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MODELING DIRECT DAYLIGHTING FROM THE SKY ON THE PANORAMA'S SURFACES

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Work is devoted to geometric modeling of direct daylighting with cloud firmament conditions on the inner surfaces of the building panorama for further define of their lightings because of the multiple reflection of light between them. In the article the charts of direct natural light on all panorama surfaces are shown.

Key words: panorama, daylighting, light vector, exposure, subject plan, the area of integration.

Formulation of the problem. One of the special types of exposition, exhibition halls have panoramic halls museum, which combines comprehensive means of painting, architecture and lighting to demonstrate historical events and natural phenomena. Panorama - a closed pattern placed on the inner surface of the cylindrical wall of the building, which together with the objective to plan for availability of the natural light passes full of events recorded by the author. The audience in the panorama at the center of events portrayed, and to review the exposure moves in a circle observation deck. Quality panoramas perception depends on the light level visibility and paintings. It is therefore necessary to provide such illumination, in which the viewer can be seen not only details in the picture and objective terms but also fully convey colors, avoid glare, shadows and blinding of direct light.

Fig. 1 shows a circuit panorama buildings, lighting and art-piece in which the objective of the plan is due to the reflected light from the surface of the panorama. To simulate natural illumination created by reflected light exposure on cylindrical surface 7 (fig. 1), you must first determine the direct illumination of all surfaces firmament panorama.

Analysis of recent research and publications. The analysis showed that in the literature there are no publications on modeling of direct daylight in buildings panorama. The method presented in design standards [1], not to determine the direct surface illumination panorama since it is valid only for rectangular vertical svitloproriziv. In [4,5] the authors developed a zoning surfaces panoramas and cylindrical area svitloprorizu shown that natural light illuminate them from the firmament shows the form fields and described their borders.

Formulation of the article purposes. The aim is to determine the direct natural light from the vault on the inner surfaces panorama to further simulate illumination exposure considering multiple reflection of light.

Main part. As can be seen from fig. 1, building panoramas are seven internal surfaces illuminated by direct light from the vault through the cylindrical svitloproriz. It:

- conical reflector surface Zonta-1;
- cylindrical surface Zonta-reflector 2;
- tapered surface observation platform 3;
- cylindrical surface observation deck 4;
- the horizontal plane observation deck 5;
- the horizontal plane of the objective of the plan 6;
- cylindrical surface of the objective of the plan 7.

Since the surface that is illuminated by direct light rotation surfaces (Figure 1) in the model of cloud firmament brightness is symmetric vertical axis, the model will direct illumination along their generators in the plane.

Note that depending on the position calculated in terms of generating visible region svitloprorizu it changes its shape. Illumination is defined as the reference point for the integration of the said areas which were described in [4,5] for each surface panoramas. Light vector coordinates in the reference point on the inner surface of the enclosure created by elementary ploschynkoyu, located within the visible outline svitloprorizu, determined by the known formulas (1) [3]:

$$\begin{aligned} \varepsilon_x &= t_x \frac{L_\theta \cdot cos\gamma}{l^2} \cdot dS, \\ \varepsilon_y &= t_y \frac{L_\theta \cdot cos\gamma}{l^2} \cdot dS \;, \\ \varepsilon_z &= t_z \frac{L_\theta \cdot cos\gamma}{l^2} \cdot dS, \end{aligned} \tag{1}$$

