

Analysis on design and performance of a solar rotary house

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Abstract. A solar rotary house is designed, composed of rotating main structure, fixed cylinder, rotating drive system, solar photovoltaic system and so on, to achieve 360° rotation. Thus it can change the dark and humid situation of the traditional fixed house shade. Its bearing capacity, driving force and safety are analyzed. Rotary driving force and living energy are provided by solar photovoltaic system on roofs and walls. The Phonetics, Ecotect simulation analysis conclude that the rotating house indoor has better natural ventilation effect, more uniform lighting, better the sunshine time compared with traditional houses, becoming a green, energy-saving, comfortable building model.

1. Introduction

For traditional housing, the longitudinal depth is extended, housing location is fixed, the sunshine time is relatively short, causing the cold winter and hot summer. Therefore a solar rotary house is designed. Now research on rotating house is few. In China, Genqiang LAN designed "a rotating house"^[1], and Qi Xiangchun designed "rotary solar ecological housing"^[2]. In foreign countries, Brazil design has 11 layers of rotation of the apartment building^[3]. Australia designed a sunny house^[4].

2. The Deidgn of a Solar Rotary House

2.1. Structure Design

The solar rotary house is composed of a rotating body structure (1), a fixed inner cylinder (2) and a fixed outer cylinder (3), a pair of thin cylindrical magnetic pole (4), foundation (5), the rotation drive system (6), solar photovoltaic panels (7) and the storage battery (8). The rotary drive system (6) is fixed in an inner cylinder (2) and an outer cylinder (3). Solar photovoltaic panels (7) are mounted on the rotary body structure (1) and a fixed outer cylinder (3). The rotary drive system (6) is composed of engines (15), gears (16) and hinges (17). Electric energy produced by solar photovoltaic panels is stored in the storage battery (8) to provide daily life power and motive power. The shape of floor layer of the rotating body structure (1) is a thin cylinder, whose periphery can be designed as the circular, eight polygon, sixteen polygon. The hinge (17) is fixed on each floor layer of rotating body structure (1). The main structure can be designed with steel structure, shear wall structure. The column (9) and beam (10) can be made of steel, steel and concrete composition of high strength and high performance material. The fixed inner cylinder (2) comprises a solid part and a concave part. The solid part is used as a stair walkway, and the hollow part is used as an elevator shaft and a pipeline well. The engine (15) is fixed on the outer wall of the fixed inner cylinder (2) or on the inner wall of the outer cylinder (3). The gear (16) is fixed on the engine (15). A rotary drive system (6) is installed at every 30°~ 60° between the body structure (1) and the inner cylinder (2) or between the body structure (1) and the



fixed outer cylinder (3). Figure 1 is a design sketch of a solar rotating house; Figure 2 is a rotary drive system; Figure 3 is a partial view of structure; Figure 4 is a top view of floor; Figure 5 is a pair of thin cylindrical electromagnetic poles; Figure 6 is a circular orbit (14) on the lower electrode (11); Figure 7 is a combination chart of circular orbit (14) and steel ball (15).

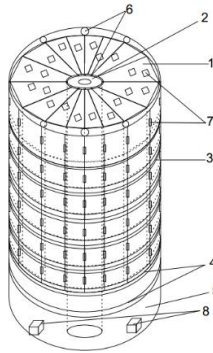


Fig.1 Design sketch of a solar rotating house

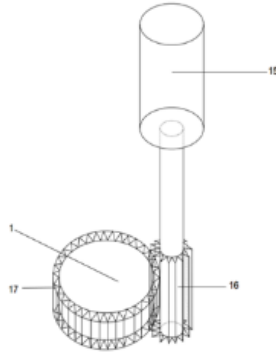


Fig.2 Rotary drive system (6)

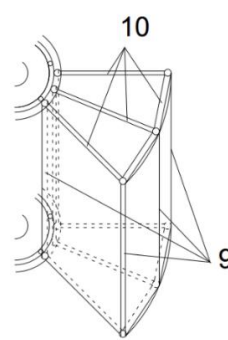


Fig.3 Partial view of structure (steel or steel concrete composite structure)

