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Study on appropriate structural technology for energy-saving of housing in cold region

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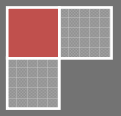
ABSTRACT

Residential construction and design in cold area should maintain a high level of adaptability with the climate features in that region, which can meet the people's practical needs to live. This article that effectively combines the sunlight characteristics researches on the requirements of location selection for building the house in the cold area, and explores design process and standpoint of residential layout. Through the study on above two aspects, the dwelling in the chill region can achieve the ultimate goal of effective energy-saving. In this dissertation, Beijing and Yantai city are taken as an example, through effective analysis of sunshine intensity and then establishing long range of the housing construction, it makes the paper more scientific and instructive. From the point of view of this essay, planning layout and residential space as the body of the cold primer residential energy-saving construction, rely on the powerful terrain conditions, combined with its climate characteristics and natural environment, to make it have positive effects on reducing the wind from heat loss of residential building, and hence to achieve the ultimate goal of this article research. This research thought is the main line studied in this paper, which makes the closeness of expounding the viewpoints enough to be fully guaranteed.

KEYWORDS

Cold region; Residential building; Adaptability; Energy-saving construction; Explore and research.



INTRODUCTION

The suitability of the residential construction is constantly improved, whose premise is that the climate characteristics in the region can be adapted to it. The fundamental purpose of residential building in cold area is to improve the time and intensity of sunlight receiving, and effectively study the shape of housing architecture and layout, fully considering that the architectural shadow will influence the loss of sunshine energy to make the climate features of the residential building in cold areas adapt to each other, so that to achieve the ultimate goal of energy-saving building. This paper mainly researches two aspects of the site selection requirements, planning layout and residential distance in dwelling district, which effectively expounds the key factors. This thesis hopes to be able to lay a solid foundation of theory and practice for continuing to study in the future work.

SITE SELECTION REQUIREMENTS IN DWELLING DISTRICT

In cold area, the location of residence community should be scientifically chosen according to the corresponding terrain and environment, which enables the housing to better avoid the direct air and large wind speed. In according to the characteristics of the terrain, it should effectively avoid lakes, beaches and the mountaintop which is relatively easy to form ducts. It is also more unfavorable to select the site in the hollows. However, the residential area should be chosen to build in sloping fields that faces south[1].

Site selection of residence

It can be learned from the above discussion that the construction of residential area should not choose to built in low-lying place. Because the cold air in cold area can form the frost effect in concave, while the cold air will be deposited in the low concave area. As long as the air is unable to form a huge flow, then the cold air will not flow in dips zone, which can keep time and make the surface temperature much lower. It is shown in Figure 1.

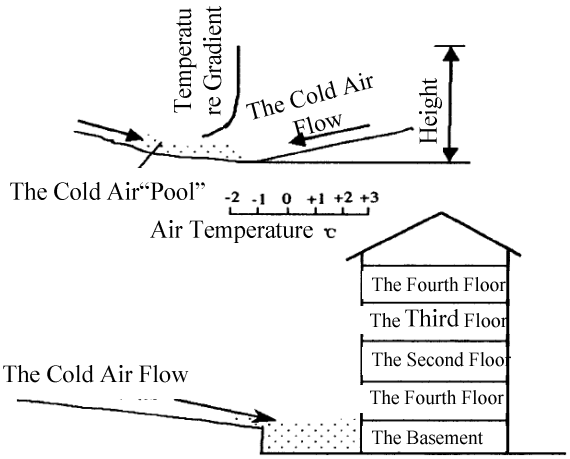


Figure 1 : Frost effect of buildings

However, it is the one reason that the indoor temperature of lower floor in the residential district is relatively low, while energy consumption will also continue to increase[2]. And houses built in low concave zone will be seriously affected by the rain erosion, and the dwelling established in the valley will be hit by torrential floods and mudslides. The blizzard was more severe in cold area, however, in case of heavy snow the houses may suffer from immersion.

As for the location selection of residential district, however, it is favorable to establish in the place around large green area. At the same time, it can be affected by the climate to make the indoor energy effectively reduced[3]. But for different building materials, it is also not the same to the reflection effect of energy, and it is proper to build in the place around the river(As shown in Figure 2).

