The Application of Intelligent Electricity Management System in the Water Transport Engineering Construction

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Abstract. In view of the problems existing in the construction, such as the unstandard operation of builder, special environment, the difficulty of troubleshooting the hidden trouble and the situation of simultaneous jumping or leapfrog jumping, the paper developed an intelligent management system for water transport engineering construction power. The intelligent electricity management system consists of four parts, which can realize the water transport engineering construction site of real-time monitoring and data acquisition. It can enhance the safety of the construction site and improve the efficiency of the management personnel.

Keywords: intelligent electricity, cloud platform, water transport engineering construction

1 Introduction

Transportation industry is the pillar industry of China and plays an important role in the national economy.According to the relevant statistics of the Ministry of Transport, from January to September 2023 was 2.1447 billion yuan, with a year-on-year growth rate of 4.3%; the fixed asset investment in waterway transportation construction reached 144.1 billion yuan, including 66.6 billion yuan in coastal construction, with a year-on-year growth rate of 16.2%[1].However, due to the complex construction environment, the number of ship and machine equipment, and many water operations in the water transport industry, the safety accidents in the industry are frequent, which seriously threatens the life and property safety of employees, and is not conducive to the high-quality development of the water transport engineering construction industry.According to relevant data statistics, from 2012 to 2018, there were 4100 safety accidents in China, including 105 electric shock accidents, accounting for 2.56% of the total number of accidents; 5011 deaths, among which the number of deaths caused by electric shock was 112, accounting for 2.24% of the deaths[2].The Jiangsu Transportation Engineering Construction Bureau has investigated the temporary electricity consumption in the field of water transport engineering construction.Then they found that there are problems such as the large residual current protection action current and the long action time in the construction site[3].The relevant investigation and research of temporary electricity safety hazards on the construction site show that the distribution box has the highest

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proportion, and the next step is electrical installation, line laying, protection and zero hidden dangers. The above four items account for more than 90% of the total[4].

In recent years, as water transport engineering construction continue to develop towards large-scale and offshore , the construction environment has become more complex, and the exchange and transmission of information has become more frequent. The traditional management mode is difficult to solve the safety problem of temporary electricity management on the construction site, so it is necessary to introduce modern and intelligent electrical equipment to assist the site management in the construction project[5].

2 Analysis of electricity consumption problems for temporary construction of water transport engineering construction

2.1 The unstandard operation of builder

According to the requirements of relevant specifications, the low-voltage distribution box used in the construction generally adopts the three-level distribution box composed of the total distribution box, the distribution box and the last distribution box, and the power supply of electrical equipment should be drawn from the last distribution box[6]..In the current field of water transport engineering construction, the comprehensive quality of the construction team is not high, most of them are migrant workers, who have only received the basic entrance education, there are some defects in the actual operation of the equipment and the safety awareness is weak. The number of professional electricians in the construction site is insufficient. Part of the professional level engaged in electrical maintenance is insufficient. In some cases, there are even unlicensed working cases.

2.2 Special environment

Compared with other construction engineering fields, the natural conditions in the field of water transport engineering construction are even worse. The site of water transport engineering is close to coastal areas or inland rivers, with high humidity and high corrosion, is also greatly affected by extreme weather such as typhoon, cold wave and strong wind. The distribution box of conventional protection level or without effectively plugging the piercing hole is prone to the excessive humidity in the distribution box and the inner wall hung with condensed water beads, which greatly increases the risk of electric shock.

2.3 The difficulty of troubleshooting the hidden trouble

Restricted by the water depth conditions and shoreline resources, the newly built water transport terminal project is large in scale, far away from the rear substation, and the construction contents are widely distributed in space. This is the reason why the construction site of water transport engineering often sets up a large number of distribution box and the final distribution box. When a certain electrical equipment line aging, damage leakage and other conditions, the distribution box can only through the leakage of the protector and circuit breaker to provide protection, can not provide real-time warning. Due to the inability to obtain real-time information, coupled with the large number of power distribution boxes, the

maintenance personnel will also spend a lot of energy after the occurrence of the failure, and the efficiency is extremely low[7].

2.4 The situation of simultaneous jumping or leapfrog jumping

In the course of construction, this is a frequent occurrence that the circuit breaker protecting the setting priority trip is not cut, the circuit breaker of the upper level is tripped or the two-level circuit breaker is cut at the same time. It will cause a large scale of power jump, and may even affect the normal power supply of the distribution room[8].The reasons can be divided into the following points: the leakage switch or circuit breaker is not selected in the residual leakage current and fault action time; the load of the construction site is not clearly calculated, the single leakage current is excessive, leading to the simultaneous leakage in the multistage distribution box; the simultaneous leakage in the final distribution box, leading to power jump in the total distribution box.

