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IMPLEMENTATION OF THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN CREATION OF OPTIMAL WORKING CONDITIONS ACCORDING TO THE LIGHT ENVIRONMENTAL FACTOR

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Problem statement. The implementation of the concept of sustainable development as an energy-efficient, balanced, environmentally friendly construction with a comfortable lighting environment involves a harmonious combination of resource use (natural light) and aspects of technological development (artificial sources). Since natural light is the most favorable for humans, the subject of the study was the impact of artificial lighting on human performance in the process of work [1].

A person receives up to 90 % of information through sight. V. Vavilov said that "the eyes are a remote part of the brain", so the creation of a comfortable light environment is a priority for the implementation of the concept of sustainable development in occupational safety.

According to the source of origin, there are two types of lighting in the room: natural and artificial. The natural light environment in the workplace is provided by the spatial planning solution of the room and the flow of natural light through the openings. Indicators of artificial lighting are mainly determined by the choice of lamp in the lamp. Priority solutions are the use of fluorescent or LED lighting.

Purpose of the study. **Staging an experiment.** The main indicators of efficiency are the speed and accuracy of the task. The employee focuses on the task, increases the tension of the central nervous system, emotional state, so for the reliability of the results selected the following research criteria:

1. The choice of methods of analysis of the psychophysiological state of the employee, which determines the indicators of human performance: concentration, quality of information processing, thinking process.

2. Light environment parameters:

a) levels of illumination of the workplace according to DBN B.2.5-28: 2018 and the international standard DSTU EN 12464-1: 2016 (EN 12464-1: 2016, IDT) [2; 3] from the minimum normalized to physiological comfort, obtained by scientists in branches of physiology [4; 5];

b) types of light source: natural (as a standard). Artificial: fluorescent and LED in the same levels of lighting;

c) the value of the color temperature of the LED lighting on the plane of the work surface.

Maine results. **Conducting an experiment.** Analysis of methods for studying visual performance and psycho-emotional state allowed to choose the one that adequately reflects the concentration of attention, the thought process - the Bourdon test. The paper contains 81 columns with 30 different shapes in each. Task: according to the sample, which is located at the top of the column, you need to select and cross out the figure in 12 seconds. (According to the test results it was determined: the number of processed lines, the number of errors in each line, the amount of unprocessed information) [6; 7].

Performance assessment was performed on the coefficient of productivity ($K_{\text{П}}$), which was calculated by the formula:

$$K_n = \frac{П - О}{Т},$$

where: $П$ − the number of characters viewed; O − number of errors; T − task execution time.

The higher the figure $K_П$, the higher the labor capacity labor capacity at short-term labor intensity.

Every 12 seconds the column work ended and started with a new row. This allowed at the end of testing to determine the speed during the proposed dosing load. Indicator of concentration E, was determined by the formula:

$$E = S\frac{\Sigma}{\Sigma + O},$$

where: S − the number of characters that were viewed; Σ − the number of missing characters; O − the number of correctly crossed out characters.

The smaller the figure E, the higher the efficiency at long-term labor intensity.

The study involved men and women aged 18 to 65 years, a total of 500 people. A total of 1,500 tests were processed. The study was conducted in groups of 10 employees.

The time of the study was selected, which was conducted with individuals in a state of average stability (from 14.00 to 15.00), according to the psychology of work, according to the self-assessment of psycho-emotional state (SAN scale) from 5 to 9 points. The experiment was conducted in the spring and summer, which is characterized by increased human activity and high levels of natural activity.

Light levels were measured using an instrument CHROMA METER ST520. The measurement was performed immediately before the experiment and again every 3 minutes until the end of the experiment.

Experimental studies on the effect of light parameters on the employee were conducted in 3 stages.

Stage I. Natural light environment. The experimental group of workers performed testing in the workplace in the ranges of lighting levels (300, 400, 500, 600, 750, 1000 lux). After testing, employees did not feel fatigue or overexertion (on a scale of SAN 7-9 points), the average number of errors - 16. Parameters of performance: $K_П$ = 2,5; E = 70,56.

