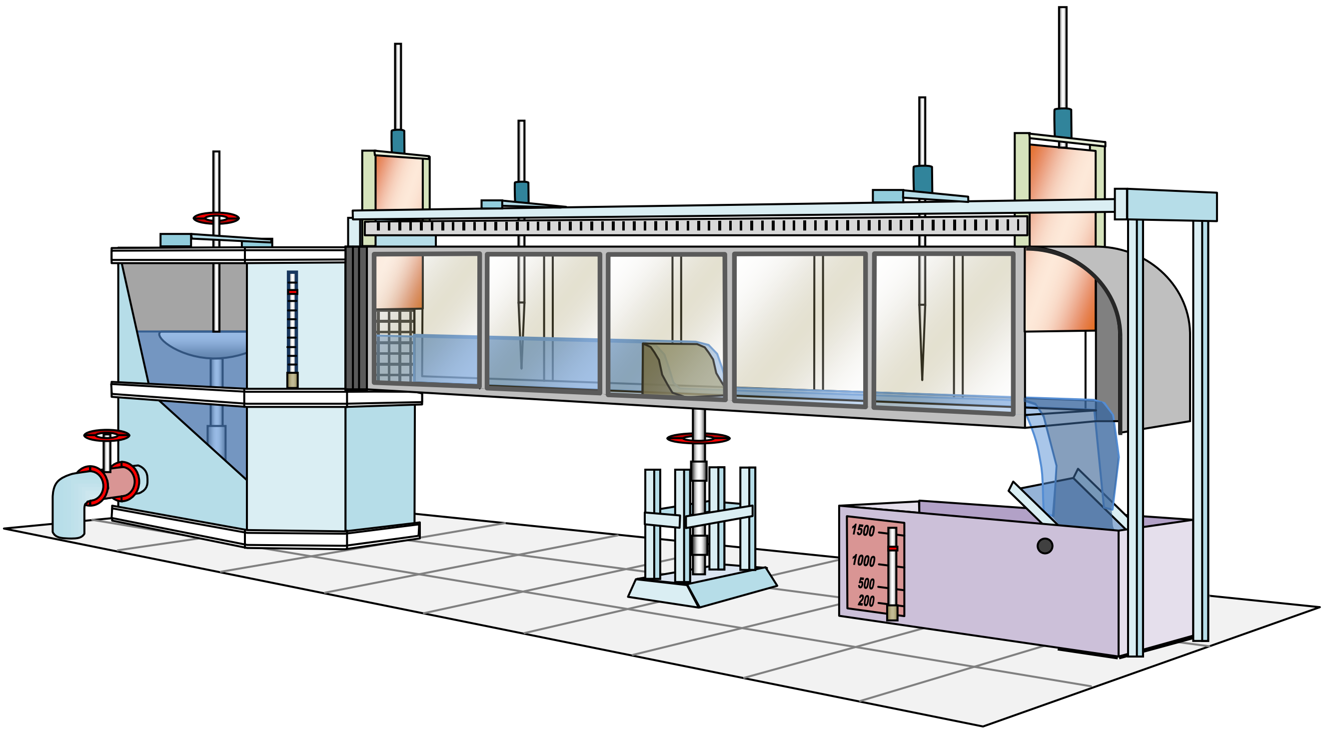
VIRTUAL LAB
«OPEN CHANNEL HYDRAULICS»

Water Surface Model Editor
User Manual



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The Procedure for Working with the Simulation Models Editor

Description of the Elements of the Main Window

After installing the software product on the computer's hard drive, shortcuts for launching programs are created in the Start menu and on the «Desktop» of the Windows operating system (Figure 1).

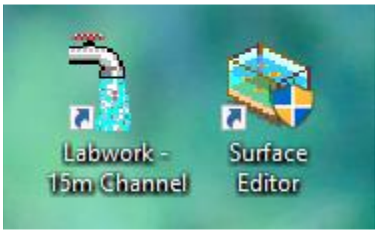


Figure 1 – Launcher Shortcuts

By default, the model editor starts with administrator rights, which is necessary to freely save data on the hard drive (in particular, on the system partition «C» of the computer's hard drive). To start the model editor, hover over the corresponding shortcut and double-click (click) the left mouse button. When starting the program from the Start menu, one click on the shortcut is required.

After starting the editor, the main program window will open on the screen (Figure 2).

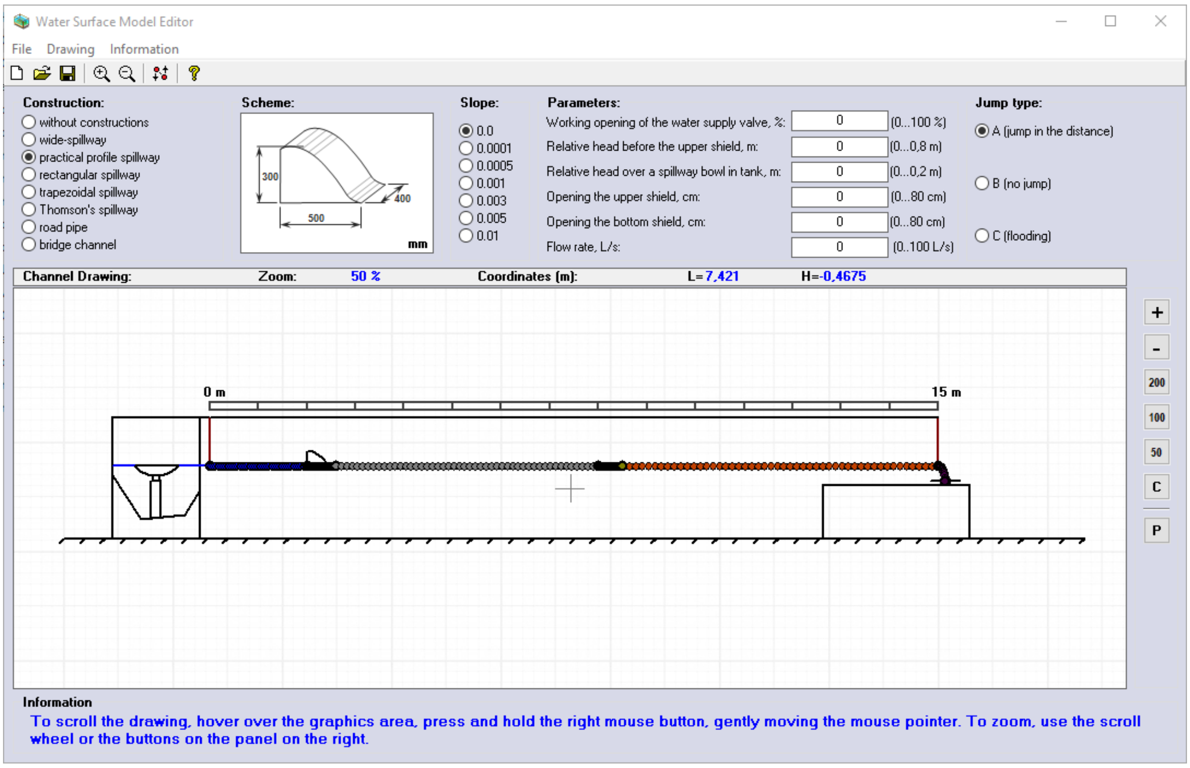


Figure 2 – Main Window of the Program

In the main part of the window, a drawing of the laboratory installation is displayed. To scroll a drawing, you need to move the mouse pointer to any area of the drawing, press and hold the right mouse button, smoothly moving the mouse in the desired direction. During the move, the mouse pointer will look like a crosshair from the arrows (Figure 3).

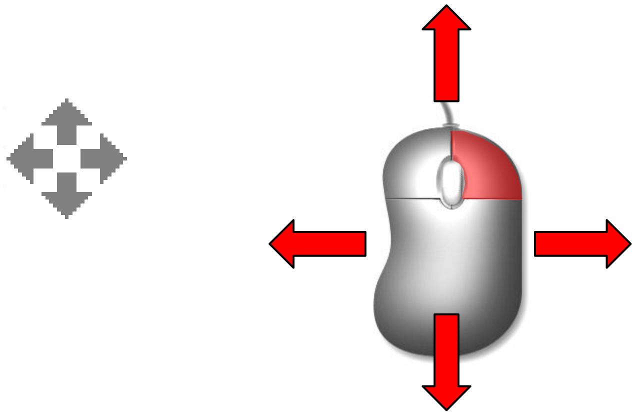
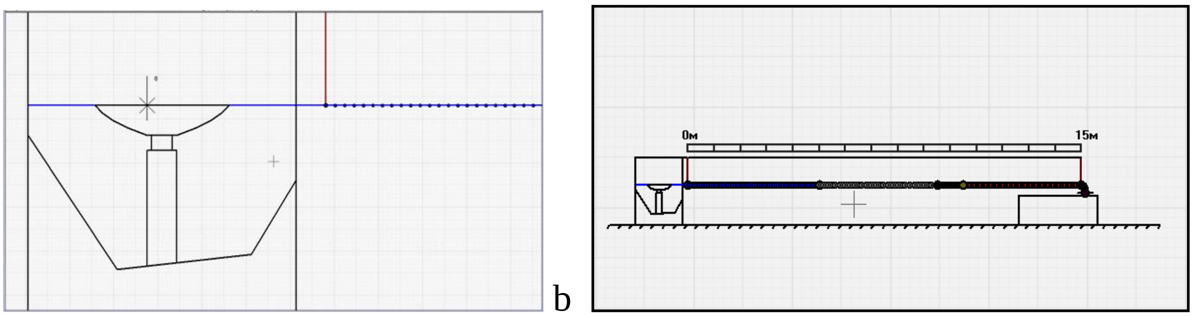


Figure 3 – Scrolling a Drawing with the Mouse

You can use the mouse scroll wheel (scroll) to scale the drawing. Rotation of the scroll from itself will lead to an increase in the scale of the drawing, and rotation to itself will decrease. Numerically, the scale is estimated as a percentage of the increase in the original (screen) image. The minimum scale is 30%, and the maximum is 2000%.

a 

b

Figure 4 – Image of the Drawing at Scale Values: 300% (a) and 30% (b)

All constructions in the drawing are made automatically, depending on the specified parameters. The drawing is the main means of visual control of the free surface curves of the simulated flow. Above the drawing is an information line (Figure 5), which displays the current scale and coordinates of the center point of the screen (sight) in natural units (meters).

Figure 5 – Drawing Info Line

To the right of the drawing is an auxiliary quick access panel (Figure 6), which includes 7 function buttons.

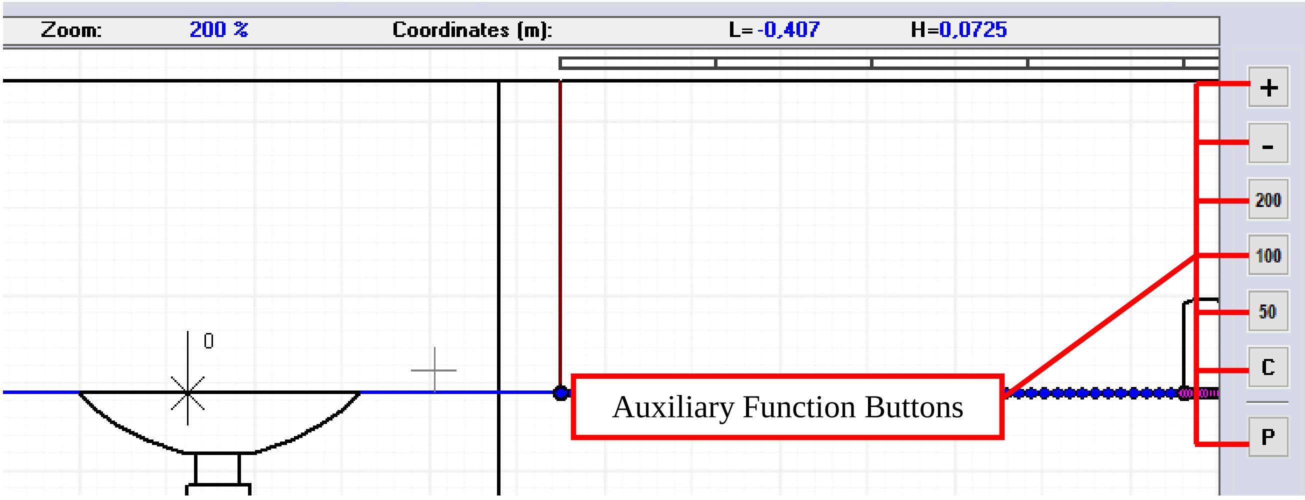


Figure 6 – Assistant Quick Access Toolbar

The first 6 buttons (from top to bottom) duplicate mouse functions when working with a drawing. The buttons with the «+» and «–» signs change the scale of the drawing step by step. The buttons «200», «100», «50» specify 200-, 100-, and 50 percent scales, respectively. The «C» button centers the drawing (the sheet is positioned so that the center point of the screen is in the middle of the channel image). The last point with the image «P» opens the editor of the points of the designed curves of the free surface, the description of which will follow. Some of the functions presented are duplicated in the main window menu (Figure 7.a), as well as on the toolbar at the top of the window (Figure 7.b).

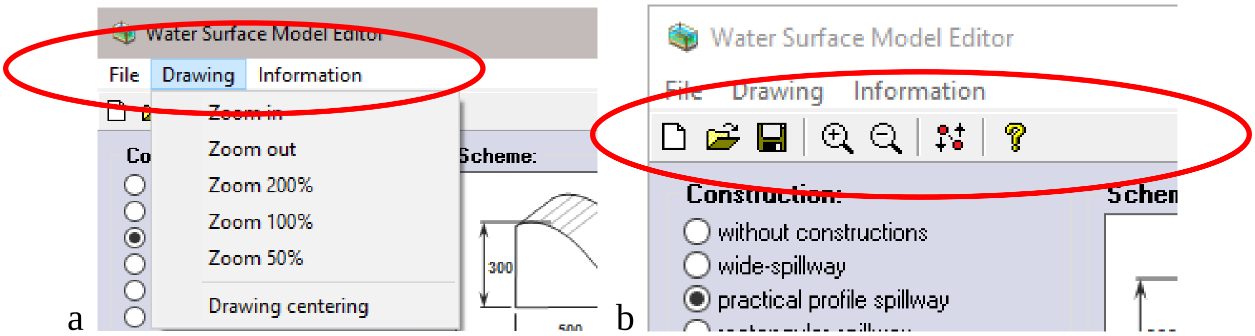


Figure 7 – Duplicate Functional Elements of the Interface: Main Window Menu (a), Upper Toolbar (b)

At the bottom of the window (below the drawing), brief text messages are displayed that reflect basic information about a specific interface element.

An important functional element of the program is the panel of parameters of the laboratory equipment located above the information line of the drawing (Figure 8).

