Reinforced concrete deep beam example with SCIA Engineer

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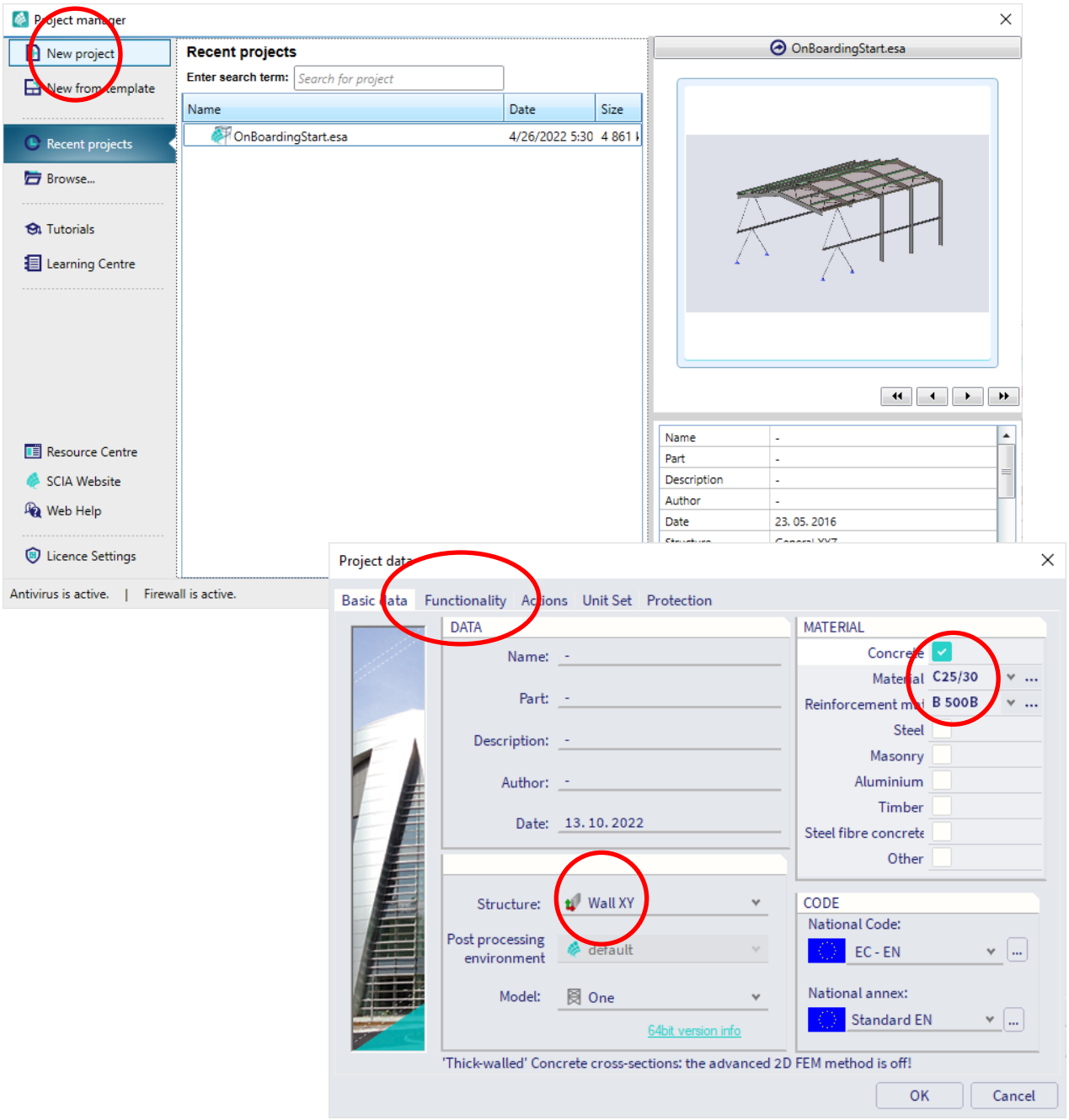
("SCIA" is pronouced "see-a" because it stands for scientific analyser.)

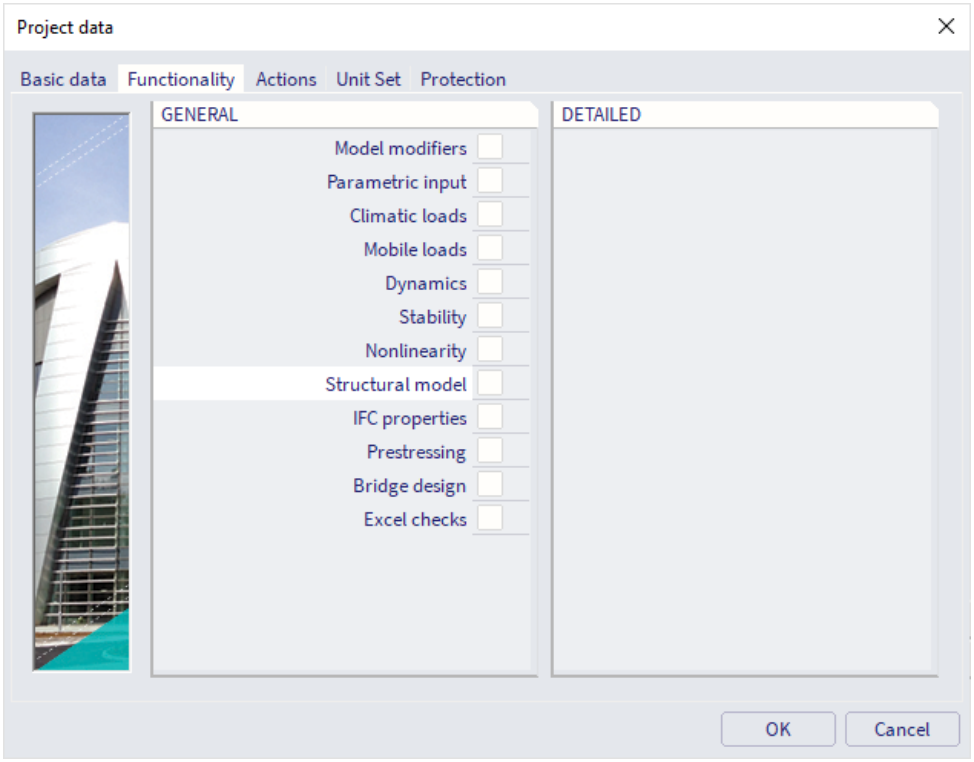
Every finite element computation consists of three steps:

1) Pre-processing = we enter shape, supports and load
2) Computation = the computer computes the deformation, stresses and support reactions
3) Post-processing = we check the computation results

