Design and application of natural light comprehensive energy-saving and emission reduction system in the underground parking lot

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Abstract

Due to the limitation of location and space, the traditional underground parking lot often has problems of poor light, no air circulation, and a large amount of energy consumption to solve lighting and ventilation. The process of finding a parking space in an underground parking lot consumes not only a lot of time and effort of the owner but also the exhaust gas emitted by the vehicle further increases the air pollution inside the building. The "Underground Parking Lot Natural Light Energy Saving and Emission Reduction System" designed by us is based on energy saving and emission reduction and green health. The lighting, ventilation, and signage of the underground parking lot are thoroughly and meticulously improved so that the underground parking lot can achieve a considerable degree. Energy-saving and emission reduction, thus creating a green, environmentally friendly, low-carbon, and energy-saving underground parking space. The system has three significant advantages: 1. Utilizing daylight illumination: the natural light is led into the interior of the building by a combination of panoramic sunroof + hood + light pipe + diffusing mirror. The photovoltaic panel solves the problem of night lighting and reduces the operating cost of the underground parking lot. 2. natural ventilation: natural wind mechanics calculation simulation device, will be installed in the best ventilation position, cleverly change the sunroof blinds into the air intake system, solve the problem of electric ventilation through the air pressure difference caused by natural wind.

3. Intelligent vehicle guidance system device: The vehicle guidance system is used to combine it with lighting and ventilation. The photovoltaic panel solves the problem that part of the system uses electricity. The application of this system will significantly reduce the energy consumption of underground parking lots and create a green, environmentally friendly, low-carbon, and energy-saving underground parking space. It is a significant innovation in the new basement parking system.

Keywords

Energy saving and emission reduction; intelligent system; parking system.

1. Introduction

1.1 Background of the study

Underground parking lots can make full use of space, which mainly solves the problem of parking difficulties in modern cities. However, due to the limitations of location and space of traditional underground parking lots, there are often problems of poor light, no air circulation, and a large amount of energy consumption to solve lighting and ventilation. The process of finding a parking space in an underground parking lot consumes not only a lot of time and effort of the owner but also the exhaust gas emitted by the vehicle further increases the air pollution inside the building. 24-hours continuous lighting, continuous operation of high-power exhaust fans, will consume much energy. With the emergence of more and more underground parking lots, the disadvantages of high power consumption have been increasingly valued by society. According to the survey data of Chengdu Environmental Science Society: a 6400m2 underground parking lot can generally reach 10400w per hour, so energy saving and emission reduction have become an urgent task in underground parking lots.

The "National Light Integrated Energy Saving and Emission Reduction System for Underground Parking Lots" designed by us is to adapt to the development theme of the society, and to carry out in-

depth and meticulous treatment of the lighting, ventilation and signage of the underground parking lot, so that the underground parking lot can effectively achieve energy saving and emission reduction. Thereby creating a green, low-carbon, and energy-saving underground parking space.

1.2 Domestic and foreign research status and development of dynamic analysis

At present, the problem of high energy consumption for the construction of underground parking lots at home and abroad is mostly unilateral from the use of LED lights, photovoltaics, etc., to solve the energy consumption of lighting, but the energy-saving and emission reduction of underground parking lots from lighting, ventilation Leading all aspects of overall consideration, as a complete system to study and design has not yet been discovered. Our underground parking lot natural light comprehensive energy-saving and emission reduction system is a combination of various ways to save energy, maximize the use of natural light and natural wind, combined with LED lights, photovoltaics, and skylights to use light source design, so that underground parking lot Achieve maximum energy saving and emission reduction, economic and environmental protection.

2. Design plan

We take the simulation of this system as an example to analyze the underground parking lot of Jinsha Mansion in the third phase of Chengdu New City Garden. The system intends to use the reinforced concrete structure to open the skylight for the slab, and at the bottom of the pyramid skylight, the louver steel is used for air circulation. The power of the LED lamp determines the size of the sunroof. It is mainly 4 to 6 squares, which plays a functional role in lighting and ventilation. The specific shape is shown in Figure 1.

