

A Talk on Optimized Designing of Energy-saving Rural Housing

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Abstract: In recent years the annual rural housing built-up areas amount to 900,000,000, even to 1,000,000,000 sq.m.. However, in such great number of house buildings, the heating insulation and heating preservation are poor, which lead to serious energy-consumption. The consumption in Chinese rural housing is 3 ~ 5 times as much as that in the developed countries. In view of the serious waste of housing energy in Chinese rural area and in accordance with the rural resources and conditions, some plans on optimized energy-saving design of Chinese rural houses were explored based on the housing energy-saving factors.

Keywords: energy-saving; optimized designing; plan

0. INTRODUCTION

In recent years the annual rural housing built-up areas amount to 900,000,000, even to 1,000,000,000 sq.m.. However, in such great number of house buildings, the heating insulation and heating preservation are poor, which lead to serious energy-consumption. The consumption in Chinese rural housing is 3 ~ 5 times as much as that in the developed countries. so it's necessary and urgent to take effective measures to save energy in rural housing.

The optimization design of housing energy-saving lies in two aspects: heating insulation and heating preservation. Because of the hot summer and lack of heating facilities, building in south China need better designs in. Ventilation, heating insulation and heat shock prevention in summer. And those in the North need more designs in warmproof and preventing heat loss.

1. FACTORS ON HOUSING ENERGY CONSUMPTION

1.1 Solar radiation

Solar radiation is the energy source, how much energy we get from the sun depends on the change of day and night, because of the rotation of the earth, the change of seasons because of earth revolution and the latitude of our location.

1.2 Wind force

This factor include the direction and intensity of the wind. In actual design we should mainly consider whether there're high trees, buildings or hills around the house which may hold back the wind force.

1.3 The conduction of heat

This factor mainly include the thickness of walls and roof, building areas of the doors and windows, and the absorption and reflection of solar radiation and heat

conduction performance of the building material.

1.4 Afforestation

This factor mainly refers to tall trees around houses and the plant cover on the outer walls and roofs, which equally affects the absorption of solar radiation as well as the wind force obstruction.

1.5 Heating and cooling equipments

This refers to those various indoor equipments such as electric fans, ventilating fans, air conditioners to lower the temperature, and gas stoves, heated brick beds, heating walls and so on.

2. INQUIRY INTO THE OPTIMIZED DESIGNS

2.1 The location and orientation of houses

Because cold currents from Siberia and Mongolian Highland. Often invade our county in winter and strong solar radiation affects the hinterland in summer, Cold winter and hot summer is the feature of the climate in China. Generally in deciding the location and orientation of the houses we mainly take local topographic condition, sunshine time, the prevailing wind, direction throughout the year and the degree of solar radiation into consideration. Usually in North China the orientation of rural houses should avoid winter prevailing wind and prevent the cold air, while in the South, the rural houses need to face the prevailing wind in summer and increase the air circulation as well as avoiding the western exposure.

2.2 Design of energy-saving outer walls

This includes the designs of outer walls and roof. Among them, the energy-saving design of outer walls involves the optimized design of build coefficient and use of energy-saving building material.

The build coefficient, as a build-control quota in common use, refers to the ratio of the exterior area. Exposed in outdoor atmosphere and the volume enclosed by the buildings. The larger the exterior area

of the building, The larger the heat-dissipating area. So heat dissipation will increase with the build coefficient. There are several ways to control the build coefficient. 1) Choose appropriate plane shape according to the topographic condition(see Table 1); 2) Increase the number of floors can lower the building coefficient; 3) Place the building units side by side can also lower the building coefficient, for one building unit is added, one gable is left out and the exterior area is reduced.

Table 1 : Build coefficients of different shape

Parameter	Triangle	Square	1:2 Rectangle	Circle
Number of bottom sides	3	4	4	∞
Standard building area	0.77	1	0.89	1.27
volume	0.39	0.5	0.45	0.64
Build Coefficient	5.13	4	4.44	3.13

When it comes to the building material, 240mm or 360mm solid sticky brick walls were traditionally used in Chinese rural houses. Although less investment is involved, it will destroy severely the cultivated land and consume lots of coal. According to relevant data, on average, to make 100 million solid sticky bricks 150 acres farmland and 7,850 tons coal are needed. On the other hand, the sticky bricks used as the outer walls have lower thermal resistance compared with others (see Table 2). Usually hollow bricks or porous bricks can be used in those areas rich in clay, while in those places with convenient transportation facilities, 190mm or 240mm double-hole concrete bricks or 240mm triple-hole concrete bricks can be chosen.

Table2: Thermal Resistance of common used bricks

Type of walls	Thickness of walls (mm)	Thermal conductivity (w/m ² .k)	Thermal resistance (m ² .k/ w)
Solid clay brick	240	2.05	0.49
Hollow clay brick	240	1.50	0.67
Poroue clay brick	240	1.57	0.64
Single-row-hole concrete brick	190	2.14	0.467
Double-row-hole Concrete brick	190	1.309	0.764
Double-row-hole Concrete brick	240	2.44	0.641
Triple-row-hole Concrete brick	240	1.26	0.792

And the design of rural houses roof can adopt traditional slopping roofs. Together with tiles on the slopping roofs, this design is economic and convenient

for maintenance and has good heat insulation effect. If the flat roofs are adopted, we can increase the bearing and against-seep capacity of the house surface. At the same time, we can add plant layer for heat insulation to the roof. That means to grow plants on the roof which can shelter the roof from heat and absorb the heat energy for photosynthesis, transpiration and respiration. These plants change the solar radiation heat into bio-energy and useful air components.