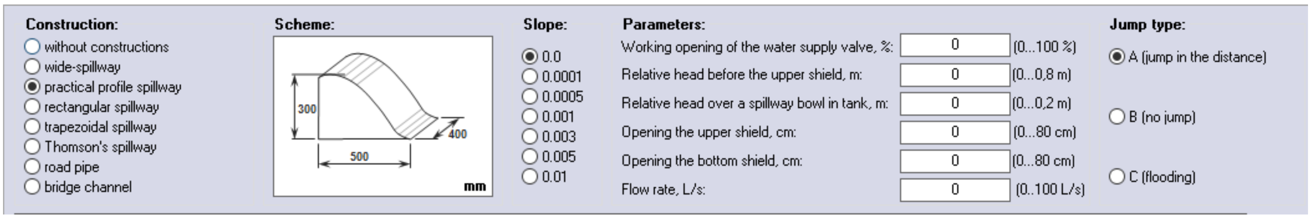


Figure 8 – Parameters Setup Panel

The first block (from left to right) contains 8 switches that are responsible for the choice of structures installed in the channel, depending on the conditions of the task in question. By default (when the program starts), the first position "Without constructions" is selected. The choice of the user is available 7 designs that mimic various hydraulic structures. To the right of the first block of switches is a miniature design diagram (Figure 9), and its main dimensions (in millimeters).

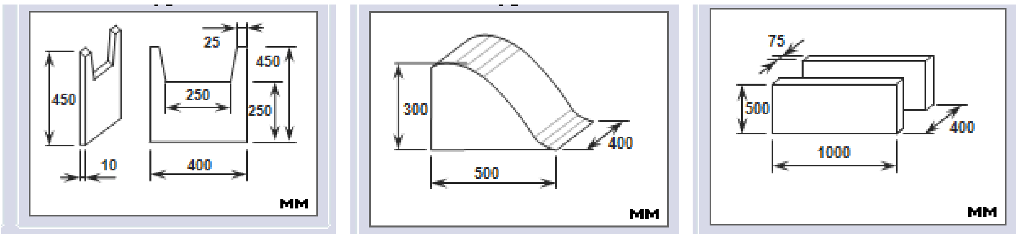


Figure 9 – Constructions Schemes

Construction No. 1: «Spillway with a wide threshold» – a horizontal rectangular geometric body, the dimensions of which are shown in Figure 10.

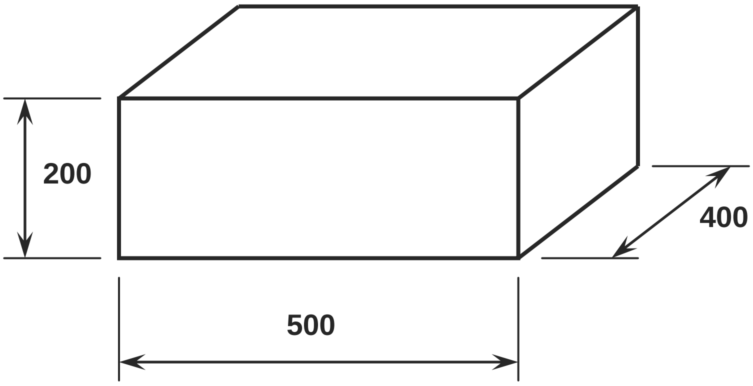


Figure 10 – Dimensions of Wide Threshold Spillway Construction

Construction No. 2: «Practical Profile Spillway» – a curved geometric body, the dimensions of which are shown in Figure 11.

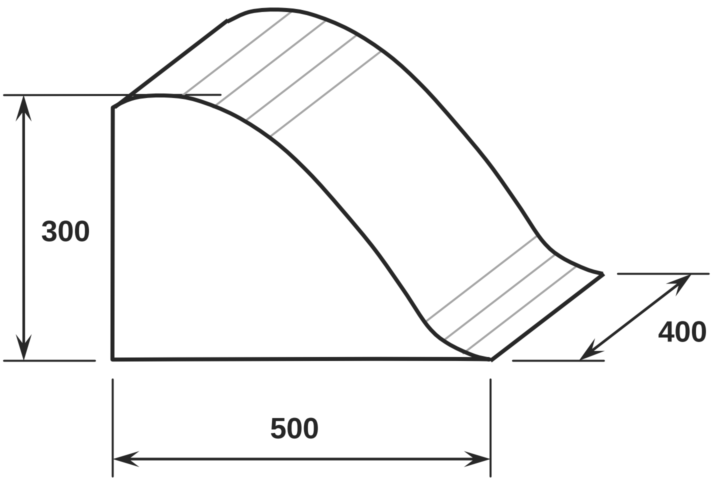


Figure 11 – Dimensions of the Construction of the Practical Profile Spillway

Construction No. 3: «Rectangular spillway with a thin wall» – a rectangular thin-walled geometric body, the dimensions of which are shown in Figure 12.

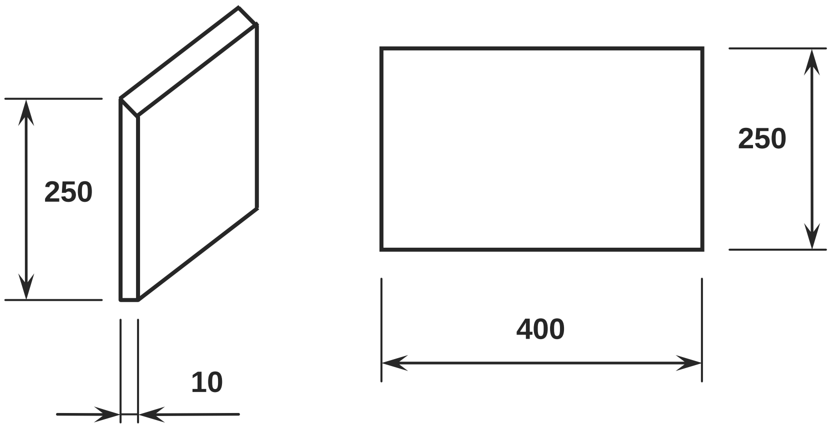


Figure 12 – Thin-Wall Rectangular Spillway Construction Dimensions

Construction No. 4: «A trapezoidal spillway with a thin wall» is a thin-walled geometric body with a characteristic shape of a cut, the dimensions of which are shown in Figure 13.

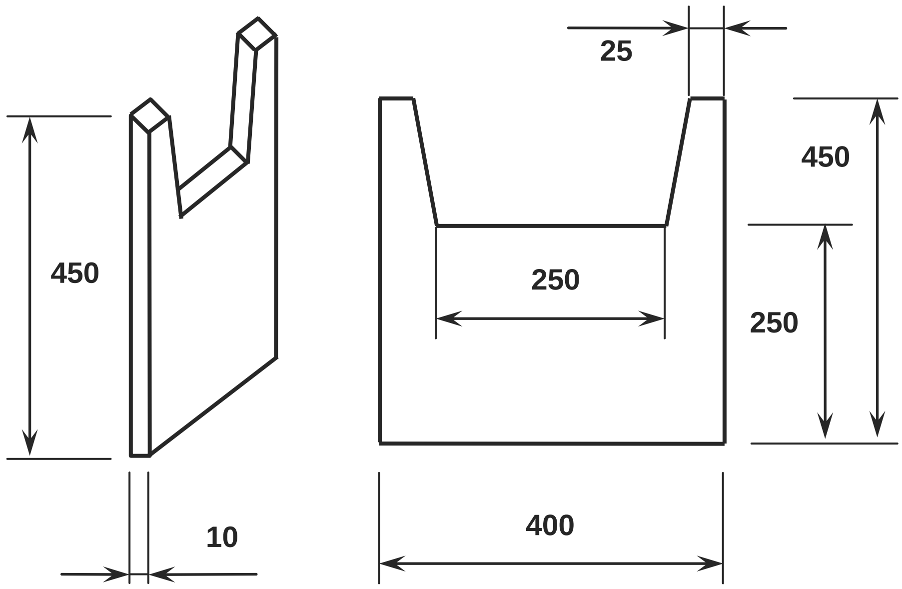


Figure 13 – Thin-Wall Trapezoidal Spillway Dimensions

Construction No. 5: «Thomson Spillway» – a thin-walled geometric body with a characteristic cut-out shape, the dimensions of which are shown in Figure 14.

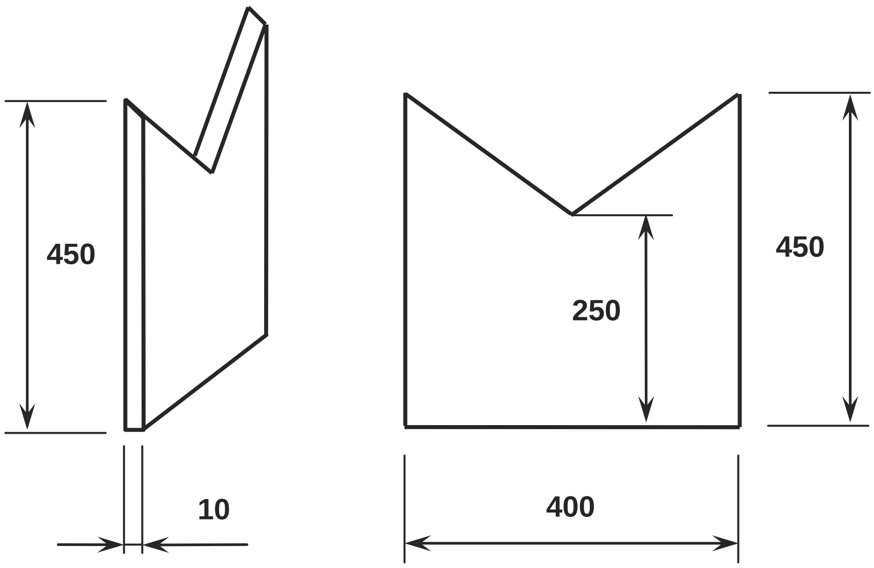


Figure 14 – Thomson Spillway Construction Dimensions

Construction No. 6: «Road pipe» – a geometric body of regular shape, simulating the construction of an embankment with a transverse through hole, the dimensions of which are shown in Figure 15.

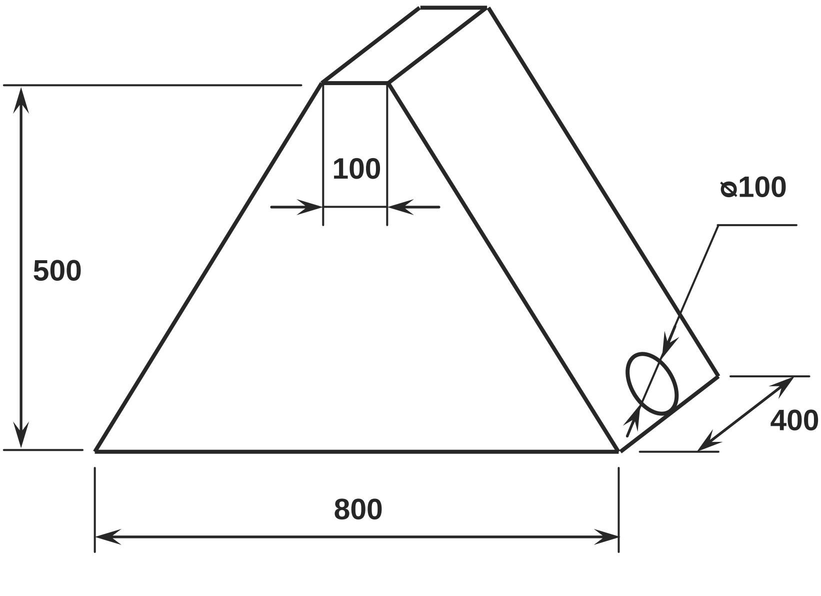


Figure 15 – Pipe Construction Dimensions

Construction No. 7: «Bridge Channel» – a pair of rectangular geometric bodies that simulate the span of a bridge. The dimensions of the structure are shown in Figure 16.

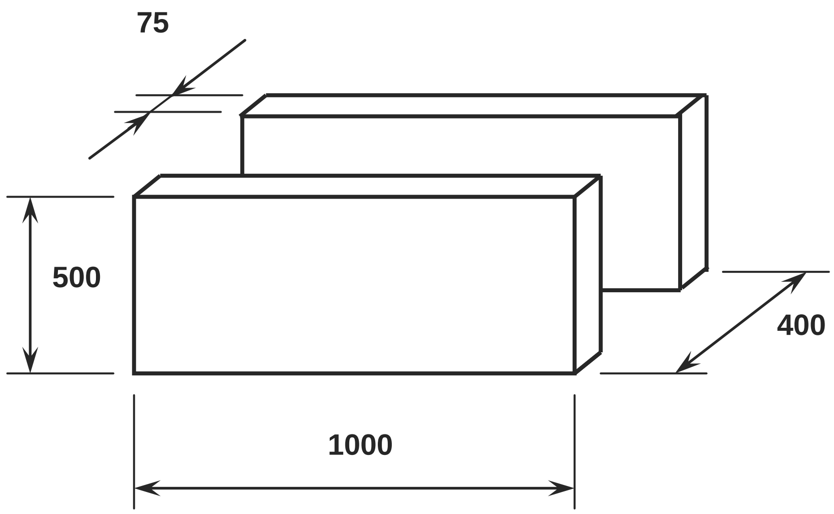


Figure 16 – Dimensions of the Bridge Channel

The next block of the parameter panel contains 7 switches (Figure 17) that specify the slope of the bottom of the channel.

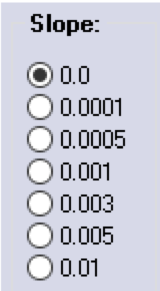


Figure 17 – Channel Bottom Slope Switches

The bottom slope (*i*) is the ratio of the difference in the vertical coordinates of two points to the difference in their horizontal coordinates (Figure 18), or the tangent of the angle of inclination of the channel. This model considers only positive slopes (tilt the channel down). Zero slope corresponds to the horizontal position of the bottom of the channel.

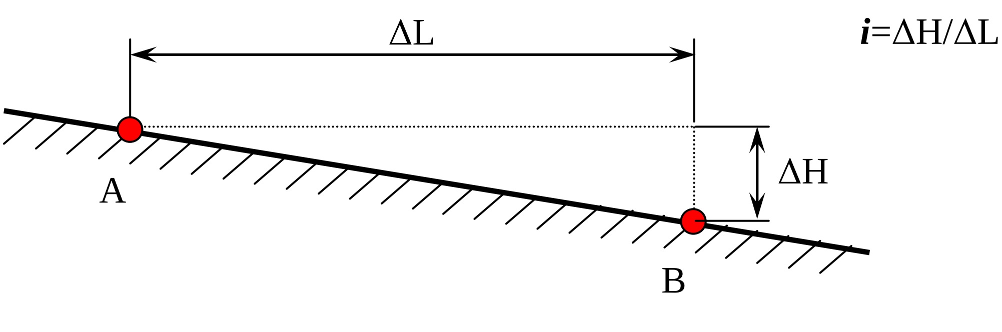


Figure 18 – To the Definition of the Slope of the Bottom

The next block contains text fields for entering the main parameters of the laboratory setup (Figure 19).