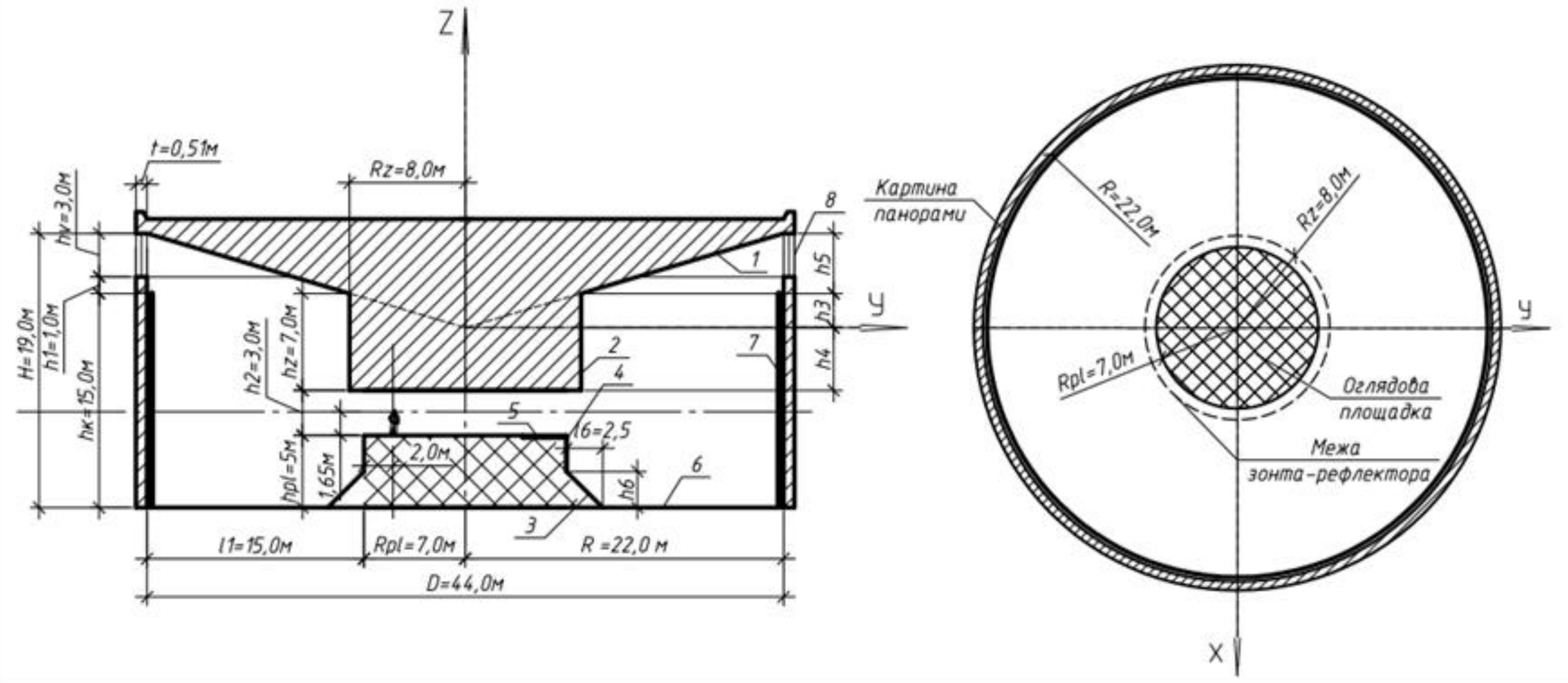


Fig. 1. Scheme of buildings panorama:

1 - conical surface reflecting Zonta; 2 cylindrical surface reflecting Zonta;

3 - tapered surface observation deck; 4 - cylindrical surface observation deck;

5 - horizontal plane observation deck; 6 - the horizontal plane of the objective of the plan;

where t_x, t_y, t_z – coordinates of the unit vector $\vec{t}$, directed from the middle unit ploschynky dS a calculated point; x_t, y_t, x_t – the coordinates of the target point; L_θ – brightness point in the sky with an angular height θ:

