

The use of object programming on Blender 3D for designing on the example of the calculation of the skinning and arrangement of stringers of the segment hydraulic shutter

Zayniddinov B.G.

Assistant, Tashkent State Technical University, Uzbekistan

ABSTRACT: The article considers the automation of the design of the segment hydraulic shutter by means of Blender 3D. Calculation and drawing of the shutter is performed in the Blender 3D environment.

KEYWORDS: Blender 3D, programming, object, segment hydraulic shutter, automatic water distribution system.

I.INTRODUCTION

General information on Blender 3D. The Blender program is an excellent 3D editor with Russian language support that can surprise any user with the size of its installation file and the amount of space it occupies on the hard drive of the computer. However, this does not mean that the set of useful functions and pre-installed textures in the editor is truncated or limited. To increase the toolkit the user can use third-party plug-ins, both from free developers, and from the official manufacturer of this software. Blender 3D also has many other advantages: High speed of creating applications with a graphical interface for MS Windows.

If desired and proper skills, the user can make the necessary changes to the kernel of the program, because the blender software for 3d modeling is free software with open source. This is what distinguishes it from other free analogs that do not allow interfering with the work of its own algorithm.

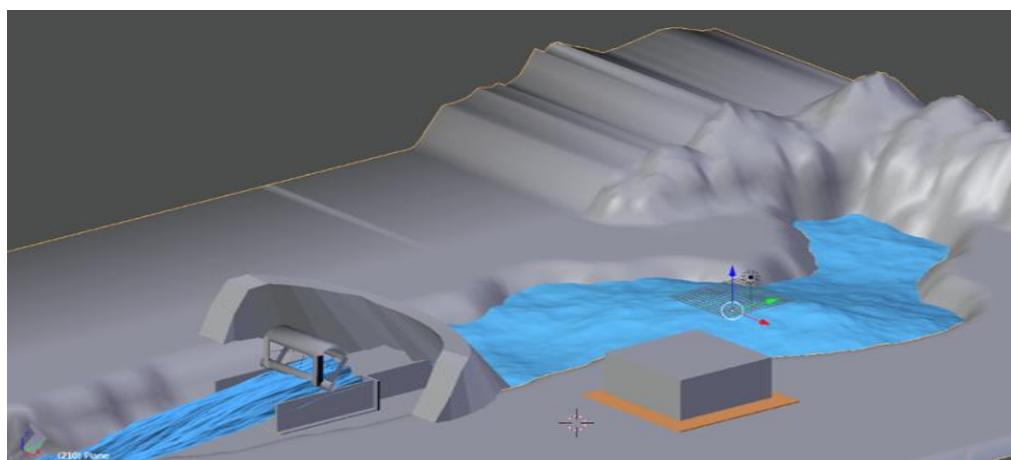


Fig 1: 3D model of automatic water distribution system by channel in the water storage.

The installation of the Blender 3d editor on the computer is no different from installing any other windows-program. This procedure, as a rule, does not cause problems even for not very experienced users. However, in the first seconds after the launch of the 3D editor, the working interface can be very surprising. This applies to even a sophisticated



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expert in 3d modeling. You will notice that nothing similar to the usual Light Wave, 3DS Max or Maya in the Blender program is not present. Do not be scared and the variety of bright colors of numerous icons and the lack of familiar hints that should pop up when pointing at the cursor object. Introduction to the Blender management system should start with reading a special help file. After all, only at first glance the interface seems complicated and not easily understood - it's all about its high interactivity.

In addition to the help, in the network you can find a huge number of lessons, which will allow you to better understand the wisdom of this editor. When creating a 3D model, every detail on the screen can be moved to a convenient place for you and fine-tune the work of the application for your own style of work. The main and most popular functions can easily be transferred to special buttons - hot keys, and unnecessary tools to be removed further out of sight [1].

