

Green and Low Carbon Design Strategies in Senior Living Buildings

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Abstract: As a group of buildings with both residential and public characteristics, senior citizen buildings provide space for the daily care and nursing functions of the elderly. In order to optimize the design effect of elderly buildings, the green and low-carbon design strategy of elderly buildings is proposed. Firstly, the concept of senior buildings is analyzed and compared with other building types, pointing out that senior buildings have various characteristics such as humanity, publicity and care. The meaning of green senior buildings is also analyzed, and it is proposed that senior buildings follow contemporary green building design concepts, combine regional characteristics, and produce characteristic building clusters under energy-saving technologies. Then the significance of carrying out green senior buildings is analyzed from the social level and low carbon level respectively. Finally, specific architectural design strategies are proposed, including optimizing the spatial layout of the building, deepening the application scenarios of green technologies, and rationally utilizing water resources, aiming to promote the transformation and upgrading of the construction industry and improve the quality of life of the elderly.

Keywords: elderly buildings; green and low carbon; building design; building structure

1. Introduction

Elderly buildings are buildings that provide care, medical care and nursing care for the elderly and meet their physiological and psychological needs, and consist of nursing homes, homes for the elderly, and nursing homes, which are the core elements of the elderly building system. Unlike senior citizen apartments or senior citizen residences with residential attributes and senior citizen communities with public attributes, senior citizen buildings need to consider both residential and public attributes in a unified manner. In terms of functional distribution, it provides comfortable space for living, open recreational space for the elderly, and functional space for daily care and medical checkups for the elderly. Compared with general buildings, the users of elderly buildings have special physiological and psychological needs, and their planning, design and construction have strict norms and standards. In recent years, China has issued a series of norms and standards for the design of buildings for the elderly, which play an important role in guiding the design of buildings for the elderly and solving the problem of the elderly. Currently, the separation of senior buildings from urban space and the disconnection from urban social life have increased the sense of loss and loneliness of the elderly. Secondly, senior care buildings are unable to meet the multifunctional service needs of the urban elderly^[1]. In addition to physiological needs, safety needs and sense of belonging needs, the urban elderly also have a higher level of social identity needs. Lastly, the design standard for senior buildings lacks specific requirements for the application of green technology. China's building energy consumption accounts for a large proportion of the total energy consumption of society, especially the urbanization process has brought great pressure on urban resources and the environment^[2]. Green building advocates minimizing environmental damage and saving resources during the whole life cycle of the building, focusing on the comfort of the living environment, the health of the living space and the efficiency of operation and management. Utilizing the advantages of green building in terms of health, safety and efficiency, and applying green building concepts to the design of urban elderly buildings can help improve the health and living environment of the elderly, promote the sustainable development of the urban ecological environment, and enhance the quality of life of the elderly in urban areas^[3].

2. Conceptual analysis

2.1 Concept of senior citizen building

Elderly building refers to the buildings that provide special or comprehensive services for the elderly in the areas of housing, life care, medical care, culture and recreation in accordance with the physical and mental requirements of the elderly, specifically including elderly housing in units of sets, elderly apartments in units of buildings, as well as old people's homes, nursing homes, elderly day-care centers, elderly service centers, and so on, which provide elderly services^[4].

In order to make the research in this paper more detailed and relevant, the object of the study is further defined here. This paper argues that The definition of a building for the elderly should be one that is adapted to the physiological and psychological characteristics of the elderly and is equipped with appropriate medical and other auxiliary facilities. A specialized residential community for the elderly to reside and inhabit as the main demographic. It can be as small as a single apartment for the elderly that serves a whole residential area. It can also be as large as an entire specialized senior living area. Depending on the depth of medical care provided, self-care, assisted living, and nursing care are provided^[5]. The elderly service areas are required to meet the living requirements of the elderly at all stages of their lives. The differences between buildings for the elderly and other buildings are shown in the table below.

Table 1: Differences between retirement buildings and other buildings

	residential building	Medical buildings	Elderly Buildings
Functionality	Residential	Medical	Residence + Life Care + Medical Care
Space Layout	Occupant's movement	Patient's movement line for medical treatment + doctor's service	Daily activities of the elderly + work flow and efficiency of the service and nursing personnel (Elderly buildings with a high level of care are similar to medical buildings)
Spatial Needs	Comfort of living	Safety of space hygiene	Safety of space + comfort requirements of physical and psychological environment

2.2 Meaning of green senior living buildings

For the purpose of this paper, 'green building for the elderly' refers to a building design that adheres to contemporary green building design concepts, incorporates regional characteristics, and utilizes energy-saving measures and technologies. The goal of this design is to reduce the energy consumption of buildings for the elderly during use by applying green design concepts in a rational manner. This building design technology aims to lower energy costs without compromising user comfort^[6].