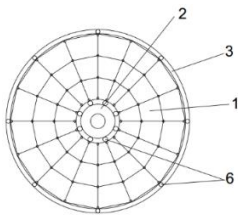


Fig.4 Top view of floor



Fig.5 A pair of thin cylindrical electromagnetic poles

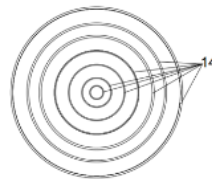


Fig.6 Circular orbit (14) on the lower electrode (11)

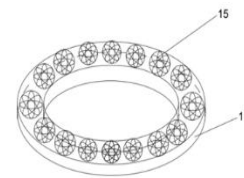


Fig.7 The combination chart of circular orbit (14) and steel ball (15)

This paper designs a rotary house, whose rotating part is sixteen edge shape. Its circumcircle radius is 12 m, including a 3m fixed part and a 9m rotatable part. The fixed part includes elevator wells, 1m tube well, and the rotatable part includes bedroom and other function rooms. The upper structure is located on a pair of thin cylindrical electromagnets with a radius of 12m and a thickness of 0.15m. The rotary actuator is composed of 32 gears, whose rotary power is provided by four 1000W motors. The solar photovoltaic panels on wall and roof are about 800 m^[5].

2.2. Workflow

When the housing needs to rotate, a rejection reaction controlled by the intelligent control system is formed by the lower electrode (11) and the upper electrode (12) of the thin cylindrical electromagnetic pole (4). The distance between the two electrodes is controlled by fastener (13). Then the intelligent control system of rotary drive system (6) drives the rotary drive system (6) to work. The engine (15) drives the gear (16) to rotate. The gear (16) drives the hinge (17) to rotate. Thus the rotating body structure (1) is driven to rotate. After a certain angle, the rotation can be stopped.

3. Key Technologies

3.1. Bearing Capacity of Rotation

The overall weight of the rotating housing about 6 floors is about 200 t. However, a pair of repulsive force formed by the magnetic induction of the electromagnet can be as high as 600t. Therefore, the separation between superstructure and substructure can be achieved^[6].

3.2. Driving Force of Rotation

The friction resistance is relatively small, due to the separation of the upper structure and the lower part of the building ^[7].

3.3. Safety of House

The upper construction is an outer clad steel beam and column composited structure. When a house is not rotating, its structure frame is tube structure; When it rotates, structure frame is the shear wall structure. In addition, a large number of vibration isolation dampers are installed on the structure, which can effectively reduce the damage caused by rotation. So rotating houses are safe and reliable.

3.4. Intelligent Control

The control system is used to realize the intelligent control of building rotation time, rotation angle, elevator and so on.

3.5. Energy Saving Measures

Solar photovoltaic panels are designed on the roof, walls, glass design for Low-E glass to make the housing zero energy consumption.

4. Analysis of Main Performance

4.1. Analysis of Natural Lighting and Sunshine

Natural lighting: By the ECOTECT natural lighting: simulation for the rotating housing and the traditional housing, the results are shown in figure 8. The lighting of the rotatable housing along the periphery is uniform, and lighting coefficient above 2% is more than 85% of the area. As for the traditional dormitory, the lighting only near north and south window is good, and the lighting near the east and west is poor.

Sunshine: For the traditional housing, the southern sunshine is long , and the northern is short. For the rotating housing, each function room can receive good sunshine, where is also the biggest advantage for rotating houses than traditional buildings. In addition, a uniform natural light and a longer period of time make the room more comfortable, beneficial to physical and mental health.

