Research on the Implementation of Technological Measures for Controlling Indoor Environmental Quality in Green Residential Buildings

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Abstract. This paper analyzes the design technology of controlling indoor quality in engineering practice, it is proposed that, in framework system of green residential building design, how to realize the design idea of controlling the indoor environment quality, and the design technology with feasibility, including the sunshine and lighting, indoor air quality and thermal environment, sound insulation and noise reduction measures, etc. The results of all will provide a good theoretical supportting for the design of green residential building.

1. Introduction
The green building stresses the quality of the indoor environment, because the mainstream of air-conditioning industry is to strive for a balance between the internal and external environment, for the internal environment, that is different needs for health, comfort, and building the production efficiency[1]. The development of moden economy and the progress of science and technology has made human to use mechanical air conditioning to improve the living and working environment, it is lucky of human, but with the increasing of requirements for our residential quality, the requirements of indoor environment is gradually improved, this kind of high energy consumption building, which is against the natural climate environment, makes us pay a great deal of economic and energy cost, at the same time, and which results in great extent increasing of the pollution of ecological environment[2], also to a great extent, the habitant and the nature are separated as so. In order to overcome the negative impact of the current architectural model on human beings, the green buildings focus on the relationship between natural environment and architecture, and the design of considering local climate has been as a basic method of the green building, which is a systematic way according to human comfort requirements and climatic conditions for architectural design, that is according to the local climate characteristics, using the principle of building physics, rational organization of various construction factors, the natural lighting and energy-saving lamps are applied in the design; to give priority to the use of natural means to coordinate the indoor air quality and requirements of controlling thermal environment, by mechanical means on the part of space in the part time assistant adjusting, in order to meet local demand; to take insulation, noise reduction measures and so on, all of above have become the dominant idea of green residential design[3].

2. The technological measures with realizability
In the design of the green residential building, in order to control the indoor environment quality, so as to achieve the evaluation criteria of green residential building, the following aspects should be considered.
2.1. Sunshine and lighting
In the survival and development of human beings, the sun is an important survival factor indispensable as air and water. Natural light is inexhaustible energy, which should be effectively used. If the natural light come into a space, the electric light source can only be a supplementary light source, as the illumination at particular point, to balance the brightness. The residential light environment focuses on the intensity to meet the requirements of sunlight, the natural light should be used as much as possible indoor.

In the residentail building, it has a major role and practical significance to make full use of light, not only its economic significance, but also in people accustomed to natural light, whose physiological health value is very high. At the same time, the natural light has a strong impact on people's psychological state. How to make full use of and reasonably develop natural light resources in residential buildings, is closely related to indoor lighting, daylight, the construction of the window size, and lighting materials, etc.. In China the region is vast, especially in the northeast, with abundant natural light resources, it is the important need to be solved to well use of these resources and natural lighting, improve light environmental quality of residential[4].

With different indoor light environment, it will be directly affected that the work efficiency and the indoor atmosphere. In the green building, the introduction of no pollution, good color sunlight as the light source is a part of the green light environment. Comfortable and healthy light environment should also include easy to watch, safe and beautiful brightness distribution, to control glare and uniform illumination, therefore, the light strength should be adjusted according to different time, location, so as not to affect the sunshine quality. Besides, the attention should be paid to the living area to prevent light pollution, such as light advertising, glass curtain wall and so on.

2.2. The air quality
The air quality reflects the degree to meet the environmental requirements for people. The usual factors that affect air quality include air flow, air cleanliness and so on. If the air flow is not enough, people will feel uncomfortable, if too fast will affect the temperature and cleanliness[4]. Therefore it should be done that the adjustment the amount of new wind by different environment, controlling of air cleanliness and speed of air flow in order to make the air quality to reach the optimum state. At the same time, one of the main ways to improve indoor environment is to control effectively the air pollutants indoor. In the view of green building, it is not only to make the concentration of pollutants air below the recognized concentration of harmful indicators, and but also to make the vast majority of people to satisfy the indicators of air quality indoor.

In the green residential building, the indoor air environment should meet the natural ventilation of room, to ensure the fresh air and prevent indoor moisture and mold breeding[5]. According to "health residential" ecological standards of developed countries, such as European and American, the living room, kitchen, bathroom, corridor, annual temperature should be maintained at 17°C~27°C year-round, and humidity maintained at between 40%~70%, the concentration of carbon dioxide is less than 1000×10⁻⁶, the concentration of suspended dust is less than 0.15mg/m³. In China, according to the specifications of different departments, the design standards of indoor air quality is: the air health standard value of formaldehyde indoor should be less than 0.08mg/m³, in new housing the balance equivalent radon concentration of annual average should be lower than 100Bq/m³, the maximum allowable concentration of sulfur dioxide in indoor air should be lower than 0.15mg/m³, the nitrogen oxide is less than that of 0.15mg/m³. In order to achieve a good indoor air quality standards, the sun should be introduced into the indoor to sterilization and anti mildew, the environmentally friendly decoration materials should be applied, and as far as possible the use of natural ventilation to regulate indoor air quality.