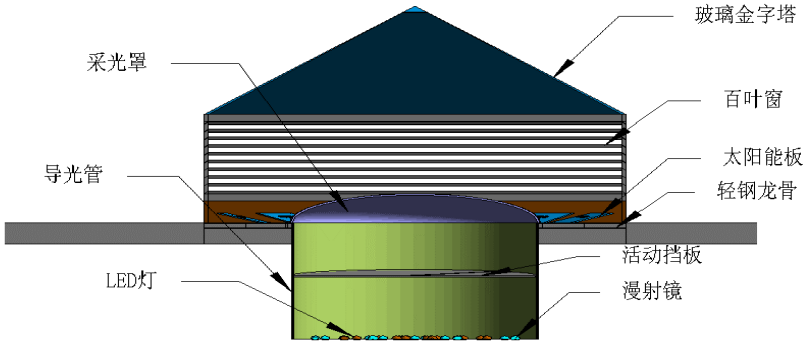

Figure 1. Schematic diagram and details of the natural light comprehensive energy saving and emission reduction system in the underground parking lot

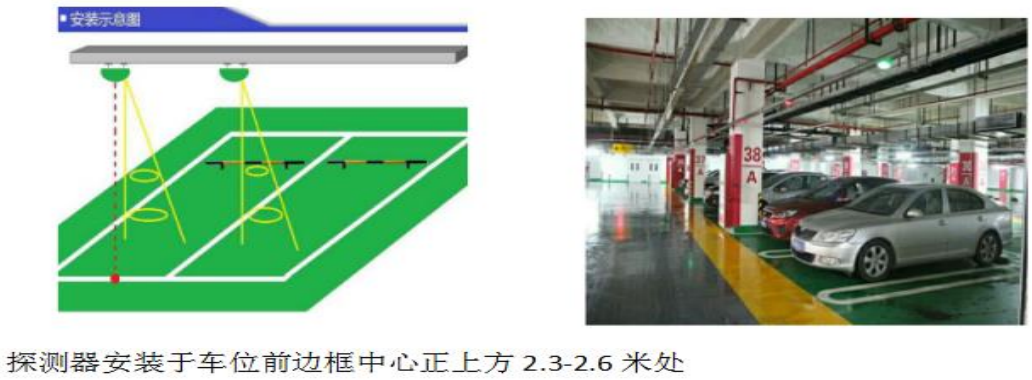

Figure 2. Location of the parking sensor light installation and real scene

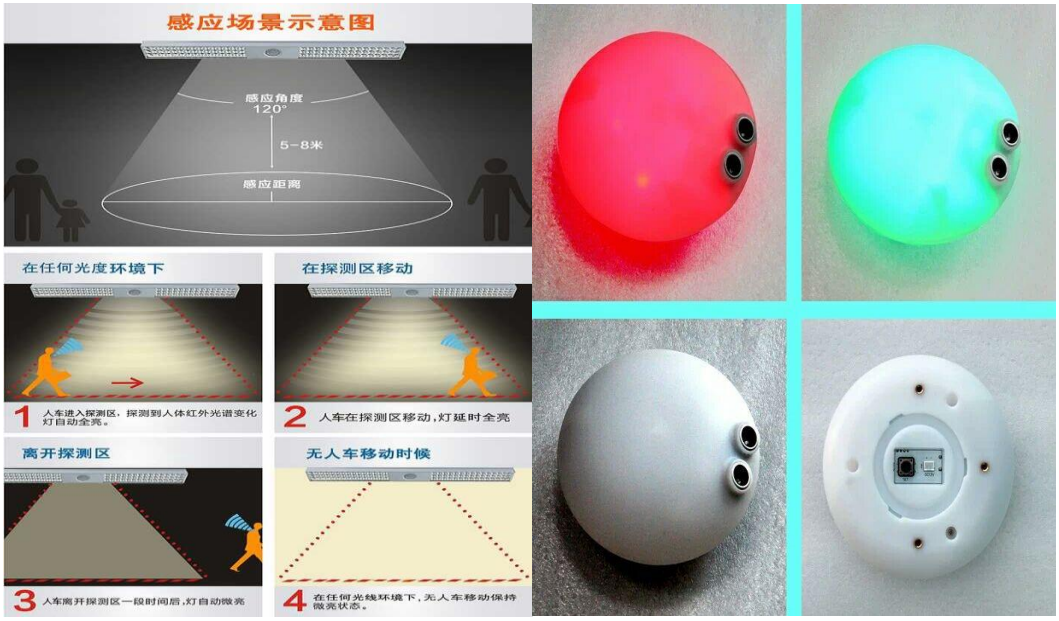

Figure 3. Schematic diagram of the parking space sensing scene

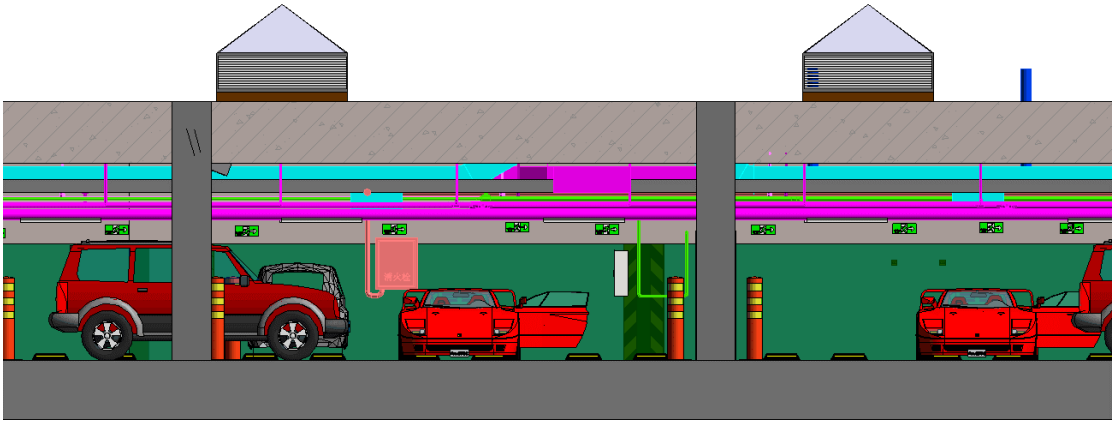

Figure 4. BIM renderings

2.1 Specific plan

The scheme firstly designs the structure of the building itself and builds a pyramid-shaped skylight on the reinforced concrete floor after the completion of the building. First, install the rust-proof steel window of the shutter on the floor, and then waterproof the floor between the floor and the skylight. Finally, A highly transparent solar collector panel is installed, and each sunroof is equipped with a solar collector battery and illumination for night use. The light is in a photosensitive form and automatically turns on when it is dark.

For the use of LED lights and tracking systems in the basement where the skylight cannot be opened, reducing the time for turning on the lights can greatly save energy.

2.1.1 Practice of skylight envelope structure

(1) Each skylight is provided with a warning device, and the structure itself is made of a reinforced concrete structure and waterproofed.

(2) The external structure adopts a pyramid-structured high-transmitting lighting board, and the wall is internally equipped with a solar energy collecting device to provide internal LED light.

(3) Environmental protection treatment: Planting plants around 1m from the skylight for decoration.

2.1.2 Indicator system use

At the same time, the system is added to the empty position of the car to realize the driving time of the car inside the large parking lot and reduce the emission of exhaust gas to achieve environmental protection.

2.2 Supplementary notes

The use of energy-saving LED light fixtures that cannot open skylights, the use of the vehicle-sensing system for "tracking"-type lighting to save much power, "car to light, people go off" 3 Working principle and performance analysis The project uses natural lighting system, and The inductive LED lighting system combines modes to achieve illumination. Moreover, install the parking space indicator to save time for the car to find empty parking spaces in the parking lot.

3. Lighting system

3.1 Natural daylighting system

The natural daylighting system mainly uses natural sky lighting to open the skylight to solve the problem of lighting in the basement. The skylight is composed of a high-transmission solar energy collecting plate, which forms a pyramid shape, enlarges the irradiation area, and enlarges the collection area. Each sunroof is accompanied by a solar collector to illuminate the pre-LED lights. Solved the illumination when the natural light is insufficient.