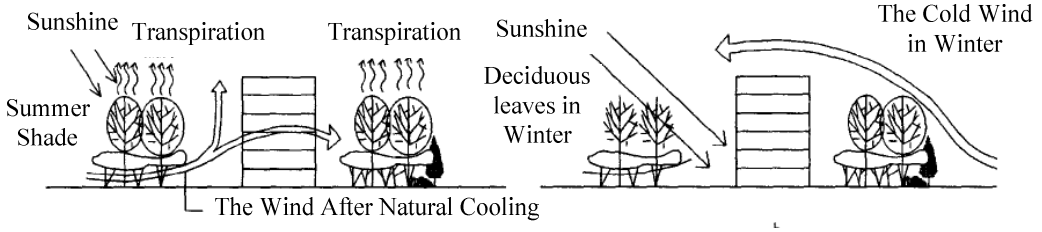


Figure 2 : The influence of tree species allocation to micro-climate

The size of green area to the urban allocation can have positive influence on effective absorption effect, and it also plays an positive role in controlling the city's air pollution, which makes the atmospheric transparency will gradually increase. It has an active impact on increasing the light intensity in the house. However, the heat capacity of water is relatively much larger than other substances, and the area of the water can correspondingly relieve the temperature change in the air(As shown in Figure 3).

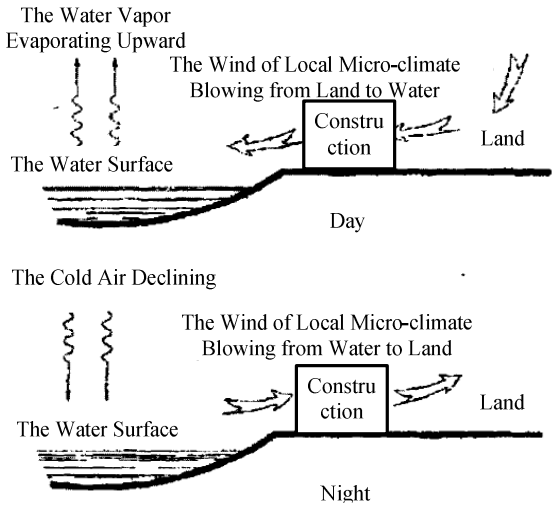


Figure 3 : The wind changes formed by large area of the water

Sunlight

Sunlight is irreplaceable for the survival of mankind, and is tightly connected to each people. What's more, people in cold region increasingly demand plenty of sunshine. For the interior space, how can achieve the longest time of light is the key to better keep the indoor temperature, thereby effectively guaranteeing the indoor energy-saving effect. It should be started from three aspects to achieve this purpose. The first one is effectively to design the building for the cold region. Secondly, it should place the sunshine time in an important position for the successful site selection. The last one is scientifically to grasp the space between buildings(As shown in Figure 4).

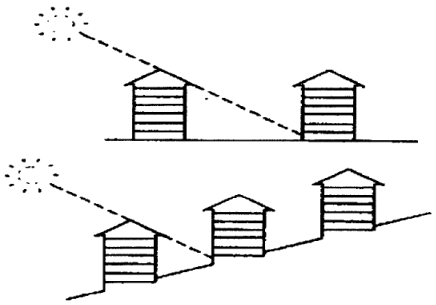


Figure 4 : South slope beneficial to heat in winter and increase volume rate

PLANNING LAYOUT AND SPACE BETWEEN HOUSES

Planning layout

In the process of community construction design, the rational layout should be as one of the primary purpose, so that it can get the sunshine between each building. Therefore, it seems particularly important to research the shadow organization effect of the building, which will be able to maximize its role. Through the reasonable layout for the building, it makes to form an ideal interface, thus the climate protection can be reflected, and the micro climate can be optimized, making the energy saving effect of the construction to the best. However, for the climate protection unit effectively established, the natural environmental factors should be fully considered, making the building function gradually strong.

Utilizing reasonable layout of residential buildings and striving for the good sunshine

The sunlight is the source of life for everything in the world, whose important meaning is self-evident. But in the cold areas the role of the sunshine is able to effectively keep the indoor temperature, and the long time exposure can make the indoor temperature rising, which can reach the effect of energy-saving. For the long time of sunlight, residential orientation should be fully reasonable, and the distance between the buildings should be scientifically measured. Here goes to the layout

design process of the building. For residential buildings, however, its shape design and direction will generate the corresponding architectural shadow, while for the high ring-fence area, the building itself has larger shadow area. So it should be paid attention to, when it comes to the regional planning of residential buildings on the north shadow, in order to strengthen the residential building able to better obtain the light time[4].

First of all, during the planning for a number of buildings, it should pay attention to the buildings that can form the dislocation. It can make more row of buildings get enough sunlight through dislocation gap(As shown in Figure 5).

