

TOPIC 1

CONSTRUCTION AND ANALYSIS OF THE SOIL BASE MODEL IN THE FORM OF A LINEARLY DEFORMABLE LAYER OF FINITE WIDTH

There are analytical spatial models of a continuous linear-deformed environment (half-space or layer), which were developed by well-known scientists and were adopted in regulatory documents for calculating the deformations of foundation foundations and remain in the state construction norms of Ukraine. However, today, due to the powerful development of information technologies, the most widespread model of the soil base is the model of a continuous layer of finite width (Fig. 1.1), which, in addition to limiting vertical deformations at a certain depth H , also has limitations on horizontal deformations at a certain distance from the load in plan ($L_x \times L_y$). For calculating foundations that interact with a soil foundation under plane strain conditions, this model can also be a plane model, as a special case. When modeling and performing numerical calculations of the "soil-foundation-structure" (SFS) system in powerful computational complexes such as SOFiSTiK, ABAQUS, Plaxis, SCAD, Lira, etc., the soil foundation model in the form of a continuous layer of finite width is typically used. In this approach, any patterns of soil deformation under loads can be specified, including time-dependent behavior. [1].

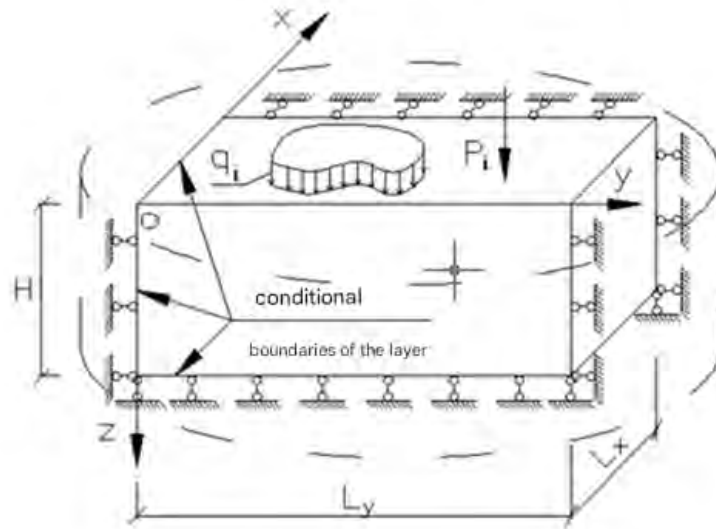


Figure 1.1 – Model of the soil base in the form of a continuous layer of finite width

It is well known that in order to obtain reliable and reliable results for calculating the stress-strain state of foundation structures in the "SFS" system, it is necessary to

choose such a model of the soil base with appropriate parameters, which is close to the real soil environment according to two criteria: dissolving capacity and deformability of the foundations of structures. In practice, the model of a linear-deformed layer of finite width is the most common, since it requires only the task of deformation characteristics of the soil (modulus of total deformation E and Poisson's ratio ν). However, a significant resolution of the model causes the occurrence of excessive reactions at the edges of foundation structures and, accordingly, an increase in moment forces from the total bending of foundations, especially large-sized ones.

At present, there is no single approach to the dissolving capacity of soil foundations, therefore, the study of the influence of boundary conditions in the plan (according to the angle of distribution α) of the model of a continuous linear-deformed layer of finite width on the stress-strain state of foundation structures is an urgent task for adequate modeling of the "SFS" system.

Creating a flat model of the soil base.

With the help of the SCAD software package, we will create a model of the soil base in a flat problem statement

