Formation Of Schools Of Architecture Based On Providing Comfortable Lighting Of Classes

Saodat Mirdavidova

Abstract: The article deals with the formation of school architecture, taking into account the creation of comfortable lighting conditions in classrooms. And also provides a methodology for calculating the level of natural lighting using computer technology.

Index Terms: classrooms, computer modeling, database, light climate, methodology, module, natural lighting, programming, school building architecture.

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1 INTRODUCTION

The main task of improving the quality indicators of architectural and planning decisions of modern school buildings should be considered from the point of view of creating a hygienic environment, eliminating the possibility of deterioration in the health status of children, where the issue of normal lighting of classes occupies a special place, since this factor is the most important regulator of the functional development of the organs of vision students. The need for such an approach to the problem has matured due to the fact that, despite the existing regulatory recommendations and research by specialists in this field, comfortable lighting conditions have been created in rare classrooms. In most of them, studies show that there is either an excess or a lack of natural light, which, in turn, negatively affects the eyesight of children. One of the reasons for the formation of an uncomfortable light environment in the classrooms is that when designing natural lighting systems, the light-climatic conditions of the region are not sufficiently taken into account. The complexity of the problem lies in the fact that the natural lighting in the classrooms is constantly under the dynamic influence of such external factors as; time of day and year, state of the sky, albedo of the earth cover. Its level and quality is also influenced by internal conditions: the color of the walls, the shape and size of the room, the area of the window opening, its position relative to the wall, orientation, the use of sunscreens, etc. In conditions of such a large number of components, conducting calculations in order to select the most optimal one options for solving comfortable lighting, it seems quite complicated, long and time-consuming work, which is especially true at the modern pace of development of school construction. It seems that in this situation, only the method of mathematical modeling using computer technology will allow to obtain positive results in a relatively short time, which makes the calculation method even more promising in connection with the development and widespread introduction of computers in design practice.

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For the purposes of lighting simulation software, it is necessary to clarify and justify the requirements for comfortable natural lighting conditions, which will form the basis of a single interconnected system of mathematical calculations, the input data of which will consist of changing conditions of the external and internal environment. The study of scientific material according to the light climate of Uzbekistan, the functional features of children's vision, the effect of color finishes on the psychological state of students, the influence of the parameters and orientations of classrooms on the light mode, as well as some field measurements carried out in the course of scientific work, made it possible to put forward the following requirements, which will form the basis of lighting modeling: Given the low average annual number of cloudy days, it is necessary, when designing classrooms, to calculate the level of natural light, not only for diffusely uniform, but also for a clear sky; The minimum allowable amount of lighting at workplaces created by both artificial and natural light should not be lower than 100 lux. Studies on the work of the organs of vision show a beneficial effect on their functioning, increasing this indicator to 1000 lx. In this regard, in the calculations, in addition to the normal lighting coefficients normalized for classrooms, 1.5 and 2%, allow calculations when normalizing KEO equal to 2.5%;The basis of lighting modeling will be two main types of classrooms: square and transverse classes, taking into account the features of their application in the typical design of school buildings; When using the system of one-sided side lighting, the given parameters of the classroom must be checked for their compliance with the required standards of light coefficient and depth coefficient; Based on the operational features of classrooms, the maximum number of windows should be taken equal to 6, with a minimum distance between them of 40 cm. Also, taking these requirements into account in the calculation software will allow the architect-designer to reduce the time spent on lighting modeling related to the selection of data that complies with the standards.

2 DISCUSSION

For rooms of quadrangular shapes, which include two types of classes, the illumination is calculated at the calculated points of the characteristic vertical sections at the level of the conditional working surface (in the class it is the surface of the desks). The number of longitudinal sections depends on the depth of the room, the number of transverse sections on the number of window openings and the width of the piers that pass along their transverse axes. With this arrangement of points, a computational grid is formed, for each point of which

KEO should not be lower than the normalized value, and the uniformity of the distribution of lighting should not exceed 33%. In the case of two-sided lighting, the computational grid is built relative to the main light windows, while the KEO at each point is summed from the values created by all the window openings of the room. Today, in mathematical modeling, more accurate results can be obtained by the analytical method proposed by N.A.Danilyuk, where the geometric coefficient of natural light is calculated by the formula:

$$\varepsilon б = (\sin\alpha 2-\sin\alpha 1)/2\times 1/\pi\times((\gamma 2-\gamma 1)\times\pi/180^{\circ}+ +\sin\gamma 2\times\cos\gamma 2+\sin\gamma 1\times\cos\gamma 1)\times 100\% \qquad (1)$$

where $\angle\alpha 1$ is the angle of inclination of the plane of the triangle formed by the upper side of the light transmission and the calculated point M to the vertical surface.