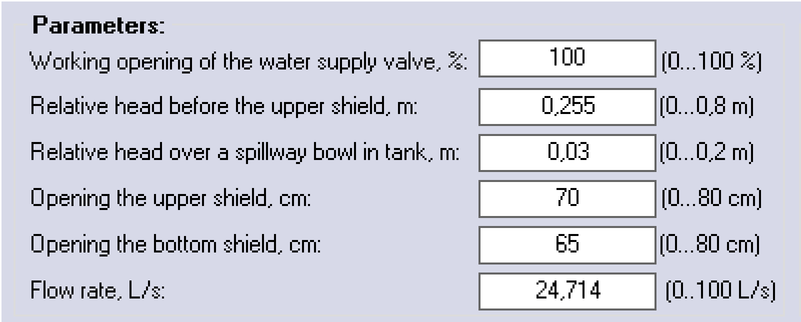


Figure 19 – Setting the Basic Parameters of the Laboratory Equipment

Parameter No. 1 (from top to bottom): «Working Opening of the Water Supply Valve» sets the percentage of final opening of the valve. This parameter affects only the visual part of the process of filling the equipment with water in a three-dimensional simulator. The rotation of the flywheel of the water supply valve is carried out to the value specified in this text box. The range of acceptable values: 0...100%.

Parameter No. 2: «Relative Head Before the Upper Shield» – excess (H_0) of the free surface level of the water in the pressure tank above the horizontal bottom of the channel (Figure 20). The range of acceptable values: 0...0.8 m.

Parameter No. 3: «Relative Head Over a Spillway Bowl in Tank» – the difference (Δh) of the levels of the upper edge of the spillway bowl and the surface of the water in the pressure tank (Figure 20). The range of acceptable values: 0...0.2 m.

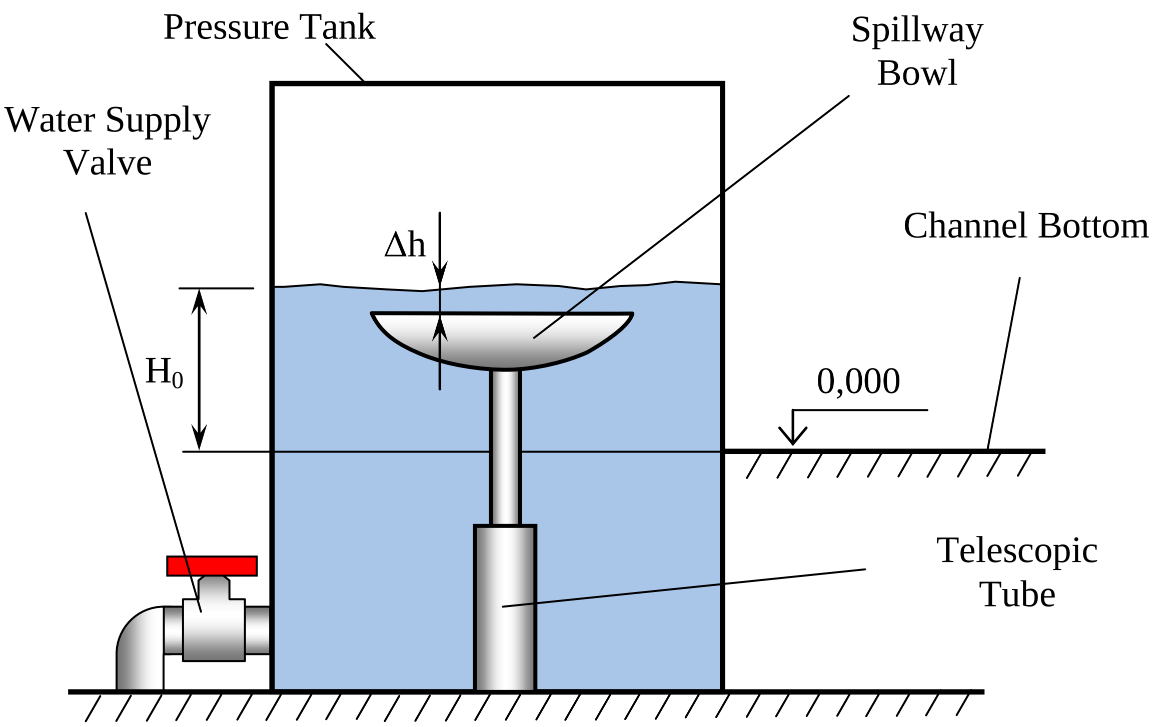


Figure 20 – Схема напорного бака лотка

Parameter No. 4: «Opening the Upper Shield» – the gap (A_1) between the bottom of the channel and the lower edge of the upper shield (Figure 21). The range of acceptable values: 0...80 cm.

Parameter No. 5: «Opening the Bottom Shield» – the gap (A_2) between the bottom of the channel and the bottom edge of the bottom shield (Figure 21). The range of acceptable values: 0...80 cm.

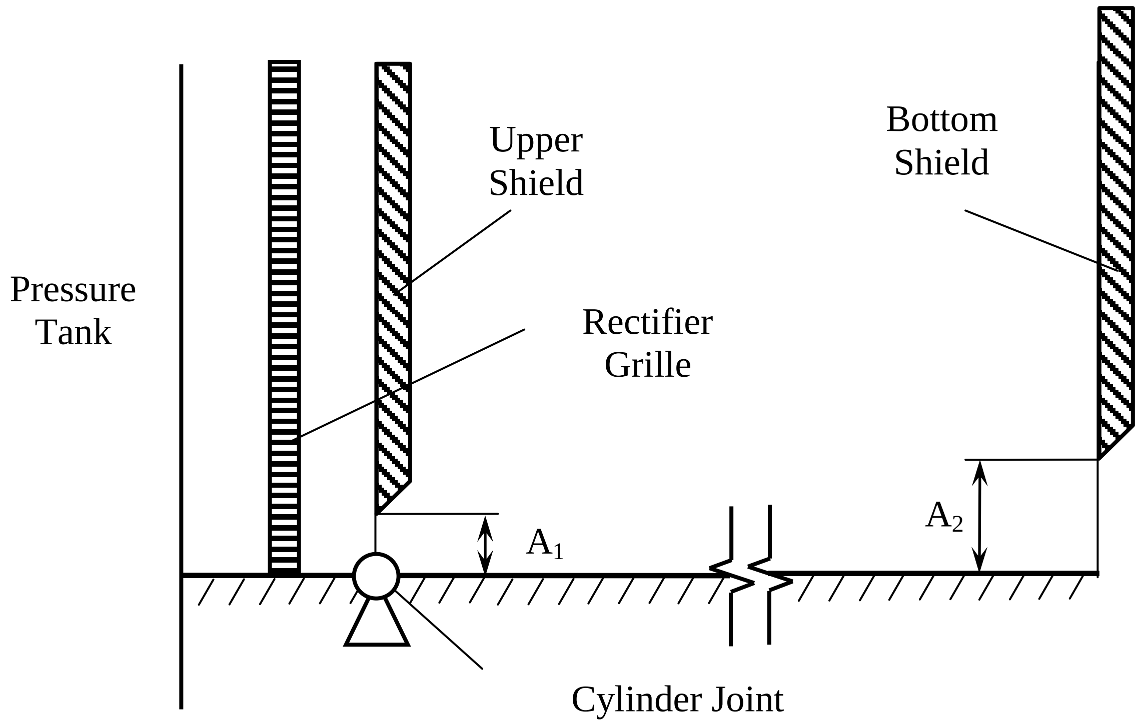


Figure 21 – Shileds Layout

Parameter No. 6: «Flow Rate» – the value (Q) of the total water flow in system. Range of admissible values: 0 ... 100 L/s. In simulation laboratory work, the flow rate is determined by measuring the filling time of the tank to the desired volume mark.

The last block of parameters contains three switches describing the presence or absence of a hydraulic jump in the flow. These parameters will be described below.

Main Dimensions and Coordinate System of the Channel

In the simulator, a laboratory hydraulic channel is simulated with a length of 15, a width of 0.4 and a height of 1 meters (Figure 22). The beginning of the channel (the origin of the coordinate system) is the left edge of the bottom. The rotation of the channel is relative to the starting point.

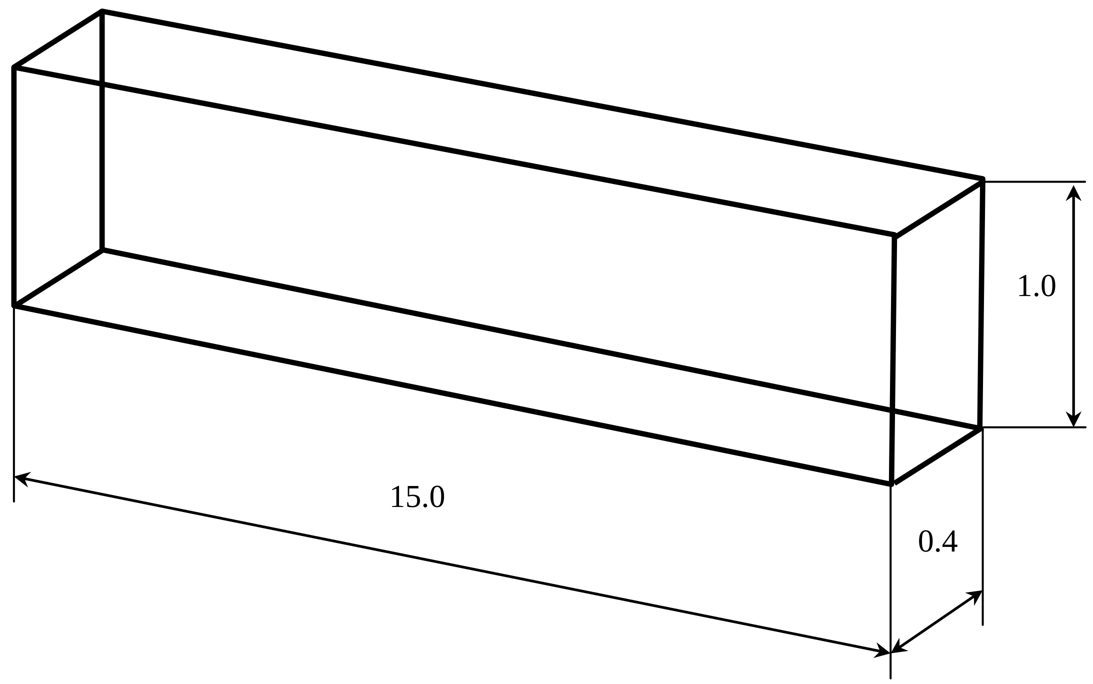


Figure 22 – Hydraulic Channel Dimensions

The channel coordinate system includes two axes – the axis of lengths (*L*) and the axis of depths (*H*) or marks. The *H* axis is always vertical. The depth below a specific point within the channel is measured from the bottom, taking into account the slope of the channel (Figure 23). When arranging constructions in the channel, an axis of lengths *L*' is used parallel to the bottom of the channel, and when constructing free surface curves, an axis of lengths *L* is used that has a strictly horizontal position. In the laboratory work, measurements of the free surface levels are made using special devices – measuring needles. The longitudinal movement of the needles is carried out along the *L* axis (strictly horizontal). Due to the negligible discrepancy between the lengths *L* and *L*', only the horizontal axis *L* is used in all calculations, and the inclined axis *L*' is used only when constructing the bottom profile of the channel (both in the drawing and in the three-dimensional model).

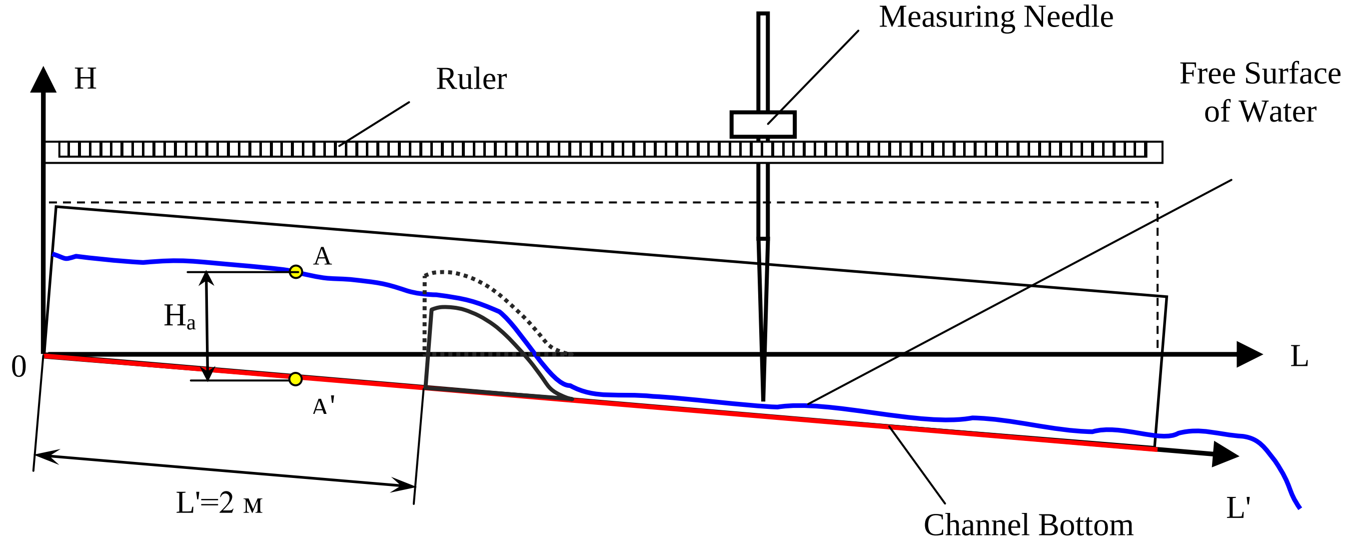


Figure 23 – Channel Coordinate System

The drawing above the channel shows the horizontal ruler of the *L* axis (Figure 24). The graduation of the ruler varies depending on the scale: with a scale less than 150%, the step of the divisions of the ruler is 1 m, and with a larger scale, the step of the divisions is 0.5 m. As noted above, the exact value of the length (the current position of the center of the screen relative to the beginning and end of the ruler) is displayed in the information line above the drawing.

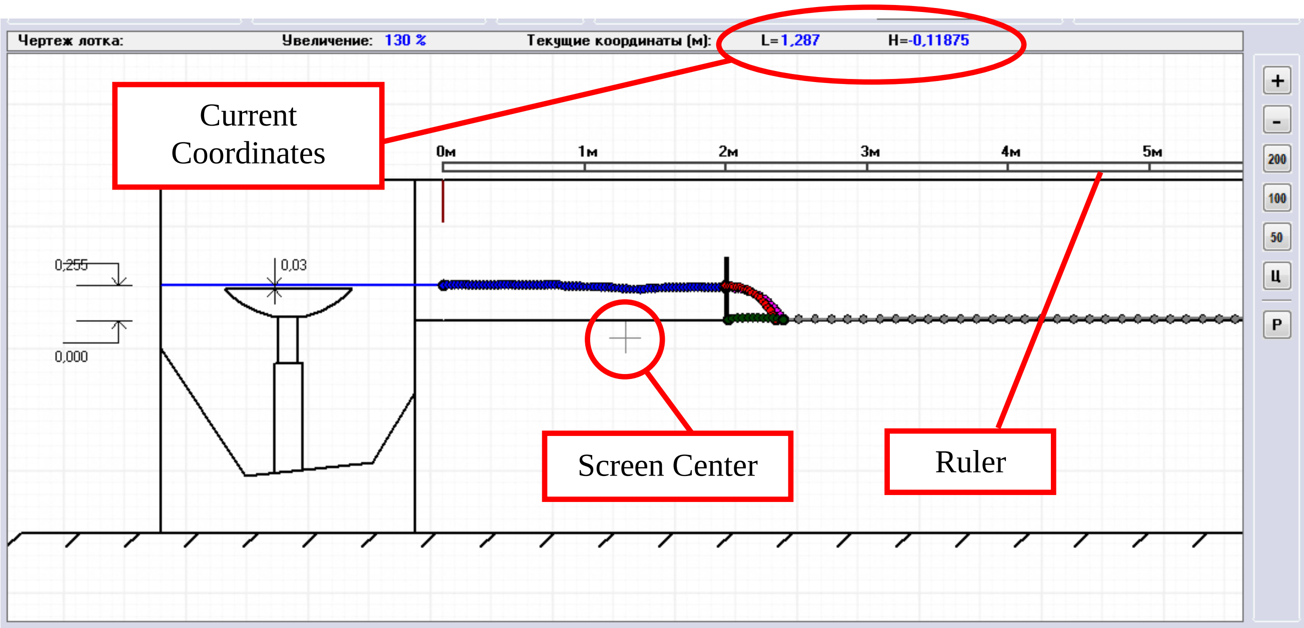


Figure 24 – The Image of the Horizontal Ruler in the Drawing

<u>General Description of the Free Surface Curve Points Editor</u>

The construction of free surface curves is carried out in a special point editor. The point editor window is called up either by the «P» button on the quick access panel, or by a similar button on the top toolbar (Figure 25). By a single click of the left mouse button on one of the indicated buttons, the point editor window opens (Figure 26).