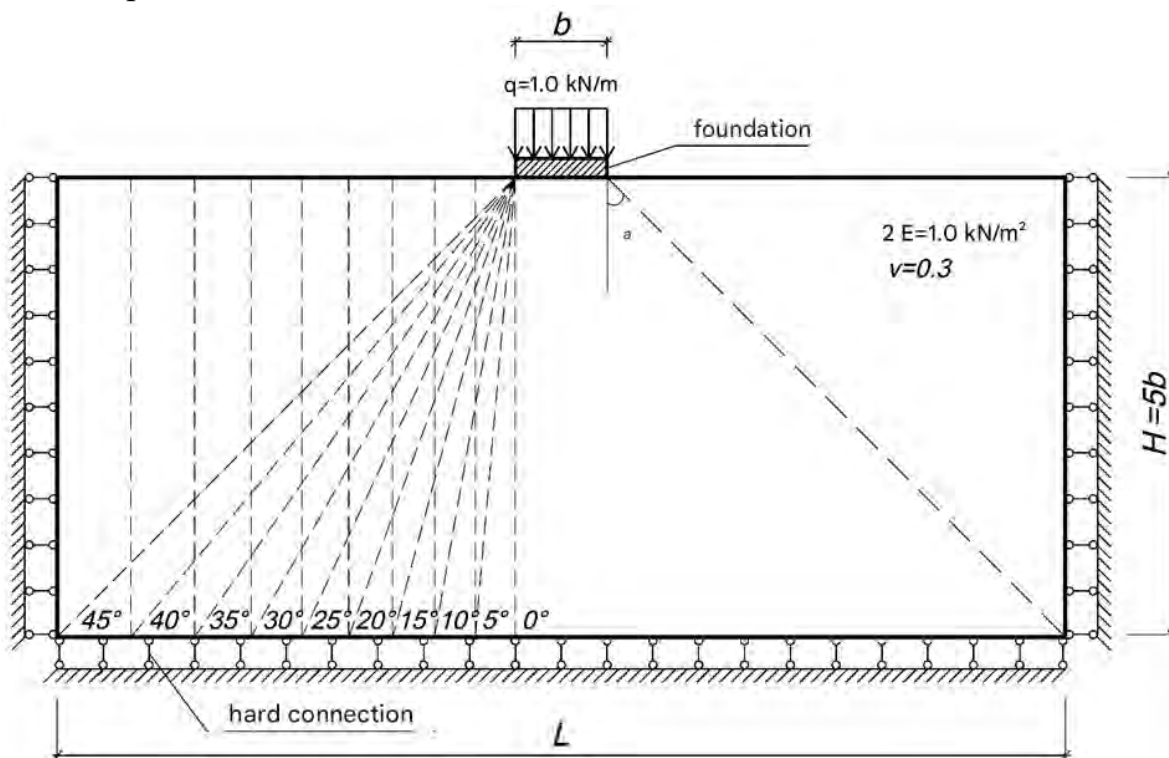


Figure 1.2 – Diagram for creating a flat model of the soil base

Create a new project in the SCAD++ application. In the name field, enter your last name, select the type of scheme "2 – Flat frame" and click OK (Fig. 1.3).

Download the stencil diagram at the link <https://tinyurl.com/y33p2f8a> and open it in AutoCAD (Fig. 1.4).

Project identification

Name:

Organization:

Object:

OK Reference Cancel

Reliability coefficient by responsibility:

Reliability factor for responsibility (second limit state):

Scheme type:

Location in space	Movement in a node in the direction of the common coordinate system	Characteristics of constructions
XOZ plane	Linear along X, Z; UY rotation around oci Y	Flat frame

Figure 1.3 – Dialog box for creating a new project

$H/B=5$ $H/B=4$ $H/B=3$ $H/B=2$ $H/B=1$

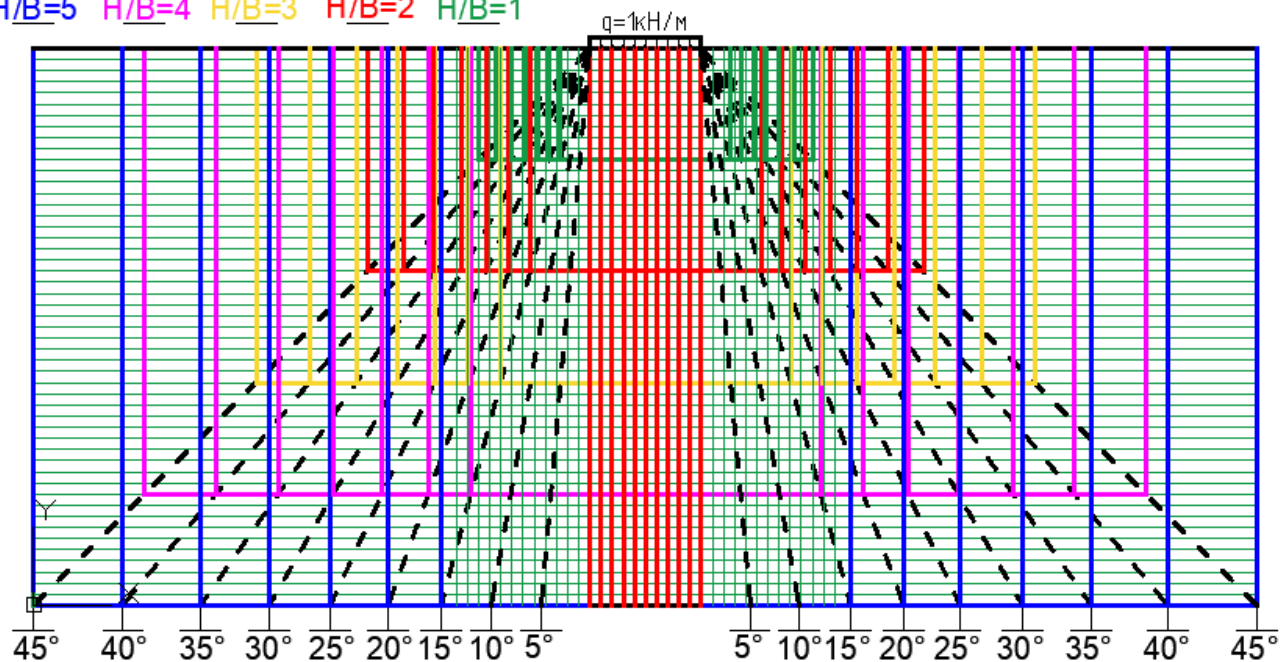


Figure 1.4 – Scheme of a stencil for the formation of a design scheme

Adjust the stencil scheme according to your individual task. Remove additional symbols from the diagram and save it under the name "Last Name_HB = _Y =.dwg", where HB = the ratio of the depth of the soil model to the width of the foundation, Y = the angle of distribution in the soil mass according to the individual task. Use the File-Import-DWG import function to import the saved file.

