Key Techniques Applied for Lighting Design on Chinese Historical Sites—Taking the Great Wall Resort in Kelan County as an Example

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Abstract. As treasure of Chinese cultural heritage, Chinese historical sites are expected to display their unique historical and architectural charm at day and night. Taking the lighting project of the Great Wall Resort of Song dynasty at Kelan county as an example, this paper explores how to set off the cultural atmosphere of Chinese ancient buildings through the design of night scenery lighting and at the same time conform to the concept of green lighting. Key techniques applied in lighting design are discussed, and through which the resort atmosphere and theme corresponding to different festivals are created.

Keywords: Historical site · Lighting design · LED

1 Introduction

Night lighting is at a stage of rapid development, and it is becoming more and more common in people's daily life [1]. Architecture is no longer a dark face at night. Under this ever-changing change, Chinese ancient buildings with unique architectural features must "wear" the "new clothes" of the lights, and they are high-quality, green and environmentally-friendly "new clothes", so as to reflect the charm of ancient buildings at night [2].

With regard to ancient architecture, people gradually realized its preciousness and paid more attention to it. The structural features of Chinese ancient buildings are that the roof wing angles are lifted; the top to bottom layers is distinct, and the left and right symmetrical layouts [3]. At present, there are many problems in lighting of ancient buildings. First of all, the cultural value of ancient buildings is greater than the value of lighting design, so we should respect history and not cause damage to buildings [4]. Secondly, the installation position of lamps is too obvious, and the daytime effect is very unattractive [5]. In addition, some ancient architectural lighting cannot express the structural characteristics of the buildings, and the lighting effect loses the historical value of the ancient buildings [6].

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2 The Song Dynasty Great Wall Resort Project

The Great Wall of Song Dynasty is located in Kelan county, Shanxi Province which starts from Qingcheng Mountain in Kelan County and east to Heyeping Mountain in Wuzhai County. The existing wall of the Song Great Wall, which is more than 20 km in the county and made up of pieces of stone. The preservation is about 4.2 m high and the top width is about 2.1 m. The implementation of the project can revitalize the countryside, integrate with the tourism industry to achieve a win-win situation in which the poor rural areas are beautiful and the industry is prosperous.

The project includes the architectural landscape lighting and Road lighting design of the Song Great Wall and surrounding Xikouzi Village, Koujia Village, Loufangdi Village, Xinjiawan Village, Wangjiacha Village, Ningjiacha Village, Qiannangou Village, Huangtupo Village and Wujiagou Village.

The Great Wall Resort in Song Dynasty is mostly built around local villages. Each village forms part of the historic block of the resort. Meanwhile, the ancient buildings inside the village have become landmarks. Therefore, the lighting of the block and the lighting of the building have become the focus of the whole project. In addition, good green planting lighting can also enhance the natural vitality of the scenic spot (Fig. 1).

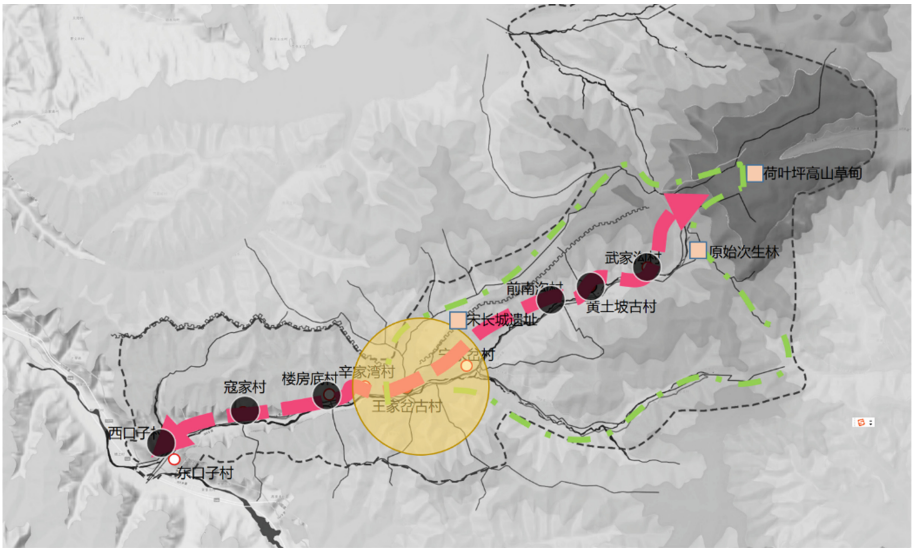

Fig. 1. The song great wall resort planning map

3 Lighting Design Concept of Ancient Architecture

3.1 Lighting of Ancient Building Streets

The opening and closing of the street are one of the artistic features of street landscape design. The opening and closing of the street start from the landscape requirements and

can form a space with an open landscape. From the night landscape, it is reflected in the light and shadow changes of the street lighting. The opening and closing of the street landscape lighting brings rich light and shadow changes to the street night scene. (see Fig. 2). The turning and opening of the street lighting bring a rich contrast of light and dark, and also enhances the sense of space throughout the night scene.

Fig. 2. Ancient building street lighting.

3.2 Lighting Layer of the Facade of an Ancient Building

The facade of traditional ancient buildings is usually composed of three levels. The eaves and the edge of the foundation plus the contour of the walls on both sides constitute the first level, the column array constitutes the second level of the building, and the wall and Windows behind the column constitute the third level. To some extent, these three levels reflect the aesthetic characteristics of Chinese ancient architecture: axis, symmetry, rhythm and proportion. Therefore, for the unique facade form of Chinese ancient buildings, it is necessary to outline the architectural structure by using facade lighting. Three levels are respectively strengthened by lamps to create the independence of each level, and "dark areas" are left between floors, which will make the architectural levels highlight through lighting techniques (see Fig. 3).