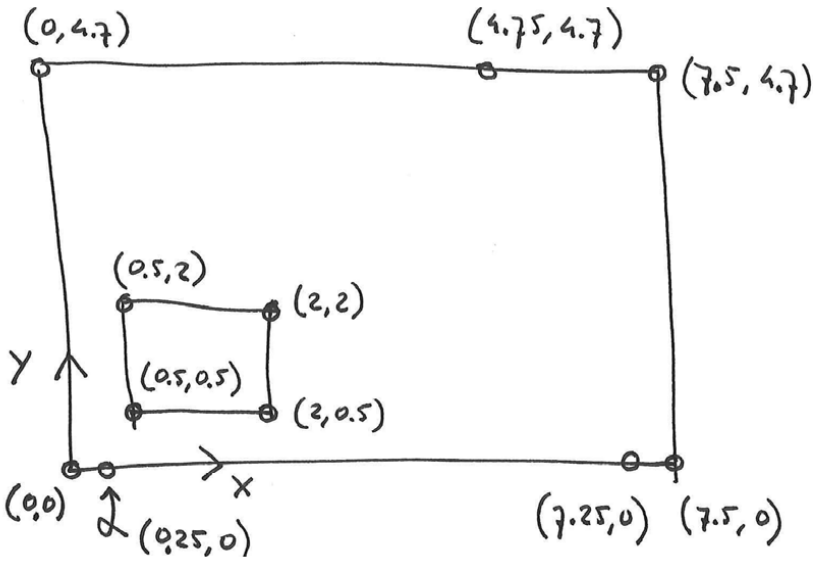
Pre-processing

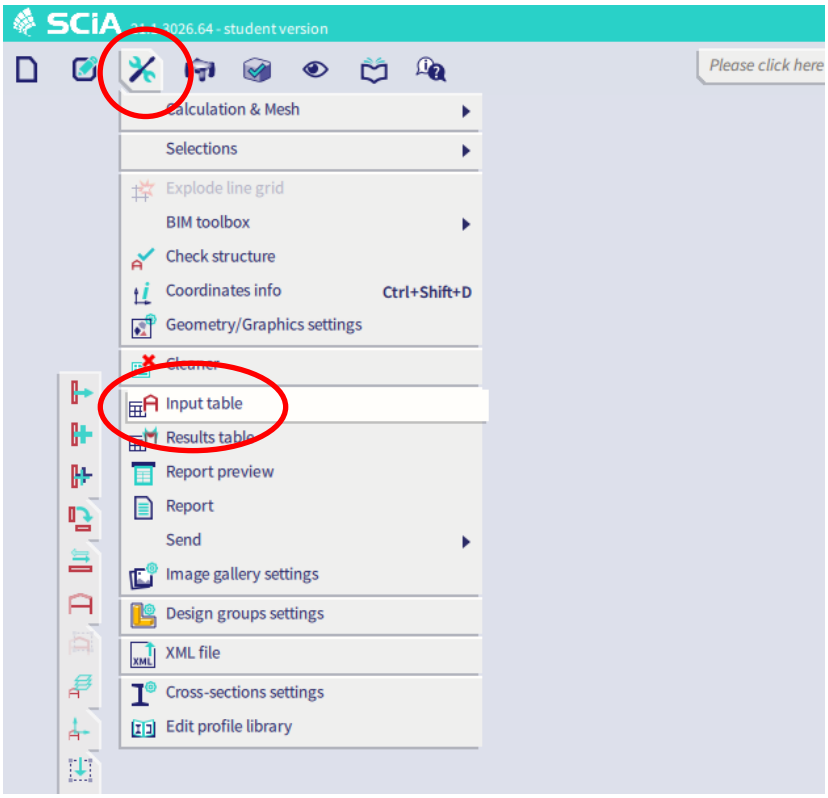


We switch off all advanced functionality. Then it will not occur in the menus and not distract us.



We will analyse a reinforced concrete deep beam (wandligger) with an opening.

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Please click here
Calculation & Mesh
Selections
Explode line grid
BIM toolbox
Check structure
Coordinates info
Ctrl+Shift+D
Geometry/Graphics settings
Cleaner
Input table
Results table
Report preview
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Image gallery settings
Design groups settings
XML file
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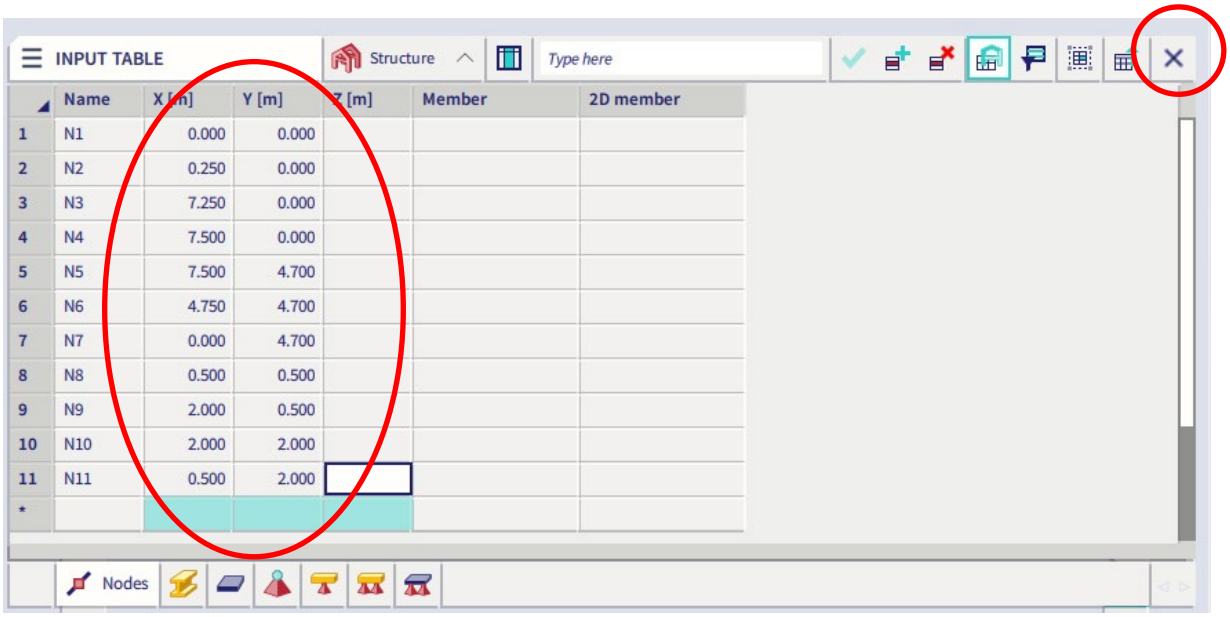
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Structure