$\angle\alpha 2$ is the angle of inclination of the plane of the triangle formed by the lower side of the light guide and the design point M to the vertical surface

$\angle\gamma 1$, $\angle\gamma 2$– angles formed between the straight line passing through the calculated point M to the middle of the light guide and the straight lines passing through the calculated point M to the middle of the sides of the light guide [8]. The angles $\alpha 1$, $\alpha 2$, $\gamma 1$, $\gamma 2$ can be calculated by calculating the distances in the spatial coordinate system, where you need to place the class with the location of the coordinate system in the lower left corner and determine the coordinates of the calculated point (x, y, z) and points corresponding sides of the window opening (Fig. 1). Long-term instrumental measurements carried out by H. Nuretdinov in the conditions of Uzbekistan, allowed him to recommend a formula for determining the coefficient of uneven brightness of a cloudy and clear sky:

$$q= Li/Lcp = (a + (1-a) \sin \alpha 3) / a + 2 \times (1-a)/\pi, \qquad (2)$$

where $\angle\alpha 3 = 2\times\theta$ (Fig. 1)

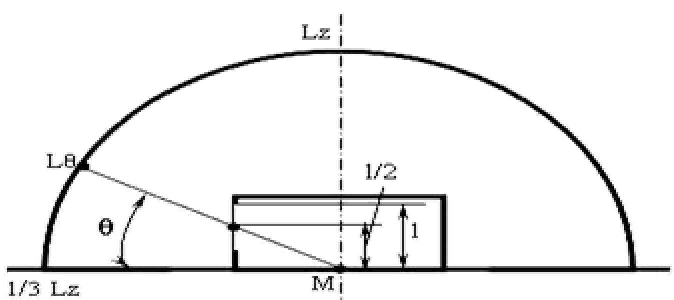


Fig. 1.

The only parameter of this formula is the value of a, which characterizes the degree of uneven brightness of the sky and represents the ratio of the brightness at the horizon Lo to the brightness of the sky at the zenith Lz. The calculation of a for the conditions of cloudy and clear sky was carried out by the approximation method, according to the results of which for a cloudy sky a = 0.42, for a clear sky a = 2.74 [4]. The calculation of sin□3 can also be done using linear distances (Fig. 1). Thus, the coefficient of natural light at each point of the room e (.) M, in the absence of an opposing building, is summed up from direct light of the sky (ε b × q × τo) entering through the window opening taking into account general light losses during passage of the glazing and light repeatedly reflected from the internal surfaces of the room and the adjacent layer, which is calculated by the formula:

$$eo = \varepsilon б\times q\times\tau o \times (r1 - 1) \qquad (3)$$

where r1 is the coefficient taking into account the increase in KEO due to the light reflected from the internal surfaces of the room and the adjacent layer, which is determined by the tabular method. Thus, the calculation of the coefficient of natural light at each point in the room is reduced to determining the linear distances from the calculated points to the window opening and the opposite building, depending on the parameters of the input data. The algorithm of these calculations was implemented in the Delfi (Paskal) software package, the results of which, subsequently, were verified by field measurements. The discrepancy between the results of field measurements with the results of theoretical calculations is 10-15%, which is an acceptable norm given the multifactorial nature of the task. In the course of computer simulation, where classes of square (7.8 × 7.8) and transverse (6.8 × 8.8) forms were considered, corresponding to the occupancy of classes of 30 people, with various input data, results were obtained that satisfy regulatory requirements for creating comfortable conditions at all workplaces of the class with the following input data:

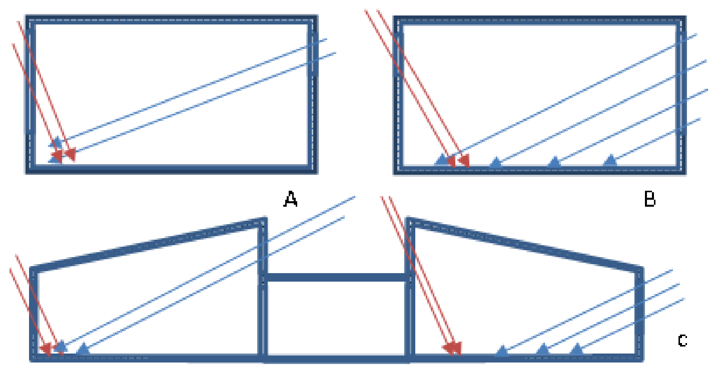


***Fig. 2**. The nature of the fall of sunlight depending on the orientation of the window openings.*

A. The windows of the main light are oriented towards the solar rumbas.
B. The windows of the main light are oriented to the northern rumbas.
C. If classrooms are located relative to a common corridor.

