


Figure (7) The different wall layers

Building walls are consists of several layers completely separated from each other, it is serves as completely separate building units, the arrangement of the layers from the outside to the inside is as follows:

- A. layer of heat transfer insulation
- B. layer to achieve acoustic insulation of the sintered felt on both sides
- C. layer of protection from reinforced plastic with additives to achieve light weight and integration of building elements.
- D. protection layer against radiation and Bullets for special applications
- E. The windows are penetrates the insulation layers
- F. The bottom base is the interior floor of the building

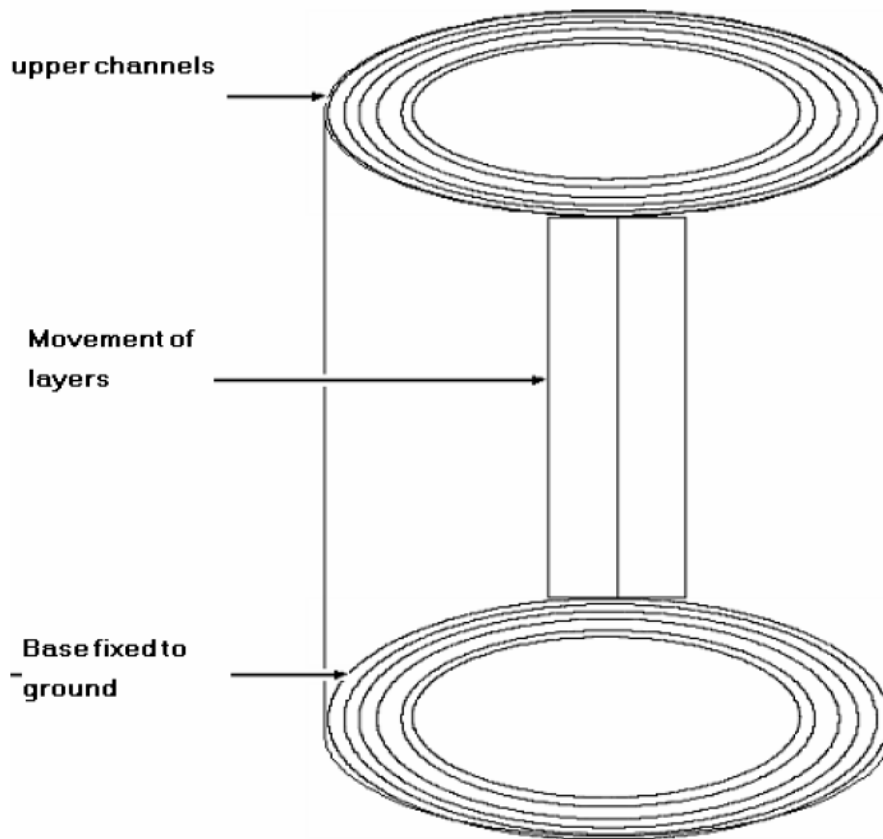


Figure (8) The movement mechanism of the different layers

Side places where the layers are combined, allowing the unused layers to fold, Elements for fastening elements while folding. Figure (8) shows the movement mechanism of the different layers relative to each others, while figure (9) shows the folding of layers and fixation techniques. The insulating layers (5) are attached to the fixed rings, each layer is installed to the upper and lower rings to fix the ducts moving of the circular layers, it is maintain their ability to slip and control the folded or visible amount of circular layer. The new design in spherical shape have the best energy distribution to achieve thermal comfort. The unit also contains an anchor base (6) topped by a lower cavity (3) and adjacent to the surface of the soil, the lower base (14) is considered as raised floors for construction, it is allow all ducts and cables such as electricity connection computer cables,web wires water and sewage pipes to connected from the base of the building to outside sources vice versa