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Name
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Member
2D member
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2 N2 0.250 0.000
3 N3 7.250 0.000
4 N4 7.500 0.000
5 N5 7.500 4.700
6 N6 4.750 4.700
7 N7 0.000 4.700
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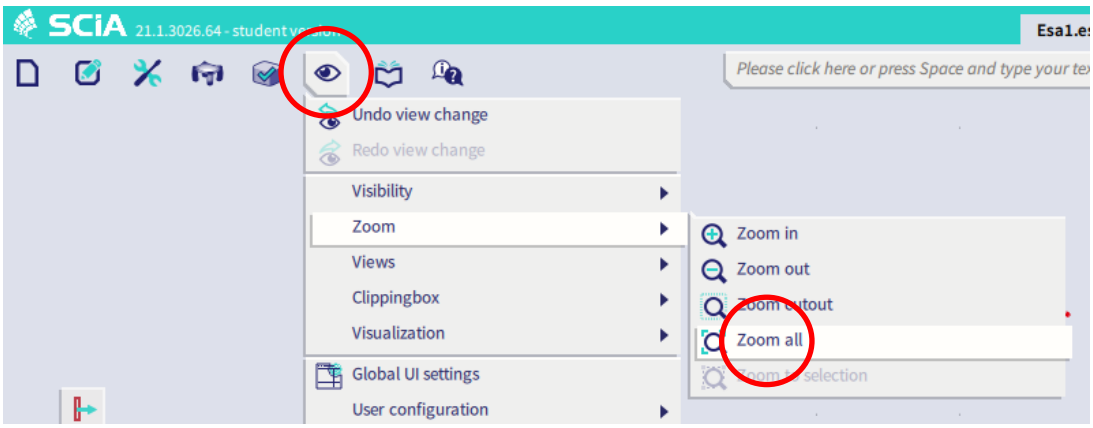
9 N9 2.000 0.500
10 N10 2.000 2.000
11 N11 0.500 2.000
Nodes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Esa1.e
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Undo view change
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Visibility
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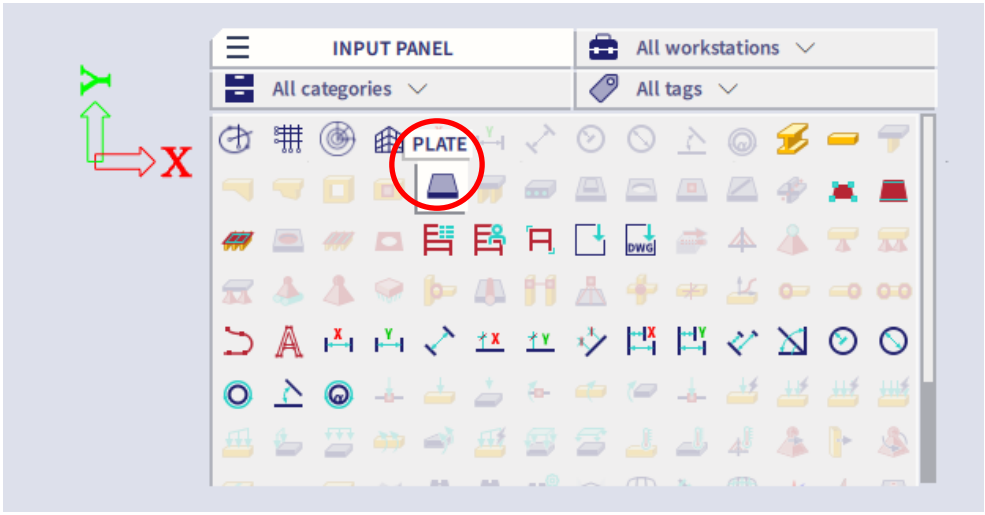
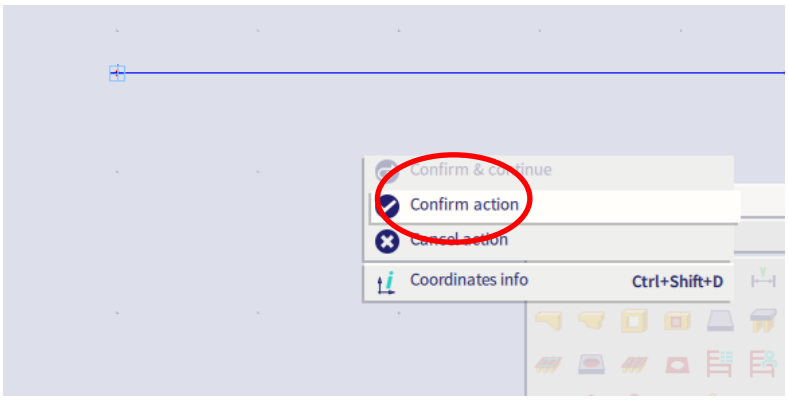
You can see the table points on the screen (red).

