Intelligent research on electrical design of stadiums

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Abstract. The power system of the stadium needs to be matched with the size of the stadium to make it economically reasonable and meet the scale requirements. Due to the complex internal functions and large functions, large stadiums put forward stricter requirements on the reliability and economy of the distribution system. The paper combines engineering examples, starting from the engineering design ideas, analyzing the electrical design system of the stadium, discussing and proposing corresponding solutions, and hopes to provide relevant reference value for the electrical design work of the stadium.

1. Introduction

How to plan and design the Olympic stadiums and the purpose of the Olympic Games in the design of the stadium. In recent years, various provinces and cities across the country have also invested in the construction of sports venues for national sports games and regional sports games [1]. However, how to design sports stadiums, how to apply modern technology to sports venues, and to keep the construction of sports venues in line with the pace of technological advancement in the times is an important task for people. Since the 1990s, the construction of stadiums in many countries has undergone a major transformation. From the past one-sided pursuit of large-scale development to moderate scale, versatility, advanced equipment, safety and comfort, energy conservation and environmental protection. The advanced equipment is fully reflected in the development and progress of science and technology, especially the application of information technology, so that the stadiums are developing in the direction of informationization and intelligence [2]. On the basis of paying attention to these high-tech applications, it fully reflects people-oriented, enables high-tech to better serve the society, pays more attention to coordination with the environment, and fully reflects energy conservation and environmental protection. The following is a discussion on the intelligent design of electrical design in sports venues.

2. Project introduction

The electrical design of the stadium needs to be combined with modern sports architecture, using communication network technology, computer and other technologies. Take the design project of a sports center project in a city as an example. Its 250,000 building square meters covers an area of 72 hectares. The sports center "one" two halls are a Grade A sports building complex with 60,000 stadiums, 12,000 gymnasiums and 4,000 swimming pools [3]. The first floor of the stadium is a fitness center, a competition management room, a multimedia room, a technical equipment room, and an office. The stadium is 400m imported plastic standard runway. The main venue of the stadium is to meet the professional grade wooden floor of the NBA level competition. The swimming pool is a
standard pool for international swimming and diving. Its specifications and facilities meet the standards. From the overall function point of view, the stadium must play the role of entertainment, training, professional competition, etc., but also have the function of television broadcast [4].

3. Power distribution system design

3.1. Load grading
The stadium is powered by a primary load. The classification and capacity statistics of various types of power load are shown in Table 1.

| Load grading          | Load name                                | Equipment capacity P_/KW |
|-----------------------|------------------------------------------|--------------------------|
| Particularly important primary load | First aid station (3 in total) 10          |                          |
|                       | Light control room 20                    |                          |
|                       | Post-match control center 15             |                          |
|                       | Voice control room 80                    |                          |
|                       | OB van reserved 40                       |                          |
|                       | Fire and Security Center 20              |                          |
|                       | Doping control 20                        |                          |
|                       | Fire pump room 40                        |                          |
|                       | Announcement room 20                     |                          |
|                       | Auditorium emergency lighting 80         |                          |
|                       | Camera conversion, timing control 20     |                          |
|                       | Floor emergency lighting 130             |                          |
| Primary load          | Press room 15                            |                          |
|                       | VIP kitchen 180                          |                          |
|                       | Electronic big screen 150                |                          |
|                       | Site lighting 540                        |                          |
|                       | Reserve reserved (2 places) 120          |                          |
|                       | Auditorium lighting 190                  |                          |
|                       | Reporter 20                              |                          |
|                       | Floor lighting and reservation 390       |                          |
|                       | Network room 20                          |                          |
|                       | elevator 40                              |                          |
|                       | Site reservation (2 places) 30           |                          |
| Secondary load        | Electronic large screen ventilation air conditioner 20 |  |
|                       | Outdoor square lighting and reservation 170 |  |
|                       | rainwater collecting 500                 |                          |
|                       | air conditioning 250                     |                          |

3.2. Load power supply mode at all levels
The fire load is powered by the mutual power supply of the dual power supply terminals of the transformer room. The non-fire-fighting primary load is powered by the dual-channel power supply of the transformer room at the appropriate distribution point after the mutual investment [5].

The evacuation lighting in emergency lighting uses the centralized battery of the emergency power system (EPS) as the backup power source. Diesel generators are used as backup power sources for fire-fighting pump rooms, fire-fighting centers, fire-fighting machine rooms, and other fire-fighting
loads and venue lighting, sports technology room power, and emergency lighting in emergency lighting.

Especially important loads require equipment with continuous power supply and data storage requirements (such as timing scores, network switches, fire control equipment, security monitoring equipment, etc.), and centralized storage batteries using uninterruptible power supply systems (UPS) as backup power sources.

The secondary load is powered by a single-loop power supply that is powered by a dual-circuit power supply in the transformer room at a suitable distribution point or a reliable independent outlet (automatic input from the low-voltage bus-switch of the transformer room).

3.3. Estimation of electricity consumption for exhibitions
The electricity load of different seasons and different types of exhibitions is quite different. The designed power is temporarily reserved at 150 W/m², and the total capacity of the booth is about 3150 kW. During the exhibition, in addition to the electricity used in the booth, some of the stadium's electrical equipment continued to be used, as follows: 1) Two sets of electronic large screens in the north and south of the venue will continue to be used as information display and distribution facilities. 2) Some venue lighting continues to be used. The lighting of the competition venue is designed to be 750 lx horizontal illumination [6]. In the group lighting and lighting control group, the “exhibition” mode is added. In this mode, the stadium venue (also known as the exhibition venue) is 200 lx illumination, and about 1/3 of the venue lighting continues. Use. 3) The lighting and air conditioning of office, commercial and other supporting rooms will continue to be used. 4) The emergency lighting system of the entire stadium continues to be used. 5) Outdoor lighting and parking lot lighting continue to be used.