Table 1. Indicators of the coefficients of natural light obtained by computer simulation for the square shape class.

Room Parameters	*Check Point*	*Illumination at control points*	*Check Point*	*Illumination at control points*
7,8×7,8	*1*	*6,57*	*6*	*4,5*
	2	*5,32*	*7*	*2,15*
	3	*6,54*	*8*	*2,26*
	4	*4,5*	*9*	*2,14*
	5	*4,57*		

For square-shaped classes, windows of the main light can be separate with piers up to 0.6 m (large piers, create negative contrasts, as well as on desks opposite piers there will be insufficient lighting). For such classes, it is necessary to use additional light windows above the upper part of the right-sided wall, which go out, above the recreation ceiling or into the atrium space of the common hall. The orientation of the main light windows is both southern and southeastern, with the condition for the use of the necessary sun protection devices, and the north, which will allow the first half to actively use the light from the second light windows, due to their orientation to the solar rumbas, but the classroom will not overheat in the hot season. (Fig. 2) It should be noted that in this case, the orientation of the window openings to the northern rhombuses is preferable to the southern ones, since in this case the efficiency of the upper light openings increases due to the angle of direct sunlight to the farthest places from the main light windows As can be seen from table 1, in the square-shaped classes, subject to the use of right-sided light apertures, the illumination at all workplaces will be sufficient, the ventilation will also improve, but at the same time, the roof structure is complicated, which limits the building in the number of storeys. Such school buildings require a large building area, which allows them to be recommended for construction in rural areas and small towns, as well as in developing suburbs, as schools of small capacity. In a one-story building, the risk of accidents during fires is reduced, the best connection with nature is provided (at the school experimental site) and the most favorable conditions are created for outdoor activities in good weather.

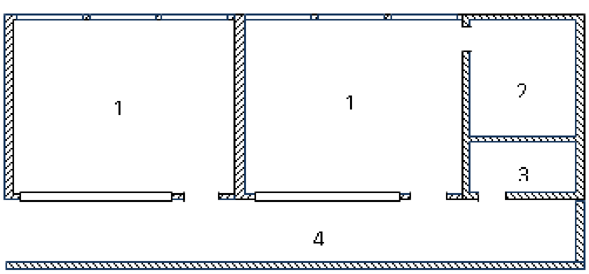


Fig.3. An example of a module of two square-shaped classes with second-light windows above

Fig.4. School project with square-shaped classes

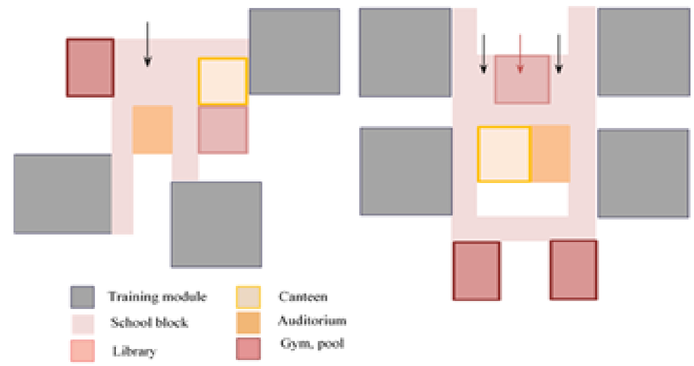
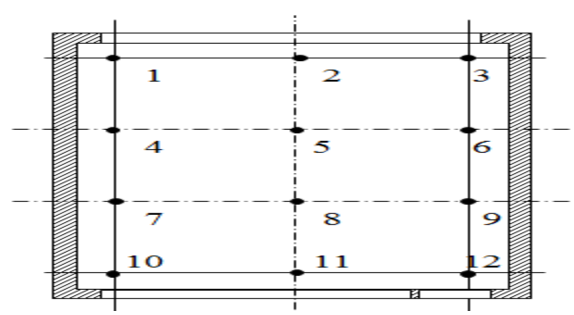


Fig. 5. Planning solutions for school buildings using the module

Such classes can be designed with access to a common corridor or recreation room, which can also be done as an atrium room, which will create a common block or module from which you can subsequently draw up a school project with options for expanding (increasing the number of blocks) as necessary. Figure 3. shows an example of one module consisting of two classes of square shape, one of which has a utility or laboratory room, with windows overlooking the recreation area and a bathroom. Using this module, you can make blocks consisting of 4 or 6 classes of square shape, depending on the planning decision of the school and easily fit the architecture of the school building into the terrain. (Fig.4) There is another advantage of the modular approach, it is possible to increase the school building as necessary (as the population increases, etc.), since the module is an independent unit that can be added to the school complex, if initially it was provided for in its architectural and planning solution. (Fig.5)

Table 2. Indicators of natural light coefficients obtained by computer simulation for the transverse form class.