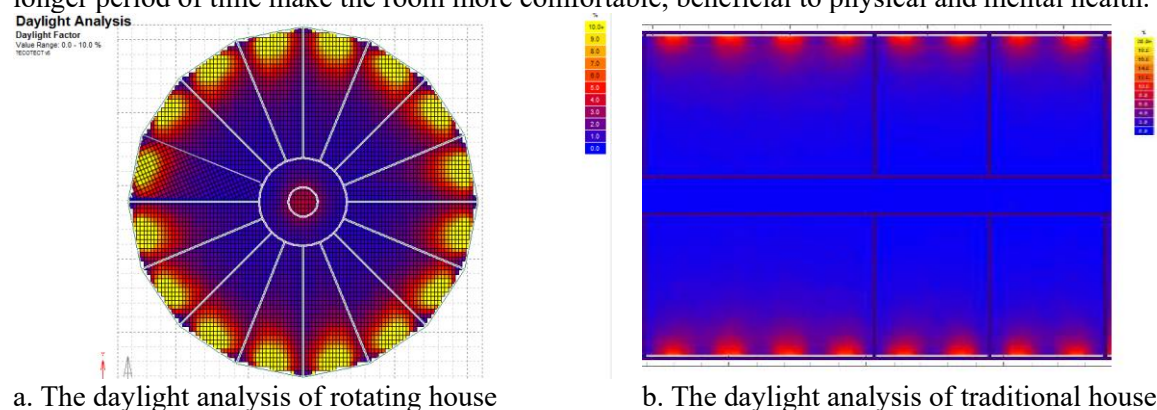
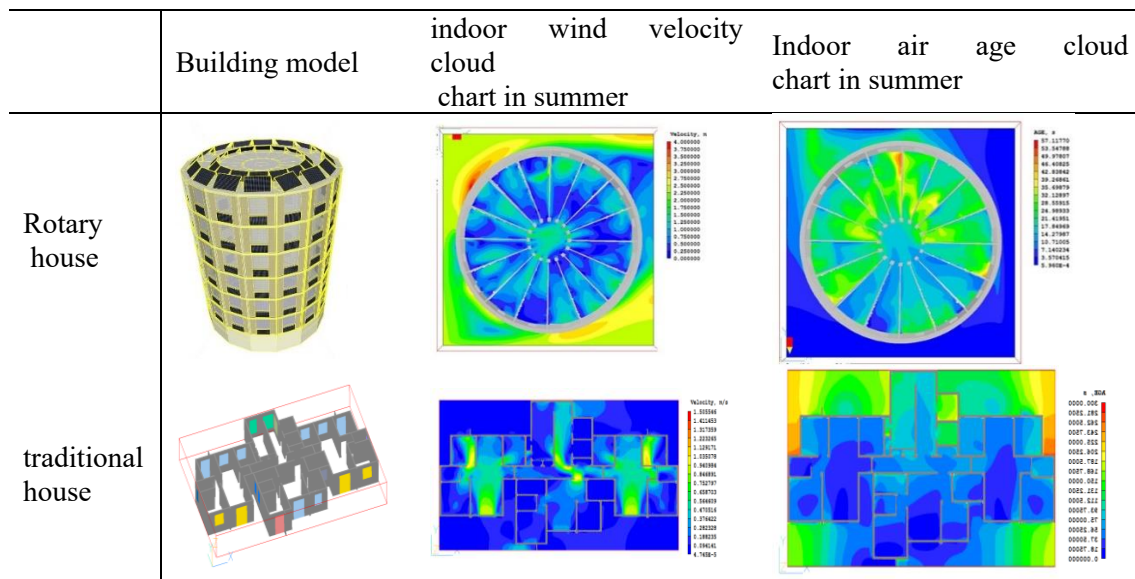


Fig.8 The comparative analysis of daylight

4.2. Analysis of Indoor Natural Ventilation

The PHOENICS simulation analysis of indoor natural ventilation is showed in figure 9. For rotary house, the speed of the main function room is basically controlled in the range of 0.5-2.5m/s, the air age is basically in the range of 50 to 100s, and the air pressure is even, and the airflow direction is smooth. For traditional house, the speed is not uniform, the air age is in the range of 200 to 1000s, and the air pressure is uneven, the direction of the wind is only north and south. Therefore, the indoor comfort for rotary house is better than it for traditional house.

**Fig.9** Analysis of natural ventilation in summer

4.3. Analysis of Energy Saving

Solar photovoltaic power has the advantages of safe, no noise, no pollution, convenient construction and so on. If the capacity of solar photovoltaic panels is 340 kWp, the total annual generating capacity is 340000 kWh. At the same time, it can save 113 tons of standard coal, greatly reducing emissions of CO₂, SO₂, dust.

5. Conclusions

The designed rotary house based on the solar energy is a green, energy saving, environmental protection, zero energy consumption, intelligent building, but also has the value of artistic appreciation.

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