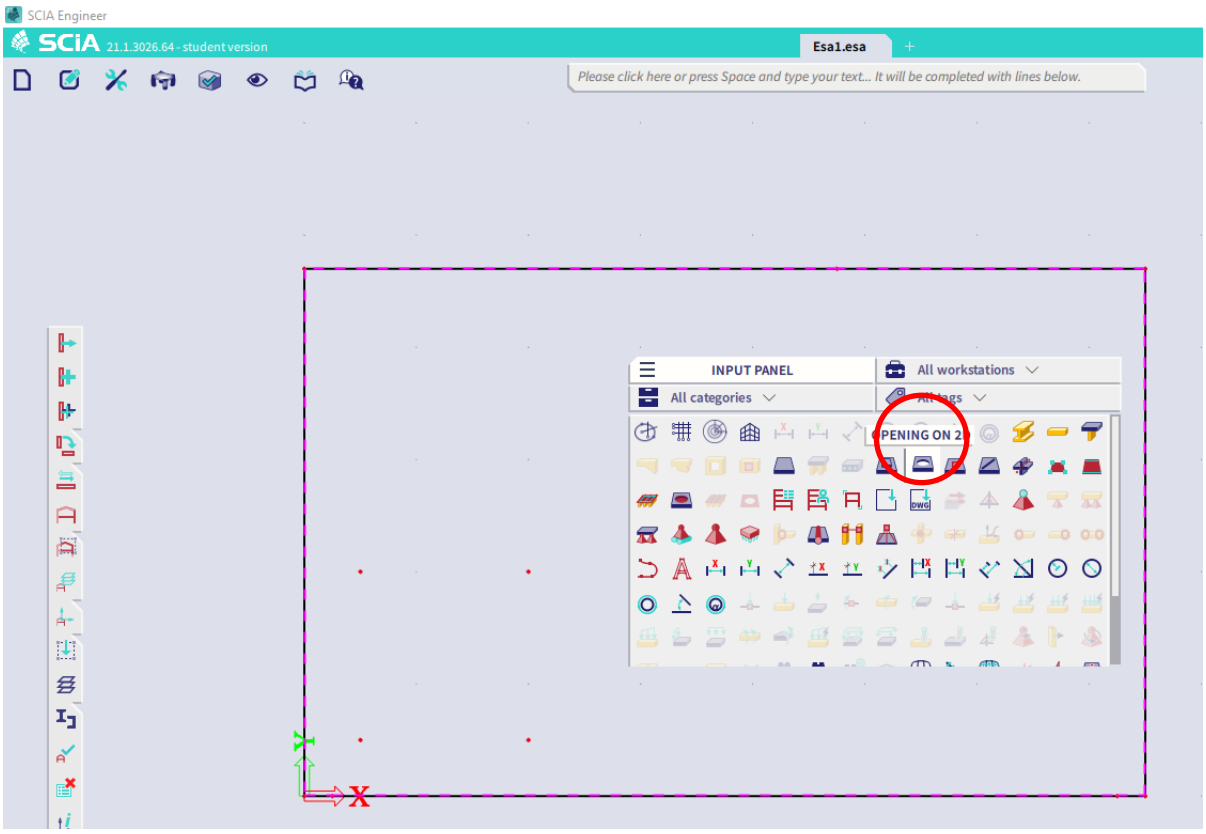


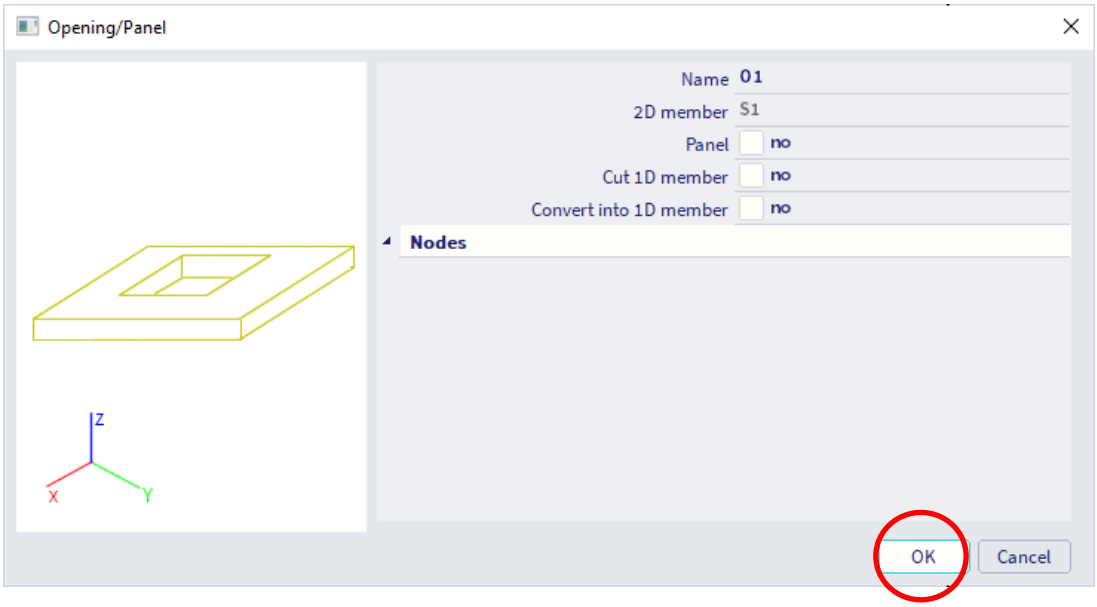


Click on ALL points of the circumference, left around or right around, you choose.

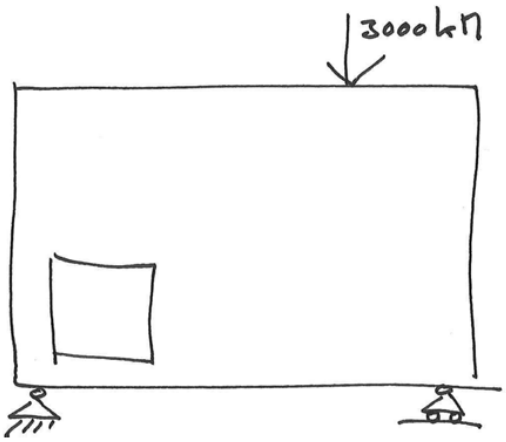
The command can be completed by right-mouse-click on the middle screen and afterwards a left-mouse-click on “Confirm action”. If you are stuck in a command, press a few times the “esc” button.