Natural ventilation is the use of natural energy sources or do not rely on air conditioning system, a suitable indoor environmental quality can be still maintained. The natural ventilation should be full used to provide fresh air, eliminate air pollution indoor, improve indoor environment, adjust the air temperature and humidity indoor, in order to ensure the psychological needs of connection with people
and nature[6]. Natural ventilation is the most easy to meet the requirements of green building, because it generally does not need any non renewable resources, and often can save a considerable amount of air conditioning load throughout achieving the purpose of energy saving and environmental protection all year. But to make full use of natural ventilation must consider the facing direction, spacing and layout of buildings. For example: the south direction is the most sun radiation direction in winter and decreasing in summer, and in most area of China in summer the dominant wind direction is the southeast, so from the view of improving thermal environment of room with natural ventilation in summer and reducing heating and air conditioning load of the room in winter, the building facing south is the best choice.

All of above, for the green house, in order to realize the indoor air quality standards, in design attention should be paid to as follows: to fully consider the relationship between local wind direction and building orientation, and make full use of the architecture crowd, geographical space, hot press, and so on, to realize natural ventilation, through the cultivation of large trees or the flow of water to filter the air, to avoid the impact between buildings or exhaust system between layers, the bathroom should be set with ventilation equipment; the kitchen should be centralized smoke discharge system, in the room with the large flow of people and the high use frequency, it should be also installed air purification equipment; the decoration material indoor should be paid attention to health and environmental protection, to reduce the air pollution of the material.

2.3 Thermal environment
The thermal environment is reflected in the characteristics of the indoor temperature. Thermal system of residential area should meet the requirements of the residents of the heating and comfort, energy saving and environmental protection, especially in the northeast, the indoor thermal environment in winter significantly affects the working efficiency and occupant comfort[7]. In winter the heating room temperature should be 20℃~24℃, in summer for the room with air conditioning system the suitable temperature is 22℃~27℃. The traditional conditioning system can maintain the indoor temperature, but recent research shows that, the room reaching absolutely comfortable easily leads to air conditioning disease problems, and with consume of a lot of energy, and increasing the destruction of Freon for the ozone layer. The green building requires to use of natural resources as well as, energy saving and environmental protection, therefore, the following aspects should be considered to improve the thermal environment:

- To build a good indoor thermal environment in a single building space.
- To avoid the use of glass in great area, because the greenhouse effect may occur in summer, and low temperature radiation effect from the cold glass surface in winter. Therefore, to analyze influence of the local climate and the change of load in building for indoor environment comfort.
- To strengthen the heat insulation performance of building envelope, adjust the construction, reduce the heat transfer coefficient; improve thermal environment conditions of public region, add the heating system in stairwell if possible, keep intact of windows and the door shut down at any time, greatly reduce the heat load.
- The use of solar energy, geothermal energy and others to solve the problem of heating and cooling. In the case of mature technology, to consider air conditioning system through solar and ground source heat pump system to improve the thermal environment, at the same time to achieve energy saving and environmental protection.

2.4 Sound insulation, noise reduction measures
The key of the sound environment system is to control the noise, which can be divided into indoor noise and outdoor noise according to the space. When the indoor noise is more than 60dB, it will make people feel restless. According to the requirements of "Green Ecological Residential Quarter Construction And Technical Guidelines" of China, the green residential should meet the daytime noise less than 35dB, night noise is less than 30dB. The control system of sound environment in the
residential area includes noise isolation measures of outdoor, indoor and outside the area. When the plane is designed to set the bedroom back to the direction of the noise source, which can reduce the noise of about 30dB, the soundproof window can significantly prevent the outdoor noise, for the noise of public facilities, equipment of area, it should try to be increased that the distance of the noise source and the point of receiving sound, and it also has some effect on noise reduction to plant the appropriate green plants, set water along roads of residential region.

3. Analysis of Engineering Practice
Taking two practical projects as an example, "Shanghai Vanke Langrun Park" and "Shanghai Green Exchange International Plaza Office Building", analysis of technical measures to control the quality of the indoor environment are adopted in the design, these measures have achieved good results in practical application, can be used in the design in the future.

3.1 Shanghai Vanke Langrun Park
Sunshine and lighting: in architectural planning and design stage of Vanke Langrun in accordance with the "City Residential District Planning and Design Standards" and "Architectural Lighting Design Standards" requirements, through detailed calculation and research, the buildings of the two practices can meet the requirements of sunshine time, the space of buildings, lighting standard coefficient of room for occupants activity.