Green senior citizen building means applying appropriate building design methods, energy-saving measures and convenient energy-saving means to senior citizen settlements at the early stage of design, moderately reducing major energy use (reducing energy use to an uncomfortable level is not conducive to sustainable development), adopting comfortable, low-energy-consumption technologies that do not reduce the quality of life of the occupants, and optimizing the structure of the building^[7]. For example, the use of air-conditioning can be replaced by other design methods, and natural ventilation can be fully utilized to achieve a cooling effect. The energy requirements for the use of senior housing include lighting, water, ventilation, air conditioning and heating, as well as power for food services, laundry, vertical transportation and other equipment. The energy consumption of buildings for the elderly will vary considerably depending on the climatic characteristics of the location and the level of care that matches the costs and financial outlays of the occupants and operators. Therefore, the green design of buildings for the elderly in a given geographic area and for different types of occupancy will present a wide variety of contrasting strategies and measures^[8].

3. The significance of green senior building

The practice of green and low-carbon thinking in senior buildings helps to improve the quality of

life of the elderly. As they grow older, the physical functions of the elderly gradually decline, and their requirements for the living environment are more stringent. Green and low-carbon senior buildings can provide them with a comfortable, healthy and safe living environment^[9]. For example, by adopting design techniques such as natural ventilation and lighting, it reduces the building's reliance on artificial energy, lowers indoor air pollution, and creates a pleasant living space for the elderly. In addition, the introduction of green vegetation not only beautifies the environment, but also serves to purify the air and reduce noise, creating a peaceful place for the elderly to relax. In addition, traditional buildings for the elderly often ignore the impact of environmental factors, leading to waste of resources and environmental pollution. Green and low-carbon buildings for the elderly, on the other hand, reduce energy consumption and carbon emissions through the use of energy-saving technologies and renewable energy sources, and realize the rational use of resources. This not only helps to alleviate the energy crisis, but can also contribute to the sustainable development of society^[10].

The architectural style of a city is a reflection of its cultural connotation and taste. As an important part of the city's architecture, green and low-carbon buildings for the elderly, with their unique design and environmental protection concepts, can enhance the overall image of the city. At the same time, it can also attract more elderly people to choose to spend their twilight years here, which can further promote the city's population concentration and economic development. In addition, the practice of green low-carbon ideas in senior buildings also has a demonstration effect. By applying green and low-carbon ideas and technologies in actual projects, it can provide reference for other types of buildings. This helps to promote the transformation and upgrading of the entire construction industry and the popularization and application of green building technologies^[11].

4. Green and Low Carbon Design Strategies in Senior Living Buildings

4.1 Architectural space layout

He rational layout of building space and the improvement of space utilization efficiency are important design strategies for improving land utilization^[12]. In addition, considering that the natural environment of different regions has unique regional characteristics, the planning and design of elderly institutions should maintain and utilize the original topography and water system as much as possible, and take effective measures to reduce the negative impact on the ecological environment caused by development^[13]. Elderly people's physiological functions degenerate, outdoor activities and exercises help the elderly to be strong and healthy; As people reach old age, their psychological needs for social recognition and interaction increase. Simultaneously, the elderly enjoy resting in sunny places. Therefore, in the face of the contradiction between the high land use index of the elderly institutions and the land saving requirements of green buildings, the design of the elderly institutions should make full use of the limited space to create as much outdoor activity space for the elderly as possible^[14]. When the site area is restricted, more outdoor activity space can be created by utilizing overhead floors, roof platforms, retreats, etc. in combination with the site conditions in order to reduce the waste of land resources. Specific outdoor space creation strategies are shown in the table 2 below.

Table 2: Outdoor Space Creation Strategies for Senior Living Buildings

Outdoor activity space creation	Characteristics	Specific Strategies
Ground floor elevation	The elevated ground floor space increases the outdoor activity space for the elderly on the ground floor and reduces the building's massing.	Transition between indoors and outdoors is realized by elevating the ground floor, and the space on the ground floor is reduced to zero.
Rooftop activity platform	This approach can also realize the zoning of activity space for special types of elderly (e.g., mentally retarded, disabled elderly).	Utilizing the roofs of multi-story buildings or high-rise podiums to create activity spaces for the elderly.
Step back from the ground floor	The technique of retreating from the terrace not only saves land, but also enriches the form of the building and creates a landscape terrace and other activity places.	The design of the retreat should be combined with the requirements of the technical regulations of urban planning and management, so as to maximize the use of the site. The design of the retreat should be combined with the requirements of the technical regulations of urban planning and management, so as to maximize the use of the site.