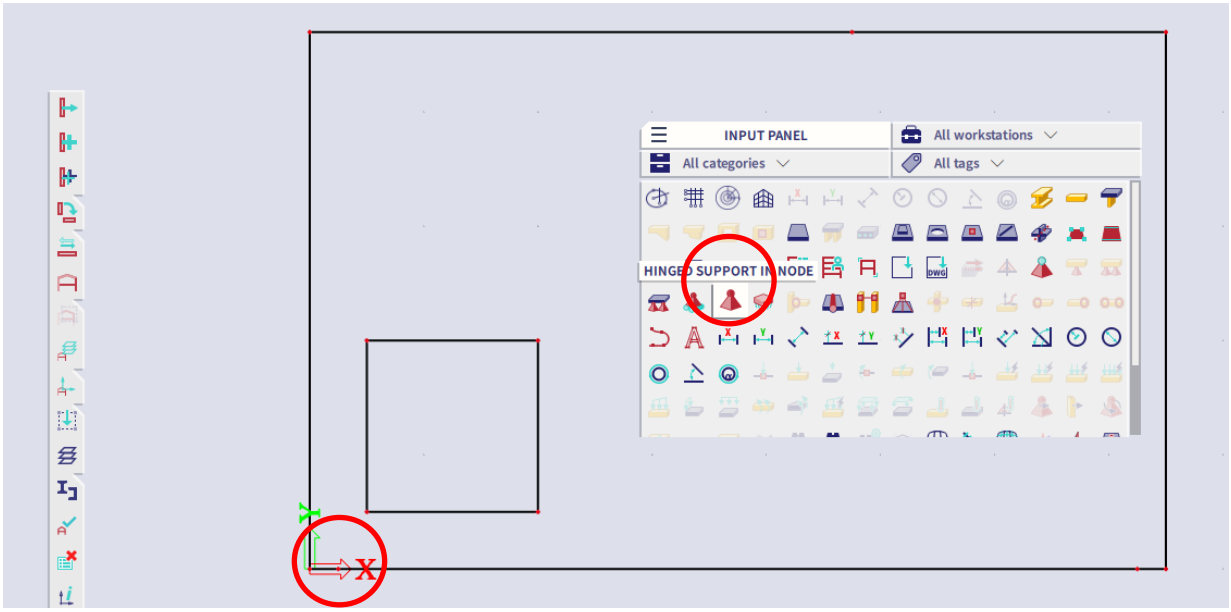




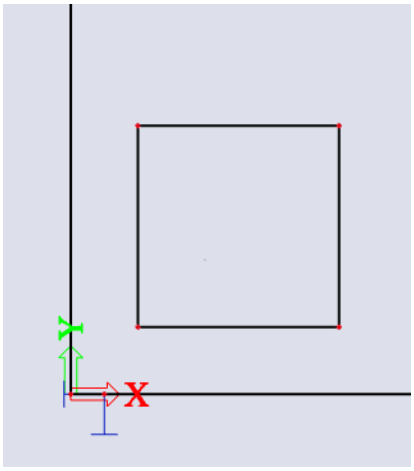


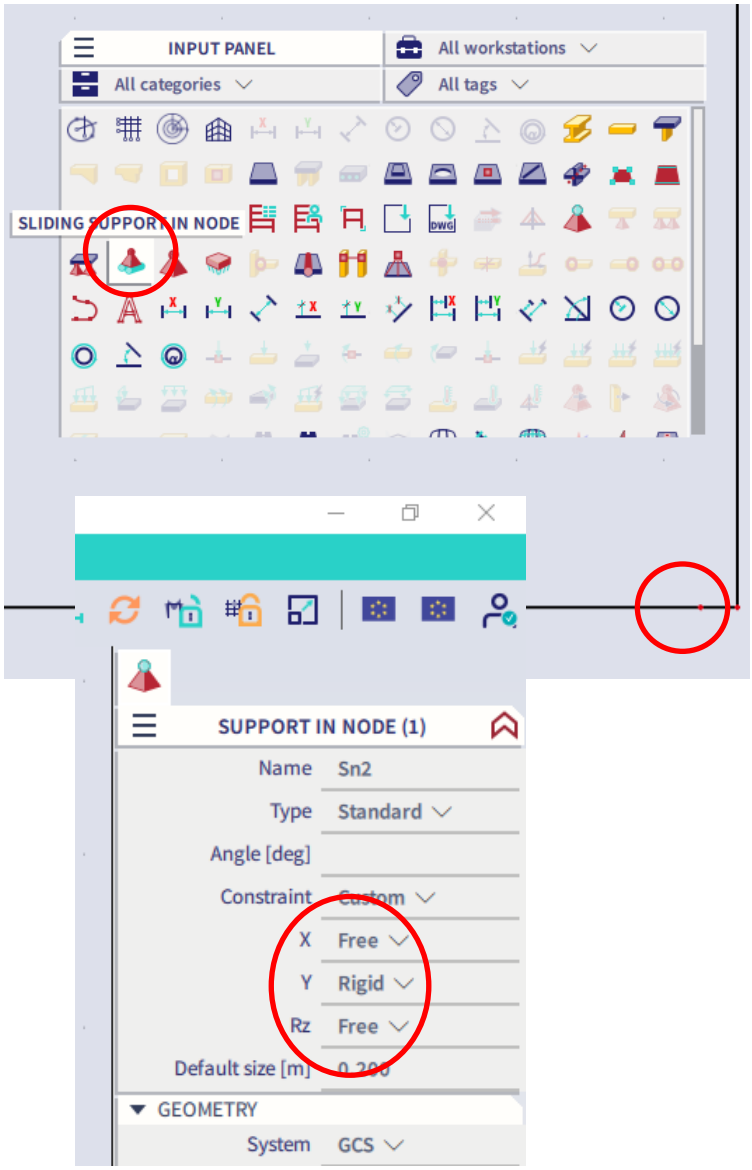
Click on point – click on point – click on point – click on point – click right – click confirm action – press esc

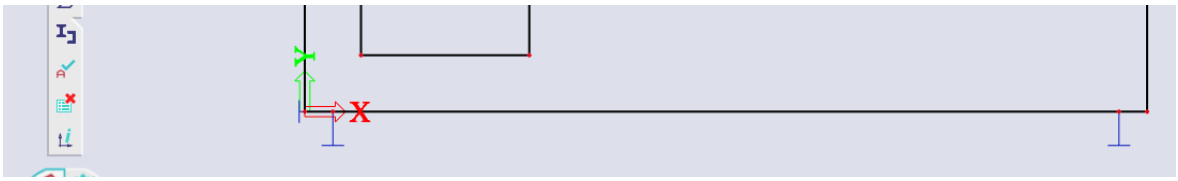


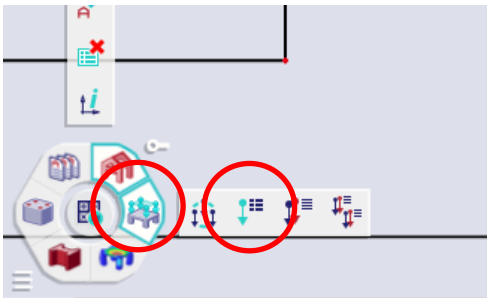


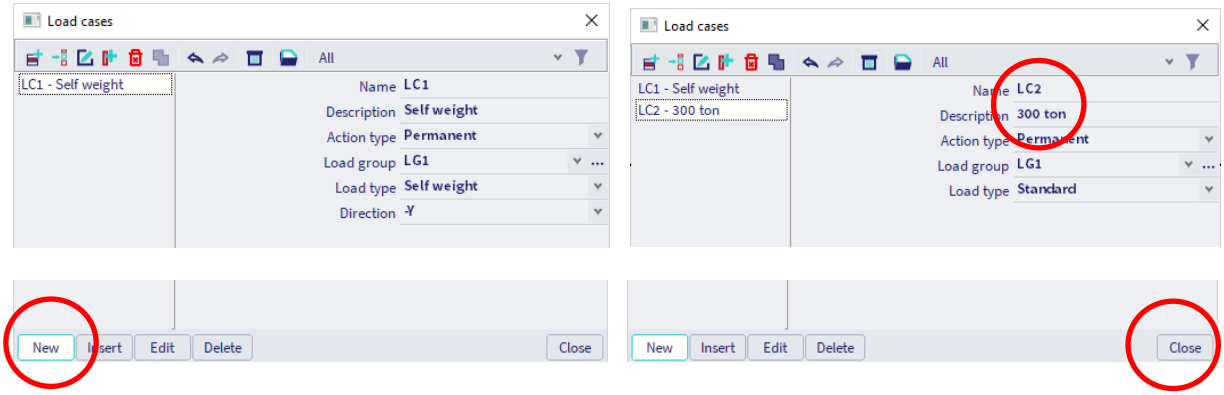
Click on node, click right, click confirm action, press esc