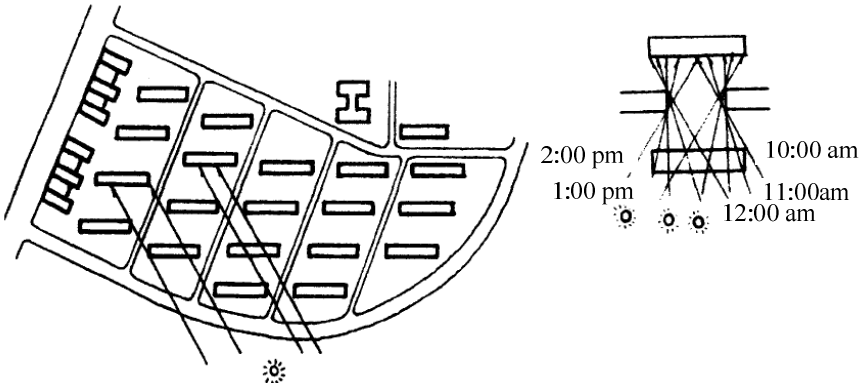


Figure 5 : Building dislocation arrangement to improve the level of sunshine

The second is to fully use of point-strip building design concept, making the residential location layout get better orientation, thereby enlarging the sunshine area as well as reducing the space between buildings(As shown in Figure 6).

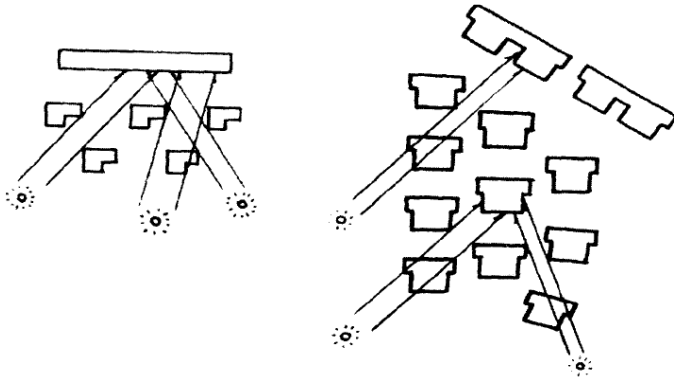


Figure 6 : Using point-strip residence to increase the sunshine effect and appropriately narrowing spacing

Selection of orientation range

Because the different housing orientation can have great influence to the sunshine, it is very important to reasonably choose residential housing orientation. However, compared with the orientation in north and south, the one in east and west consumes 20% more electricity for heating each year[5]. But the design scheme of the northern and southern orientation has become a theorem for residential design concept which is not unfounded, but has certain scientific basis.

By comparison to the vertical direction of sunlight from different orientation, it can be obviously found the overlapping position of housing orientation. According to the different urban geographical climate, the orientation range of residential construction also has a certain difference. Taking Beijing for example, the best position of Beijing residential orientation is south by east, and yet Yantai has some different thought from Beijing. As a result of the different geographical position, the best residential orientation of Yantai is 150 degrees from south by east to south by west. According to TABLE 1, it can be known the best residential orientation range in cold area.

TABLE 1 : Part of urban residential orientation table in cold area

Area	The Best Orientation	Appropriate Orientation	Inappropriate Orientation
Beijing	Within 30° South by East Within 30°South by West	Range in 45° South by East Range in 45° South by East	30°～60°North by West
Xi'an	Within 15° South by East	South、South by West	West、Northwest
Yantai	Within 15° South by East Within 15°South by West	Within 30° South by East Within 30°South by West	West、Northwest

Also taking Beijing as an example, it can be clearly seen the daily total radiation of the sun in Beijing through the Figure 7. The daily exposure from south in winter is more than 3 times than in summer. However, when the housing deflects, and the amount of the sun stays the same, then exposure received by the residence will gradually reduce. When summer comes, the exposure will continue to increase. However, when the deflection angle reaches 60 degrees, the exposure received by Beijing residence in summer will be much higher than that in winter. So for residential orientation, it will have the corresponding reaction for both winter and summer. In the process of residential energy-saving design for cold area, the deflection angle should be controlled at about 15 degrees, so the daily exposure can be reduced gradually, and that of sunlight in winter will continue to increase, which makes the indoor energy consumption reduced. Therefore, this orientation is the ideal[6].