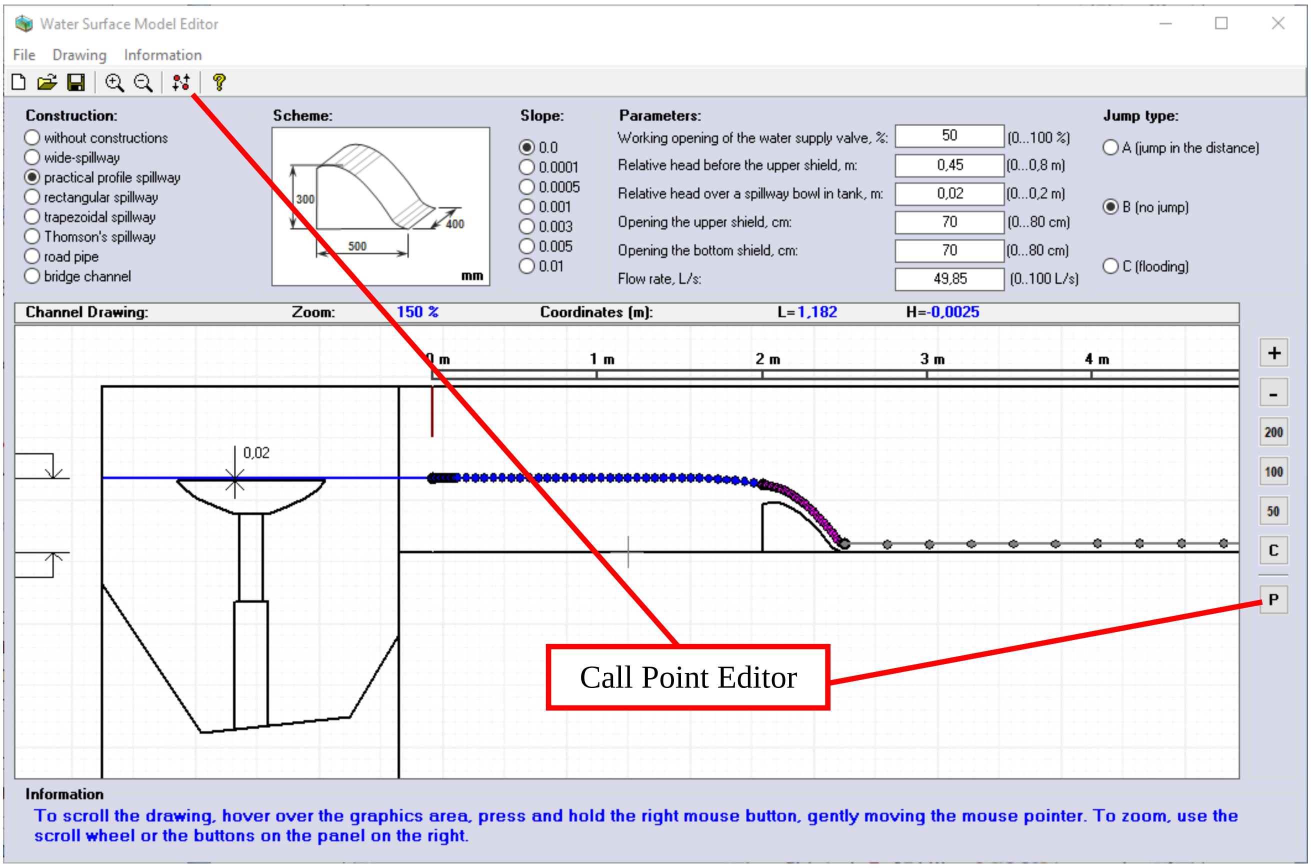


Figure 25 – Point Editor Call Buttons

The point editor window is located on top of the other windows, which makes it possible to work simultaneously with the tools for editing the coordinates of points, as well as with the drawing. The size of the point editor window has a fixed width (even when expanding the window to full screen). The window interface is divided into two parts. In the left part of the window are spreadsheets with the coordinates (L, H) of the points of the curves, as well as a legend with the color designation of the lines in the drawing. In the right part of the window there are panels with auxiliary tools for editing coordinates, as well as reference information on specific sections of the stream. Scrolling of panels and tables is carried out by scrolling the mouse (in case this control is active), or using the scroll bars located to the side of the panel (or table).

Before proceeding with the editing of coordinates, it is necessary to familiarize yourself with the numbering system for stream sections. Since this editor of simulation models is primarily aimed at preparing model files for a three-dimensional simulator, the concept of a free surface curve is considered in a spatial sense. In other words, the free surface curves calculated in this editor, built on the drawing in a two-dimensional coordinate system, are projections of spatial surfaces. In view of the last remark, the program uses the term «surface», instead of the term «curve».

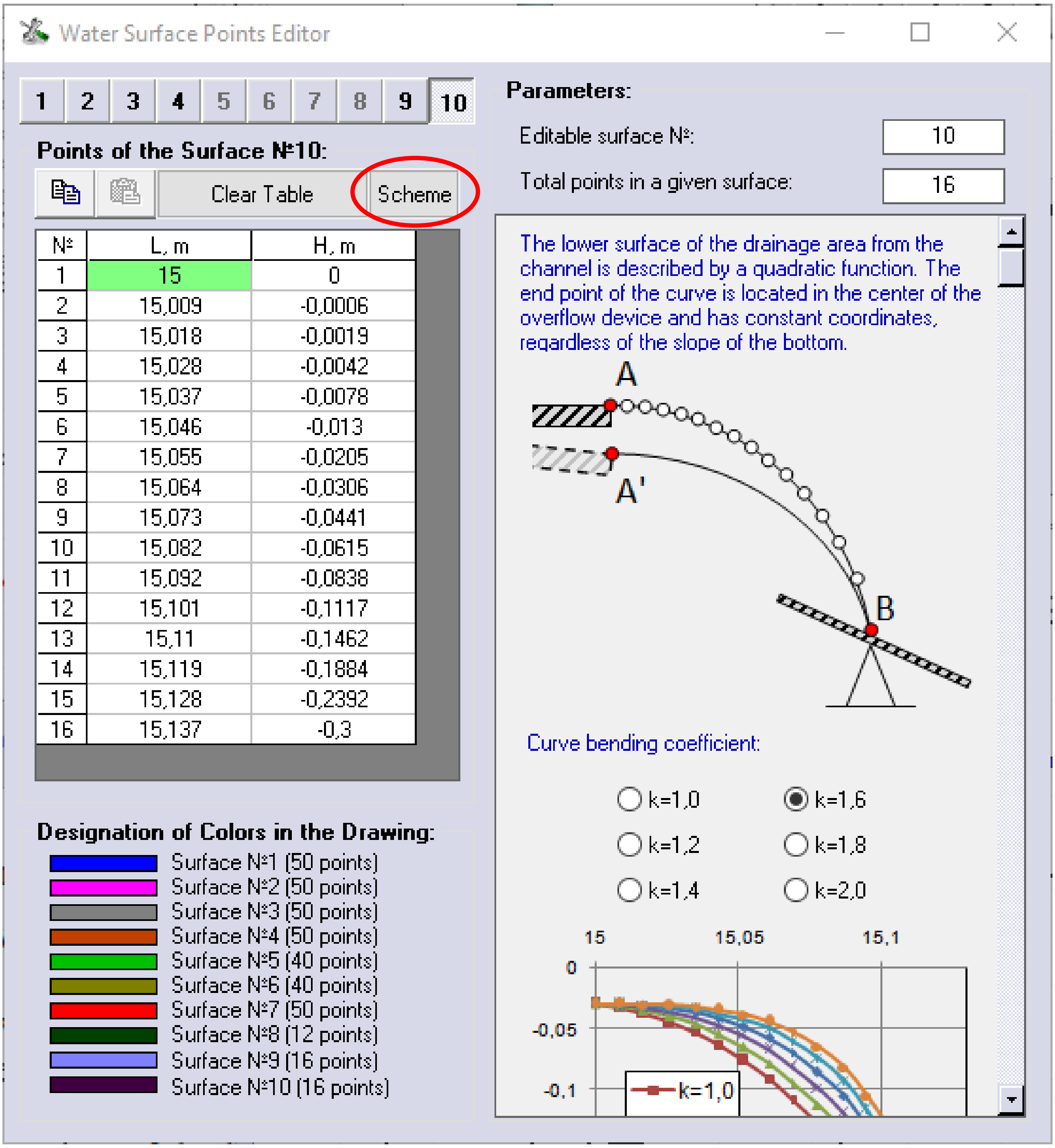
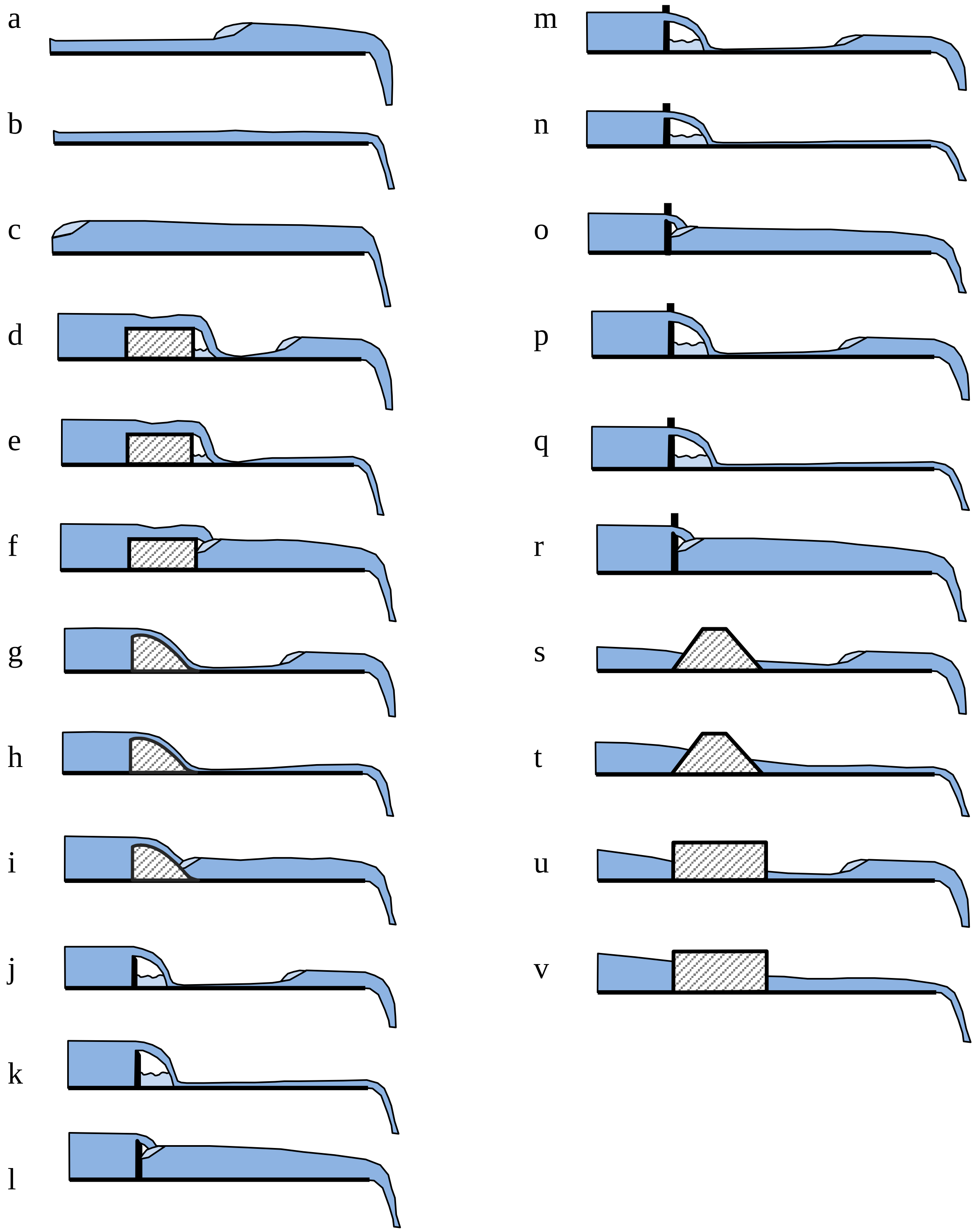


Figure 26 – Point Editor Window

For 8 channel options (7 constructions and the option without constructions), various situations of forming a flow model are provided. In addition, each model provides additional options, depending on the presence of a hydraulic jump. In general terms, the situations that are realized are presented in Figure 27.



without constructions: a jump at a distance of (a), no jump (b), flooding of the upper shield (c); spillway with a wide threshold: jump at a distance (d), no jump (e), flooding of the spillway (f); practical profile spillway: a jump at a distance (g), no jump (h), flooding of the spillway (i); rectangular spillway: jump at a distance (j), no jump (k), flooding of the spillway (l); trapezoidal spillway: jump at a distance (m), no jump (n), flooding of the spillway (o); Thomson's spillway: jump at a distance (p), no jump (q), flooding of the spillway (r); road pipe: distance jump or flooding (s), no jump (t); bridge bridge: jump at a distance (u), no jump (v)

Figure 27 – Types of Implemented Simulation Flow Models

The flow model is broken up into separate surfaces. In total, 10 surfaces are available for editing. Depending on the complexity of the model in a particular situation, a different number of surfaces is used. In general, the set of surfaces is shown in Figure 28. This diagram can be opened in the points editor (in Figure 26 the «Scheme» button is circled in red).