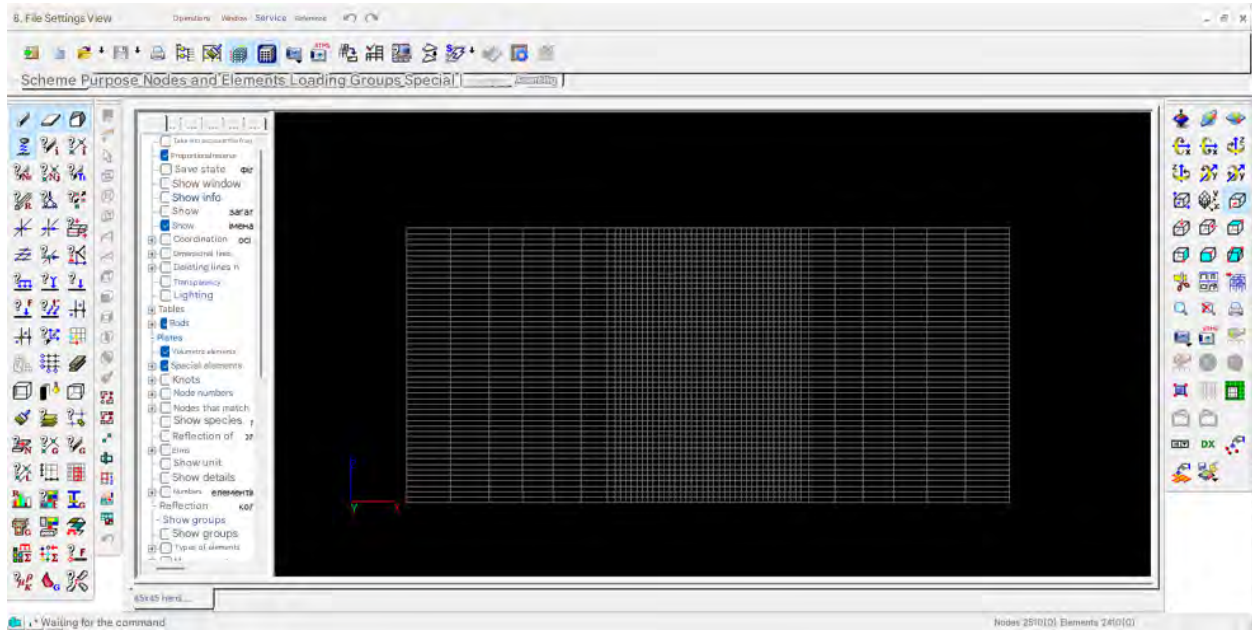


Figure 1.5 – Result of importing the calculation scheme

Next, we will create a load model from a flat foundation of unit length. To do this, we build a flat rod in the middle of the calculated soil model, for ease of use, we set a slight excess of the coordinates "Z" above the surface of the soil model (for example, 1.0 m). We divide the unit length foundation model into 10 equal parts using the rod split function on the nodes and elements tab (Fig. 1.6).

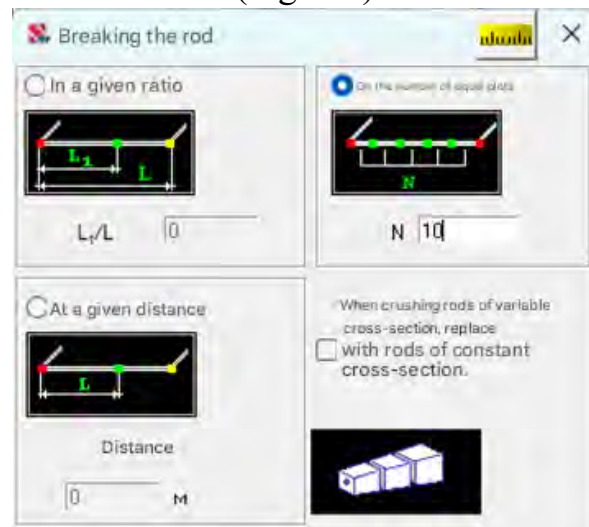


Figure 1.6 – Rod Partition Dialog

Combine the displacements of the corresponding nodes of the foundation model with the soil base model using the function of combining displacements on the "Purpose" tab (Fig. 1.7). Having set the directions of joining X and Z, press the OK button and select the corresponding nodes in pairs and press the confirm or "Enter" button.

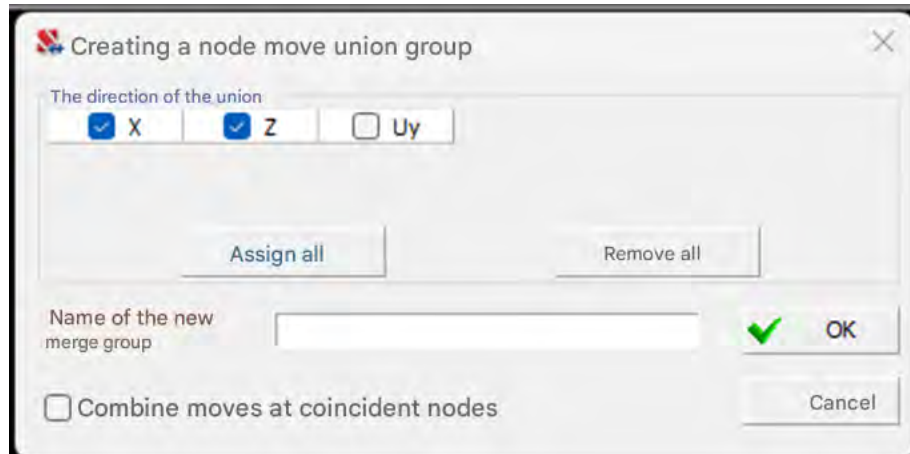


Figure 1.7 – Movement Merge Dialog Box

Check the correctness of the merge using the function of displaying the merge of movements in the filter panel. The corresponding nodes in the diagram must have the same color and union designation in the specified directions. Further, the movement of the nodes of the foundation model will occur together with the corresponding nodes of the surface of the soil model (as if the foundation lies on its surface).