In addition, the rational design of the building interface can enable the outdoor green environment

of the elderly institutions to penetrate into the interior. The introduction of the external natural environment can enhance the elderly's perception of the natural environment through the dialog between the inside and outside of the building, and help the elderly relax and regain their love of life and interest in their surroundings. A large number of studies have shown that the natural landscape outside the window of the elderly living room can make the elderly feel happy, trigger beautiful associations, and is also very good for health. Therefore, in the architectural design of elderly institutions, the direction, size and material of the windows of the main rooms for the elderly should be reasonably designed to form a green landscape with visual aesthetics^[15].

4.2 Deepen the application of green technology

Under the background of active aging, the creation of aging-adapted architectural space, in addition to meeting the basic living needs of the urban elderly, maximizes the maintenance of self-care and self-reliance living habits of the elderly. Applying green building concepts to the design of ageing-adapted building space can give full play to the great advantages of green building technology in saving resources, protecting the environment and reducing pollution, and can more actively adapt to the special physiological and psychological needs of the urban elderly to ensure that the urban elderly "have fun in their old age".

(1) Green energy-saving technologies and energy utilization. The problem of energy shortage in Chinese cities is becoming more and more prominent, and green buildings have unique advantages in building energy-saving technologies such as high-efficiency energy utilization, energy-saving design of lighting and utilization of renewable energy. Aiming at the characteristics of elderly people's slow movement and poor eyesight, intelligent energy-saving lighting design is carried out for indoor and outdoor spaces, corridors, bathrooms, toilets, public spaces, elevators and emergency spaces of the elderly buildings by means of timed and sensed technical means and methods. To address the slower metabolism and deteriorating temperature-regulating ability of elderly people in urban areas, it is necessary to strengthen the building enclosure structure's heat preservation and insulation design. This can be achieved through energy-efficient modifications. Supply and distribution line optimization, high-efficiency HVAC technology, radiant floor heating, and other technical applications are essential for ensuring comfortable and safe heating setups.

(2) Green water-saving technology and water resource utilization. China is a country in the world where water resources are relatively scarce, and green buildings have strong advantages in water-saving technologies such as water supply system design, water metering, use of high-efficiency sanitary appliances, and water-saving system design. In response to the water quality requirements of the elderly, water supply technology is utilized to apply high specifications to high-quality water resources and low specifications to low-quality water resources by means of quality-separated water supply technology. With regard to the water flow rate requirements of the elderly, by limiting the pressure outflow, reasonably limiting the water pressure at the water distribution point or adopting pressure reduction measures, the water pressure of the middle and low-rise senior citizen buildings is controlled within the limit, so as to guarantee the comfortable water flow rate of the elderly. In view of the serious cold water waste phenomenon in the hot water supply system, branch pipe or standpipe circulation technology is adopted to improve the efficiency of warm water supply for the elderly. In addition, water-saving faucets, small-volume water tank toilets, green and environmentally friendly no-flush urinals, delayed self-closing flush valves and other equipment are used in elderly buildings to ensure that elderly people use water comfortably, safely and efficiently.

(3) Green material-saving technologies and utilization of new materials. Green buildings have greater advantages in material-saving technologies such as building structure design, assembly construction and the application of renewable material technology. In view of the elderly's sensitivity to construction waste and construction noise, senior citizen buildings should adopt the concept of integrating civil construction and decoration, and carry out construction, building and assembly by means of industrialized prefabricated components. In view of the indoor air quality requirements of the elderly, the building decoration should use green building materials and decoration materials with low content of harmful substances, good environmental protection effect and strong durability. For the elderly who are prone to slipping and falling, flooring materials with good anti-slip performance and smoothness should be laid indoors, such as cork flooring, and handrails with low heat transfer coefficients should be set up in the corridors, bathrooms, toilets and staircases. In view of the decline in coordination and control of the elderly, the corners of corridors in public areas should be designed with rounded corners or wrapped in soft materials to avoid collision and injury of the elderly.

4.3 Comprehensive utilization of water resources

For areas with abundant rainwater resources, permeable or porous non-hard paving can be used to promote surface water circulation; effective collection and utilization of natural precipitation, the design of rainwater storage and collection tanks in the base, and at the same time to ensure that the discharge of sewage meets the relevant requirements of medical sewage, is the main water-saving measures for the green architectural design of the elderly institutions, and also one of the contents of the construction of "sponge city" ①. It is also one of the contents of building "sponge city".