$$L_\theta = \frac{1 + 2 \cdot sin\theta}{3} L_z, \qquad (2)$$

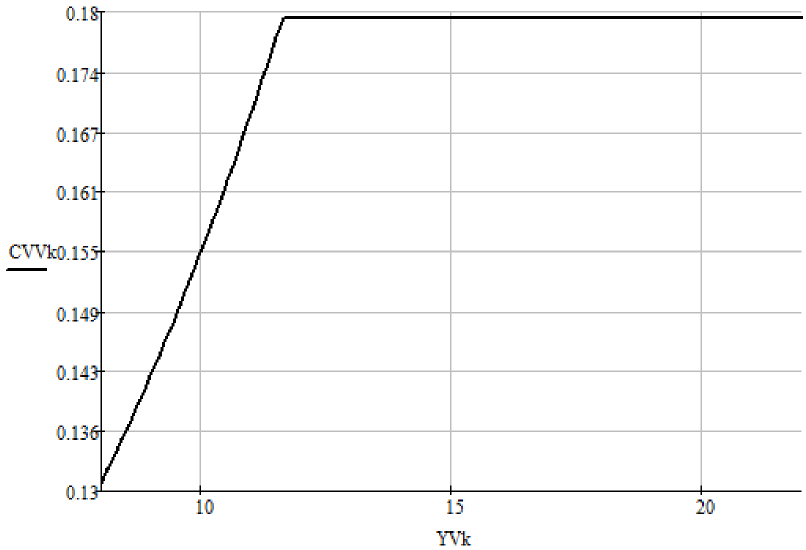
where $L_z = 1$ – the brightness of the firmament at the zenith; θ – angular height in the middle elementary ploschynky svitloprorizi; γ – the angle between the vector directed from the middle of the unit ploschynky in the design point and the unit vector normal to this ploschynky.

Integrating expressions (1) across the region Ω, limited visible from the estimated point circuit svitloprorizu, determined projection light vector corresponding to the coordinate axes. All calculations were carried out in a computer environment MathCad. As a result, received plots of direct natural light from position PT on surfaces panorama along their generators in a plane $X = 0$.

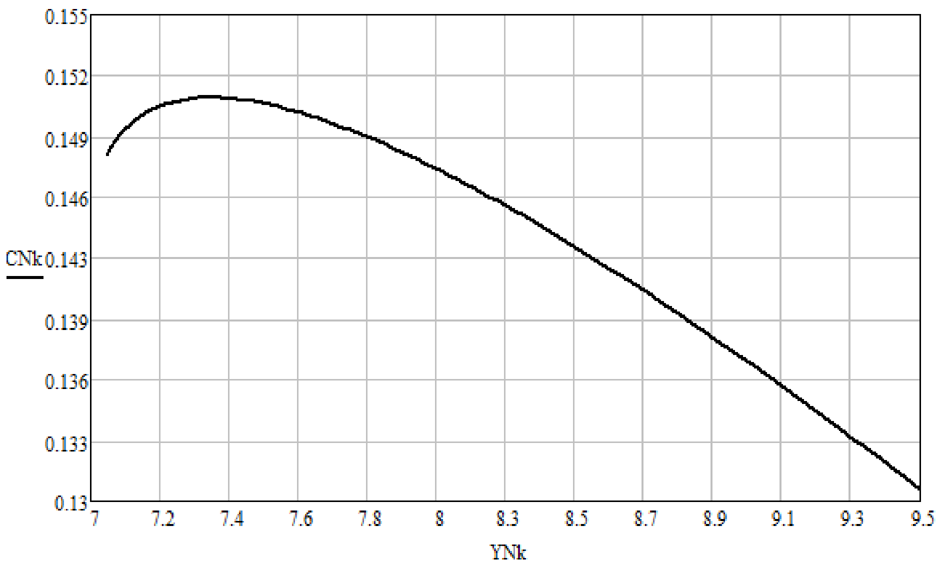
Fig. 2 shows graphs of direct illumination conical surface reflecting Zonta 1 and tapered surface observation deck 3. Illumination module is defined as the product of the light vector by the cosine of the angle between the normal to the estimated surface and the light vector. The horizontal axis applicant delayed settlement terms.

For cylindrical surfaces Panorama 2, 4, 7 illumination along their generators in the plane $X = 0$ defined as ordinate light vector. In particular, the cylindrical surface Zonta-reflector 2 and the cylindrical surface observation deck 4 was accepted ordinate with the opposite sign as ordinate vector has a direction opposite axis Y. Figure 3 shows the curves direct illumination along the generators on cylindrical surfaces 7, 4 and 2 on the vertical axis ordinate delayed settlement terms.

From the analysis of graphic dependence (Fig. 4) it is clear that the most illuminated is a central part of the cylindrical surface Zonta-reflector 2 (Fig. 4a), lighting on a cylindrical surface observation platforms 4 increases proportionally reduce the distance between RT and svitloprorizom (Fig. 4c), and the maximum value of the illumination cylinder substantive plan 7 - at the bottom of Zonta-reflector (Figure 4, b).