Self-balanced ventilation system: in the Langrunyuan project, one united equipment is set per household, one exhaust port is separately set in each the kitchen and bathroom, each living room, bedroom and other room is provided with a plurality of air tank, which makes indoor space more than 90% to achieve natural ventilation; indoor air quality has reached the condition, that is energy consumption of the second class equipment is lower, such as energy consumption of large wind volume operation (375m³/h) is 70W, small wind volume (160m³/h) is 30W.

Swing check against the wind: for every household owners, they have been installed that the swing type check, through the logical combination of the flue, flue body, Venturi plate, guide bending, check valve with reasonable interpretation of air dynamics, it is combined with a practical flue products, which will solve the trouble caused by smoke gas intrusion and odor flue of the household.

The design of sound insulation: the door with double seal steel soundproof is applied, whose sound insulation performance is up to 30dB, Aluminum Alloy insulation doors and windows with good thermal insulation effect, sound insulation reaches 30dB, the green belt outlying residential areas planted with high density, low Joe, shrub (Figure 1), can effective absorb, cover and control noise, the elevator is without machine room. To take underground garage, which reduces vehicle noise, air conditioner equipped with damping device and other measures.

![Figure 1: The green belt surrounding area to effective control and absorb the noise](image)

3.2 Shanghai Green Exchange International Plaza Office Building
The air conditioning terminal system with displacement ventilation and radiant plane-the bionic air conditioning. In winter, the low temperature hot water in the capillary can radiate the heat to the room, the cold water in the capillary is higher in the summer, and the radiant cooling to the room is soft. Because of the large heat transfer area and the heat transfer rate, the heat transfer efficiency is higher, and the capillary is arranged under the ceiling and the wall surface (1 meters below the ceiling) according to the characteristics of the building. The biggest advantage of radiant heat transfer is: there is no sense of air in the room, no air flow noise, creating a healthy indoor environment.
The design of wind environment indoor: through the simulation analysis, to select the direction of 1.5m height, the wind speed near the window is slightly higher than about 1.8m/s, the average wind speed in other parts of the region is about 0.6m/s. The office building corridor area is region collecting air, wind speed slightly higher about 0.9m/s. In the transition season to use natural ventilation office building can satisfy the requirements that indoor natural ventilation flow field and velocity field is more uniform, and the need to set the windows at the middle position of the office in the north and south to in order is to achieve the regional natural ventilation.

The design of light environment indoor: through simulation analysis by professional software, a quasi main room office building can basically meet the minimum specifications of the daylight factor, but the uniformity of natural lighting indoor for most office of 3 to 19 layers, is less than the standard value of 0.7. So the recommendation is: (a) due to a larger net space in the office at east and west sides, it is recommended to set up the lighting board to light, in order to adjust the lighting uniformity indoor; (b) in the rooms needed air-condition, it is best to use adjustable external shading, not only shading energy saving, but also trying to meet the needs of lighting.

The real-time monitoring and warning system-the monitor and stethoscope of building: a machine with touch screen and inquiry, the LCD touch mode is taken, it can check all energy consumption information of the building, with rolling display real-time energy consumption information of building, and broadcasting the corresponding equipment control.

The light guide tube-a light guided into the ground (Figure 2): in the project, the six light guide tubes with 1200mm diameter is applied in the underground garage, the transmission coefficient of the optical collector material is greater than 0.89, the reflection coefficient of the light guide tube wall reflective material should be greater than 0.96, the transmission coefficient of exit light of diffuser material should be greater than 0.88, which can meet lighting standard 75LX of the underground garage, the savings of electric lighting is 3756 degrees annual.

![Figure 2: The set diagram of light guide tube and introduction of natural light in underground garage](image)

4. Conclusions
It can be seen from the above analysis, the natural lighting and energy-saving lamps should be attach importance to in the design; the use of natural means should be given priority to coordinate the indoor air quality and thermal environment control requirements, by mechanical means for the part of space in the part time to assist adjusting; to meet partial demand, to take measures of noise reduction and sound insulation, and so on; under the circumstances, the indoor air quality monitoring device should be set up, which will become the dominant idea of controlling indoor environmental quality.

In fact, from the view of green building design, nature is the main supply, and auxiliary equipment system belongs to the second. So most of the lighting can be provided by sunlight, the air flow generated by the cooling and heating can be obtained from the human body and office equipment, supplemented by other means. The design considering features of the local natural environment, is a method that can be used in any technical level, because of various factors, included in the natural environment of the green building can be considered as a resource, to make full use of natural resources, is the design nature to consider local natural characteristics. If to combine the principle and the future of intelligent technology with information technology, control technology and other energy saving technology, it will form a rich and colorful prospect of green building.
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