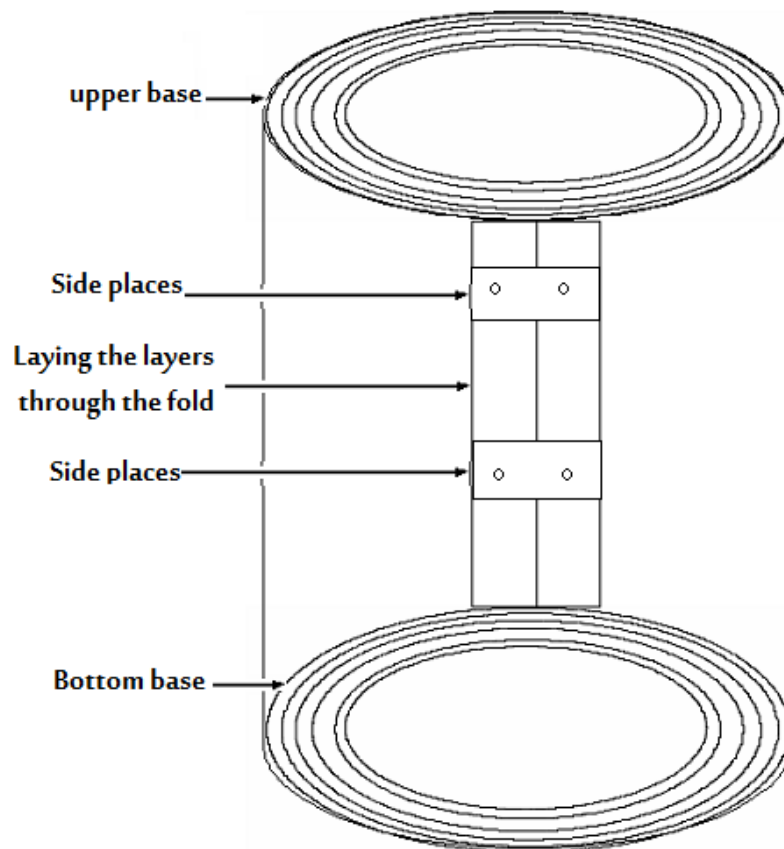


Figure (9) The folding of layers and fixation techniques.

the body of the internal building is almost completely isolated from the external climate. The movement of the successive layers is done manually or automatically with mechanical system connected to electrical circuit with remote control 26.] [

The building width can be controlled by increasing or reducing layer size and movement ,it is done by controlling the separation between the successive and second layers by folding some of the layers or storing them in the upper cavity (2), each of the previous layers forms a unit in itself closed from both sides with a wooden or metal casing to assemble the layers when folded and not needed.

2.4 Building installation method

The building can be moved from place to place by loosening the fixing screws represented by the eight (8) fixing columns and reinstalling them, Figure (6) showing the mounting columns and conical tops.

The installation columns are distributed regularly over the area of the building, three converging and concentrated columns are located below the conical top, while the other columns are distributed regularly on the outer circumference and along the body of the building, it is in the distances between the insulating layers (4), the columns are fixed centrally between the upper base (7) And the bottom base (14) by fastening nuts.

The distance between the two bases is about (2/5) the total length of the fastening columns, which constitute the exploited height of the building, the columns are extended up to penetrate the conical top (1) with a length of about (1/5) the total length, it penetrates the bottom base (14) and the socket bottom (3) so that it is about (2/5) the total length of the stabilization columns below the soil surface.

2.5 The internal division of the building

It is done through metal cutters that are fixed in the upper base (7) and the lower base (14) and the metal cutters are provided with doors to facilitate access between different regions inside the building, it also controls the rate of their division.

2.6 External entry door

The door is in the form of a metal plate followed by a panel of tent fabrics, it is fixed and wrapped on a cylinder, the cylinder is fixed on its sides in the upper base, the door is opened and closed by rotating the cylinder and wrapping the fabric on it, the bottom end of the door contains removable fastening rings that attach easily to the bottom base, when it is removed the door moves automatically up.

2.7 Windows

The window penetrates the insulation layers, it is a cylindrical pipe that can be opened and closed from both sides (16) The pipe can be pulled inside to return the insulation layers to its original place. Each temporary opening can be covered with a layer of the same type of insulation present in the layer.