3 The intelligent electricity management system

As shown in **Figure 1**,the intelligent electricity management system is composed of four modules: distribution box, data acquisition system, data transmission system and cloud platform system. It can realize remote state monitoring, data reading and analysis and other functions, and can release remote commands for control.

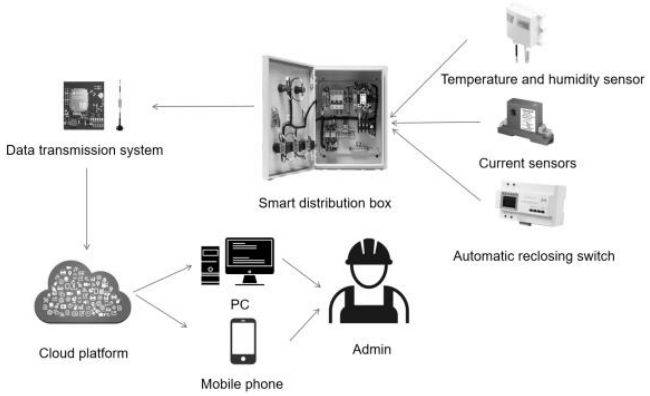

Fig. 1. The intelligent electricity management system

3.1 Distribution box

The shell level of the distribution box is higher than IP45, and the box has LCD display, which can display the internal temperature, current, voltage and other data of the box. There is an emergency button outside the box. The emergency power off of the electric box can be realized by pressing the emergency button. The sound and light alarm is set outside the box, and the alarm can be automatically realized in special circumstances. The box door switch adopts the fingerprint identification switch, and the switch management of the distribution box is realized by inputting the fingerprint of the personnel with the professional electrician

certificate, so as to reduce the possibility of illegal operation of the non-professional personnel. All the switch components are anti-corrosion products, the cable inlet is sealed with rubber sealing ring for corrosion, and the cable pipe port is blocked.

3.2 Data acquisition system

There are current sensor and temperature and humidity sensor in the distribution box, which can realize the collection of relevant parameters of the distribution box. Sensors are electronic components that can sense the specified measurement amount and be converted into usable output electrical signals. Different sensors have the principle and applicability of not use. The current sensor chooses to use the Hall current sensor to monitor the leakage, current and voltage of the protected distribution circuit. The temperature and humidity sensor chooses to use non-contact sensor, and through the monitoring of the electrical line temperature, reduce the line temperature caused by the aging damage, the air moisture, the loose electrical connection and other reasons. The distribution box is equipped with automatic reclosing power protector to realize short circuit, leakage, overload and overvoltage protection. After the current voltage returns to normal after overload and overvoltage, the protector can realize automatic closing and reduce manual intervention. In addition, the automatic reclosing power protector and the intelligent cloud platform can realize the remote opening and closing.

3.3 Data transmission system

Because the water transport engineering is generally widely distributed in the space, and the construction site environment is complex and changeable. Therefore, the traditional wired optical fiber transmission system cannot be used in this scenario. Compared with wireless transmission technologies such as WIFI, Bluetooth and mobile communication, NB-IoT technology has the characteristics of wide coverage, low power consumption and high reliability[9].Based on the characteristics of NB-IoT technology and the environmental characteristics of water transport engineering, NB-IoT technology is selected for the long-distance transmission of construction data. After the sensor in the distribution box collects the information of construction, the data is transmitted to the background application through the signal transmission module. Then the background program will upload the relevant data to the cloud platform system for data processing.

3.4 Cloud platform system

The cloud platform system is the core of intelligent electricity management system. It collects a series of data collected by the construction site in front and analyzes and calculates according to relevant requirements[10], so as to provide suggestions, assist management personnel to make leadership decisions, reduce management pressure and improve management efficiency.

The cloud platform system can realize the following functions: real-time data display function, it can read the current, voltage and temperature data in different intelligent distribution boxes of the construction site in real time, and understand the temporary electricity consumption situation of the construction site; remote control function, the management personnel can send the distribution box unlocking and distribution box power off instruction to different distribution box through the system; It can control the circuit opening and breaking in time periods, realize the power interruption and power transmission function of the construction

site, avoid workers' illegal construction operations in non-working time, and strengthen the energy consumption management of the construction site； The function of circuit hidden danger detection and processing. When the system detects the circuit hidden danger is the first time, the hidden danger will send the data to the designated mobile phone number and upload it to the cloud data center synchronously, so as to facilitate the later sorting and statistics.