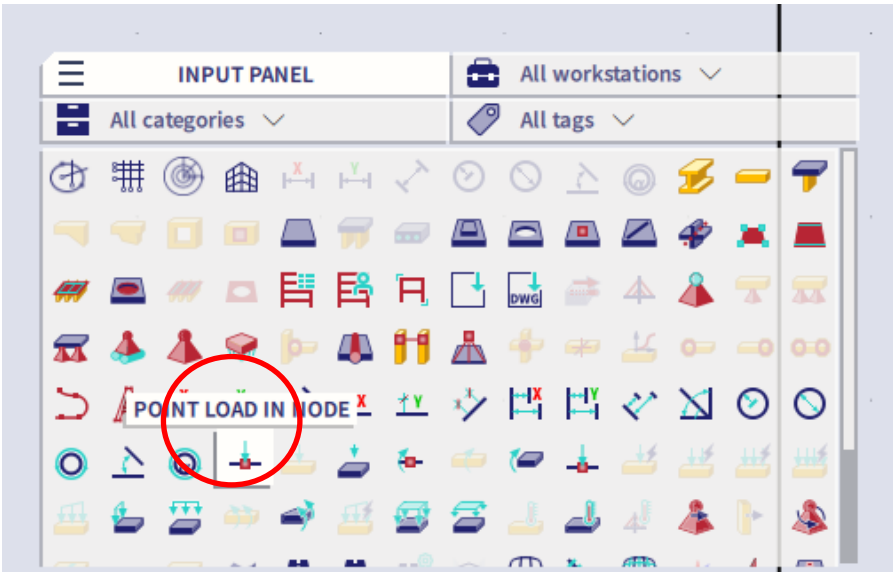


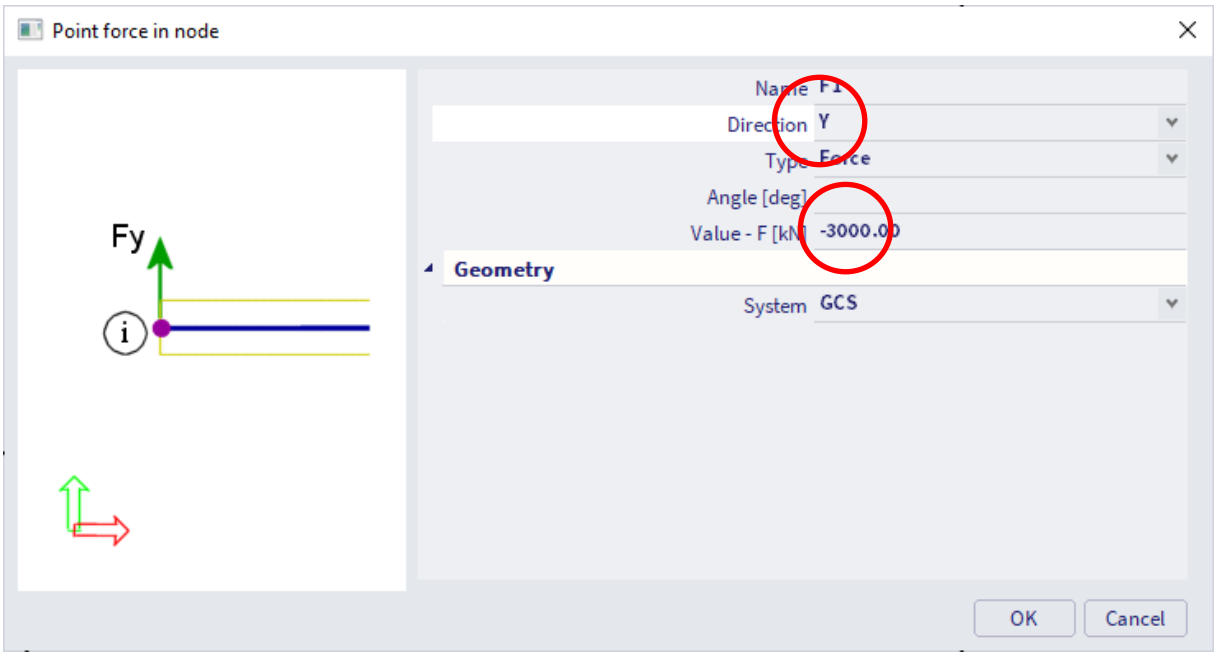




Self-weight is in load case 1 (LC1). This is predefined.

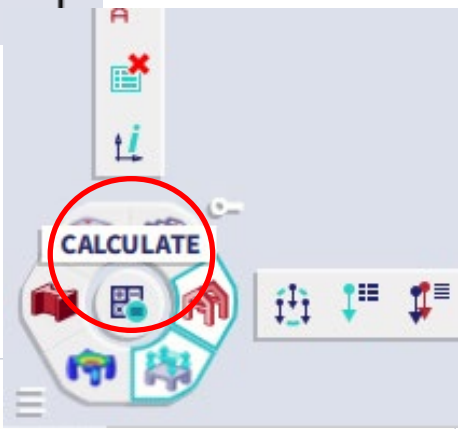
A point load of 3000 kN is in load case 2 (LC2).