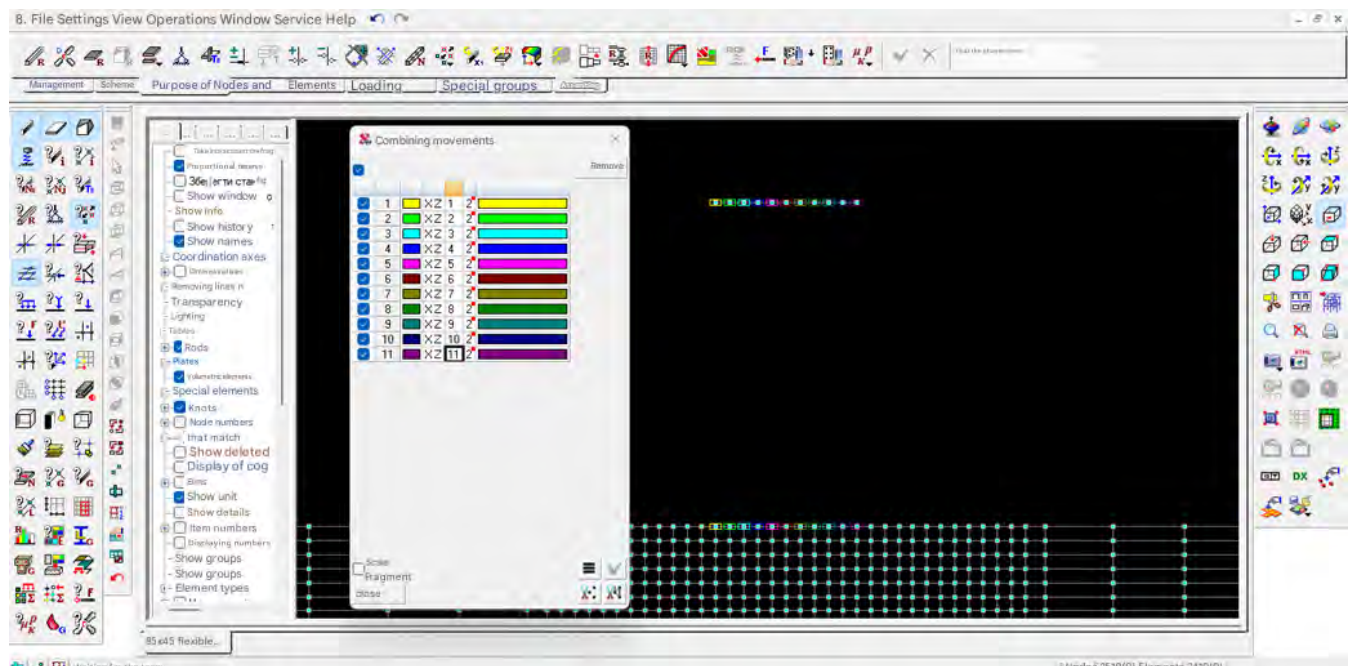


Figure 1.8 – Displaying the "Merge Displacements" filter

We assign soil models and foundation models to stiffness. To do this, go to the "Assignment" tab and click the button for assigning "Stiffness to plates" and "Stiffness to rods" to perform the appropriate actions.

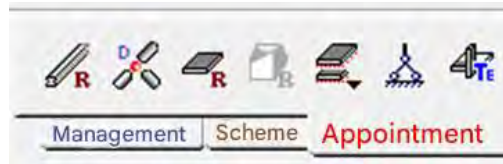


Figure 1.9 – Buttons for assigning stiffeners to plates and rods on the corresponding tab

We assign stiffness to the soil mass and foundation according to the individual task using the appropriate dialog boxes with parameters according to the individual task.