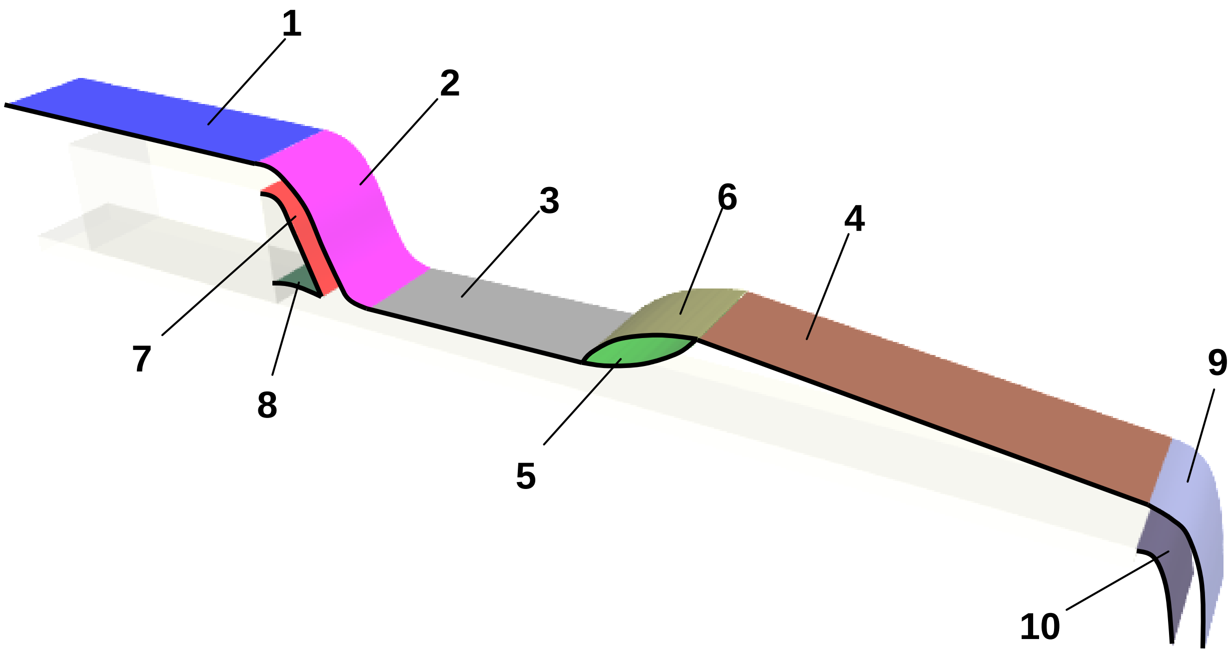


Figure 28 – Surface Numbering Scheme

The configuration of the hydraulic jump is set in the last block of the main program window (Figure 29). Three general cases are allowed for each type of design selected (see Figure 27). For the designs of the road pipe and the bridge bed, two hydraulic jump configurations are allowed (either there is a jump or there is no jump).

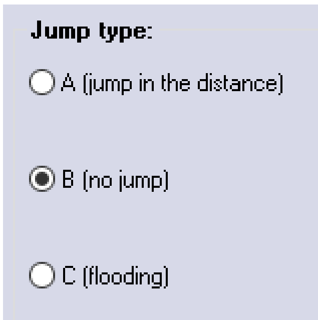


Figure 29 – Hydraulic Jump Position Switches

<u>Ways to Change the Coordinates of Surface Points</u>

The coordinates of the points of the surfaces *L* and *H* are stored in the spreadsheets of the point editor window. Above the tables is a block of buttons for switching surface indices (Figure 30). Depending on the specified flow configuration, some of the switch buttons may be blocked (if a specific surface is not used in the model). Left-clicking on the buttons, switches, you can switch the number of the currently edited surface.

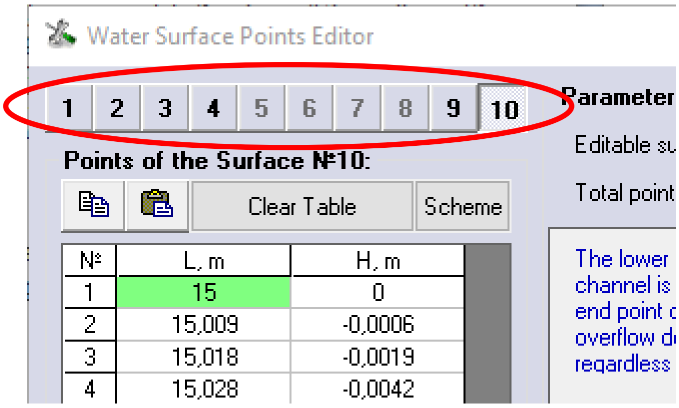


Figure 30 – Editable Surface Index Buttons

Below, under the block of switch buttons, there are 4 function buttons – «copy» , «paste» , «clear table» and «scheme» (it was mentioned earlier). The «copy» button carries out the operation of copying the entire contents of the current table to the clipboard. The copied data can be pasted in an external program, for example, Microsoft Excel editor. It should be noted that for insertion you will need exactly the same number of rows and columns (2 columns for *L* and *H* coordinates). The «paste» button performs the operation of pasting data from the clipboard into the spreadsheet of the point editor. The «clear table» button deletes the contents of the cells of the current table (in the event that the coordinates of the points are not automatically calculated by the specified function). Working with these buttons is the first way to change the coordinates, namely, using an external editor.

The second way to change the coordinates of points involves entering data into tables directly from the keyboard. To start entering, left-click on the desired cell (the cell is displayed in green) and enter a numerical value. The program automatically filters the information entered from the keyboard, excluding syntax input errors. The entered number is automatically converted to the desired number format, assuming one separator of the integer and fractional parts (comma character). If the cell already contains a number, typing with the keyboard will continue to enter new characters at the end of the number. Pressing the minus key adds a minus sign to the beginning of the number. Pressing the plus key deletes the minus sign from the cell. This option is useful when quickly changing the sign of a number. Only cells whose contents are not calculated automatically are available for editing.

The program implements the function of automatic joining of surfaces with each other. The possibility of a break in the flow model along the length is excluded. Information about joining surfaces is presented on the right side of the point editor window.

The first point of surface No. 1 has a constant coordinate *L*=0 m. The level *H* of the first point of the surface can be attached to the water level in the pressure tank (to the relative pressure in front of the shield), or to the lower edge of the left shield

(Figure 31). The second situation is applicable in the case of modeling the process of flow out from under the shield.

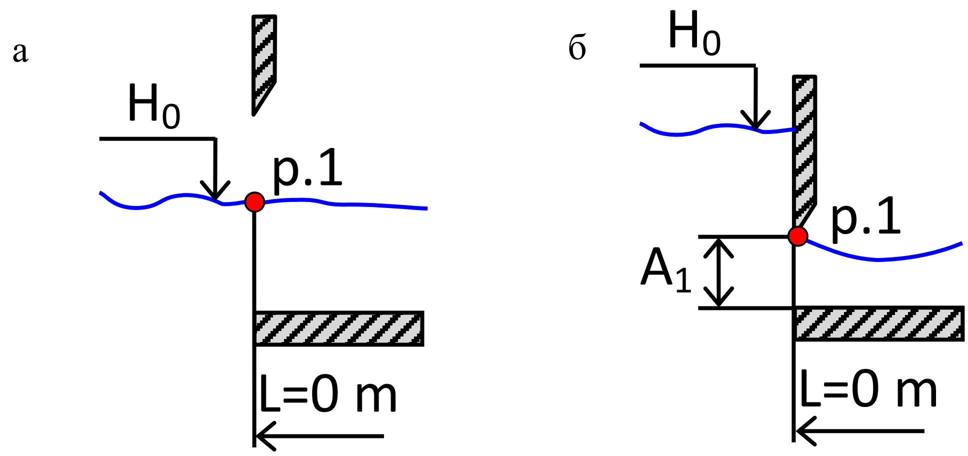


Figure 31 – Scheme of the Surface No.1 First Point Snap Mode: Binding to the Water Level in the Pressure Tank (a), Binding to the Edge of the Upper Shield (b)

Thus, the coordinates *L* and *H* of the first point of surface No. 1 are calculated automatically. Entering data from the keyboard into the first row of table No. 1 (or inserting values from the Excel editor) is not possible. Switching the snap mode of the first point is carried out by a special switch button on the right panel (Figure 32).

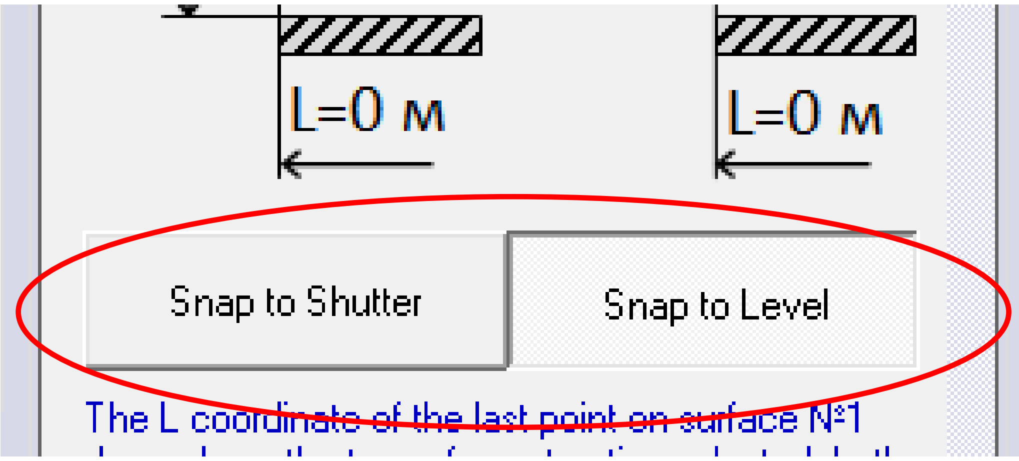


Figure 32 – Buttons for Switching the Snap Mode of the First Point on the Surface No.1

The *L* coordinate of the last point on surface №1 depends on the type of structure selected. In the case of a spillway with a wide threshold, the last point of the surface is located above the right edge of the spillway structure (Figure 33.a). In the case of a weir of practical profile (Figure 33.b), as well as spillways with a thin wall (Figure 33.c), the last point of the surface is located above the left edge of the structure.

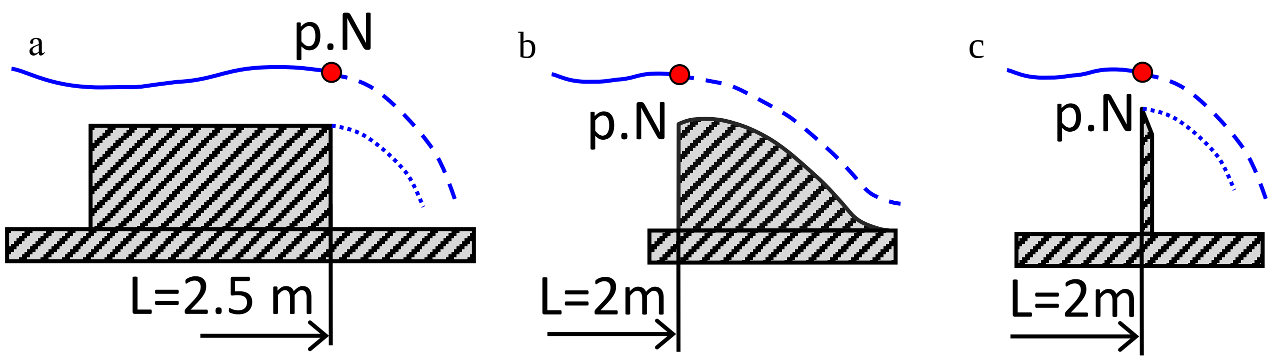


Figure 33 – Scheme of the Surface No.1 Last Point Snap Mode: in the Case of a Spillway with a Wide Threshold (a), a Practical Profile Spillway (b) and Spillways with a Thin Wall (c)

In case of installation of the road pipe and bridge structure in the channel, as well as in the absence of a model of the channel without structures, the L coordinate of the last point of surface No.1 does not have a binding (user-defined).

Next, under the snap-in schemes for the start and end points of surface No. 1, 4 function buttons follow (Figure 34). These functions are auxiliary and designed to distribute the coordinates of intermediate points on the site. The first function button distributes points along the *L* axis (from the first point on the surface to the last) in equal increments. The second function allows you to distribute the first 15 points in increments of 1 cm, and the rest evenly along the remaining length. This function can be useful in modeling the outflow from under the shield, where a compressed section at a certain distance from the shield is required to be displayed on the initial surface area.

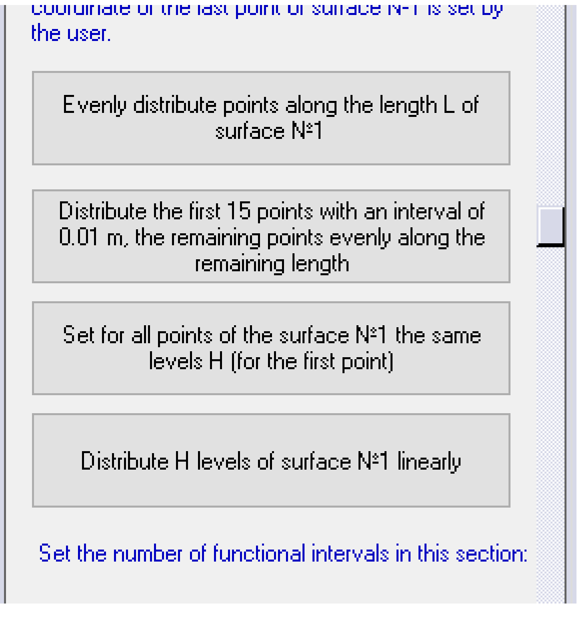


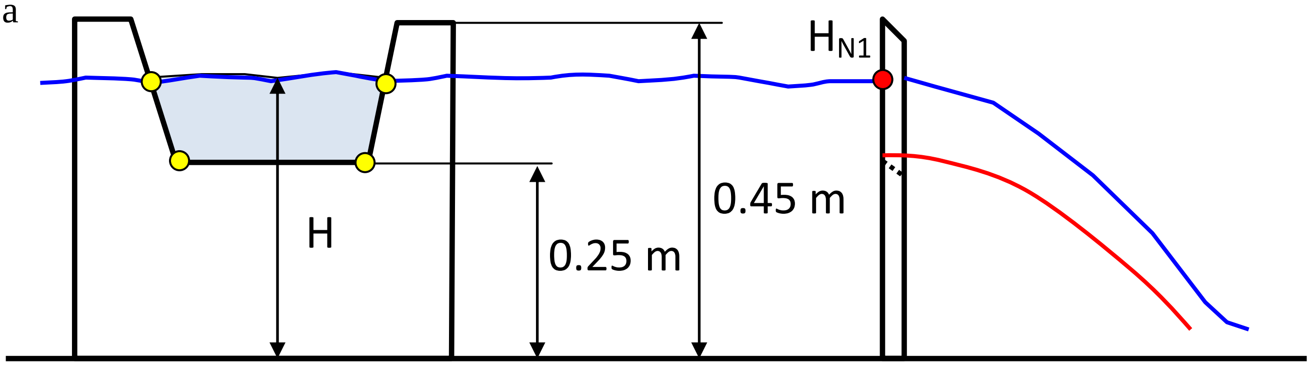
Figure 34 – Auxiliary Functions of Changing the Coordinates of Surface Points No.1

The third function sets the equal level *H* of all points of surface No. 1 at the level of the first point. The last function distributes the points linearly (from the first point on the surface to the last).

