Research on Green Application System of Energy Saving and Environmental Protection in Urban Gymnasium Greening Project

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Abstract. The rational utilization and protection of ecological environment and resources has become the main premise of social development and construction. In the planning and design of urban gymnasium greening project, the concept of green energy saving has been popularized and become the main idea of planning and design of new urban gymnasium greening project. Gymnasium has higher energy consumption than other buildings because of its different characteristics and usage. Therefore, the gymnasium has great influence on energy and environment. Energy-saving design of gymnasium plays a vital role in energy saving, environmental protection and ecological construction of gymnasium. The full text starts from practice, based on the on-the-spot investigation of the form of city gymnasium, and through the problems found during the on-the-spot investigation, discusses the solutions to the practical problems of city gymnasium, puts forward the design principles of the form of city gymnasium, and provides a referential guiding framework and theoretical basis for the design of city gymnasium.

Keywords: City gymnasium, Greening, Energy conservation and environmental protection, Application and optimization.

1. Introduction
Urban gymnasium greening project is an inevitable outcome of urban development, which must meet the needs of urban development and people for a better life. It is of great significance to beautify the urban environment and promote the ecological restoration of green space through the greening project of urban gymnasium, which is of great significance for building a low-carbon city and promoting the sustainable development of the city [1]. It has become the choice of most people that urban gymnasium provides perfect infrastructure and abundant material supply for residents. At the same time, architects are aware that the construction of big cities is on the verge of the limit, and they have turned their attention to the construction of cities. As an important branch of social and economic development, sports culture has a far-reaching impact on the development of urban culture [2].

As we all know, at the present stage in China, energy conservation and environmental protection are gradually gaining popularity and getting more and more attention. It can be said that all sectors of society are taking various effective measures to thoroughly implement the concepts of sustainable development.
and energy conservation and environmental protection, and some phenomena such as "green buildings" and "ecological buildings" have gradually appeared in the construction industry, which also reflects the development status of China's construction industry to a certain extent [3-4]. Ecological environment and residents' happiness index have become the main topics of future social development. In the future planning and design of urban gymnasium greening project, it is necessary to put forward a green and energy-saving urban gymnasium greening project design and construction scheme, which is in line with the concept of social development in China.

2. Analysis of problems in the planning and design of urban gymnasium greening project

2.1. Lack of scientific and rigor
Urban planning and design are seriously influenced by human factors, which leads to unreasonable planning and design of urban gymnasium greening project, and creates obstacles to the overall urban planning. In the planning and construction of some cities, there is a lack of long-term vision, which causes many problems in the later stage of urban gymnasium greening project planning and affects the future development of cities [5]. For example, in the planning and construction of the gymnasium, there are not enough redundant green areas, which makes it necessary to re-plan in the process of building the ecological health gymnasium in the future, resulting in the waste of manpower and other resources.

2.2. The planning and design of the gymnasium lacks characteristics
China has a vast territory, and there is a big gap between the north and the south. Each city has its own unique historical and cultural accumulation. However, in the development planning of the gymnasium, the local historical and cultural characteristics are not paid attention to, which leads to the lack of innovation and uniqueness of the whole gymnasium. Some cities are also imitated in this area, which does not match the surrounding ecological environment and human and historical resources, and has not produced outstanding economic effects [6]. Therefore, in the urban gymnasium greening project planning, it is necessary to highlight the unique advantages of the region and carry out the characteristic urban gymnasium greening project planning and construction.

2.3. Lack of integrity and unity
In the planning and design of greening projects of urban gymnasiums in some areas of China, the lack of consideration for the integrity and unity of gymnasiums leads to the disharmony of various areas of gymnasiums. There is a huge difference between the two regions, which not only affects the overall visual effect, but also causes the economic development of the two regions to be divided.

3. Characteristics of green gymnasium

3.1. The utilization rate of resources is high
Green gymnasium has many functions, which can realize the flow of information, logistics and population. Therefore, it needs high scientific and technological support to ensure the smooth flow of these elements, ensure that the energy-saving and emission-reduction functions of each link can be thoroughly brought into play, and maximize the ecological and environmental protection effects during its service life.