Stage II. Artificial lighting environment equipped with lamps with fluorescent lamps. The experiment was conducted in a specially selected room without light openings, so that natural light does not affect the psycho-emotional state. The walls are painted yellow to maintain the call sign mood. The room is equipped with lamps with fluorescent lamps. The level of illumination varied in lamp power in the range of 400...750 lux. Number of errors − 17. Performance parameters: $K_П$ = 2,3; E = 136,25.

After testing, employees felt stress, fatigue, assessed the psychological state on a scale of SAN 3...5 points.

Stage III. Artificial lighting environment with CD lighting system. The same room was used for the experiment as in the second stage. Fluorescent lights off. LED lamps are connected. The level of illumination also varied the lamp power in the range of 400...750 lux. Number of errors − 15. Performance parameters: $K_П$ = 2; E = 65,8.

Conclusion

1. On the basis of the analysis of modern scientific researches of visual working capacity and existing methods of definition of their parameters, it is expediently chosen and artificially created conditions of the stated researches providing reliability and validity of experiment.

2. Indicators of working capacity of the employee increase in the range of 600...700 lux, which is consistent with scientific physiological studies of visual performance. Such levels of illumination in the workplace are provided only by adding artificial light sources in the morning and evening.

3. Productivity at short-term influence of tension is more with use of fluorescent lamps.

4. Indicators of concentration of attention of workers at long-term pressure in work are higher at use of LED lighting in the same range of levels.

5. The use of LED lighting in the workplace not only saves electricity, but also increases occupational safety, which corresponds to the concept of sustainable development as a balanced human life.

References

1. Rabich O.V., Chumak L.O. and Meshcheriakova I.V. Problema stvorennia bezpechnoho ta komfortnoho svitlovoho seredovyshcha na robochomu mistsi.*Visnyk DVNZ PDABA* [Bulletin of PSACEA]. 2018. no. 5, pp. 245−246. (in Ukrainian).

2. DBN V.2.5-28:2018. Pryrodne i shtuchne osvitlennia. Zatverdzheno Nakazom Ministerstva rehionalnoho rozvytku, budivnytstva ta zhytlovo-komunalnoho hospodarstva Ukrainy vid 03.10.2018, no. 264. (in Ukrainian).

3. DSTU EN 12464-1:2016 (EN 12464-1:2016, IDT). Svitlo ta osvitlennia. Osvitlennia robochykh mists. Chastyna 1. Vnutrishni robochi mistsia. Zatverdzheno Nakazom Derzhavnoho pidpryiemstva «Ukrainskyi naukovo-doslidnyi i nachalnyi tsentr problem standartyzatsii, sertyfikatsii ta yakosti» (DP «Ukr NDNTs») vid 28.12.2016, no. 456. (in Ukrainian).

4. Ronky L.R. O ezhednevnoi yzmenchyvosty zrytelnыkh funktsyonalnыkh vozmozhnostei. Svetotekhnyka [Lighting engineering]. 2009, no. 6, pp. 21−27. (in Russian).

5. Van den Beld H. *Svet y zdorove* [Light and Health]. *Svetotekhnyk*a [Lighting engineering]. 2003, no. 1, pp. 4-8. (in Russian).

6. Rabich O.V. and Meshcheriakova I.V. Vykorystannia metodyk psykhichnoi diialnosti pratsivnykiv dlia stvorennia spryiatlyvoho svitlovoho seredovyshcha. *Stroitel'stvo, materialovedenie, mashinostroenie. Seriya: Sozdanie vysokotekhnologicheskih ekokompleksov v Ukraine na osnove koncepcii sbalansirovannogo (ustojchivogo) razvitiya*. Vol. 99, 2017, 228 p., pp. 141−146. (in Ukrainian).

7. Rabich O.V., Chumak L.O. and Meshcheriakova I.V. Vplyv svitlovoho seredovyshcha na zorovu pratsespromozhnist operatora. *Stroitel'stvo, materialovedenie, mashinostroenie. Seriya: Komp'yuternye sistemy i informacionnye tekhnologii v obrazovanii, nauke i upravlenii*. Vol. 101, 2017, 239 p., pp. 160−165. (in Ukrainian).