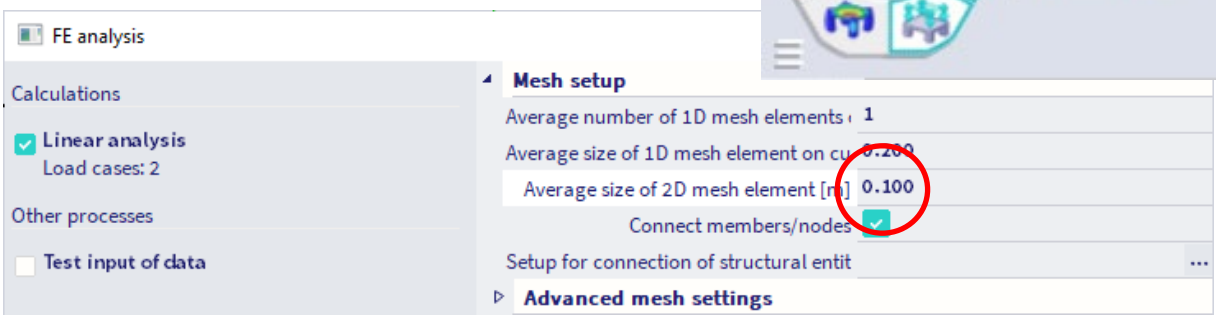


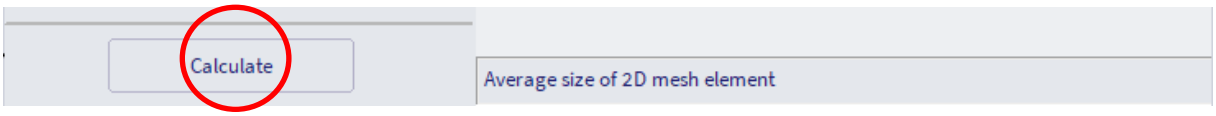


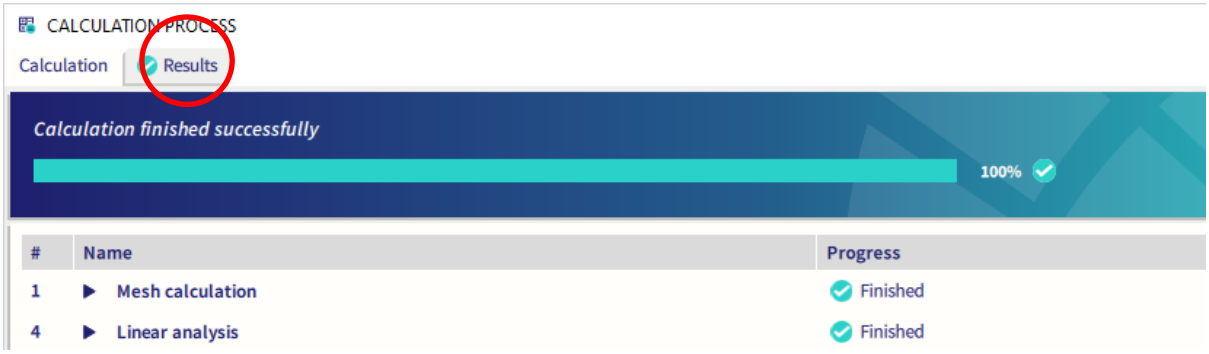


Computation

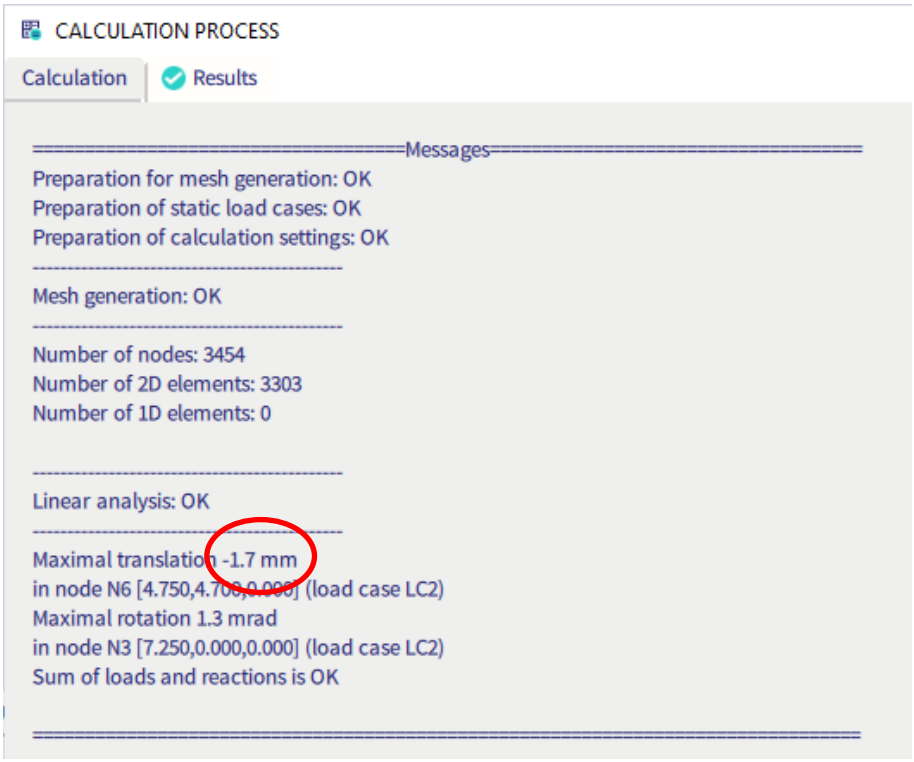




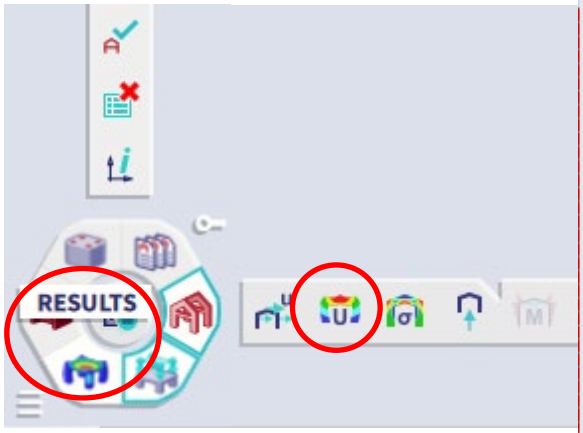


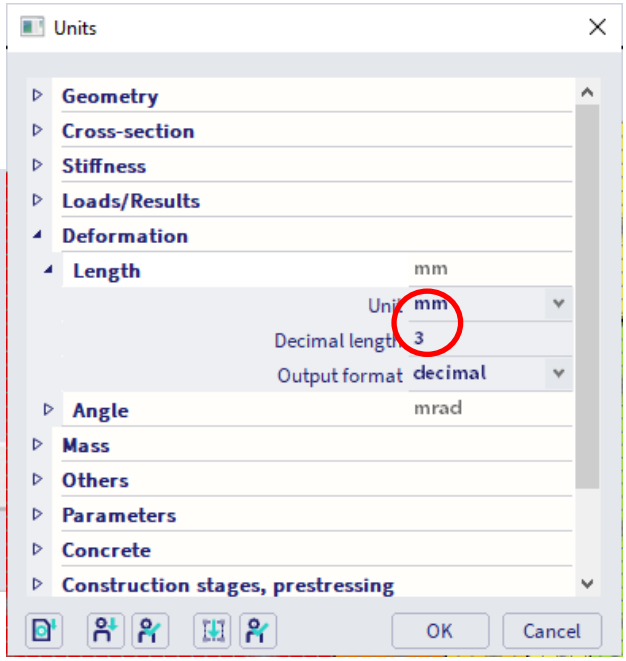


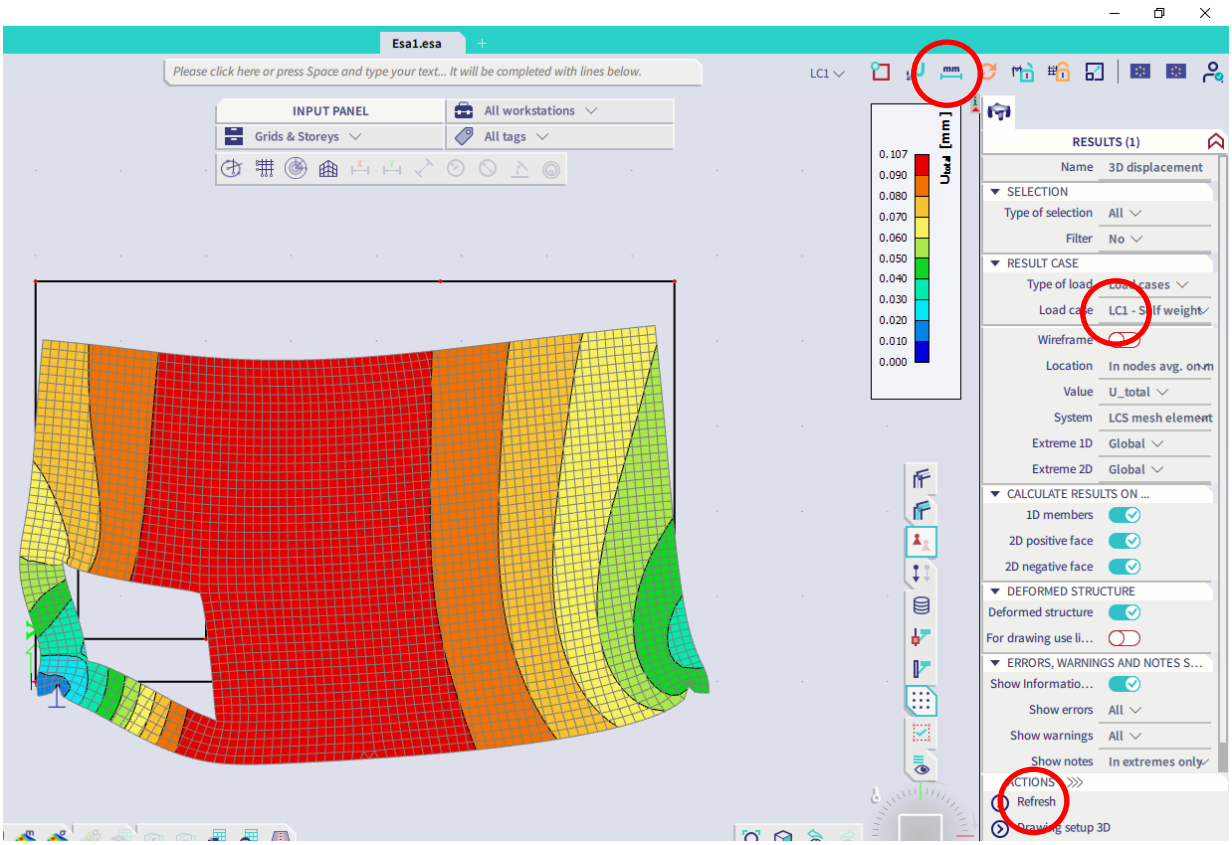
Check whether the deflection agrees with what you approximately expected.

