Investigation on Illumination Status of Subway Station Lighting in China

Zhongchao Zhao

Department of Environmental Design, Art school, University of Jinan, Jinan, Shandong, China
534988821@qq.com

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Abstract. The energy consumption of lighting in metro stations in China is large, and illuminance is one of the important factors affecting lighting energy consumption. The article investigated the illumination of 52 station halls, 77 station platforms, and 12 channels. It was found that the illumination design was confusing, and most of them did not match the lighting design standard.

Introduction

As we all know, the subway has the advantages of large traffic volume, good comfort, fast punctuality, environmental protection, safety and efficiency, and the development of rail transit is a mature experience in solving urban traffic problems in developed countries. In Tokyo and London, the subway has taken 86% and 71% of the city's passenger traffic, which is the main way for citizens to travel [1]. China has also vigorously developed subway transportation. Until December 2014, there are 25 cities in China that have opened subways, and there are 2,027 stations in operation [2]. The next 5 to 10 years will be the golden period for the development of China's urban metro industry [3].

However, the subway is a project with high energy consumption and has become a major city power consumer [4]. Lighting is an important part of the energy consumption of the subway. In order to save energy consumption of lighting, we should understand the current situation of illumination of subway lighting projects. After all, illuminance is the main factor affecting lighting energy consumption [5]. Therefore, in July and August 2014, author and the research team members conducted a centralized survey on the station space in major cities of China, measured and recorded the illuminance data, and conducted and analysis on the survey results.

Design on Investigation

Research Methods and Means
The survey mainly uses three methods. (1) observation method. Use this method to understand the lighting source category, lighting method and other information.(2) the measured method. The illuminance meter (TES1300A) is used to measure the ground illumination of the station hall, platform and channel space. In addition, in the measurement time, try to choose the peak period of passenger flow. (3) Image recording method. During the investigation, some typical problems that are ubiquitous will be found. These problems will be recorded by camera.

Research Objects and Quantity
The illuminance survey is mainly for the subway station hall space, platform space and channel space. 52 station halls, 77 station platforms and 12 channels will be researched.

Research and Analysis

Station Hall Space
Among the 52 station halls surveyed, the vast majority used general lighting and six used partitioned general lighting.

Illumination Status of General Lighting
The average illuminance values of different subway lines are quite different. In the 46 stations, the minimum average illuminance is 22Lx at Xiaohongmen Station of Yizhuang Line of Beijing Metro.
The maximum average illuminance is 520Lx of Jing'an Temple Station of Shanghai Metro. The latter's average illuminance is 23 times than former. In order to facilitate the reasonable analysis and comparison of the current status of illumination in different stations, a statistical method using 50Lx as an illumination unit is used. Illumination unit is divided into 11 levels, namely <50Lx, 50Lx-100Lx, 100Lx-150Lx, etc. until >500Lx.

The lighting standard stipulates that the illuminance standard of the hall floor is 200Lx. but it can be seen from Figure 1, the station hall that basically matches the standard illuminance accounts 39% of the total number of surveys, and another 46% is lower than the standard, 15% is higher than the standard. In addition, about 6% is less than 50Lx, which is seriously lower than the standard, and another 6% is higher than 400Lx, which is much higher than the standard.

**Illumination Status of Partition General Lighting**

The six stations with partitioned general lighting are Ciqikou Station of Beijing Metro Line 5, Yaohua Road Station of Shanghai Metro Line 8, Xujiahui Station and Longyao Road Station of Shanghai Metro Line 11, and Suzhou Metro Line 1 The Xiangmen Station and the Gulou Station of Nanjing Metro Line 1. It can be seen from Fig. 2 that the general lighting of the station hall has the following three characteristics. (1) The illumination between the longitudinal wall and columns is generally higher than that between the longitudinal columns and columns. Among the six station hall spaces, except the Longyao Road Station, all of the other halls are this phenomenon. (2) The illuminance difference is basically between 1.5 and 2 times. The illuminance difference of the other five stations is less than 2 times except that the illuminance difference of the magnetizer station is more than 3 times. (3) the illuminance difference between different stations is large.