3.2. Involving multi-disciplinary disciplines
The gymnasium itself has a large building scale, which involves the theoretical knowledge of architecture, materials science and mechanics in the process of design and construction. After combining with the green concept, it also involves environmental protection, ecology, environmental science and other disciplines, showing a strong comprehensiveness [7]. Not only that, its architecture itself can play a role of appreciation, so it is also related to the art field, such as aesthetics. The related staff, in the process of development, is doing a systematic and comprehensive work.
3.3. Harmony of ecological factors

Ecological theory has strict regulations on its ecological factors, which not only requires the gymnasium to follow the concept of environmental protection in the process of construction and use, but also requires it to realize the harmonious coexistence of various environmental factors. Under the guidance of this concept, the green gymnasium is not only a cold building, but also an organic whole that can realize ecological functions.

4. Green design strategy of energy saving and environmental protection for urban gymnasium greening project

4.1. Make full use of materials

The full use of local materials in urban gymnasiums is reflected in three aspects: first, based on the current technological development level of the city, innovative application of local traditional building materials; Secondly, it is a reasonable choice of modern building materials, which is reflected in choosing according to shape and adapting to local conditions; The third is the rational application of new building materials. Although new building materials play a certain role in saving energy, they will also lead to rising construction costs, so they should be rationally applied in combination with the economic level of cities; Fourthly, recycling waste materials, reducing the use of new materials, reducing the energy consumption of buildings in the construction process, and reflecting the application of resource saving theory in city gymnasiums.

4.2. Energy saving of building equipment

The generation of energy can be understood as fan, power generator, central air conditioner, etc. The means of energy saving is to select the appropriate host, control power and save energy [8]. Energy transmission can be understood as the connection between the host and the terminal, which generally refers to the equipment such as wires, cables, optical cables, etc. The means of energy saving is to rationally arrange the location and length distribution of each connection and select suitable materials. Such as fresh air blower, air conditioning heat exchanger, lamps and lanterns, etc., the means of energy saving is to arrange them reasonably in the design stage, reduce energy waste and improve energy efficiency ratio on the premise of satisfying the use. Since the energy consumption of large gymnasiums is 10~15 times that of ordinary residential buildings, how to achieve the design requirement of energy saving rate of 50% lies in solving the equipment energy consumption problem [9].

4.3. Rational control of building mass

The plane of the competition hall enclosed by a straight line includes square, rectangle, diamond, polygon plane, etc. The competition hall plane enclosed by straight lines is widely used in urban gymnasiums, because the number of audience seats in urban gymnasiums is small, and audience seats with less than 3,000 seats are often distributed on both sides of the short axis of the competition venue, while a small number of audience seats or auxiliary rooms are generally arranged on both sides of the long axis, so the plane of the competition hall is just square or rectangular. When there are a large number of seats, the audience can arrange seats around the competition venue. Generally, seats are not arranged at the four corners of the competition venue, leaving the entrance and exit of the venue.

The plane of the competition hall enclosed by curves includes round and oval planes. In recent years, the application of curved competition hall plane in cities is also on the rise. Curved competition hall plane can reflect the light and flexible characteristics of sports buildings. In addition to the competition halls enclosed by straight lines and curves, there is also a combination form of the two, that is, the original curved body is cut by straight lines, or the geometric body enclosed by straight lines is cut by curved lines. Both sides of the curve are used as office areas and VIP rest areas, and the use of different service rooms is fully considered. For cities with weak economic conditions, it is advisable to adopt the plane form of the competition hall enclosed in a straight line, and the plane layout is as simple as possible to reduce the cost; For cities with relatively developed economic conditions, the plane form of
combining straight lines and curves can be adopted to create the mobility and dynamic aesthetic feeling of sports buildings.