General information about hydraulic gates. Hydraulic shutters are part of the hydraulic front of the hydraulic structure and are designed to shut off culverts and navigable holes and regulate the flow of water. The gates are divided into surface and depth. For operational purposes, the gates are divided into main, emergency, repair and construction. The most common type of shutter is a flat shutter, the main advantage of which, compared to others, is the simplicity of design, ease of maintenance and repair. However, they require powerful drive mechanisms to overcome their own weight and frictional forces in the running gear when the bolt is raised.

Segmental closures are used less often due to the complexity of their structural shape and increased accuracy in manufacturing and installation. Advantage of segment shutters in front of the flat ones is a lower lifting force, greater maneuvering speed and high reliability of operation in winter. The cost of their manufacture is 10-15% higher than the cost of flat gates [2].

The cross section of the span structure of the segment gate is a segment of a circle whose center usually coincides with the axis of rotation of the shutter. The segment rests on the legs, through which the pressure is transferred to the hinges. The support hinges are fixed to the sidewalls of the culvert. The hydrostatic pressure of the water is transferred to the skin, then to the stringers, diaphragms and crossbars.

II. SIGNIFICANCE OF THE SYSTEM

Calculation of water-retaining skin and its automation. One of the tasks in the design of the steel shutter is the design of a water-retaining sheath experiencing bending. Since the skin is based on stringers, its calculation depends on the stringer's step, so the design of the skin and the placement of the stringer are performed simultaneously. Since, as often happens in the design, there are much more unknown parameters than the resolving equations, then some parameters are set initially.

We give the sequence of calculating the skin (approximately from the strength condition for cylindrical bending) and the placement of stringers of the steel segment hydraulic shutter.

The calculation begins with the determination of the general dimensions of the gate, with the known initial parameters: γ_c – is the coefficient of operating, γ_n – coefficient of reliability by designation, R_y – the design resistance of the steel of the skin to the bending along the yield point; t_0 – thickness of the skin (specified initially), $\gamma \approx 10^4 \text{ H/m}^3$ – specific weight of water; C – the excess of the center of rotation of the shutter above the water level, H – pressure level, R – the radius of the shutter along the inner edge of the skin (see Figure 2).

Length wetted with water skin:

$$e = \frac{\pi \varphi R}{180},$$

where $\varphi = \beta - \alpha = \arcsin \frac{C+H}{R}$, $\alpha = \arcsin \frac{C}{R}$.

Equal hydrostatic pressure:

$$P = \sqrt{P_{hor}^2 + P_{vert}^2}$$



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where the horizontal component of water pressure:

$$P_{hor} = 0.5\gamma H.$$

The vertical component of the pressure, equal to the Archimedean force, i.e. weight of fluid displaced by the shutter:

$$P_{vert} = 0.5\gamma R^2 \left(\frac{\pi\varphi}{180} + 2\sin\alpha \cos\beta - 0.5(\sin 2\alpha + \sin 2\beta) \right).$$

The slope of the resultant hydrostatic pressure:

$$\alpha_1 = \arctg \frac{P_{vert}}{P_{hor}}.$$

The condition for the strength of the skin when bending at the i-th section between adjacent stringers at a given thickness t_0 :

$$b_i \leq b_{i,lim} = t_0 \sqrt{\frac{2R_y Y_e}{\gamma h_i Y_n}},$$

where b_i – is the actual span of the skin (or stringer step) on the i-th section, $i = 1 \dots n$;

$b_{i,lim}$ – the limiting span of the skin on the i-th section from the condition of its strength under cylindrical bending; n – is the number of spans of the skin. Depth of immersion of the i-th stringer:

$$h_i = R \sin(\varphi_i + \alpha) - C,$$

where

$$\begin{aligned} \varphi_i &= \frac{180 l_i}{\pi R}; \quad l_i = l_{i-1} + b_i, \\ \varphi b_i &= \arcsin \frac{C + h_i}{R} - \arcsin \frac{C + h_{i-1}}{R}. \end{aligned}$$

The problem of calculating the skin consists in sequentially placing the stringers in such a way that on each i-th section condition $b_i < b_{i,lim}$, is satisfied on each i-th section, and it is obvious that this is obvious $\sum_{i=1}^n b_i = l$. The above algorithm is implemented in an Excel environment using Blender 3d. The Excel sheet contains the original data and the calculation results are displayed in a tabular form.

