

The Research & application of Super Long Tunnel Led Decoration

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Abstract

Combining with practical application, this paper proposes to apply LED decoration technology to highway super long tunnel to realize the lighting illumination of the tunnel, and to alleviate the negative attitude and visual fatigue that the driver may experience in the super long tunnel. According to the characteristics of the tunnel, this paper came up with the design principle of LED decoration technology applied to the tunnel, chose LED point light source, designed the lighting control system and deploy method, analyzed the economics of the application.

Keywords

Research & application, Super Long Tunnel Led Decoration.

1. Introduction

With the rapid development of highway construction, there are more and more long and super long tunnels [1]. How to alleviate driver's visual fatigue and psychological influence in enclosed space and reduce traffic accidents caused by driver's visual and psychological factors has become a concern of highway construction and management departments.

The technology of LED decoration refers to splicing and fixing the LED point light source on the top of the tunnel, and automatically controlling the pattern and brightness of the LED decoration through the control system, so as to achieve the beautiful and brightening visual effect. At present, LED decoration technology has been used in urban buildings, municipal construction and other projects [2]. With the maturity of LED technology and the reduction of production cost, it is gradually feasible to apply LED decoration technology to highway tunnels in order to brighten the tunnels.

2. Design principle

According to the characteristics of highway tunnels, there are some principles in the LED decoration design, which ensure the lighting effect and extend the working time.

(1) The deploy environment is the top of the tunnel under low illumination [3], with much traffic flow[4], serious pollution of exhaust gas and dust, large seasonal temperature difference, and with intermittent vibration. Therefore, lighting source should have good robust and long working life, and the control device should be reliable under these work conditions as well. In some extreme conditions, the appropriate protection should also be used.

(2) Decoration lighting facilities should not only demonstrate the figure effect, but also provides supplements for functional lighting, and conform to the relevant rules and requirements of "Highway Tunnel Lighting Design Rules" (JTG/TD70/2-01-2014) [5]. Meanwhile the system should follow the principle of energy saving and environmental protection, which means to use the LED light source with no stroboscopic, no extra pollution, long working life and high power-saving rate to achieve the best effect in the most energy-saving and environmental protection way.

(3) The control of lighting decoration needs to be flexible. The display content and pattern can be changed at any time by remote control system, so as to reduce the maintenance cost in the working time [6]. The light source should be invisible when the light is on to achieve the best display effect.

(4) All electrical parts of LED decoration system should be protected by insulation, shielding or external protection. Electrical equipment under 2.5m from the ground should use tools or keys to open the cabinet for maintenance [7].

3. The practical application method

3.1 The selection of the LED point light source

The 30 mm LED pixel lamp is used as the point light source of the LED decoration system. The lamp is specially used in the construct building like bridges, tunnels and buildings. Pixel lamp can display pictures and animation videos after forming the LED dot matrix. Its structure is simple but with good lighting effect, and the installation is convenient. DMX512 control protocol is adopted to control all the LED pixel lamp, and all the point light sources are connected in parallel, so the damage of the single lamp will not affect the signal transmission of the whole system, ensuring the reliability of the system.

3.2 The selection of the controller

The system uses JK-C810D controller to control LED dot matrix, as the sub-controller, and the master controller is JK-SD10 which is used to control JK-C810D. The main controller and the sub-controller are connected by crossed network wire. One end is 568A, the other end is 568B. The A and B ports of the network wire can be inserted into the A and B ports of the controller at will. The distance between the output ports of the JK-C810D controller and the first pixel lamp should not exceed 60m. The connection of the system is shown in Figure 1.

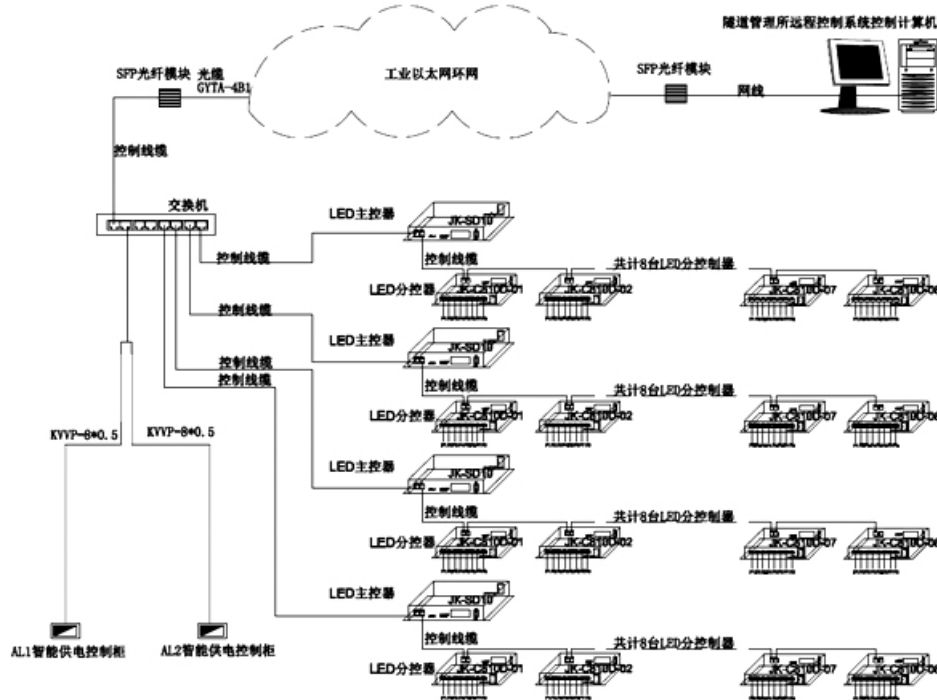


Figure 1 The connection of the system

The system support both online and offline mode. When the system is running at online mode, the network synchronization controller will segment the video data and sends it to the JK-SD10 main controller through the optical fiber network switch, and then the specific data will be transmitted to the JK-C810D controllers in preset protocol, which can update the display content of the whole LED screen decoration remotely, and reduce the difficulty and cost of maintenance. When the system is running at offline mode, the main controller JK-SD10 will distribute the data stored in SD card according to the preset protocol and send it to each sub-controller.