3.2 Inductive LED Lighting System

Inductive LED lighting system mainly uses inductive switch light to reduce lighting time to save energy. When the vehicle or personnel pass the road, the induction light passes through the infrared sensor to light up before the vehicle enters and slowly decreases after the vehicle passes. Brightness until it goes out. Achieve the effect that the car lights up and the car goes out.

3.3 parking space indicator

Add the car vacancy indicator light, when the vehicle storage rate reaches 80% or more, turn on the parking space indicator to reduce the driving time of the car inside the large parking lot and reduce the emission of exhaust gas to achieve environmental protection.

Four theoretical design calculation

3.4 Calculation ideas

We calculate the daily electricity consumption and carbon saved by the system by calculating the difference between daily electricity consumption and carbon emissions before and after using the underground parking lot natural light comprehensive energy-saving and emission reduction system in the underground parking lot of Chengdu New City Garden Phase III. Emissions, then calculate the economic and environmental benefits of the system as a unit parking space and finally find the huge environmental and economic benefits that the system can bring to Chengdu.

3.5 Daily power consumption of the parking lot before the renovation

The underground parking lot has a building area of 5,100 m2, several vehicles of 130,several lights of 120, 40 watts per lamp, and 5 exhaust fans, each of which is 1500 watts.

(1) Electricity consumption per hour: 120 × 0.04kw × 1h = 4.8kw.h

Electricity consumption of one day lamp: 4.8kw.h×24h=115.2kw

(2) Electricity consumption per hour of exhaust fan: 5 (pieces) × 1.5kw × 1h = 7.5kw.h

Electricity consumption of one day exhaust fan: 7.5kw.h×24=180kw/day

(3) Daily electricity consumption of ordinary underground parking lot: 115.2kw / day +180kw / day = 295.2kw / day

3.6 Power consumption after using this system

Using the natural light comprehensive energy-saving and emission reduction system of the underground parking lot, in the case of opening the skylight, the natural light can be used for

illumination from 8:00 to 17:00, so the time required to provide artificial lighting is only 15 hours a day. Take the underground parking lot of the third phase of Chengdu New City Garden as an example. According to statistics, the traffic volume entering and leaving the parking lot within 15 hours is 50 vehicles.