Using helper functions is the third way to change coordinates. A functional specification of the coordinates of the points by a polynomial function will be discussed later.

Level *H* of the last point of surface No.1 determines the amount of water pressure at the edge of the spillway. For a trapezoidal spillway and a Thomson spillway, there is an informal restriction on this quantity. The value of the last point of surface No. 1 level for these constructions should be no more than 0.45 m. This limitation is associated with solving the spatial problem of changing the shape of the stream in a three-dimensional simulator. If the value exceeds 0.45 m at the spillway, the dimensions of the flow will go beyond the width of the channel. Under the condition $0.25 < H_{N1} \leq 0.45$, the shape of the flow along the width of the channel is configured taking into account the shape of the cut-out of the spillway (Figure 35).

a



b

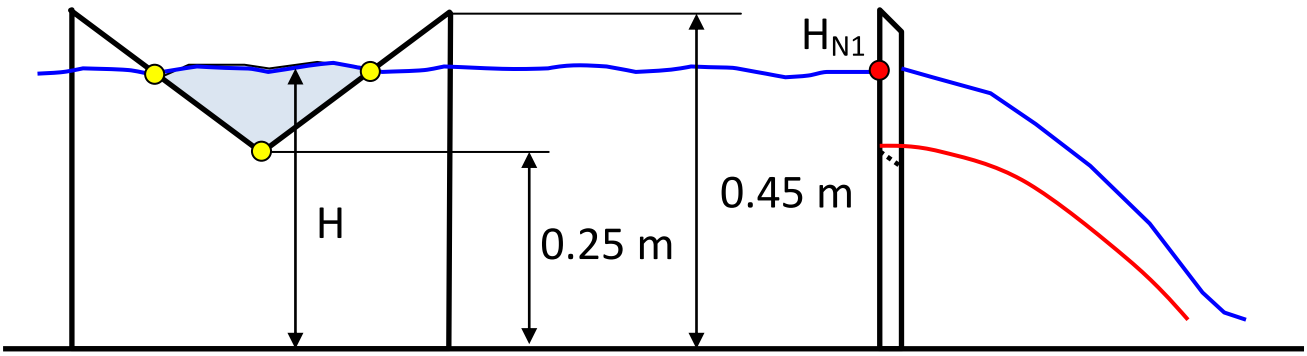


Figure 35 – Determination of the Shape of the Flow Cross-Section on the Spillway: in the Case of a Trapezoidal Spillway (a) and Thomson Spillway (b)

Surface No. 1 is not used in the model in only one case - in the situation of a flooded shield (Figure 27. c). Surface No. 2 immediately follows surface No. 1, and is used in the case of spillway modeling (upper surface of the water flow on the spillway). The first point of surface No. 2 in all cases is tied to the last point of surface No. 1 (Figure 36).

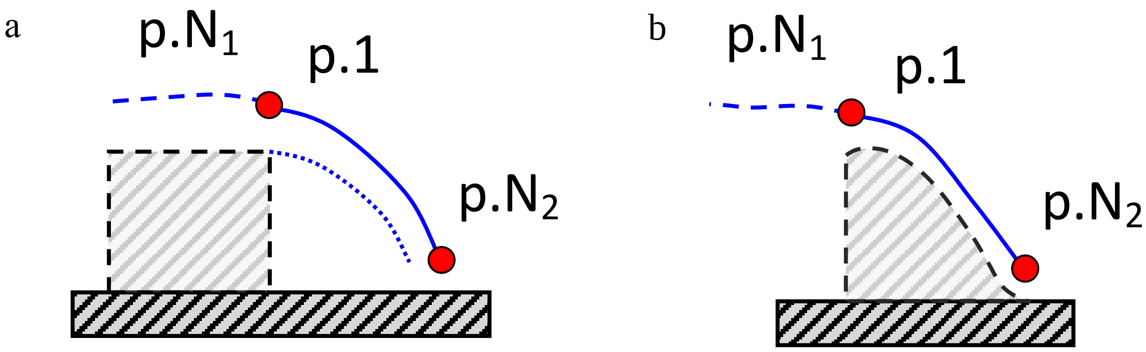


Figure 36 – Scheme of the Surface No.2 First Point Snap Mode: in the Case of a Spillway with a Wide Threshold (a) and a Practical Profile Spillway (b)

The coordinates of the last point of surface No. 2 are set by the user based on hydraulic calculations (Figure 37). This point characterizes the compressed depth of the stream after the spillway.

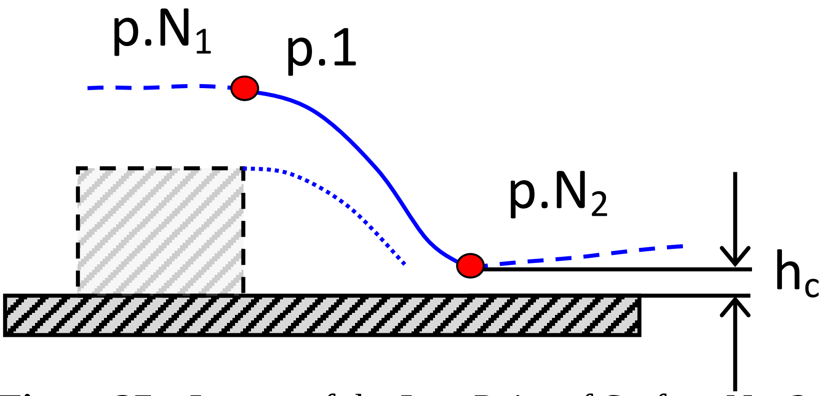


Figure 37 – Layout of the Last Point of Surface No. 2

Next, under the snap-in diagrams for the starting point of surface No. 2, there is a function button for uniform distribution of points along the length of the surface, as well as the option «Set by Arbitrary Function» (Figure 38).

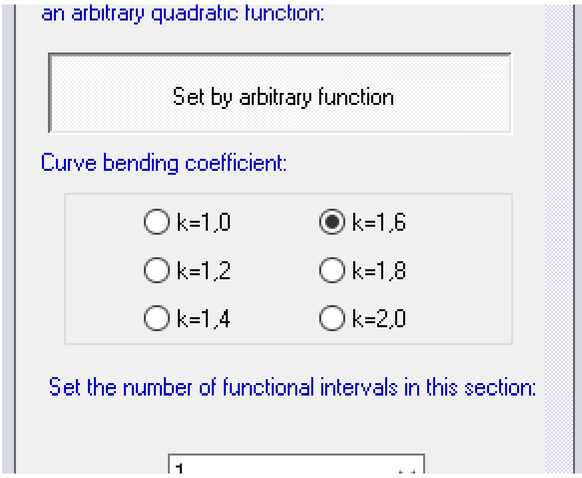


Figure 38 – Auxiliary Functions of Changing the Coordinates of Surface No.2 Points

The option «set by arbitrary function» implies a description of the projection shape of surface No. 2 by a quadratic function with a certain parabola bending coefficient. The use of this option does not imply a scientific justification from the standpoint of the laws of hydraulics, but is used only for testing or an approximate description of the flow form on a spillway. The user selects 6 values of the curve bending coefficient (Figure 39).

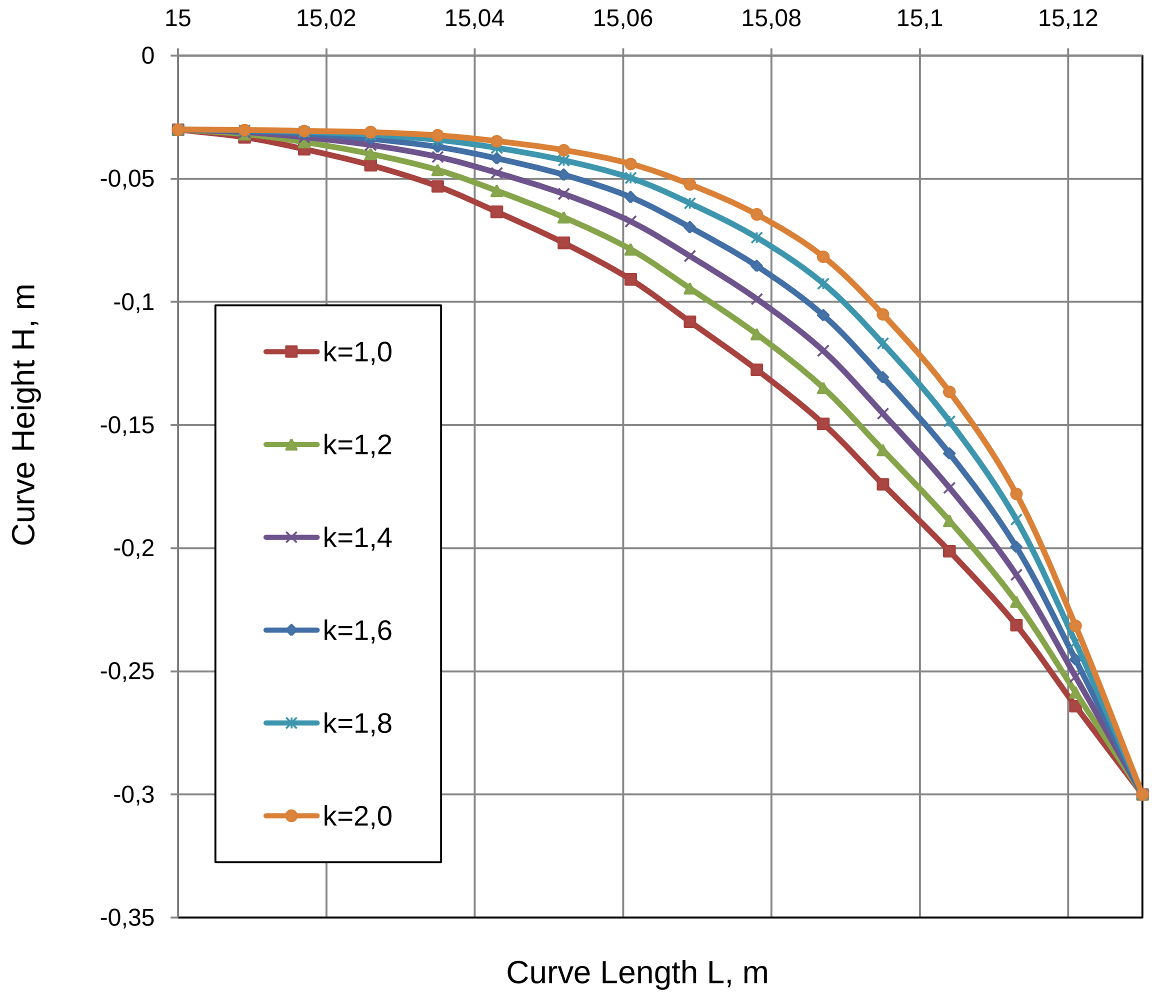


Figure 39 – Parabolic Curve Shapes at Different Values of the Bending Coefficient (k)

Surface No. 3 follows surface No. 2 (in the case of a spillway) or surface No. 1 (in the case of a channel without constructions or constructions of a road pipe and a bridge channel). Depending on the installed construction (or its absence), the first point of surface No. 3 is attached to the last point of surface No. 1 (Figure 40. a) or No. 2 (Figure 40. b). For all designs of spillways (1-5), the first point of surface No. 3 is always attached to the last point of surface No. 2.

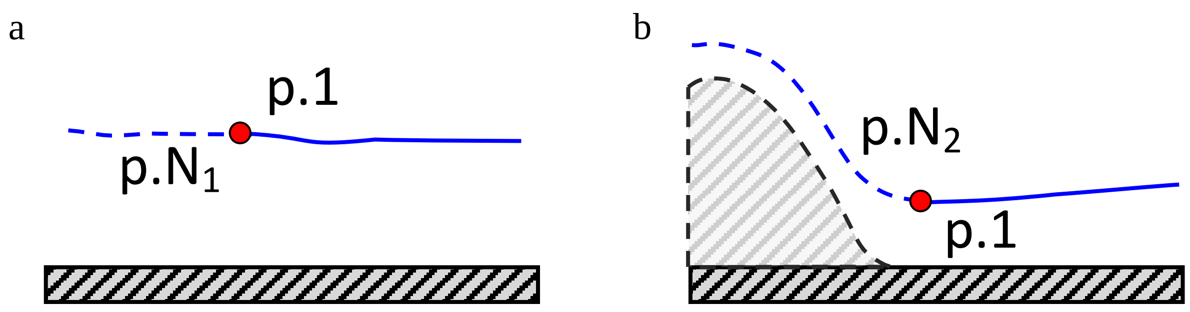


Figure 40 – Binding Scheme of the First Point of Surface No. 3:
to Surface No. 1 (a), to Surface No. 2 (b)

The position of the last point of surface No. 3 is set by the user based on hydraulic calculations. If there is a hydraulic jump within the channel (situation A), this point characterizes the beginning of the jump (Figure 41. a). In the absence of a hydraulic jump (situation B), the end point of surface No. 3 serves as the beginning of surface No. 4 (Figure 41. b).

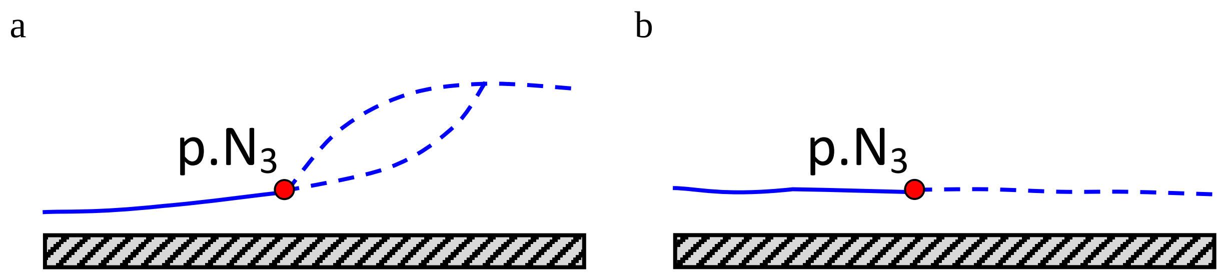


Figure 41 – Layout of the Last Point of Surface No. 3: in the Presence of a Hydraulic Jump (a) and in its Absence (b)

Next, under the position diagrams of the starting and ending points of surface No. 3, two standard function buttons follow (Figure 42).

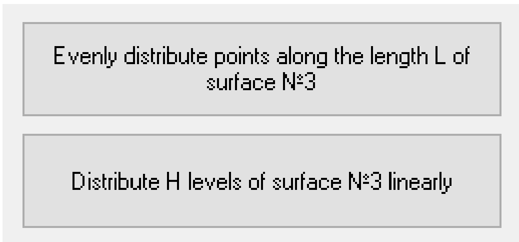


Figure 42 – Auxiliary Functions of Changing the Coordinates of Surface Points No.3

Surface No. 4 follows surface No. 3 (if there is no hydraulic jump) or surface No. 5 (if there is a hydraulic jump). If a jump is present (situation A or C), the first point on surface No. 4 is set by the user based on hydraulic calculations. This point characterizes the end of the jump (Figure 43).