3.3 The installation method of the LED lamp

The LED point light source are installed on the aluminum slot. The reserved diameter of the lamp hole is 30mm, and the distance between the lamps is 167mm. The installation method of the lamps is shown in Figure 2.

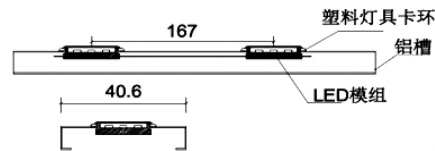


Figure 2 The installation method of the lamps

The aluminum slot is fixed on the top of the tunnel by screw, and the LED module is fixed in the reserved hole of the aluminum slot. After the installation of the slot, the cover plate should be fastened to the slot, and then fixed by screw to prevent the cover plate from falling off.

- (2) It is forbidden to install the LED point light source and the relevant electrical device on flammable materials.
- (3) The power source and all kinds of controllers must be installed in the metal cabinet according to the specifications. It should not be buried in the ground or in the wall.
- (4) The cable and wire joints of LED image point light source should be connected by terminals or tin rinse and made waterproof process.
- (5) Flexible metal conduits and flexible metal conduits can not be used as connecting conductors for grounding (PE).

3.4 The installation of the power cable

- (1) According to the location of the distribution box, cross-linked copper-core cables and armored cables are sent to the distribution point through pipe laying. According to the site conditions, cable wells and cable buried marking piles should be added. When the cable turns, the diameter of the pipe should be increased. All power supply lines and control lines should be laid through the pipe (groove) in accordance with the design specifications.
- (2) When laying out the cable construction, it must be checked by the relevant specialty before it can be constructed. When conflicting with other professional pipelines, it shall be carried out in accordance with the design specifications of power engineering cables.
- (3) The buried depth of the directly buried cable is 0.8m. When crossing the roadway, it is necessary to wear a set of ductile iron pipe to protect it. The protective pipe should extend to the roadbed of 0.5m.
- (4) Armoured cables are directly buried in the outlet line of the distribution box to the first lamp, and rubber sleeve cables are laid through the tube to other lamps since the first lamp.

3.5 Grounding System

- (1) TN-S system is used for grounding in this project. The grounding pole is set at the distribution box. The galvanized steel quasi-50 is used for the grounding pole, and the grounding flat steel is 40 x 4. The grounding resistance is not more than 10 ohms. PE line is drawn from the first lamp of each branch. The cross-section area is the same as the phase line. It is connected to the lamp shell and to the grounding bolt.
- (2) Power-off operation is required during overhaul, and personal contact is prohibited before power-off.

3.6 Notices in Construction

- (1) In the process of installation, distinguish the input voltage of lamps and lanterns so as to avoid burning out due to errors in installation.
- (2) All wiring, plug-in port connection, signal connection or power supply operation need to be carried out in the case of power failure, not live operation, all lamps and lanterns must be firmly grounded.
- (3) Pay attention to the reliable installation of lamps and lanterns.

- (4) Before switching power supply is sent, the multimeter should be used to measure whether the circuit is short-connected or reverse-connected, and the power can be sent only after confirmation of the correctness.
- (5) All wiring and joints need to be insulated and waterproof.
- (6) The wiring is arranged according to the requirements.
- (7) When connecting the waterproof joints of lamps and lanterns, they should be firmly locked.
- (8) The voltage of AC220V or its distribution box input to switching power supply should be stable, and there should be leakage protection device and lightning protection device.
- (9) Strictly abide by the requirements of electrician skills and electrical appliances during construction.

3.7 Equipment Material and Operating Cost Analysis

In super-long tunnels, a certain length of LED decoration can be set in the middle section of the tunnel according to the project conditions, and the length of 200 m LED decoration in the middle of the tunnel can be calculated as an example. The main materials of LED decoration are shown in Table 1.

Table 1 The main components of LED decoration system

Index	Name	Number
1	LED pixel lamp	48000
2	Master controller	4
3	Sub controller	32
4	Power source	280
5	Control cabinet	1
6	Network switch	1

According to each LED point power 0.72W, the total running power consumption is 34560W. According to the electricity charge standard of 1 yuan / degree, the electricity charge per hour is 34.56 yuan.

4. Conclusion

Aiming at the psychological and visual fatigue problems that often occur during driving in the super-long highway tunnel, this paper puts forward a scheme of applying LED decoration technology to tunnel lighting. According to the characteristics of the tunnel, this paper puts forward the design principle of applying LED skylight technology to the tunnel, the selection of LED point light source, lighting control scheme and construction key points, and analyses the economy of the scheme. The scheme mentioned above can alleviate the visual fatigue and psychological impact of drivers in enclosed space, thereby reducing traffic accidents caused by drivers' visual and psychological factors and improving safety.

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