3. Results

3.1 Distinctive elements of the design

The design is distinguished by the following topics:-

1. The positions of the slots are variable due to the relative movements of the successive layers, (movement up and side movements).
2. Ease of disassembling and installation is done any number of times.
3. The quality and kind of the soil does not affect the movement process it is affected only by the depth of the plug and the mechanics of fixation.
4. The elements of protection against thermal and acoustic insulation vary according to the movement of the sun during the day or during different periods of the year.
5. The semi-spherical design is ensuring energy conservation by folding, changing, or storing of different the layers.
6. The joints of electricity, water, drainers and internet cables are located in special layers away from the body of the building.
7. The joints are connected to the ceiling and the floor, that increases its life span and facilitates the dismantling, installation, and maintenance.
8. The Egyptian model is considered as the cheapest green building because it does not need any cement, sand or grit for building operations.
9. The Egyptian model does not need any advanced techniques to implement it.
10. The building consists of several moving layers each layer suitable for specific climatic or environmental conditions.
11. The building is equipped with sensors to detect external and internal light and heat change to choose the appropriate layer.
12. The process of changing the insulating layers can be controlled manually or automatically.
13. The building is equipped with layers of protection against risks such as electrical hazards and lightning strikes.
14. Multipurpose design, easy to disassemble, install and move around.

3.2 Applications of the Egyptian model in affordable housing:-

1. Rapid construction in case of relief, crisis and disaster.
2. Industrial and domestic uses such as setting up industrial parks.
3. Construction for energy efficient purposes.
4. The Egyptian model is multipurpose design which is easy to disassemble and install.

5. The Egyptian model is easy to move around from place to another places.
6. The Egyptian model is easy and speed of construction and
7. The Egyptian model has the ability to add any number of additional units because the units are easy to dismount, install and pre-equip
8. The Egyptian model is provide protection against external hazards and environmental factors. Figure (10) shows the prototype of the Egyptian patent and its main parts.



Figure (10) The prototype of Egyptian patent

4. Conclusion & recommendation

- ❖ In view of the importance of acquiring suitable housing for all segments of society, especially groups that are limited income or non-intervention or that are subjected to forced displacement,
- ❖ it is necessary to develop structural and construction systems that meet the needs of Arab societies for relief construction in disaster situations.
- ❖ Affordable housing design must be developed to resist the expected climate changes that It will lead to many environmental and natural disasters.
- ❖ **The Egyptian model that has been patented was invented and is characterized by the following- :**
 1. The Egyptian model is a one-story building that has a metal structure and is easy to dismantle and install and can be moved from one place to another so it is a unique model for rapid construction work
 2. The Egyptian model achieves cost savings in terms of construction and operation with the possibility of reuse and ease of storage
 3. Achieving sustainability in the Egyptian model by linking housing design and design elements that lead to sustainability
 4. The multiplicity of walls in the Egyptian model, and its ease of folding or expansion according to the external climate are the main factor achieve thermal comfort

5. The Egyptian model provide the energy depleted in its operation, which would achieve its sustainability.
6. The internal divisions of the Egyptian model are flexible and adapt to the needs of the user
7. The method is simple, inexpensive and environmentally compatible
8. The Egyptian model is in the form of a sphere in order to reduce the excess in internal energy loss.
9. The Egyptian model is asily change buildinge function without any cost or demolish by re-arranging layers.

Recommendations

Making industrial scale prototype for Egyptian patent number **2016-(27668)** in order to measure the following parameters:-

- Thermal comfort during day and night hours
- Thermal and acoustic insulation rate
- Different parameters change during different periods of the year
- Calculation of economical feasibility study
- Study the compatibilty of the new egyptian patent with the enviroment in the arab region
- Development of an Arabic code for unconventional building systems that support affordable housing
- Mention the required developments to make the egyptian patent suitable for different regions with different climate

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