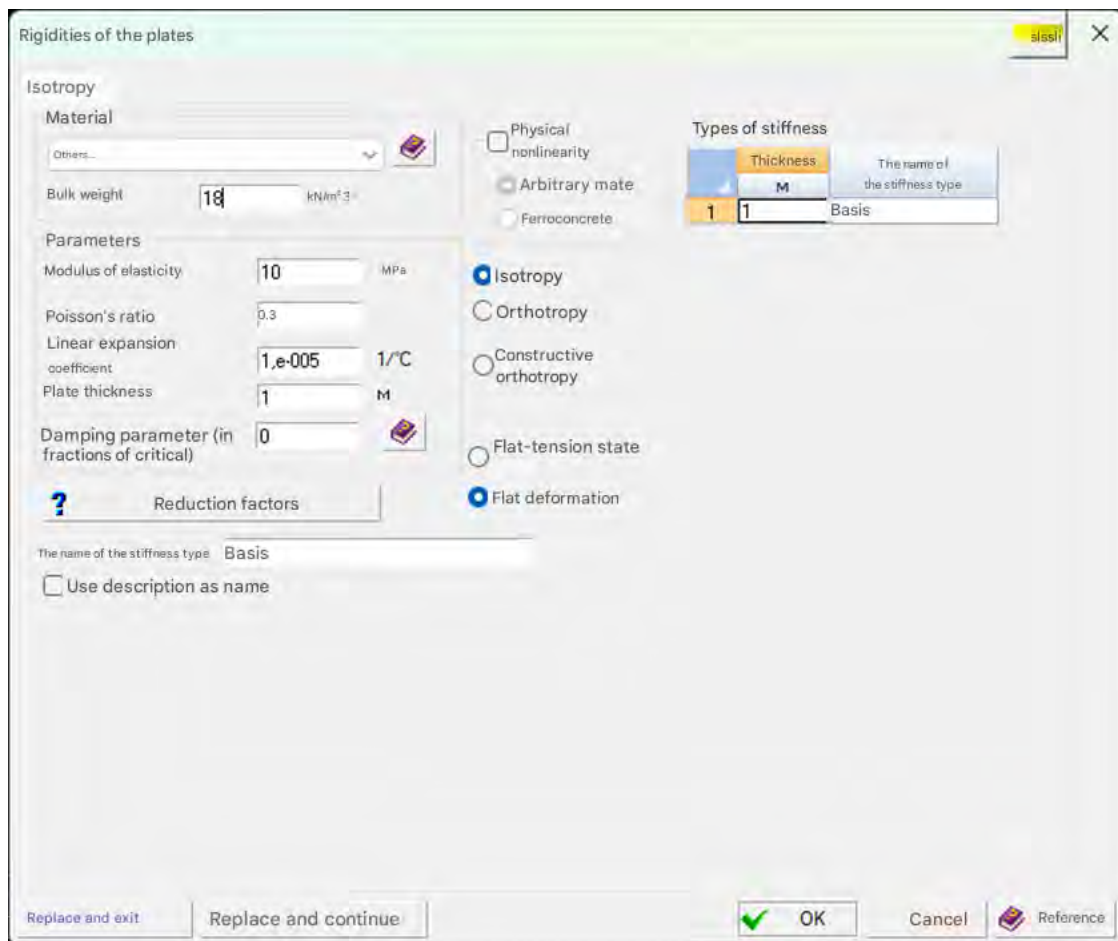


Figure 1.10 – Soil Base Model Stiffness Assignment Dialog Box

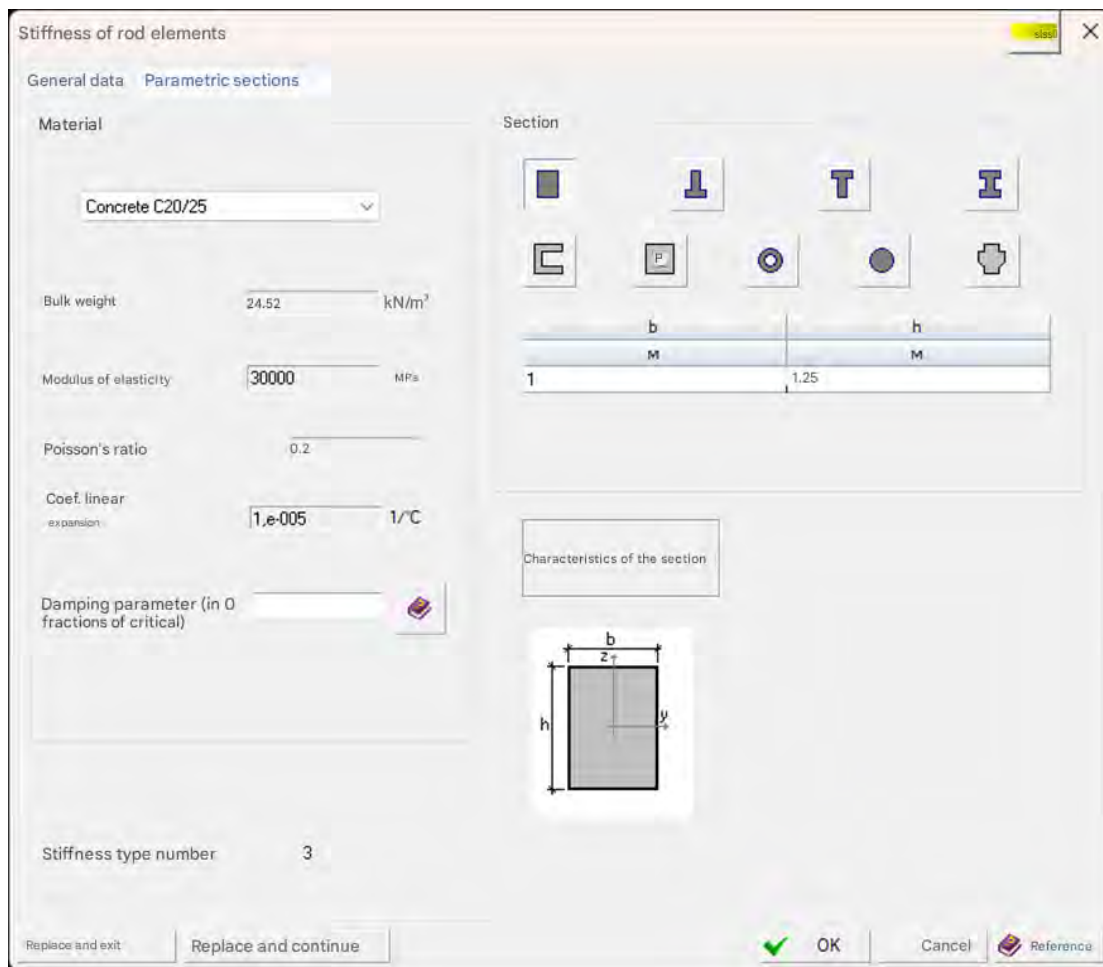


Figure 1.11 – Stiffness assignment dialog box of the foundation model

In accordance with the task, assign the load to the foundation using the button for setting loads on the core elements on the "Loading" tab.