2.3 Designs of energy-saving doors and windows

Doors and windows are the weakest parts in rural houses energy-saving design. The heating and refrigeration energy run off greatly from doors and windows. In order to prevent the energy running-off and increase the lighting of houses, the position and area of the doors and windows openings should be decided properly. Therefore, the very key point in optimized energy-saving design of rural houses lies in how to improve the heat insulation function of doors and windows.

The energy-saving design of doors and windows depends on such conditions as the latitude of the house, local sunshine rate in summer and winter, the lighting of rooms, and sunshine shelter among houses.

In North China, it's cold and windy in winter, large quantity of heat runs off from doors and windows, which makes 25%~30% of the total house heat loss. Another one is the ventilation capacity, which increases by raising the thermal conductivity and increasing the airtight property of doors and windows. Following measures can be taken: 1) Decrease the thermal conductivity and design doors and windows with proper size, position and shape. It's unnecessary to make large doors or windows if they can ensure enough lighting and convenience. They'd better face south, not north. It's desirable to use double-windows or double-glass windows with curtains, and doors with curtains which can reduce the loss of heat. And the material used for doors and windows can be wood for it has small thermal resistance. Plastic or rubber latex frame can also be used if possible. 2) Increase its airtight property. The heat lost through cracks of doors or windows makes up 40%~60% of the total heat loss. Usually, it is simple and practical to seal with paper the cracks around windows and doors.

In the South, summer solar radiation heat comes into the rooms through doors and windows. So the emphasis on saving energy lies in the proper utilization of doors and windows to decrease or take away the heat inside the house and provide cool air, it mainly involves making use of natural wind and setting up different kinds of sunshade equipment. For the former we may take the following measures: 1)Decide proper places and directions of windows to face local prevailing wind in summer and try to decrease or avoid the obstruction of air currents; 2)Properly set doors and windows to make convective wind, to guide the draught and form a short and straight wind passage. The sunshade equipment includes all kinds of indoor curtains and out-door equipment. The curtains can be made of cloth, bamboos or reeds. And the sunshade equipment can be asbestos board, light concrete, or reed mat, bamboo curtain, and mat shelter and so on.

2.4 Design of afforestation

If there're climbing plants such as Chinese ivy, Chinese trumpet creeper or Boston ivy on the east, south and west walls of the house, the heat on the walls can be reduced and the heat insulation function improved, in addition to the benefit of beautifying the environment and purifying the air.

Also we can plant trees around the houses, of which fruit trees and evergreen trees can be planted together. Fruit trees can shelter us from wind and rain, provide us with fruits. But leaves on most of them will fall in winter. It's more reasonable to put evergreen trees in them.

2.5 Indoor design and decoration

Try to arrange the bedrooms south, the kitchen, toilet and storeroom north, and connect sewer of the toilet with the methane tank.

What people use and touch mostly in the house are indoor decoration and furniture. So the indoor decoration should be energy-saving, natural, reasonable and humanizing. Unnecessary decoration can be removed to keep rational inner space, and color is of great use to our emotion, health and weariness removal. In order to improve the cosiness of rooms and reduce the load of equipment so as to save energy, the natural colors can be chosen. At the same time cosy inner environment can remove the isolation of indoor and outdoor spaces and meet the psychological needs of climate. Generally, to hang our favorite calligraphy and paintings on the wall will add our aesthetic feeling and remove the weary feeling.

2.6 Develop and utilize the methane

According to statistics the heat efficiency of rural heating equipment such as heating walls, heated kang only reach 15%~20%, the main fuels are still coal and firewood. When they are burnt, they let out oxide of sulphur and nitrogen which will do harm to human health and make the environment acid. And the dust and ash they discharge will affect the growth of agricultural plants and make the atmosphere staler. It's urgent in rural environmental and resources protection to devote major efforts to developing various energy and reducing woods lumbering and coal utilization. What's more, there is much domestic animals excrement in rural areas. The excrement of human and animals can be collected into methane tank for methane. So the energy can be put into full use and

fertilizer efficiently of manure can be improved. And the utilization of methane is cleaner and more convenient than that of coal or woods.

2.7 Exploit groundwater

If condition permits, try to use groundwater in daily life. Because groundwater gush out from underground, its temperature maintain at around 12~20 °C throughout the year, and there is no great difference in temperature between summer and winter while the atmosphere temperature change a lot, it's extremely hot in summer and bitter cold in winter. According to this feature, to draw groundwater can save much energy. What's more, the groundwater is cleaner than tap water and is rich in trace elements necessary for life.

3. CONCLUSION

In brief, how to save energy in building rural houses is a system engineering. It's meaningful to build energy-saving houses to reduce energy consumption and the great difference in solar radiation and natural condition, we should take measures suited to local condition and study closely the energy-saving designs, after expounding and proving the technology we can find the best energy-saving plan and build economic and comfortable energy-saving houses.

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