(1) Improvement of rainwater infiltration

Improving the permeability of rainwater can be achieved through the construction of green spaces, permeable paving, infiltration drainage pipes, infiltration shade wells and infiltration side trenches. The use of permeable paving in large paved areas, such as parking lots and pavements with low loads, allows natural rainwater to infiltrate freely while providing people with the opportunity to walk, enhances the land's water retention capacity, and promotes water circulation. Permeable paving is not only the permeability of the surface paving material, but also the permeability of the base layer. The surface layer can be made of permeable hard materials, such as grass bricks, hollow bricks, or natural materials such as wood and stone, and the use of dry masonry can preserve the pore space between the surface paving units, so that rainwater can penetrate downward from between the units; the grass-roots level under the surface layer should also be permeable, and it can be made up of gravel grades with good water permeability.

(2) Rainwater recycling

The scope of rainwater harvesting includes all roof rainwater and surface rainwater runoff. Roof is the most suitable and commonly used rainwater collection surface, in order to consider the security of water for the elderly, the roof rainwater collection system should be set up to intercept pollution or initial rainwater abandonment device, while the surface vegetation can be used to purify the rainwater to improve the quality of the collected rainwater. Activity plaza, driveway, green space, etc. can make full use of the terrain, through the surface facing the lowest collection; when it is difficult to produce a large difference in terrain height, you can also set up a shallow rainwater ditch, rainwater pipe canals, etc. to collect rainwater, the reasonable design of the natural drainage slope, collected by gravity flow. The simplest way to utilize rainwater is as landscape water replenishment, can be combined with ecological pools, the use of rainwater to landscape water bodies replenishment; ecological pools can not only improve the earth's rainwater retention capacity, but also for the elderly to provide a pleasant landscape environment. The rainwater recycling system is shown in the figure 1 below.

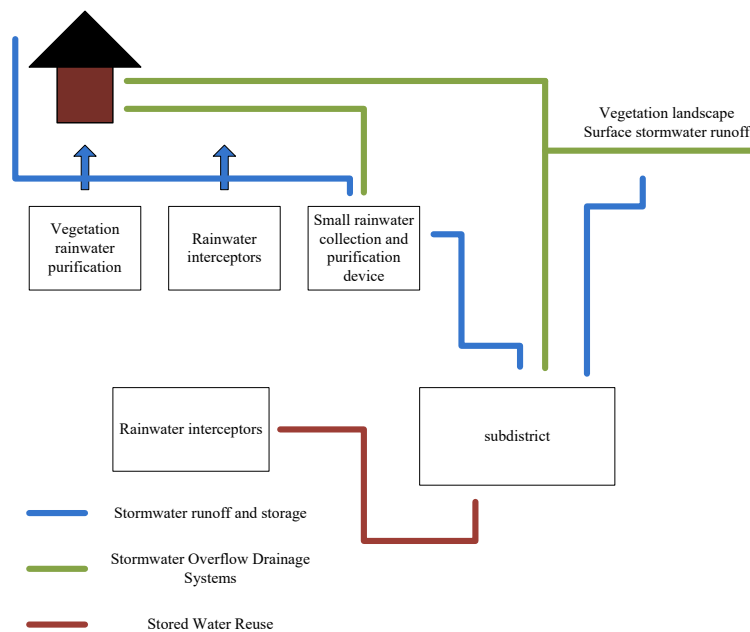


Figure 1: Rainwater recycling system

(3) Sewage treatment

In the green building design of elderly institutions, it is necessary to improve sewage treatment facilities. If there is a municipal drainage network available for the elderly institutions, their domestic sewage can be discharged into the municipal sewage network for centralized treatment by the city sewage system. Otherwise, a complete sewage collection and discharge system should be independently established. After proper treatment, the sewage can be discharged into nearby receiving water bodies. The quality of the discharged sewage must meet the relevant requirements for medical wastewater.

5. Conclusion

The green and low-carbon design strategy in senior living buildings is not only a positive response to the concept of sustainable development in the future, but also a deep concern for the quality of life of the elderly. Through carefully planned energy-saving measures, the selection of environmentally friendly materials and the creation of green space, this paper endeavors to create a comfortable and livable as well as low-carbon and environmentally friendly senior living environment. The implementation of this strategy not only provides a healthy, safe and pleasant living space for the elderly, but also sets a model for the green development of the whole society.

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