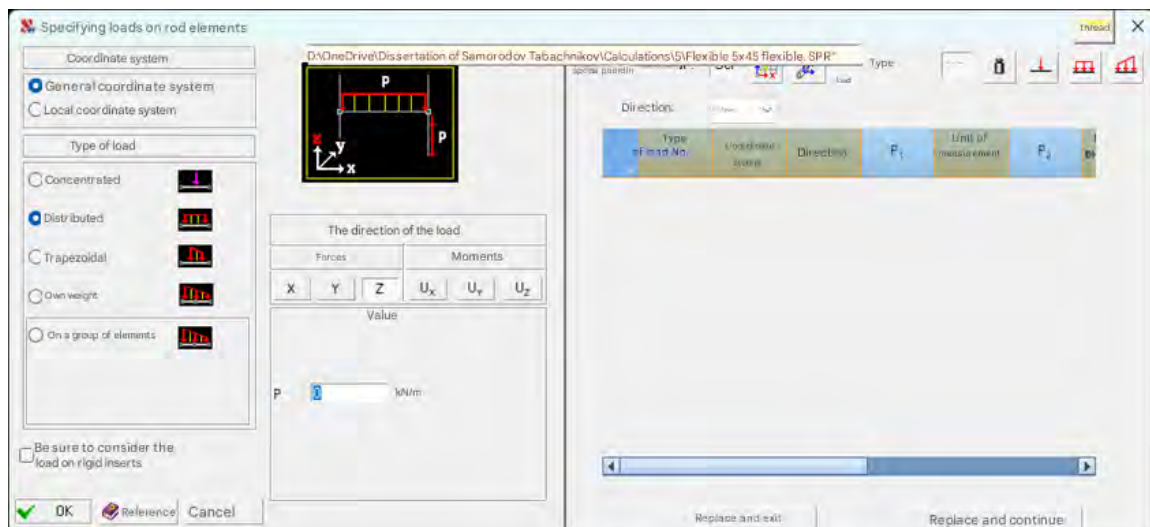


Figure 1.12 – Dialog box for setting downloads

Next, assign boundary conditions to the soil model (anchoring it in space) using the button for assigning elms in nodes on the assignment tab. For the nodes of the lower face of the model, assign fastening in the Z direction, for the nodes of the side faces – in the X direction.



Figure 1.13 – Load Setting Dialog Box

We check the correct installation of elms using the button for displaying elms in the filter panel.