Table 1. Form of the table of calculation results in the environment of Excel

Nº	b_i	h_i	φ_i	φb_i	$b_{i,lim}$	The fulfillment of the condition $b_i < b_{i,lim}$
1						
2						
3						

After the calculation, the cross sectional image of the segment shutter is automatically executed using Blender 3d. Those. the program code in Excel program calls the AutoCAD program and executes the shutter drawing in accordance with the parameter values. Drawing is performed in accordance with a given scale with automatic putting all necessary dimensions. The shutter image allows you to evaluate the correctness of its layout (including placement of stringers). Note that the calculation of the skin and the placement of stringers in a flat gate is a special case of a segment seal. Segmental shutter becomes flat at its radius $R \rightarrow \infty$. In Excel source data, you only need to enter a sufficiently large radius (in fact, it is enough 107 m) and $C = -H / 2$.

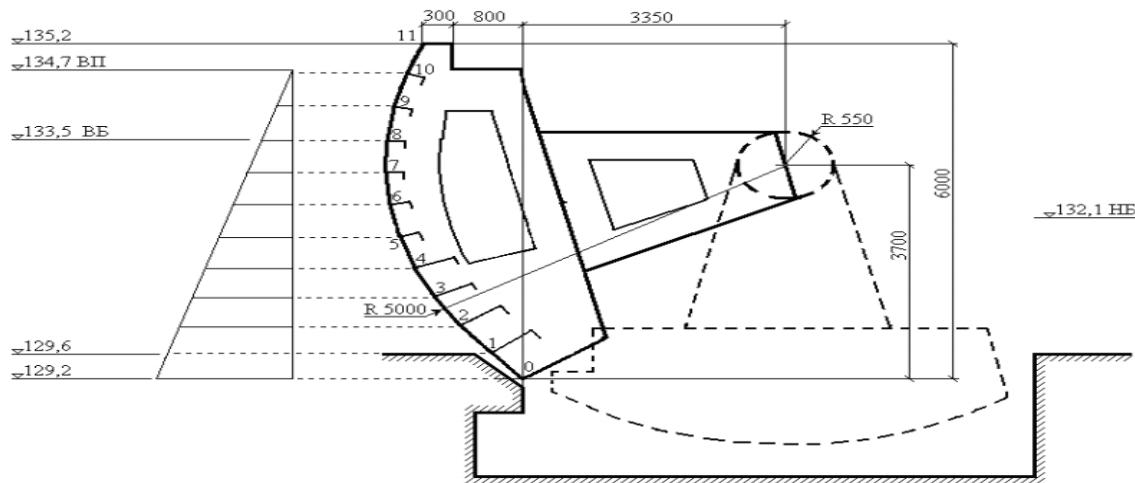


Fig 2: Segment gate circuit.

III.CONCLUSION AND FUTURE WORK

At present, all engineering, design, and economic tasks can be solved on a computer, and in most cases there is absolutely no need to engage in programming in the traditional sense. This, of course, will affect the speed of computing and will require the use of a more powerful computer. But for many analytical algorithms, taking into account their simplicity, increasing the calculation time does not play a big role, since the order of the resolving algebraic system of equations in many cases does not exceed 1000, allowing to obtain a result satisfactory for practice. But, of course, the main advantage of the proposed mathematical model is the analytical solution of the problem in the form of a formula that allows you to easily and quickly calculate various designs, loads and fastenings, that is, to optimize the design.

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