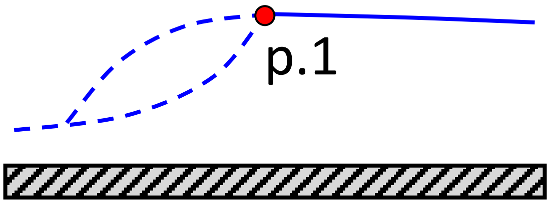


Figure 43 – The Position of the First Point of Surface No. 4 in the Presence of a Hydraulic Jump

If there is no jump (situation B), the first point of surface No. 4 is automatically snapped to the last point of surface No. 3 (Figure 44).

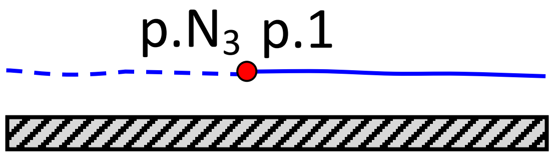


Figure 44 – The Position of the First Point of Surface No. 4 in the Absence of a Hydraulic Jump

The last point of surface No. 4 is located at the end of the channel (*L*=15 m). Next, under the position diagrams of the starting point of surface No. 4, two standard function buttons follow (Figure 45).

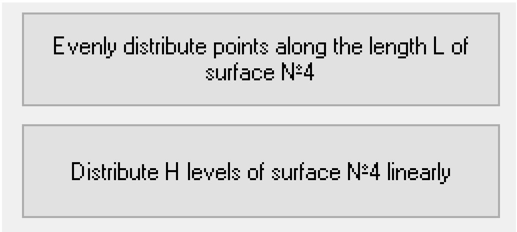


Figure 45 – Auxiliary Functions of Changing the Coordinates of Surface Points No. 4

Surface No. 5 (the lower surface of the drum) is displayed when there is a hydraulic jump in the channel (situations A and C). The surface curve No. 5 is built automatically by a third-order polynomial function without the ability to edit polynomial coefficients. In case of situation A (jump at a distance from the structure or the upper shield), the first point of the surface is attached to the last point of surface No. 3, and the last point of surface No. 5 is attached to the first point of surface No. 4 (Figure 46).

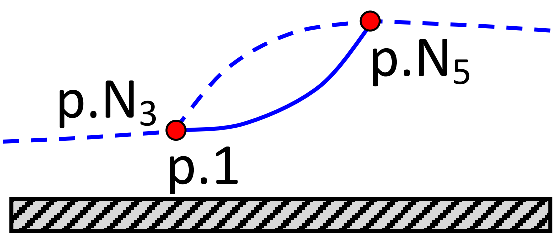


Figure 46 – The Position of the Extreme Points of the Surface No. 5

In case C (flooding), the position of the first point of surface No. 5 is set by the user based on hydraulic calculations. Two situations are assumed: flooding of the upper shield (the roller overlaps the left shield) and flooding of the spillway structure (the roller overlaps the right edge of the spillway). These situations are illustrated in Figure 47.

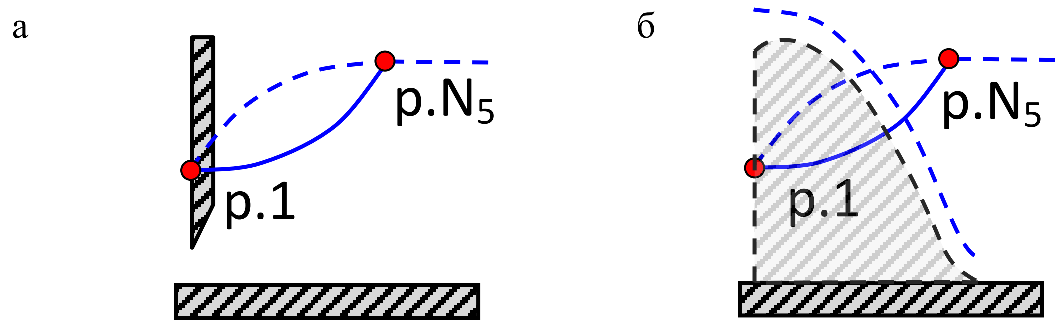


Figure 47 – The Construction of the Bottom Surface of the Jump in Case of Flooding: the Upper Shield (a) and Spillway (b)

Surface No. 6 (the upper surface of the roller) is constructed in a similar way. The beginning and end of surface No. 6 are attached to the beginning and end of surface No. 5 (Figure 48).

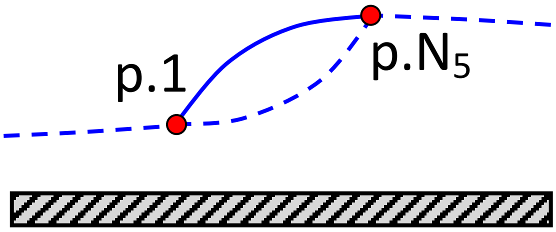


Figure 48 – The Position of the First and Last Points of the Surface No. 6

The coordinates of surface points No. 5 and No. 6 are not editable.

The construction of the surface profile No. 7 is similar to the construction of the surface profile No. 2. This surface describes the bottom of the flow on the spillway (in the case of all spillways, except for a spillway of a practical profile, where there is no separation of the stream from the spillway surface). The first point of surface No. 7 is attached to the edge of the spillway (Figure 49).

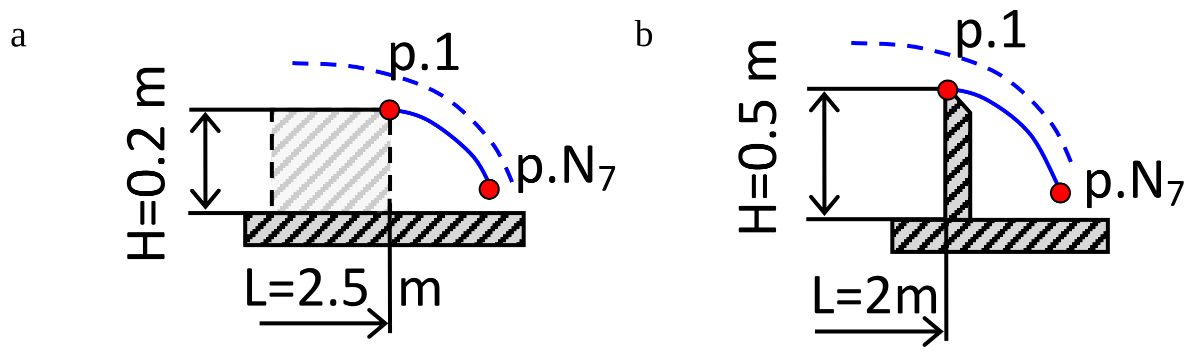


Figure 49 – The Position of the First Point of Surface No. 7 in the Case of a Spillway with a Wide Threshold (a) and a Spillway with a Thin Wall (b)

The level of the last point of surface No. 7 corresponds to the mark of the last point of surface No. 2 (Figure 50).

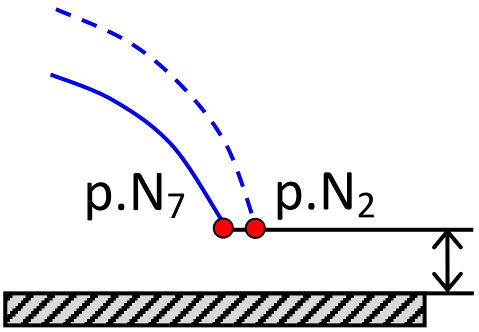


Figure 50 – The Level the Last Point on the Surface No.7

The shape of surface No. 7 can also be specified by an arbitrary quadratic function (by analogy with surface No. 2) by setting the corresponding curve bending coefficient.

The first point of surface No. 8 (the surface of the water under the spillway stream) is attached to the right edge of the spillway structure. The binding of the last point of surface No. 8 depends on the type of spillway. For a spillway with a wide threshold and a rectangular spillway with a thin tsenka, this point is attached to the last point of surface No. 7 (Figure 51. a). In other cases, the binding is carried out to the last point of surface No. 2 (Figure 51. b).

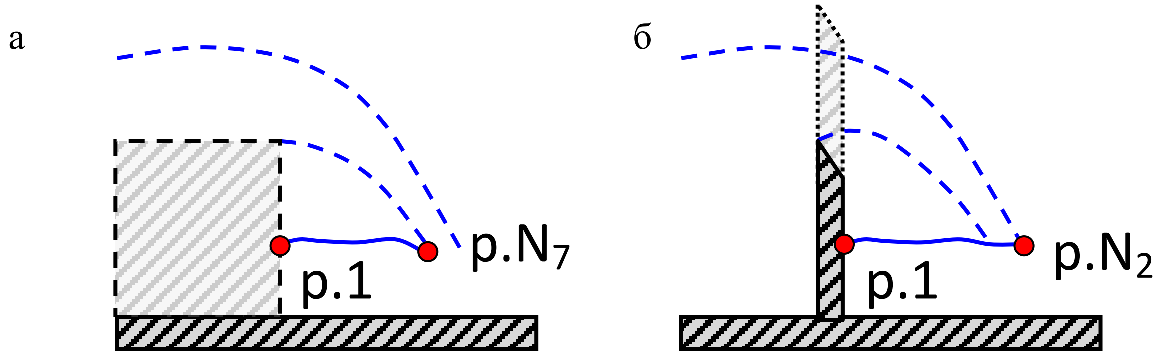


Figure 51 – Binding of the last point of surface No. 8: to surface No. 7 (a) and surface No. 2 (b)

Next, under the position diagrams of the extreme points of surface No. 8, two standard function buttons follow (Figure 52).

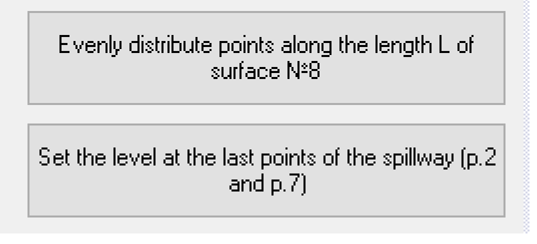


Figure 52 – Auxiliary Functions of Changing the Coordinates of Surface Points No. 8

Surfaces Nos. 9 and 10 describe the flow of water draining from the channel. No measurements are made on this flow section, therefore, there is no strict need for scientific substantiation of the flow shape from the position of hydraulic dependencies, however, there is a structural requirement for the position of the end points of the surfaces in order to avoid the intersection of the flow surfaces with the design of the overflow device in the measuring tank. Figure 53 shows the fixed lengths *L* and levels *H* of the end points of surfaces No. 9 and No. 10 with a zero slope of the channel.

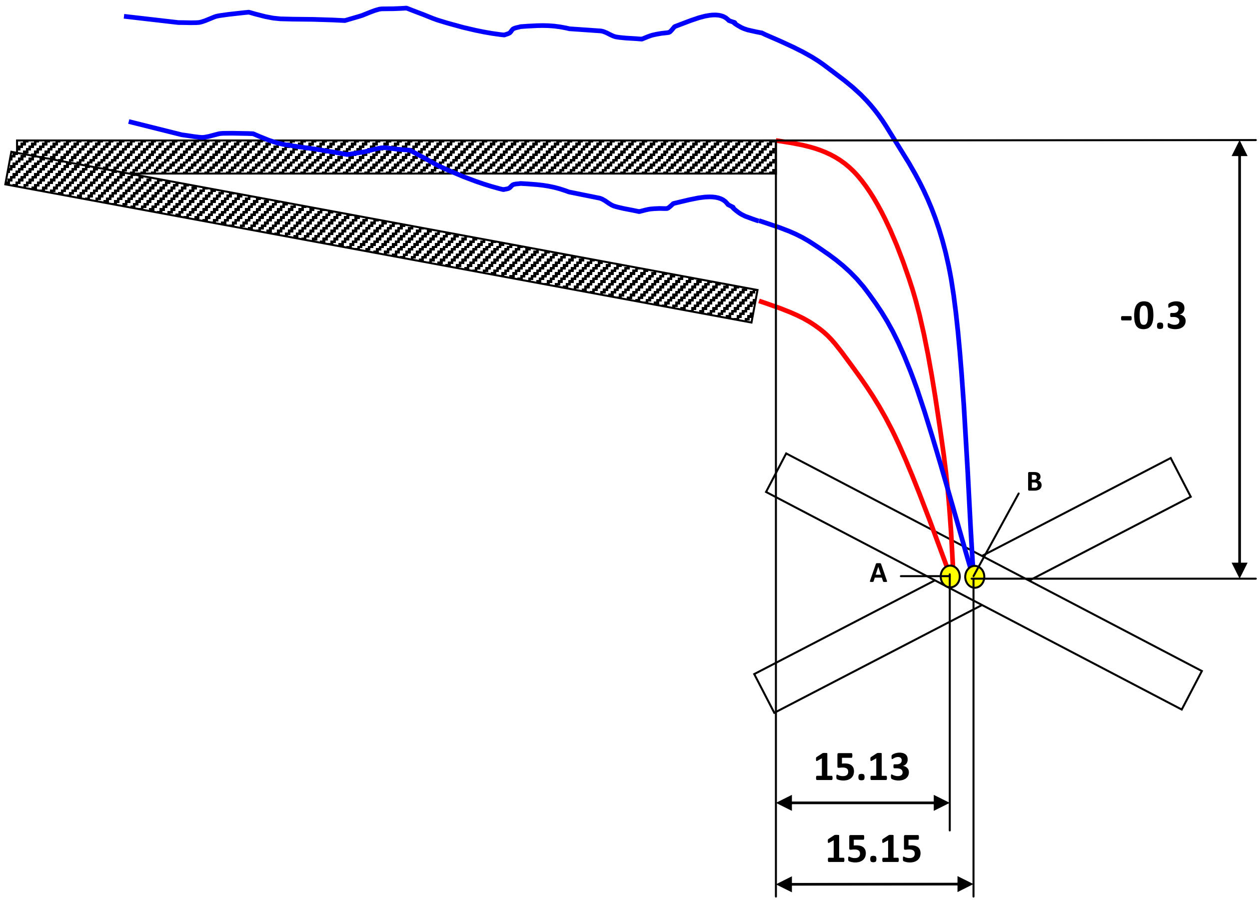


Figure 52 – Binding of End Points of Surfaces No. 9 and No. 10 to the Overflow Device in the Measuring Tank

In view of the indicated requirement, the shape of the curved surfaces No. 9 and No. 10 is automatically set by a quadratic function. The user can set the curve bending coefficient by analogy with surfaces No. 2 and No. 7. In the case of surface No. 9 (the upper surface of the confluent stream), the initial point of the curve can be attached to the lower edge of the right shield, or to the last point of surface No. 4 (Figure 53). The snap mode is set by special buttons-switches on the right panel of the point editor window (in the mode of editing points on the surface No. 9). The first point of surface No. 10 (the lower surface of the confluent stream) is always tied to the bottom of the channel (Figure 54).

