

Evaluation Method for Light Illumination of the Target Lane

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Abstract

The paper designed the light illumination of the totally enclosed target lane and found out the visual sense factors influencing the illumination system. Then, the specific index is determined and the shooting score tests and shooters' visual senses are counted in the designed light illumination system. The contrastive data analysis of natural light and light of target lane, also with optical aiming and mechanical aiming are implemented. The weight value of the light evaluation is calculated and the design is proved to be reasonable as analyzed objectively.

Keywords: subjective evaluation, light evaluation method, lighting design, closed target road

1. Introduction

All kinds of target lanes for the Ball Firing Practice are increasing with the development of the science and technology in defense and athletic sports. It's very necessary to establish the totally enclosed target lane to implement the all-weather shooting, testing, training and shooting security. The outdoor illumination environment of the target range is lit by the natural light with uniform and powerful illumination. However, the totally enclosed target lane is illuminated by the artificial controlled lights and it was always a neglected part. Usually, the light illuminate design is concentrated on the target position's illumination and the environment illumination part is ignored. In fact, environment region illumination is one of the important factors to affect the shooting for the shooters. It's the aim for the light designers to design proper illumination parameters of environment region and target position, which can reduce the differences between the indoor and outdoor's illumination to make shooters experience the comfort of the shooting illuminations (Zhang, 2012).

2. The Design Indicators of the Target Lane Illumination System

The illumination for the target lane has its own particularity and is not the same with the ordinary operation illumination. As for the totally enclosed shooting target lane, the illuminance design should be implemented in the whole space based on the night state without daylight. The design should take into account several factors, such as higher luminance in the shooting target surfaces, main environment luminance of the target lane, luminance of the target position and glare index.

2.1 Luminance of the Target Surface and Target Lane

The illuminance of the shooting target surface should be no less than 1500lx according to the technology rules of the International Shooting Sport Federation (Chinese Shooting Association, 2005). According to the visibility and amenity theory (Beijing Illumination Association, 2006), the environment illuminance of the target lane should be set as the 1/3 of the shooting target surface illuminance, i.e. 600lx.

2.2 Illumination Uniformity

Both the illumination and the illumination uniformity of the target lane should meet the system requirements. The illumination uniformity should no less than 0.6 based on the regulations of the national sports profession (Illumination Association, 2005).

2.3 Selection of the Color Temperature and Light Sources

The color temperature of the employed light source should approach the color-rendering index to simulate the natural light (sun light). The color temperature should be between 3300 K and 5300 K and the color-rendering index should be above 65. Here, the light source is selected as metal halide lamps, the color temperature is 5200

K, and the color-rendering index is 80.

2.4 The Restriction of the Glare

The glare is strictly forbidden throughout the totally enclosed target lane shooting. The direct and indirect glare will influence the aiming sense and the shooting precision of the shooters. The glare index is less than 24.

3. The Factors Affecting the Illumination Quality of the Target Lane

The construction of the target lane space is a bit special and its both sides and top are completely enclosed which should be designed as the tunnel long enough. However, it is different from the highway tunnel. The illuminance and illuminance uniformity of the target are higher than that of highway tunnel and the design should pay more attention to the visual experiences of the shooters and the choices of the ceiling, wall surfaces and material and color of the ground.

3.1 Luminance of the Ceiling

As for rooms with same height, the larger the room is, the more obvious of the visual and illuminance importance for the ceiling is. Therefore, the ceiling should be decorated by the materials with high reflectance to make use of the reflecting light beams from the ceiling to the operation surface in the target lane. The reflectance usually is set as between 0.6 and 0.9.

3.2 Illuminance of the Wall

The design for the luminance of the wall is also influenced by the length of the target lane. The wall of the target lane takes up a larger proportion in the visual range and some light beams need to reflect on the wall from the operation surface. Furthermore, it's very difficult to arrange luminance in the wall. The luminance design for wall can be implemented as the high luminance level room design method. The wall should have the sound-absorbing function, so the wall can be decorated by the materials with low reflectance and galling technique. The reflectance of the wall is between 0.3 and 0.8.