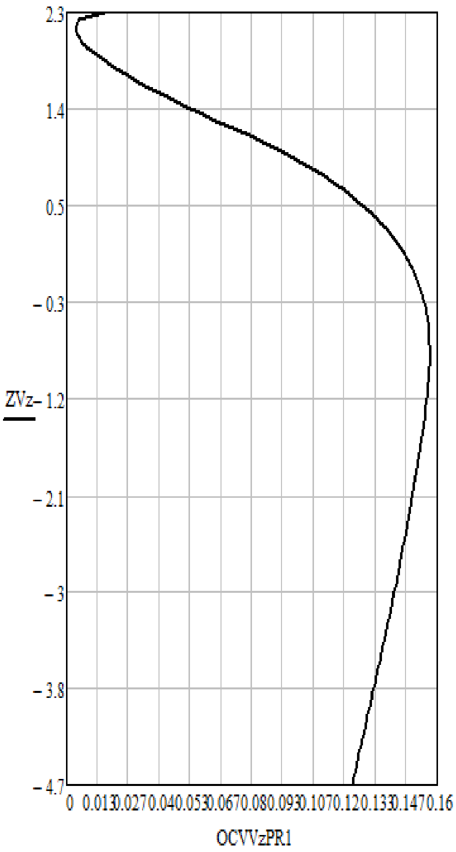
a



b

Fig. 2. table of direct natural light:
a - the conical reflector surface Zonta-1;
b - tapered surface observation platform 3

Fig. 4 shows graphs of luminance horizontal plane of the objective 3 plan and to the horizontal plane sightseeing platform 5. They are defined as illumination light vector applicants with the opposite sign, since the applicant vector directed in the direction of the axis Z. Note that the horizontal part of the observation deck is not exposed to direct light from the vault, so the illumination of the zone is zero (Fig. 4a). The horizontal axis applicant delayed settlement terms.



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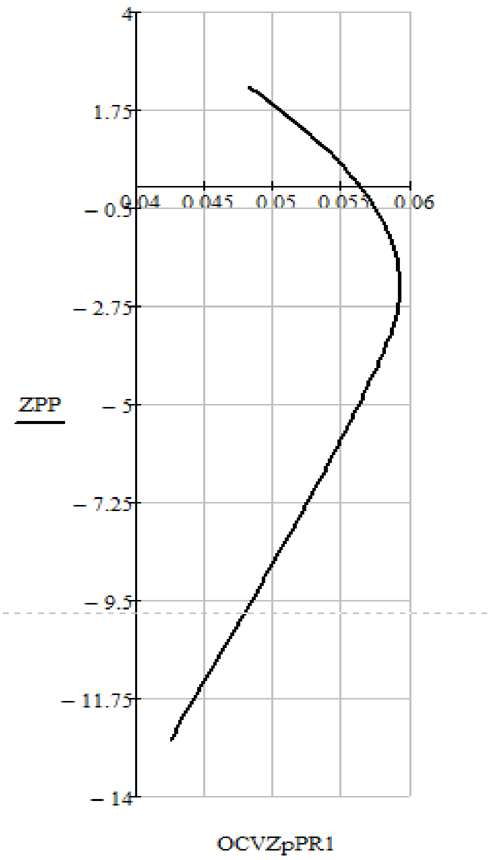