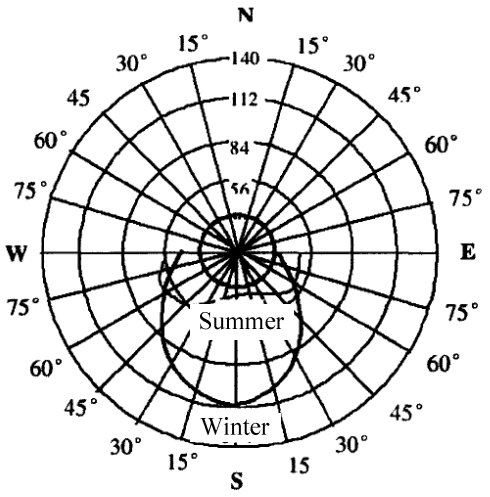


Figure 7 : Daily amount of solar radiation on the vertical surface in the beijing area

According to the calculation, the Beijing and Tianjin region between 40 days before and after the winter solstice, after considering the local sunshine duration, when the building to south is not obscured, the intensity of solar radiation through the window is 153 w/m. Compared to the heat consumption index of 20.5 ~ 20.6w/m from Beijing and Tianjin region, the number cannot be ignored. That is to say, if the heat consumption index of the buildings in this area would like to meet the standard requirements of energy-saving, as above mentioned that opens the window in the south, the heat provided by sunshine can enough maintain the indoor temperature. Of course, this is under the condition without heat loss. So when designing, it should adopt the reasonable orientation and make the sunlight uncovered.

Climate protection unit

Architectural layout has a positive effect on reducing the energy consumption of the residential interior in the city. In the process of architectural layout, it can make the cold wind speed effectively alleviate in cold region, and make the cold wind gradually transform the climate, which will have certain effect on the temperature inside the house, as well as effectively fusing the natural environmental characteristics and establishing the relative greening measures and eco-environment protection measures. Micro climate can be effectively transformed, and then gradually make the negative effects brought by the cold wind reduce to a minimum. Composition of climate protection unit is usually use of natural resources for effective protection, by a small group of natural resources forming the micro-climate, and by the radiation effects from the building surface to effectively reflect to the cold air, to make it form a powerful protective screening. Thus the energy can be maintained and the ultimate goal of reducing the resource consumption can be achieved.

Protection and utilization to the wind

Through the reasonable design for the building layout, it can make the wind speed slow down gradually in the cold season, and also make the temperature of residential surface effectively maintained, so it can better control the heat loss of residential internal and lower the indoor energy consumption, to achieve the goal of energy saving. And for the purpose of saving the heat energy, when planning the distance between buildings, it usually takes 1:2 ratio between, so it can make the buildings lessen the invasion from the cold wind, and make the cold wind speed effectively alleviated. However, For the low-rise buildings, it should effectively design the windbreak which can achieve through planting of trees, so that it can keep out the wind and reduce the cold wind speed(As shown in Figure 8).

Buildings in winter is invaded by the cold air mainly through the crack of the doors and windows and the ventilation hole. These air flow is caused by the wind power and the heating power (chimney effect) that is generated by indoor and outdoor temperature. In order to improve the indoor air quality and keep the indoor air fresh, during the winter season, buildings should be set the necessary air passage for the natural ventilation. Setting the horizontal or vertical air vent will inevitably bring the heat loss, and both are contradicted with each other. When designing, it should select the appropriate

location to set the air passage according to the local wind environment, the building site and shape, and determine the section size and form of the air vent. The interaction between the Low-rise Building and the High-rise Building is shown as Figure 9.