![Fig.1. Illumination status of the station hall general lighting](image1)

![Fig.2. Comparison of illuminance of general lighting in the station hall](image2)
Station Platform Space
This paper investigates the illumination of 77 station platform spaces. The survey found that most of station platform lighting has obvious illuminance partitioning phenomenon. The belt-type waiting area of the platform and other public areas have obvious brightness difference. Only a small number of stations have no obvious illumination partitioning. Therefore, when analyzing the current status of station illuminance, it mainly starts from two aspects. One is the current situation of illuminance distribution of strip-shaped waiting areas and other areas of different stations. The other is the distribution of illuminance differences of different stations.

Status of Illuminance Distribution
The average illuminance values of different metro lines are quite different. In the 77 stations, the minimum average illuminance is 28Lx of Shanghai Metro Line 10 Hongqiao Railway Station. The maximum average illuminance is 435Lx of Beijing Metro Qilizhuang Station. Latter average illuminance is 15 times of former, and the illuminance distribution interval is large, which is similar to the illuminance distribution of the station hall. In order to facilitate the reasonable analysis and comparison of the illumination distribution of the two station platforms in different stations, the method of analyzing the illumination of the station hall is still used here.

The standard stipulates that the average illuminance of the platform level is 150 Lx. But it can be seen from Figure 3 that the platform waiting area that basically matches the standard illuminance accounts 47% of the total surveyed, and the other areas of the platform account about 33% of the total. Overall, in the illuminance distribution, the illuminance of the waiting area is higher than other areas, and the phenomenon that the illuminance is too high or too low is still present at the platform level. For example, the waiting area of the Olympic Park Station of Beijing Metro Line 8 is only 32Lx, while the waiting area of Fengzhuang Road Station of Shanghai Metro Line 13 is as high as 470Lx. In addition, for most stations, although the illuminance of the belt-type waiting area is higher than other areas, it does not mean that the illuminance of each station space waiting area will be higher than other areas. In fact, for the same platform, the situation of many stations is that the illumination of the waiting area is lower than other areas.

Illumination Difference of Partition Lighting
Among the 77 platform spaces surveyed, there are 10 stations with uniform illumination, and there is no illumination difference between the partitions. Therefore, 67 stations with illumination difference are analyzed here. It can be seen from statistical results, 56% of the station space illuminance difference is less than 50Lx, and there does not obvious brightness difference for human visual perception. Therefore, although most platform layers use partition lighting, the difference in illumination between different partitions is not large. In addition, some sites with low overall illumination, although the illumination difference is less than 50Lx, the absolute ratio of illumination
is not small. For example, Shanghai Metro Line 10 Hongqiao Railway Station, the illumination of the
station waiting area is 52Lx, and the other area is 28Lx. The illuminance difference is 24Lx, which is
less than 50Lx, but from the ratio, the illuminance of the waiting area is close to twice the illuminance
of other areas. The illuminance difference of other 44% of the stations is greater than 50Lx,
individual sites up to 200Lx. Brightness difference is relatively large.

3.3 Channel Space
The illumination standard value of channel space is 150Lx. In this paper, a total of 13 station channels
are investigated, and the lighting methods are all general lighting. In the channels under investigation,
the minimum average illumination is 52Lx, and the maximum average illumination is 420Lx. 46% of
the channels meet the standard in illumination. This data is close to the illuminance distribution of the
platform waiting area, while the channel above or below the standard still accounts for the majority.
The channel lighting still exists similar problems and reasons to the station hall and station platform
lighting.

Conclusions
(1) On the illuminance distribution, Regardless of the station hall, platform, or channel, the
illuminance values of different stations are relatively large, and less than 50% of stations with
illuminance values meeting the standard. Most stations are higher or lower than the standard.
(2) In the mode of lighting, The station hall basically adopts general lighting mode, and a few use
obvious partition general lighting. In the platform, most of the partition lighting is used, but about
half of the partition lighting is too large different in the partition illumination value.

Obviously, from the perspective of lighting energy saving, the illuminance design of the subway
station lighting in China is chaotic, and the illuminance difference of partition general lighting is too
large. Most stations do not design illuminance according to the standard.

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