4.4. **Energy-saving treatment of building interface**

The form design of urban gymnasiums based on the concept of resource conservation is also manifested in the energy-saving treatment of building interfaces. At present, the city has ushered in the peak period of construction. However, the lack of sustainable design in the design and construction process of gymnasiums in big cities leads to serious building energy consumption and hinders the development of big cities. However, the gymnasium has large internal space and complex equipment, so more attention should be paid to the energy-saving treatment of buildings and take the road of sustainable development.

Sports itself is a sport advocating nature, so creating a natural and comfortable sports environment is the goal of gymnasium. Natural ventilation can improve indoor air freshness, take away excess temperature and maintain indoor comfort. Natural light can not only improve indoor brightness and temperature, but also play a role in sterilization and disinfection. Treatment methods of natural lighting at the top interface of city gymnasium mainly include the following:

The first is to use the scattered architectural forms for lighting, which is common in the interface treatment of urban gymnasiums. Its window opening forms conform to the architectural forms and highlight the characteristics of gymnasium roof modeling.

The second is to use the structure for lighting. The location of the lighting window and lighting belt corresponds to the internal structure selection, which avoids the indoor structure layer blocking the light.

The third is to use transparent materials such as film materials for lighting. Film materials not only have good light transmission effect, but also can filter strong light and avoid glare, which is the development direction of material selection for city gymnasiums. Besides film materials, there are new building materials such as semiconductor materials.

Compared with big city gymnasiums, urban gymnasiums have more relaxed land use environment and superior geographical position, and side lighting can meet indoor lighting and make buildings and nature integrate with each other. Compared with the north and south sides, the east and west sides of the gymnasium are more prone to produce glare because of the lower incident angle of sunlight, which has a certain impact on athletes' competition and audience's viewing. Therefore, the glare can be controlled and eliminated by using shading shutter or shading grille in the lighting of the east and west sides of the city gymnasium.

Solar energy technology can also be applied to the interface energy-saving treatment of city gymnasium. Solar energy technology can be divided into active solar energy technology and passive solar energy technology. Active solar energy technology uses some equipment to convert and store solar energy, but active solar energy is often expensive and needs to consume extra energy, which exceeds the load of cities. Passive solar energy is a suitable technology to improve the indoor environment by applying the spatial layout of buildings and the thermal performance of building materials. It has low cost and is suitable for the current resource situation of cities.

Green building materials are also called ecological building materials, that is, building materials that have little load on the environment and are harmless to human health in the process of building production and use [10]. Green environmental protection building materials include green concrete materials used for the enclosure structure of gymnasium and waterproof materials used for the outer interface surface of gymnasium. Green concrete material is mainly used in the enclosure structure of city gymnasium. The thermal inertia of concrete material is large, which can delay the release time of solar radiation heat from the wall and make the audience hall heat up rapidly, thus transferring heat to the competition hall.
5. Technical analysis of green application system for energy conservation and environmental protection in urban gymnasium greening project

5.1. Energy-saving optimization design method

Building envelope is generally composed of roof, external wall, external doors and windows, overhead floor, ground, basement side wall and basement roof. In the optimization design, because different materials can be selected for each part, there are many alternative schemes. Under the condition that the thermal insulation materials at other thermal bridges are unchanged, through software simulation, under the premise of meeting the specifications and in accordance with the principle of economy and convenience in construction, the energy consumption values generated in each time are calculated repeatedly, and the effects of thermal insulation materials with different thicknesses are observed, so as to finally determine the thickness and construction method of wall thermal insulation materials.

Calculation of energy consumption of design building
Air-conditioning area: 57027.1m²
Non-air-conditioning area: 39511.6m²
According to the parameters of the building and the parameters provided by the energy-saving standards of public buildings, the annual energy consumption of the building is obtained as follows:

Table 1. Annual energy consumption of buildings

| Load name             | Cold and hot load value(kWh/a) | Load index per unit area(kWh/m²·a) |
|-----------------------|--------------------------------|-----------------------------------|
| Cooling load          | 7128069                        | 80.21                             |
| Heating load          | 306617                         | 4.36                              |
| Cold and hot load     | 7720831                        | 84.21                             |