3.3 Luminance of the Ground

The ground space includes wall below the view and the floor. It's hard to construct the three-dimensional sense in the room with Light-colored floor and the little contrast between wall and floor will make the room dim. The light-colored wall cannot get better three-dimensional sense either. Usually, the space reflectivity of the floor is between 0.1 and 0.5.

4. The Experimental Verification

4.1 The Experimental Conditions

The experimental location is a totally enclosed testing target lane of a base. Several experienced excellent shooters are selected to implement the shooting tests both in outdoor natural lights and in the target lane light environment and they provided the sense evaluation for the shooting environments.

4.2 The Experimental Method

There are ten rounds Ball Firing Practice tests according to outdoor natural light and in-lane light environments. Ten shooters aimed and shot with optical and mechanical aiming devices in the two different environments. The static testing of the illuminance values are implemented after shooting. Every type of the aiming device is tested in three groups and there are 10 bullets in each group. The prone position with support and single shoot method are adopted and the firing dispersion is counted. During the testing, shooters experienced the visual senses.

4.3 Check and Record

The checking staffs checked the targets according to the commanding and they counted the value of R50 and R100. They recorded the shooting dispersion values, environmental illuminance after shooting and the description of shooters' visual senses.

5. Analysis of Shooting Scores and Shooters' Visual Senses

5.1 Evaluation Statistics of Shooters' Sense

Objective evaluation is implemented based on the two different scenes and the related factors of the natural light, such as time, weather and season should be taken into accounted. The evaluation values are shown in Figure 1, which includes shooting dispersion and comprehensive evaluations.

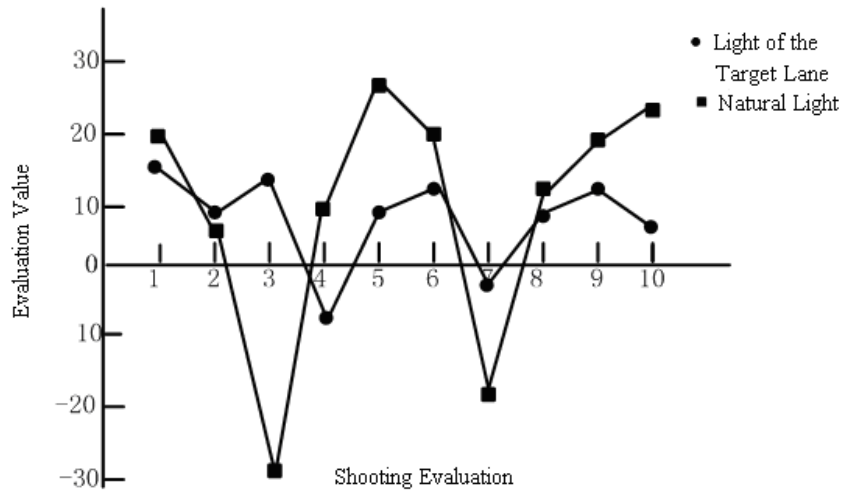


Figure 1. Shooting sense evaluation value of the mechanical aiming devices

Figure 1 shows that the shooters’ sense evaluation value after shooting of round 1 to 10 with the mechanical aiming devices, where the positive value of the ordinate denotes the satisfaction for the light and the negative one for the dissatisfaction for the light. There are outdoor natural light and target lane light environments in the figure. And Figure 2 shows the shooters’ sense evaluation value after shooting of round 11 to 20 with optical aiming devices.