Fig. 3. Lighting effect of ancient building facade.

3.3 Green Plant Lighting in Ancient Buildings Areas

Some long-standing green plants often witness the historical origins of ancient buildings, and there are some emerging green plants in these ancient buildings, which often add some vitality to ancient buildings. Therefore, in the lighting design of ancient buildings, lighting design should also be carried out on green plants. Green plants are a spatial extension of the entire landscape and can also enhance the individualization of individual lighting space. For example, the illumination of the green plants in front of the building will make the whole space three-dimensional (see Fig. 4), which not only enhances the visual beauty of the soft scenery, but also increases the natural vitality, complementing each other and setting off each other.

Fig. 4. Green plant lighting in ancient building areas. (Color figure online)

4 Key Lighting Techniques Applied on the Project

4.1 Color Controlling

The choice of lighting color in modern lighting art can be roughly divided into two types [7]. The first one is the night-time reproduction and restoration of the original color of the subject; the second is to give it a new color to express a certain subject and mood.

The historical block where the ancient buildings are located should show the details and original color of the building, and reproduce the historical charm by restoring the color of the building itself. Therefore, most of the light sources select a warm yellow light source of about 3000 K as the main color temperature, and white light and warm white light are used appropriately to distinguish the architectural level according to the specific situation.

In 1965, CIE developed a method for evaluating the color rendering of light sources. CIE stipulates that the color rendering index can be divided into special color rendering index R_i and general color rendering index Ra. In view of the color characteristics of Chinese ancient buildings, lamps only with high general color rendering index cannot fully show the color characteristics of Chinese ancient buildings. Considering the special color rendering index of the lamps, the problem of insufficient color saturation can be solved. Red is the main theme of Chinese ancient buildings, and the special color rendering index R9 is the quality index to evaluate the reproduction of red by LED. The R9 value is required at a high level, and the "Chinese Red" characteristic of the building itself is truly restored by increasing the color rendering ability of the light source to red.

4.2 Selection and Installation of Lamps

Considering the fire prevention of buildings, the light source cannot be a heat radiation source, and the lamps inside the building should fully consider the heat dissipation. In combination with the current lighting market, LEDs have been widely used in various scenes of lighting design [8].

Solve glare problems and reduce light pollution through reasonable installation. The project is based on the transformation of the village, so the lighting renovation should be carried out on the basis of not affecting the local people. For example, if the installation of the buried lamp is required, the angle of illumination should be adjusted to the wall surface, and the wall should be illuminated by the way of washing the wall. The column lamp should be illuminated from top to bottom to prevent the light from directly illuminating the human eye and causing discomfort.

The installation method cannot damage the original building structure, and more adopts the buckle and adsorption installation method. The currently popular corrugated lamp design shown in Fig. 5 avoids architectural damage caused by the mounting method by clamping the tiles or by snapping them onto the tiles.

The mechanical structure of modern lamps and the style of ancient buildings have a strong visual impact, and this visual impact is not aesthetic. In the lighting design, it is necessary to combine most of the lamps with the architectural features of the building,

Fig. 5. Corrugated lamp installation diagram

or to match the paint color of the lamp with the building to achieve the effect of "seeing the light without seeing the lamps".

4.3 Energy Saving Modes

Green lighting is a concept put forward by the US Environmental Protection Agency in the early 1990s. The complete green lighting connotation includes four indicators of high efficiency, environmental protection, safety and comfort, which are indispensable. Energy-saving means that you can get enough lighting by consuming less electric energy, which can significantly reduce the emission of air pollutants from power plants and achieve environmental protection. Ancient buildings should also follow a certain green lighting concept as part of the night lighting.

According to the structure and function analysis of the scene, reasonable lighting brightness control should be carried out. The main street building is the most crowded area. The most prominent linear space, and the luminance control level of the main building top is $15 \sim 20$ cd/m^2. The important nodes and ancient buildings on the periphery should be controlled to the next level of luminance, about $5 \sim 10$ cd/m^2.

In the overall planning of scenic spots. The Energy-saving modes are divided into weekdays, general festival lighting and festival lighting to achieve energy saving and environmental protection. Figures 6, 7 and 8 shows the different lighting modes for the entire scenic area.

Figure 6 is the lighting effect of significant festivals. The lights in the whole scene are activated, especially the laser lamp with the logo of the Great Wall of the Song Dynasty, which reflects the prosperous festival atmosphere. Figure 7 is the lighting mode of general festivals or holidays, which mainly guarantees the lighting of some commercial areas and important functional lighting. This mode stops the roof lighting

Fig. 6. Lighting effect of significant festivals.

Fig. 7. Lighting effect of general festivals.

Fig. 8. Lighting effect of ordinary days.

of villagers' residential areas and the Great Wall District area; Fig. 8 is the normal lighting mode, but also the most common lighting mode, only retained the commercial district lighting and functional lighting, 80% of the landscape lighting stopped. Through the switching of various modes, the lighting concept of environmental protection and energy saving can be achieved.

5 Summary

In summary, the paper explores the design concept of lighting and green environmental protection for ancient buildings in today's landscape lighting through the analysis and design of the Song Great Wall lighting program in Kelan County. The lighting research of Chinese ancient buildings also needs to sum up a design style that conforms to the essence of Chinese culture, popular aesthetics and energy saving and environmental protection. Through the way of light, our ancient buildings and ancient cultures can exude their unique charm even at night.

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