According to the parameters of the building and the parameters provided by the energy-saving standards of public buildings, the annual energy consumption of the reference building is obtained as follows in Table 2:

Table 2. Refer to the annual energy consumption of the building

| Load name             | Cold and hot load value(kWh/a) | Load index per unit area(kWh/m²·a) |
|-----------------------|--------------------------------|-----------------------------------|
| Cooling load          | 8402970                        | 90.24                             |
| Heating load          | 332450                         | 3.39                              |
| Cold and hot load     | 8960775                        | 92.47                             |

Comparing the simulation results of Table 1 and Table 2, they are summarized in Table 3 below, and the energy consumption analysis is shown in Figure 1.

Table 3. Data statistics of air-conditioned rooms

| Load name                                      | Cold and hot load value(kWh/a) | Load index per unit area(kWh/m²·a) |
|-----------------------------------------------|--------------------------------|-----------------------------------|
| Cumulative value of annual cooling and heating load(kWh/m²·a) | 84.21                          | 92.47                             |
The annual energy consumption of the designed building is less than that of the reference building. Therefore, the green design of energy conservation and environmental protection for urban gymnasium greening project has reached the energy conservation requirements of public building energy conservation standards.

5.2. Comprehensive optimization of energy-saving effect

Energy-saving optimization of envelope is not to optimize each thermal bridge position separately and then superimpose it, but to emphasize and sacrifice it. On the premise of meeting the specifications, it is necessary to consider the economic factors and integrate all parts of the building into a whole. When calculating, the main components should be set as variables and the secondary components as constants. After determining the main components, the values of each secondary component should be deduced one by one. Finally, a complete optimization scheme is obtained.

5.3. Economic benefit analysis

The indoor environment optimization strategy proposed in this paper makes full use of the respective characteristics of CFD simulation and POD model reduction, and realizes the quick calculation of indoor environment indexes by constructing a low-order parameter space, which not only improves the optimization accuracy, but also ensures the real-time optimization.

Kong Wen of various indoor parameters can be constructed by changing the value of control flux (displacement ventilation system air supply speed and temperature) and making corresponding steady-state CFD simulation. In the low-order parameter variation space reconstructed by POD method, the parameter distribution is described as a linear combination of finite POD modes and their coefficients in the following form:

$$ P_{mr}(k) \approx \sum_{n=1}^{\rho} b_n(k) \varphi_n $$  \hspace{1cm} (1)

In which $P_{mr}(k)$ is parameter distribution value, $\varphi_n$ is POD mode, $b_n(k)$ is mode coefficient, and $n$ is generally less than 5.

In this way, the parameter distribution corresponding to any control variable can be obtained by multi-dimensional interpolation of the mode coefficient $b_n$ and solving equation (1). This method is
embedded in each iteration of genetic algorithm to solve the environmental performance index, which can quickly get the objective function and improve the real-time performance.

As a whole, the building meets the specification requirements. Through the calculation of software technology, the basic value required by the trade-off calculation is achieved for each envelope. The thermal insulation materials used on each enclosure structure meet the requirements of local codes and regulations, and the three certificates are complete. It is convenient for construction and has a perfect and mature construction system. Energy-saving design materials have high-cost performance. Low initial investment and short payback period. Long service life, low maintenance cost and convenient repair. Safety is guaranteed, in line with the relevant provisions on fire control.

6. Summary
Under the concept of green energy saving, the design and construction of city gymnasium should conform to the development of resource-saving and environment-friendly. According to the energy-saving standard of public buildings, the energy-saving design of the outer enclosure structure of gymnasium is carried out. On the premise of meeting the requirements of energy-saving rate specification, the design scheme is optimized and the most suitable scheme is selected to participate in the construction drawing design. Put forward energy-saving optimization suggestions for air conditioning and lighting systems of buildings, and jointly achieve the goal of energy saving. Understand the energy consumption of gymnasiums from various professional angles, and deeply study the causes and solutions. Gymnasium is one of the representatives of buildings with high energy consumption. Although this building has been designed for energy saving, there are still many places that can reduce energy consumption in the follow-up operators.

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