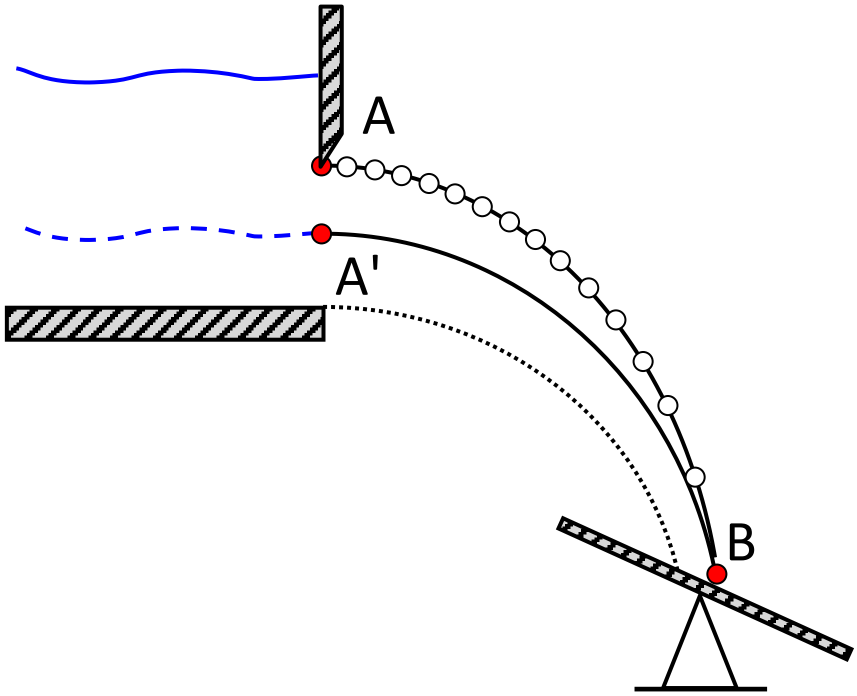


Figure 54 – Snap the First Point of the Surface No. 9

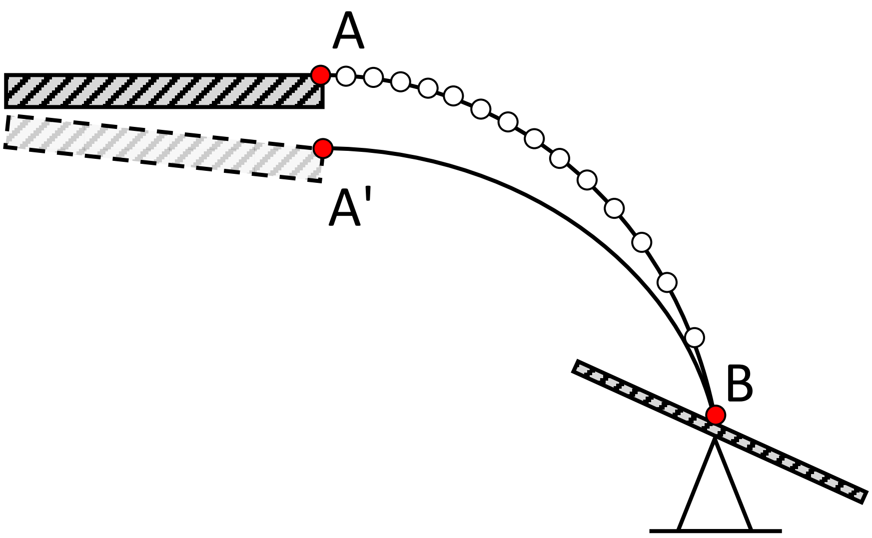


Figure 55 – Snap the First Point of the Surface No. 10

In addition to copying / pasting data, manually entering coordinates and using auxiliary functions, it is possible to describe the shape of surfaces using the third-order polynomial equation. This feature is the fourth way to change the coordinates of surface points. The fourth way you can set the coordinates of the points of the surfaces No. 1, No. 2, No. 3, No. 4, No. 7 and No. 8. The essence of the method is that the surface is divided into intervals (the maximum number of intervals for one surface is 3). In each interval, the number of surface points included in it is set, and the coefficients of the polynomial are set.

The general form of the third-order polynomial equation is as follows:

$$H = A \cdot L^3 + B \cdot L^2 + C \cdot L + D,$$

where *H*, *L* – level (depth) and length of point, m; A, B, C and D – coefficients of the polynomial.

If the coefficient A = 0, the polynomial acquires the second power. If A = 0 and B = 0, the described function is linear. If A = 0, B = 0 and C = 0, the marks of all points in the interval are the same (H = D).

The intervals are set at the bottom of the panel of parameters for a specific surface (Figure 56).

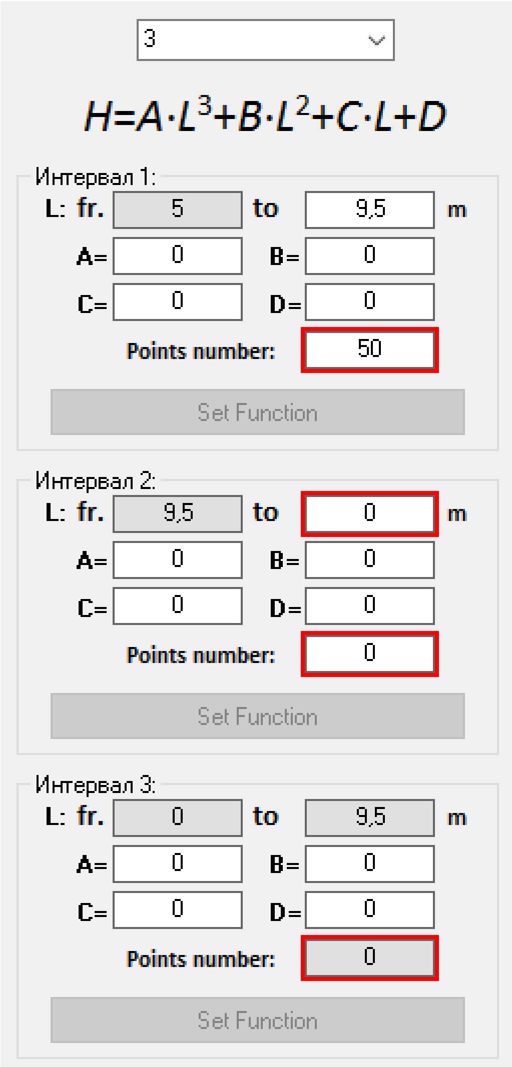


Figure 56 – Setting Fields for Entering Parameters of a Polynomial Function

The upper list sets the number of intervals. The following frames with the name «Interval» are blocked/unblocked depending on the selected number of intervals. When entering the boundaries of the intervals, the total surface length, as well as the total number of points of the given surface, should be taken into account. Fields containing syntax and mathematical errors are highlighted in red. In case of errors, the «Set function» button for a specific interval (on which errors are made) is blocked. Under the admission of syntax errors, it is assumed that non-numeric values are entered into the fields. Mathematical errors arise when the length intervals are violated (for example, the right border of the first interval is greater than the entire surface length, or less than the left border of the interval), and also when the number of points in one interval is exceeded (relative to the total number of points).

The first point of interval 2 has the length L of the last point of the previous (1) interval. The same applies to the third interval. If the surface is not divided into intervals (the number of intervals on the surface is 1), the boundaries of the interval and the number of points are set automatically (the entire length of the surface and all its points are used).

If the parameters of the function are entered without errors, the «Set function» button becomes available for pressing. When you click on the button, the coordinates will be calculated according to the described equation.

When creating a new project or at the moment of switching the types of structures, as well as the hydraulic jump modes, the program sets a certain pattern of distribution of points along the length of the channel. For example, if you click on the design type switch - a specific template will be applied for a specific type of structure, the drawing will show how the points were distributed along the length of the channel (Figure 57).

a

b

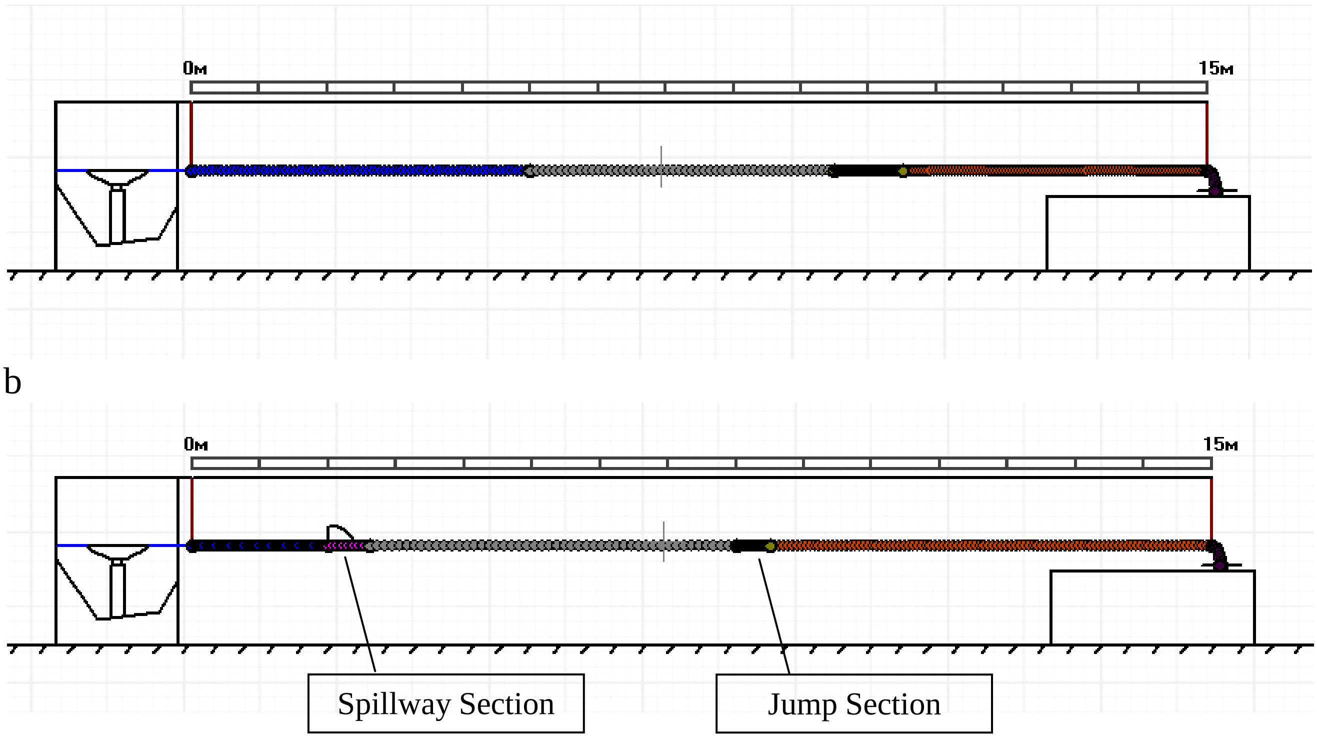


Figure 57 – Template Distribution of Points Along the Length of the Channel: for a Variant without Constructions (a), for a Practical Profile Spillway (b)

Upon completion of editing the model parameters, the project must be saved. The reset, open and save buttons are located on the toolbar at the top of the main program window. In addition, these functions are duplicated in the «File» menu (Figure 58).

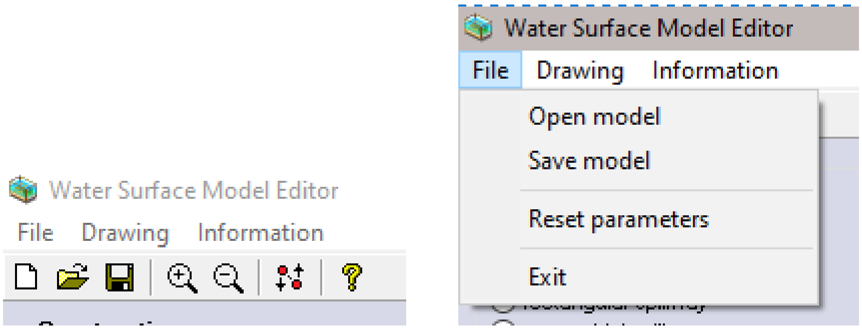
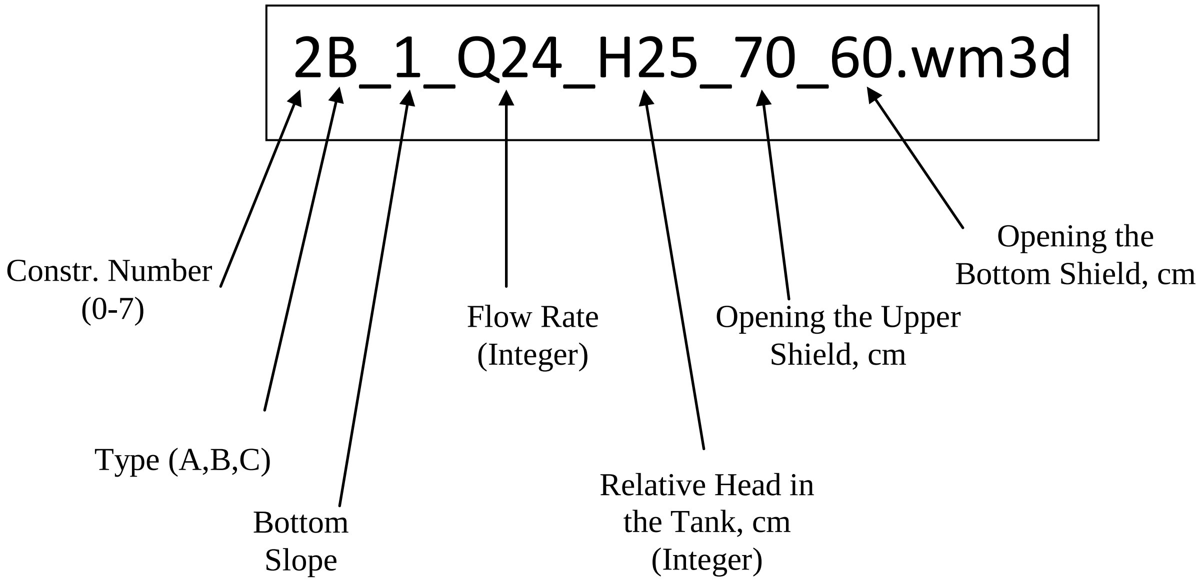


Figure 58 – Project Management Functions

The simulation model file has the extension «* .wm3d». The file name can be any, but when saving the project, it is recommended to specify a file name that includes the main parameters of the model:



When resetting, opening or saving a file, as well as when closing the program, the user confirms his action through the confirmation dialog, which mentions that the UNSAVED data will be lost (Figure 59).

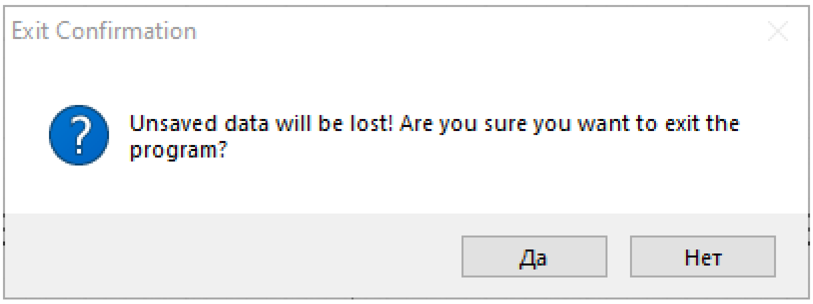


Figure 59 – Program Exit Confirmation Dialog