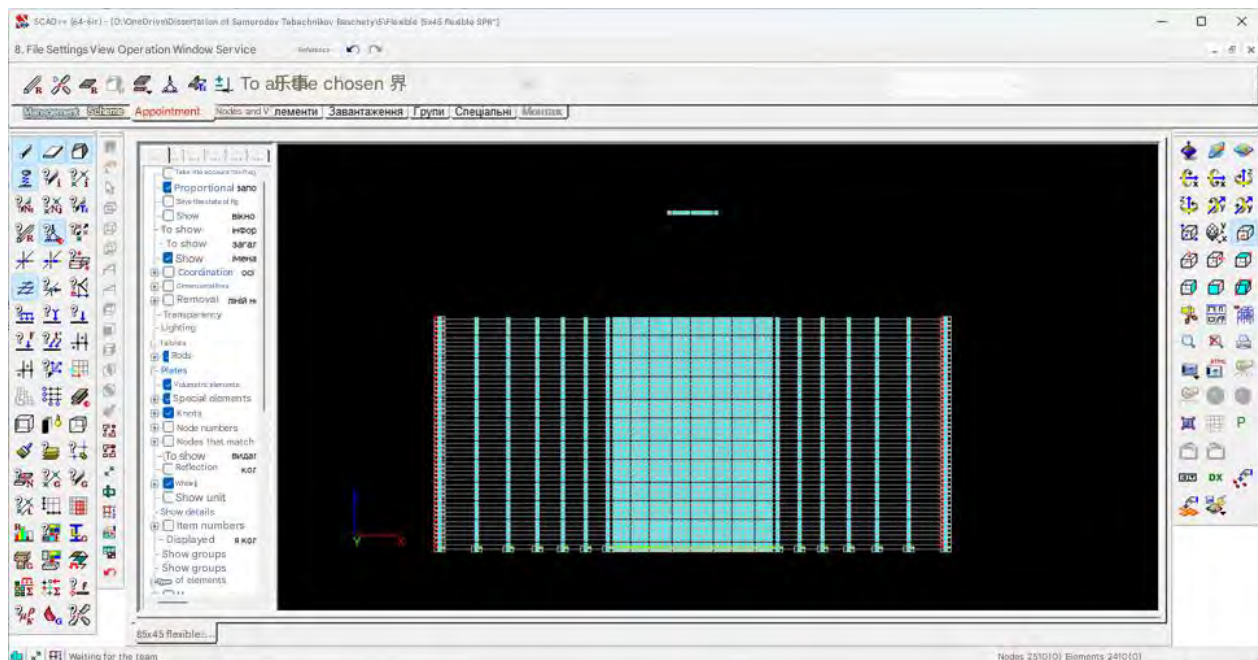


Figure 1.14 – Display of the design scheme with assigned boundary conditions

Go to the project management screen and perform a linear calculation. If everything is done correctly, then the linear calculation will be carried out without errors, after its completion we go to the "Graphical Analysis" module.

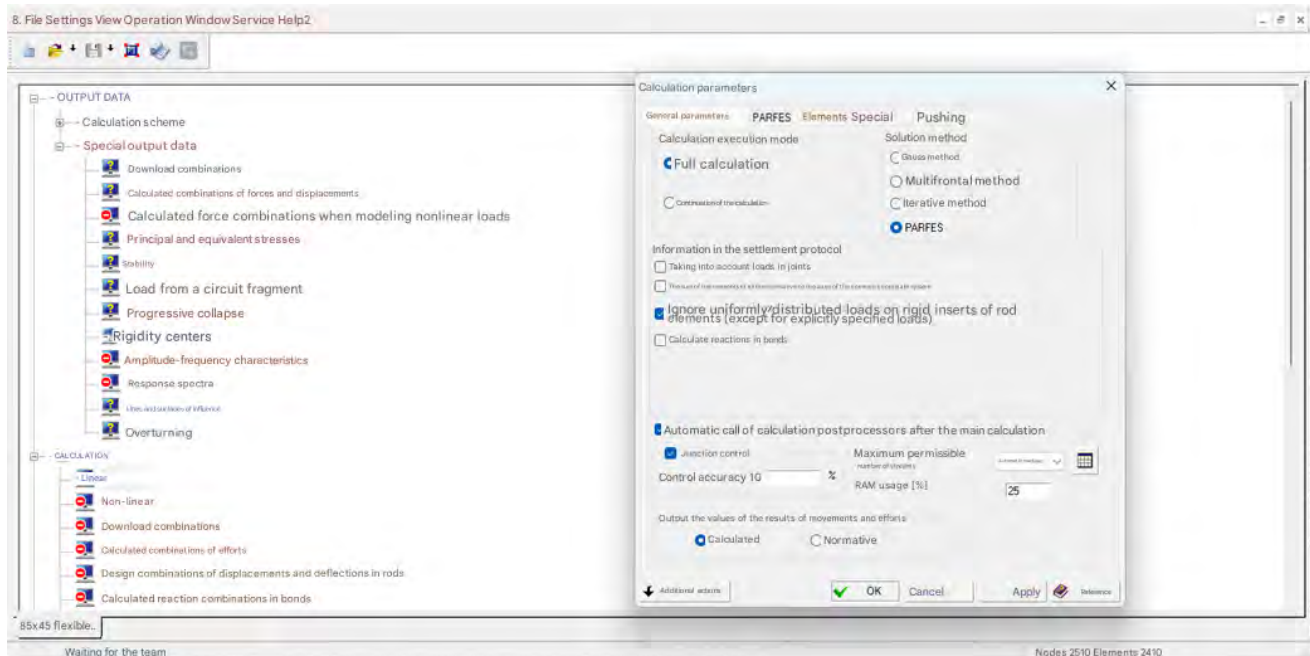


Figure 1.15 – Project management screen and running linear calculation

On the "Displacements" tab, we analyze the resulting displacements and calculate the value of the average subsidence of the foundation model S_{ser} .