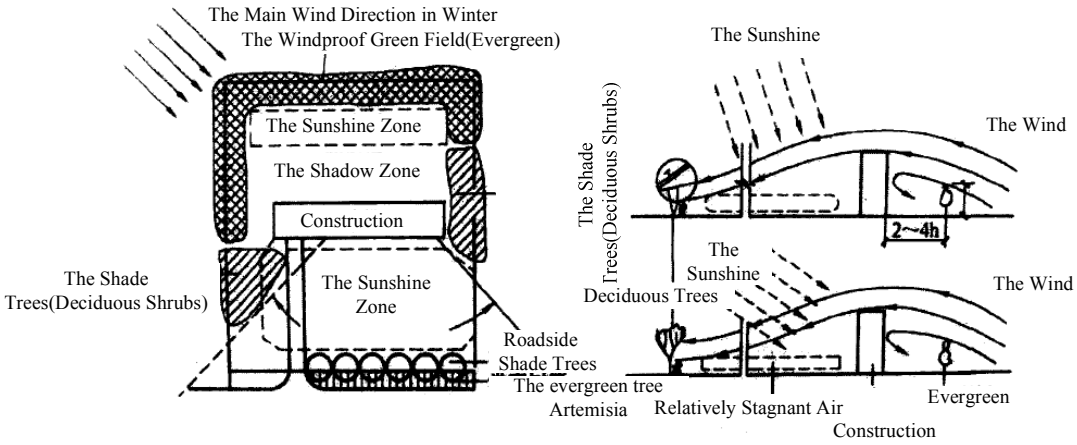


Figure 8 : Windbreak

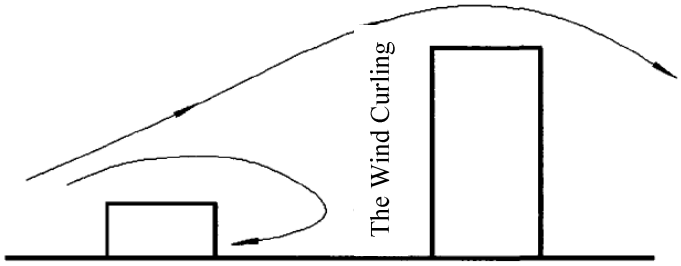


Figure 9 : Interaction between the low-rise building and the high-rise building

The larger swirl flow is usually called a whirlwind, which makes the itself-existence pressure of the cold wind continuously increase and makes the heat energy from the building surface gradually loss, affecting the indoor temperature. Suppose there was a low-rise building in front of a high-rise building, and there was a spacious channel from the tall building to the low one, and the wind speed is more three times than the normal speed in the passage. But air wind speed in the corner of the high building would be extended to 2.5 times. The residential heat will increasingly loss and the consumption of thermal energy will improve. So this phenomenon should be avoided in the process of residential building design(As shown in Figure 10).

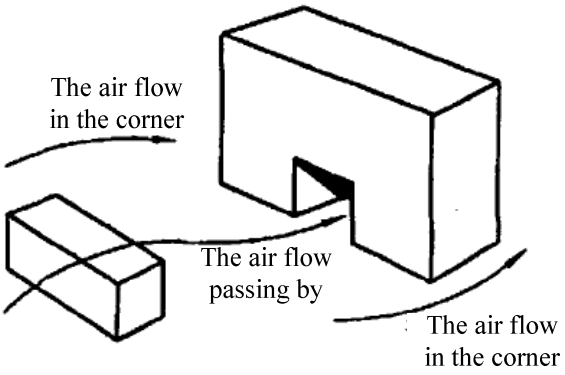


Figure 10 : The wind tunnel

The three-dimension size of single building has great influence in the surrounding wind environment. From energy-saving point of view, it should create the favorable building forms to reduce wind flow and wind pressure, and lessen the heat loss. The longer and higher the building, the smaller the width. The vortex area in the leeward is bigger, and the flow field is more disordered. Reducing the wind speed is good for the wind pressure. Taking avoiding the invasion from the winter

monsoon to construction into consideration, it should decrease the incident angle of the wind direction and the building length.

Space between buildings

The front and back of the main residential orientation which is generally in the south or to the south should have a certain distance with other buildings. And the distance is usually determined by the building sunshine, so called architectural sunshine spacing as shown in Figure 11.

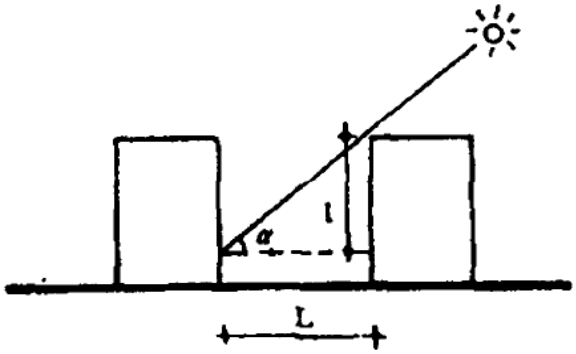


Figure 11 : The sunshine spacing sketch

It is quite important for residential design to determine the minimum distance between buildings, thus ensuring a certain amount of sunshine indoor. Because residential buildings are developed and established in high density, it will easily cause the sunshine shaded due to insufficient spacing between buildings. Therefore, the sunshine spacing standards has been determined for each region according to its own geographical latitude, sunlight hygiene standards and the urban environment conditions. Taking the Yantai city for example, the sunshine in the severe cold day should not less than 2 h according to hygiene standards, so the sunshine spacing is 1.55 times of the building height. In the specific design, it shall refer to the sunshine spacing coefficient determined by all cities to make the planning.

CONCLUSION

As mentioned above is to research the residential suitability of energy-saving technology in cold area, effectively analyze the objective factors affecting the residential building in the region, at the same time, also study the various aspects that should pay attention to in layout and residential spacing. Through the actual example, discuss the scientific residential construction, making this paper effectively guarantee the research value.

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