4 Practical application of engineering

4.1 Project Background Introduction

A container terminal project of Ningbo Zhoushan Port plans to build a 70,000-ton and a 100,000-ton container berth, with a length of 669 meters and a width of 59 meters. The wharf structure is high piled beam-slab structure, and the pile foundation of the wharf is steel pipe pile and prestressed force composite large-diameter pipe pile. The wharf is connected with the rear land area through four approach Bridges. The length of the approach bridge is 178 meters and the width is 15 meters. The pile foundation of the approach bridge are prestressed force composite large-diameter pipe piles and drilling cast-in-place piles. During the construction period, the main electrical equipment is punching drill, rotary drilling machine, electric welding machine, air compressor, mud filter press, etc. The peak period of the construction power consumption is the construction period of the approach bridge drilling cast-in-place piles.

4.2 Application

The temporary electricity supply of the project is derived from the 9 # substation built in the port area, with 1 first-level total distribution box, 5 second-level distribution boxes and 19 third-level switch boxes. The specific Settings are shown in the **Table 1**.

Table 1. Distribution box settings

Total distribution box	1# distribution box	1# drilling rig last distribution box
		2# drilling rig last distribution box
	2# distribution box	3# drilling riglast distribution box
		4# drilling rig last distribution box
	3# distribution box	5# drilling rig last distribution box
		electric welder last distribution box
		mud pump last distribution box
		air compressor last distribution box
		sewage pumplast distribution box
		last distribution box of illumination
	4# distribution box	1# electriclast distribution box in wharf
		1# air compressor last distribution box
		1# concrete vibratorlast distribution box
		1# electric saw last distribution box
	5# distribution box	2# electric welder last distribution box
		2# air compressor last distribution box
		2# concrete vibratorlas last distribution box

	2# electric saw last distribution box
	last distribution box of illumination

The secondary distribution box adopts intelligent power distribution box, and a cloud platform for intelligent power consumption management is set up to realize the remote monitoring and management of temporary power consumption on the construction site. The display effect of the smart cloud platform is shown in **Figure 2**.

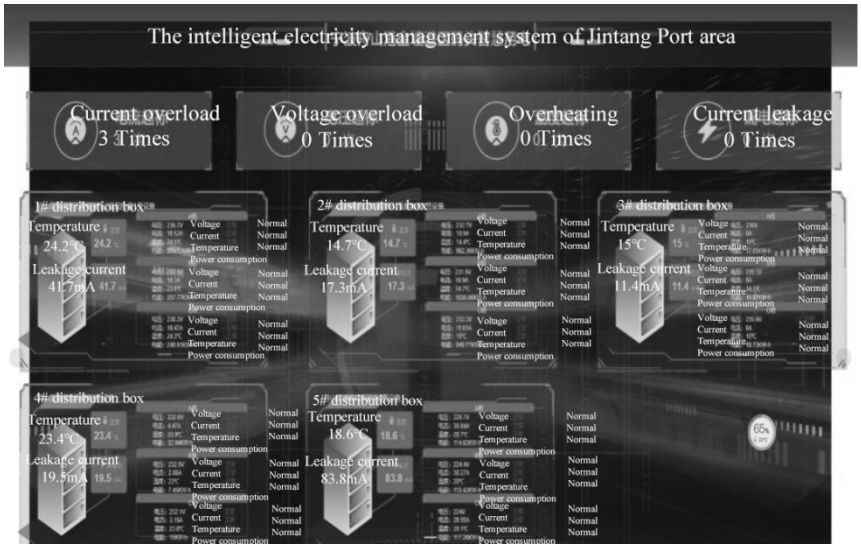

Figure 2. Cloud platform display

4.3 Effect analysis

Before the introduction of the intelligent temporary electricity management system, the construction unit organizes all parties involved in the construction to carry out temporary electricity inspection every week, and hidden safety risks can be found in each inspection, hidden dangers including workers' private wires, illegal use of sockets, the electric box is not grounded, and the non-standard erection of wires on site. After the introduction of the system, a total of three times caused by leakage alarm phenomenon, full-time electrician can according to the monitoring report quickly find out the fault point and remove fault, greatly improve the temporary electricity safety, basically eliminate the wiring irregularities or leakage protection device failure, greatly improve the management efficiency.

5 Conclusion

This paper analyzes the temporary electricity consumption of water transport engineering construction, puts forward an intelligent electricity management system. Then author introduces the composition and function of the system in detail, and applies it to the actual construction of water transport project, to prove that it has a good effect.

In the continuous development of technology now, the use of information technology for project management is the future development trend. The intelligent electricity management system can effectively solve the temporary water engineering management difficulties in the process of construction, the system can use intelligent hardware equipment and related technology, realize the water transport engineering construction site of real-time monitoring and data acquisition, ensure the safety of the site, provide support for management decisions, in the future engineering construction industry has a good prospect for development.

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