We adjusted the original fixtures in the parking lot. The lighting adopts natural light lighting system, and the original 120 ordinary lighting lamps with a power of 40W are changed to 64-inch power 60W lighting system lights; the guiding system uses 130 lamps with a power of 20w. With this system, all LED lights will be intelligently turned off without vehicle entering or no personnel entering. The parking space indicator selected by the lighting system allows the vehicle to quickly find an empty parking space after the storage rate reaches 80%, and complete the parking action. This parking lot provides artificial lighting. The number of vehicles parked in the parking lot is about 80. Each car involves an average of 10 lights, and the average light is half a minute. In this way, it can be calculated that the electricity saved by the underground parking lot after using the system is as follows:

(1) The average amount of electricity used to enter a car: 10 × 0.02 kW × 0.5 (minutes) = 0.01kw / minute

The average power consumption of the indicator light is 0.01kw/min × 130 =1.3kw

(2) Saving electricity in one day compared to ordinary lighting system: 295.2 kW.h-1.3 kW.h=293.9 kw.h

After using the system, the electricity cost will be saved every day: 293.9kw.h *0.87 yuan / kw.h = 255.7 yuan.

One year power-saving 293.9 kw .h *365 =107273.5 kw.h 4.4 Benefit calculation after transformation

According to incomplete statistics, as of the end of December 2017, the number of cars in Chengdu reached 4.52 million, with about 1.5 million parking spaces in underground parking lots.

4. Economic effects

After simulation calculation: If the system is applied to this underground parking lot (building area is 5100m2), it can save 293.9kw.h of electricity per day, which is equivalent to saving 105.804kg of standard coal, reducing carbon dust by 79.9408kg and reducing 293.0183kgco2. Moreover, about 260KL of vehicle exhaust emissions are reduced every day. The system can save electricity for the parking lot by 293.9kw.h *0.87 yuan/kw.h* 365=93327.95 yuan per year. At the same time, it can be concluded that the underground parking lot uses an intelligent lighting system to save electricity per day for each parking space: 293.9kw÷ 130=2.26kw, Chengdu currently has 1.5 million underground parking spaces, and the average daily electricity consumption is: 1.500000×2.26kw=3391153.85kw (equivalent to 4167.5 tons of standard coal). The current electricity price in Chengdu is 0.87 yuan/kw.h, and the economic benefit that the system can save to Chengdu every day can be: 3391.153.85kw.h × 0.87 yuan/kw.h =295,0303.85 yuan/day.

The economic benefits for the whole year are: 295030.385 yuan/day × 365 = 1.0768 billion yuan.

4.1 Environmental effects

(1) Taking the underground parking lot of Jinsha Mansion in Chengdu New City Garden Phase III as an example, using intelligent lighting system, it can indicate empty parking spaces, and the average parking time for each vehicle is reduced by two minutes, and the average vehicle exhaust emissions per minute. For a thousand liters, the underground parking lot has a traffic volume of about 130 vehicles a day. So the car exhaust that can be reduced every day is: 130 (car) × 1 (thousand liters) × 2 (minutes) = 260 (thousand liters).

(2) According to preliminary statistics, the daily traffic volume of Chengdu underground parking lot is 1.4 million. The daily reduction of automobile exhaust in Chengdu is: 1.400000 (unit) × 2 (minutes) × 1 (thousand liters) = 2800000 (thousand liters).

The environmental effect for the whole year is: 2800000 (thousand liters) / day × 365 = 120,200 million (thousand liters).

5. Innovations and applications

1. Daylighting equipment: The natural light is led into the interior of the building by a combination of panoramic sunroof + lighting hood + light pipe + diffusing mirror. The photovoltaic panel solves the problem of night lighting and reduces the operating cost of the underground parking lot.

2. Natural ventilation system: natural wind mechanics calculation simulation device, will be installed in the best ventilation position, cleverly change the sunroof blinds into the air intake system, solve the problem of electric ventilation through the air pressure generated by natural wind.

3. Intelligent vehicle guidance system device: The vehicle guidance system is used to combine it with lighting and ventilation. The photovoltaic panel solves the problem that part of the system uses electricity.

The most prominent feature of the system is that it is eco-friendly, energy-saving and money-saving, and responds to national policies. It solves the problem of redundant equipment investment, such as ventilation and lighting for developers. It can make a one-time investment and recover the cost within 3~5 years. The remaining 20 Free green lighting is available for the rest of the year.

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