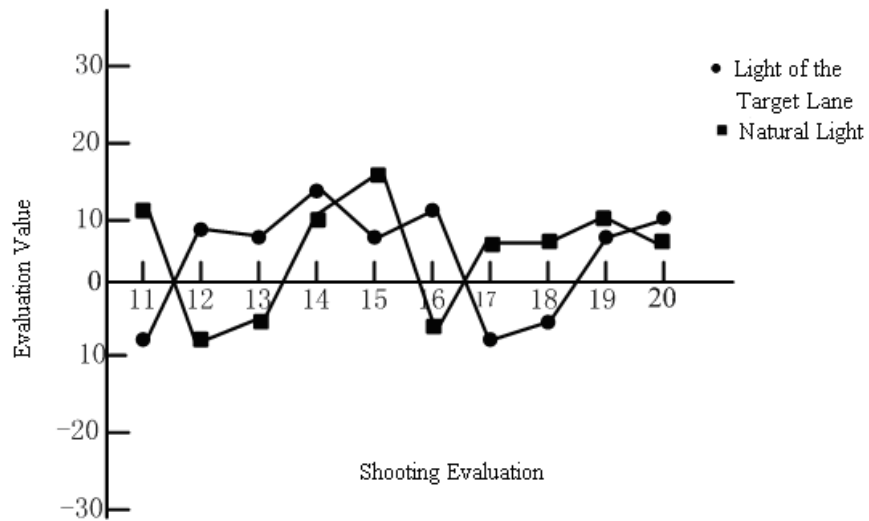


Figure 2. Shooting sense evaluation value of the optical aiming devices

Table 1. Shooting illuminance value

Scene	No.									
	1/11	2/12	3/13	4/14	5/15	6/16	7/17	8/18	9/19	10/20
Light of target lane	635	644	630	640	629	650	639	633	647	637
Outdoor natural light	30585	32556	34972	37008	41061	43709	45932	46017	48359	50085

Table 1 shows the shooting illuminance value of the target lane light and outdoor natural light. The No. 1 to 10 is shooting round number in the target lane light and No. 11 to 20 is shooting round number of the outdoor natural light. The illumination uniformity of the target lane is 0.78 and that of the natural light is 0.98. However, the illuminance of the sun will be changed from 30,000 to 50,000 to influence the shooters' visual sense because of the sun offset.

5.2 Shooting Dispersion Statistics

The visual sense evaluation is one of the objective measures and the shooting dispersion is the most important testing index shown in Table 2 and Table 3. Table 2 is shooting with 95-type general rifle of 5.8 mm and Table 3 is shooting with optical aiming of 85-type Sniper Rifle with 7.62 mm. The dispersion type includes R50 and R100 and the dispersion value of each group is an average value of three shooters. Illuminance of the target surface is 2000 Lx and that of target lane is 600 Lx.

Table 2. Dispersion of single shooting with 95-type general rifle of 5.8 mm

Shooting No.	Dispersion item	
	R50	R100
1	5.4	9.0
2	4.5	8.2
3	3.6	11.0

Table 3. Dispersion of single shooting with 85-type Sniper Rifle with 7.62 mm (with optical aiming)

Shooting No.	Dispersion item	
	R50	R100
1	4.5	9.2
2	3.9	8.6
3	3.0	8.5

5.3 Analysis of the Total Shooting Sense

The table 3 is the related analysis for the shooters' total sense of the target lane light. From the table, we can learn that shooters' sense evaluation has much contact with the shooting scores and they are necessarily related to each other. From the total evaluation, the light of the target lane is better than the natural light.

Table 4. The related analysis of the total sense

Related coefficient	Sense value	
	Sense evaluation for shooters	Shooting scores evaluation
Mechanical aiming (Sig)	0.902	0.854
Optical aiming (Sig)	0.921	0.767

6. Conclusion

The paper designed the illumination system for the target lane and many shooters with naked eye ball firing shoot to test both in optical aiming and mechanical aiming. The visual sense evaluations of both environments are recorded and analyzed. The research results showed that illuminance in the target surface is about 2000Lx and 600Lx in the target lane in the target lane light system. The parameters, such as luminance ratio among wall, ceiling and floor are designed reasonably. The illumination system of the target lane is steadier than the natural light and the target lane is an ideal training location for the firearms shooting tests.

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