Room Parameters	Check Point	Illumination at control points	Check Point	Illumination at control points
6,8×8,8	1	8,17	7	3,92
	2	6,62	8	4,33
	3	8,16	9	3,91
	4	5,19	10	5,55
	5	5,44	11	6,47
	6	5,18	12	5,47



glazing or with separate windows, the width of the walls is not more than 60 cm. In this case, the orientation of the windows is possible on almost all sides of the world, subject to the use of appropriate sun protection devices. (See table 2). Opposite buildings located opposite shadowy windows at a distance of no more than 10m with a light facade color, as in the case of square-shaped classes, will increase the luminous flux into the classroom. A block of transverse-shaped classes with full two-way lighting and access to a common corridor looks isolated. However, depending on the relative position relative to the corridor, the shape of the block will change. (Fig. 6)

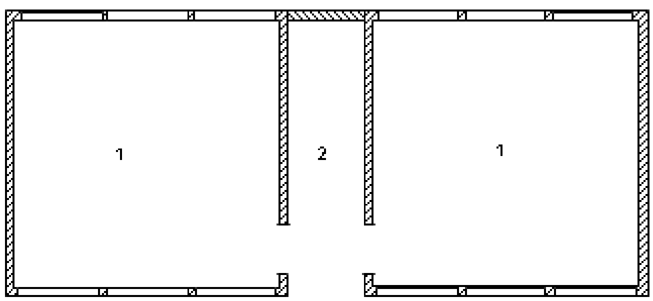


Fig 6. Module of 2 classes of transverse shape with full double-sided glazing of external walls

1- classroom, 2-recreation.

Fig 7. School project with classes of the transverse shape using full double-sided glazing

The figure 7 shows a design proposal for a two-story central-type school building, designed for 315 people for construction in rural areas with a relatively flat landscape. Educated courtyards for children to relax during breaks can also recommend these schools for construction in areas with frequent winds. Classrooms are also transverse in shape with full double-sided glazing. Classes have windows oriented eastward on one side and respectively westward on the other. Since with this orientation in clear weather, natural lighting is very dynamic in the morning and evening hours, the classroom windows are equipped with vertical screens with photosensitive sensors that allow you to adjust the angle of rotation of the screens depening on the position of the sun. In the architectural solution of the school building, vertical screens also perform a decorative function, both in shape and location, and in color.

3 REFERENCES

[1] H.N. Nuretdinov "Spatial assessment of natural lighting in the design of buildings" thesis for a doctor of technical sciences. Tashkent, 1979.

[2] V.D. Slabysheva, and A.V. Panova. "The effect of insufficient lighting in natural and artificial lighting on the health of students." Actual problems of aviation and astronautics 2.13 (2017).

[3] V.V. Chulashov, (2015). Lighting system "Smart home". In Energy, Electromechanics and Energy-Efficient Technologies through the Eyes of Youth: Proceedings of the III Russian Youth Scientific School-Conference, Tomsk, October 21-23, 2015 — Tomsk, 2015. (pp. 296-299).

[4] S.S. Khoruzhiy, 2005. School – Tradition – Translation: Aesthetic Problem in Anthropological Lighting [Electronic resource]. Access Mode: http: // www. synergia-isa. ru.

[5] V.F. Kharchenko, 2005. To the calculation of the outdoor lighting of cities. Scientific and technical collection. Public utilities of cities, (66), pp.238-242.

[6] Lyubov Teksheva, "Comparative hygienic assessment of lighting conditions with fluorescent lamps and LED light sources in schools." Lighting engineering 5 (2012): 16.

[7] Galina Fedyukina, "Modern Lighting for Schools." oletín energético. (2012): 62.

[8] B. R. Kuchma, et al. "Hygienic aspects of the use of LED light sources for general lighting in schools." Hygiene and sanitation 5 (2013).

[9] Bilal, Sameer A. "Effectiveness Of UVC Lights Irradiation To Improve Energy Saving."