4. Power supply system
The location of the substation is selected according to the distribution of power load and the loss of voltage. The stadium has two substations, which are located under the stands on the northeast and south sides of the first floor, as shown in Figure 1.
The No. B substation is the main substation, with 10 kV power distribution units and 4 transformers B1, B2, C1 and C2 for power supply to the east and north half and venue booths. The No. A substation is a substation with two transformers A1 and A2 for power supply to the west and south half.

The substation is a 2-way 10 kV power supply. The two-way power supply is used one by one and has a busbar switch. The transformer has 2 sets, the low-voltage side adopts single busbar section, and the connection mode of the bus-connected switch is provided. The substation supply and distribution system are shown in Figure 2 [7]. The generator set interface is reserved for the A and B substations, and the generator set can be rented as a backup power source for fire load and sports technology and part of the venue lighting for major events. The C1 and C2 transformers of the B substation are only for the booth power supply and can be withdrawn during the absence of the exhibition to avoid the no-load operation loss of the transformer.

The generator emergency power supply is sent to the power distribution room and the normal power supply is matched with each other. This is mainly considering that the generator room is adjacent to the 2# transformer room and is far away from the 1# transformer room. For the venue lighting, if the generator emergency power is sent to the 1# transformer room for mutual investment, there is a big difference in line length between the mains supply and the generator power supply, which cannot meet the voltage deviation requirements of the site lighting. In the design diagram, the genset start signal is taken from the auxiliary contact of the low-voltage main line switch of the power distribution room [8]. Since the site lighting power supply is directly allocated from the generator emergency power distribution cabinet to the terminal distribution box, if the power can be taken from the automatic switch of the field light distribution box, the start signals of the generator set and the start of the power distribution room can be taken. The signal constitutes an "or" relationship, and the reliability of power supply can be further improved.

The generator neutral point leads to outdoor direct grounding, and the generator and mains power conversion adopts four-level automatic transfer switch. According to the load calculation, a 1,000 kW (common power) quick-start diesel generator set is selected. The generator room is located under the evacuation platform on the northeast side of the stadium, adjacent to the 2# transformer room, avoiding the dense flow of the main entrance and exit and the auditorium of the grandstand, minimizing the fire hazard and the adverse effects of noise and vibration during the operation of the unit. Exhaust and smoke exhausted through the channel from the off-site slope to the green underground.

![Fig 2 Schematic diagram of the substation power supply and distribution system](image-url)
5. Lighting design

Stadium lighting is generally divided into venue lighting, auditorium lighting, and auxiliary room lighting. The lighting of the stadium focuses on the lighting of the competition venues, and the lighting of the auditorium and the lighting of the competition venues are considered for design. Set battery-type emergency lighting in the audience hall, and set emergency evacuation indicator lights in stairwells, public passages, main entrances and exits. Deal with four aspects according to different scales, standards, and levels.

The illuminance standard determines the corresponding illuminance level according to the scale, standard and level of the stadium. The illuminance standard of the competition venue is 150-300 lux, the auditorium is 75-100 lux, and the other auxiliary rooms are 75-150 lux. If the illuminance is too high, it will increase the investment and frequent running costs. If it is too low, it will not meet the requirements for use.

Illumination calculation. When designing a gym, it is ideal to use an electronic computer for illuminance calculations, but this is not possible in most areas. The simpler and more effective ones still use the average illuminance to determine the number of fixtures that need to be set. The formula and parameters are now as follows.

\[
E = \frac{fNUK}{A} \quad \text{OR} \quad N = \frac{EA}{fUK}
\]

Where: E: Average illuminance (L), determined according to the scale and standard of the gymnasium, gymnasium. N: number of lamps (set); U: utilization factor of the illuminator; K: dimming coefficient, taking 0.7 to 0.75; f: total luminous flux (Lm) of the light source, which will affect the reduction of illumination due to the attenuation of the luminous flux. The total amount of light from the source should be multiplied by the attenuation factor (0.7 to 0.75).

6. Intelligent design – using renewable resources

The solar photovoltaic power system is composed of a solar cell module, a solar controller, and a battery. According to the different operating modes of the system, it can be divided into independent systems and grid-connected power generation systems. For the independent system, the excess part of the solar power generation during the day is stored in the battery to meet the nighttime electricity demand, and at the same time, it can also be used as a backup power source during the disaster period. For grid-connected systems, daytime solar power can be sent back to the grid for nighttime use, and the shortfall is provided by the grid [9].

The solar photovoltaic power system should be combined with the solar energy status and engineering investment of the project site. Class 4 and below (the annual sunshine hours are less than 2200h) should not be used. There is often a large shed over the stadium auditorium, creating conditions for the installation of solar modules. The design can consider the use of independent solar photovoltaic power system for the supply of relatively stable non-critical loads such as auxiliary room lighting and outdoor lighting.

The current conversion efficiency of solar photovoltaic power system is not very high. The initial investment is large and the use is not popular. However, as an inexhaustible clean energy, solar energy is the future development direction, with the national policy support and the deepening of solar technology development, the efficiency and cost performance of solar photovoltaic power system will be improved and will be widely used.

7. Conclusion

The intelligent stadium design not only enhances the control functions of different functional areas of the stadium, but also realizes the integrated management of stadium construction equipment. In this paper, the intelligent design of the stadium sports is based on the electrical design project of the stadium. Combined with the electrical design points of the intelligent stadium, the following two
points are discussed: First, intelligent power distribution system; second, intelligent venue lighting system. I hope that the research in this paper can provide a reference for improving the intelligent design of the stadium’s electrical design in China, so that the stadium can play a greater application value.

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