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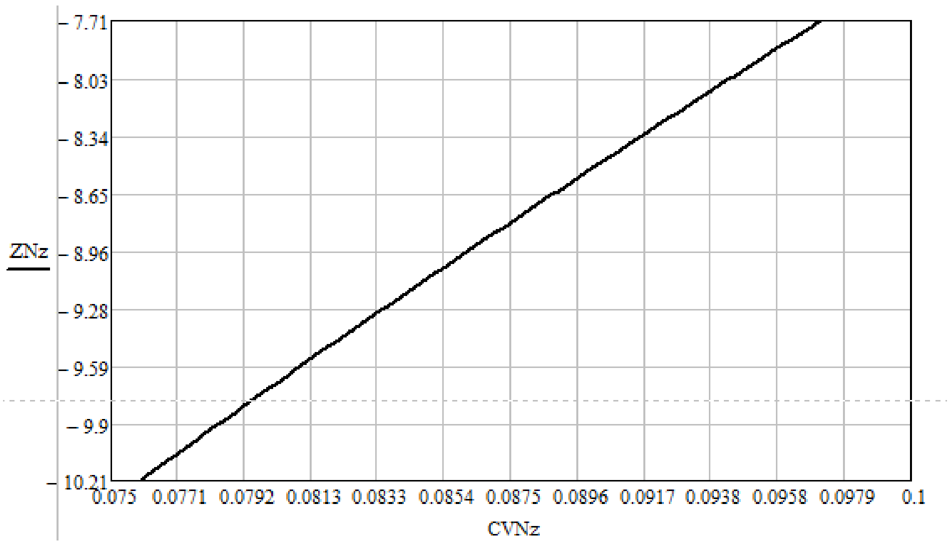
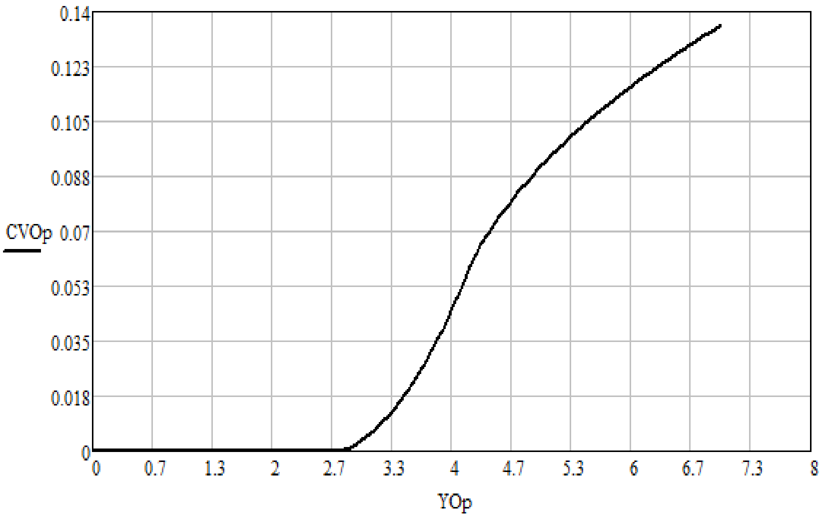


c

Figure 3. Table of direct natural light:
and - the cylindrical surface reflecting Zonta 1;
b - cylindrical surface of the objective of the plan 7;
c - cylindrical surface observation deck 4



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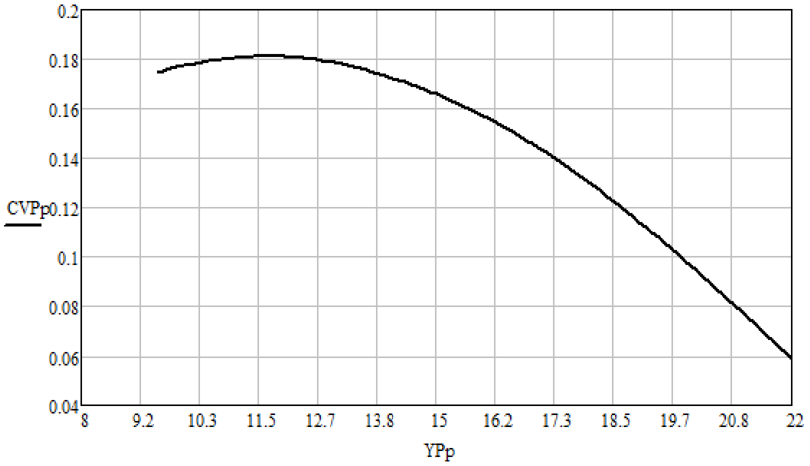

б

Fig. 4. Table of direct natural light:
a - the horizontal plane observation deck 5;
b - the horizontal plane of the objective of the plan 6

Conclusions. The paper presents a method of determining the direct illumination of interior surfaces in buildings panorama, which is implemented in the computer environment MathCad. This will further simulate the lighting of surfaces considering multiple reflection of light.

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