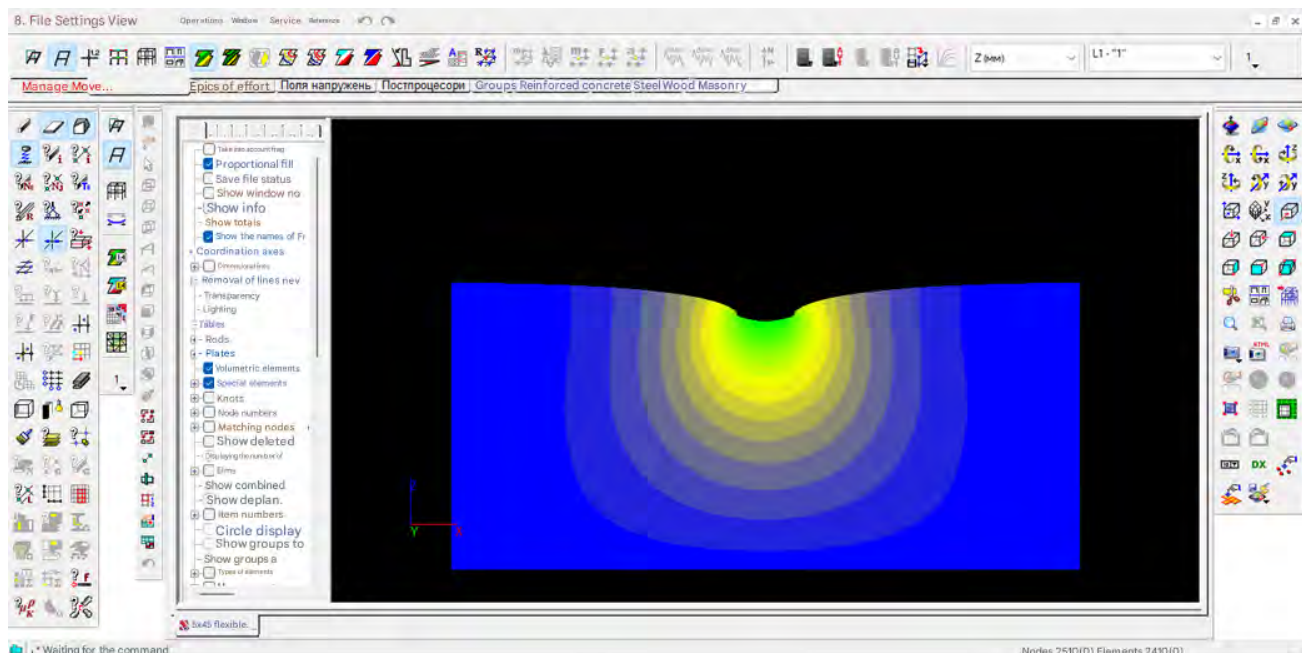


Figure 1.16 – Soil Model Deformation Analysis Screen

Go to the tab "Plots of Effort" , turn on the display of the plot of moments for the foundation and fix the value of the maximum moment in the middle of the span.

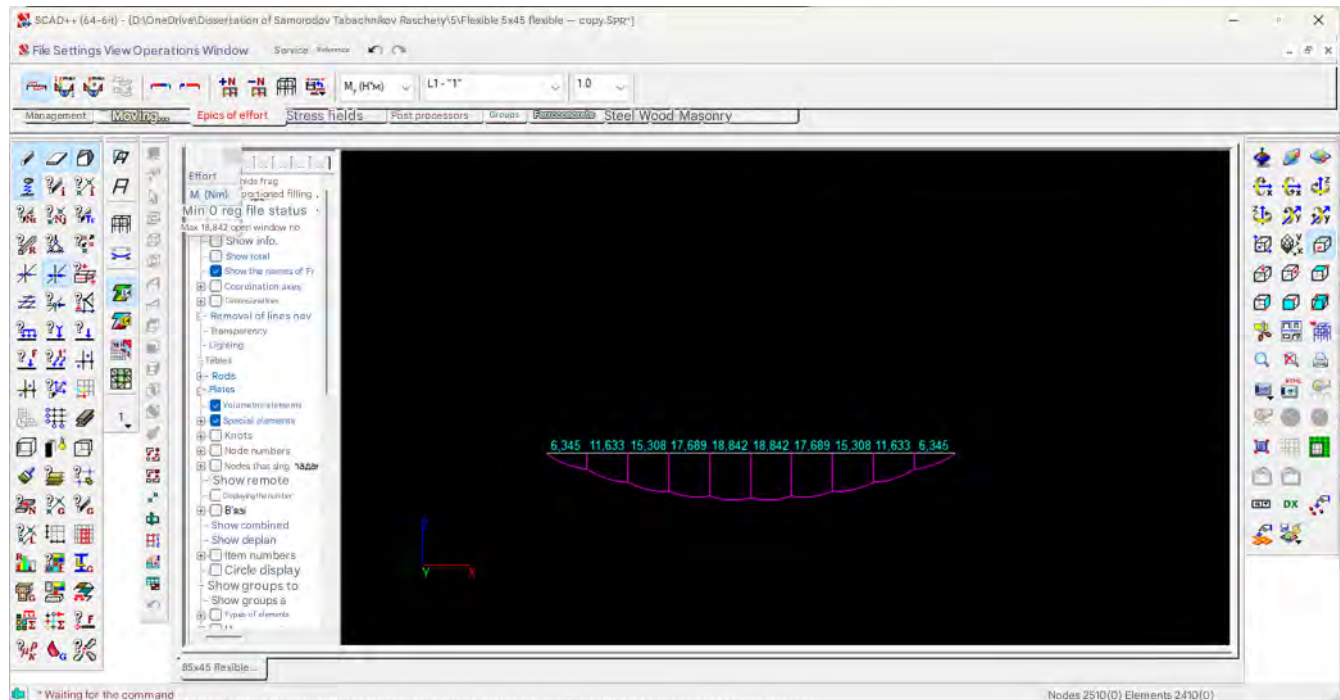


Figure 1.17 – Bending moment analysis screen in the foundation model

We repeat the entire described procedure, creating a calculation model of the soil with a distribution angle of 45° , 25° and 0° . We take the H/B ratio in accordance with the individual task.

Table 1.1 – Results of the analysis of the influence of boundary conditions of the model of a soil base of finite width.

Schema code	Average subsidence, mm	Maximum torque, kN/m
Surname HB=5 Y=45		
Surname HB=5 Y=25		
Surname HB=5 Y=0		

Tasks for independent work on topic 1. Perform the calculation of the subsidence of the foundation according to the model of a linear-deformed medium (in the program "REQUEST") using identical parameters of dimensions, soil characteristics and load. Compare the results of the calculation with the results of subsidence determination for different distribution angles from Table 1.1.