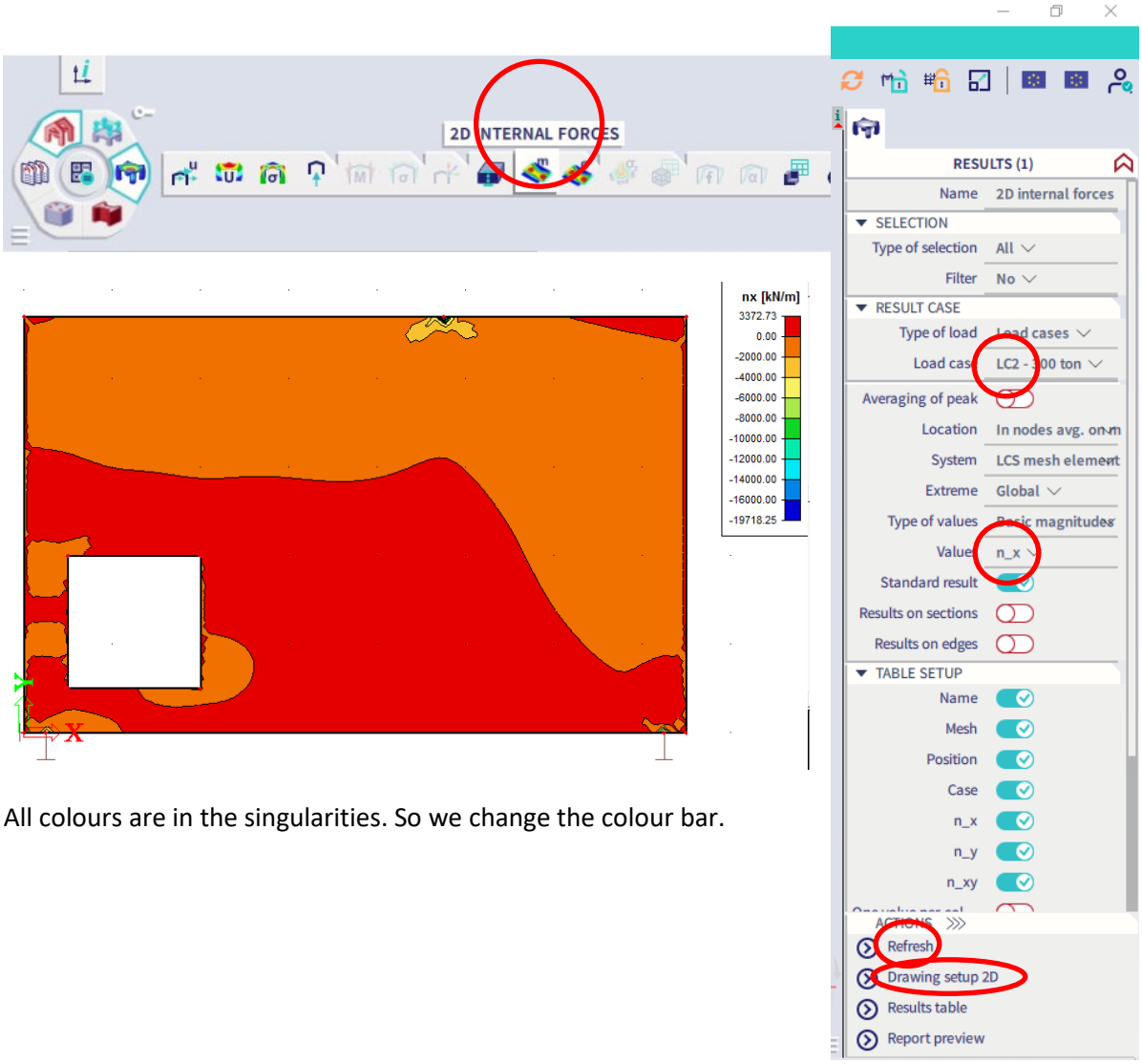


Post-processing

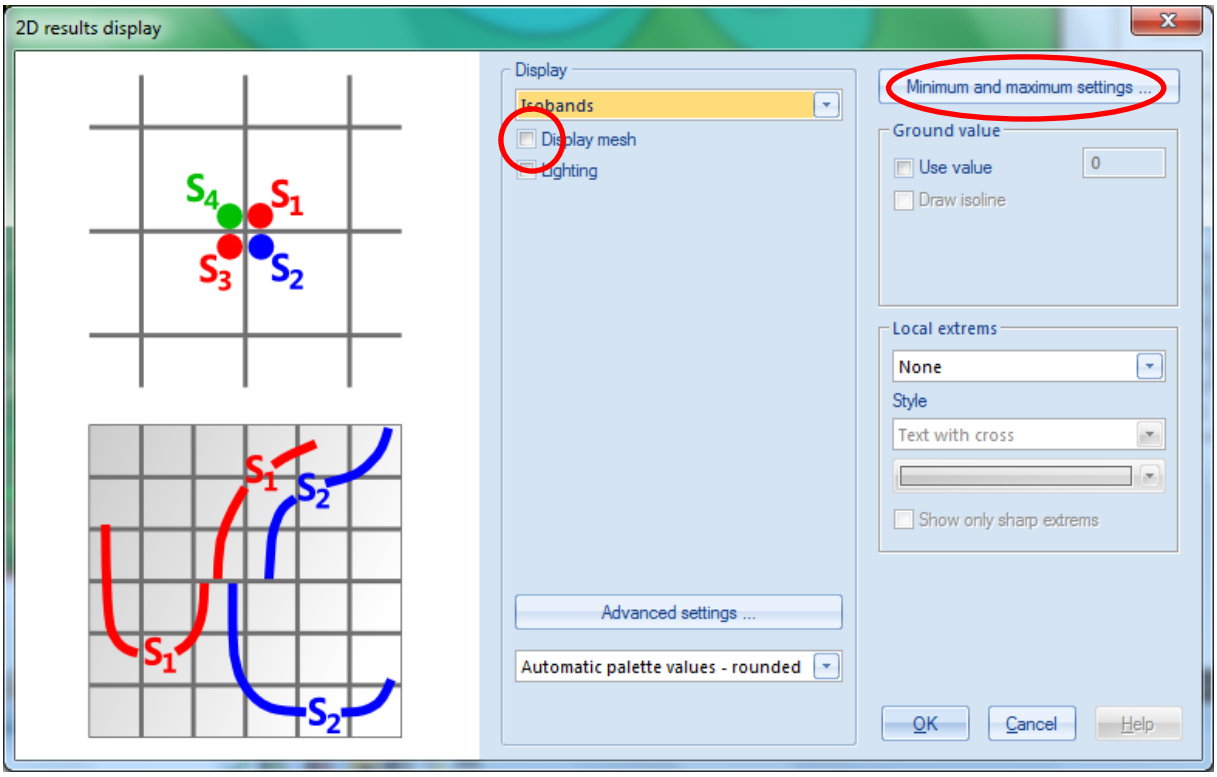


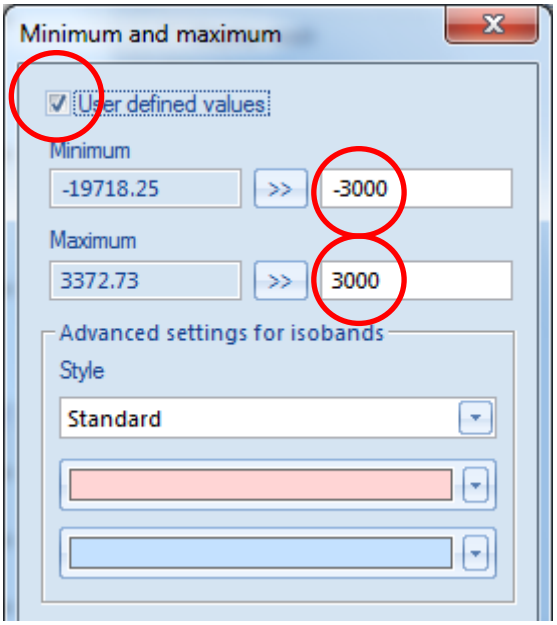






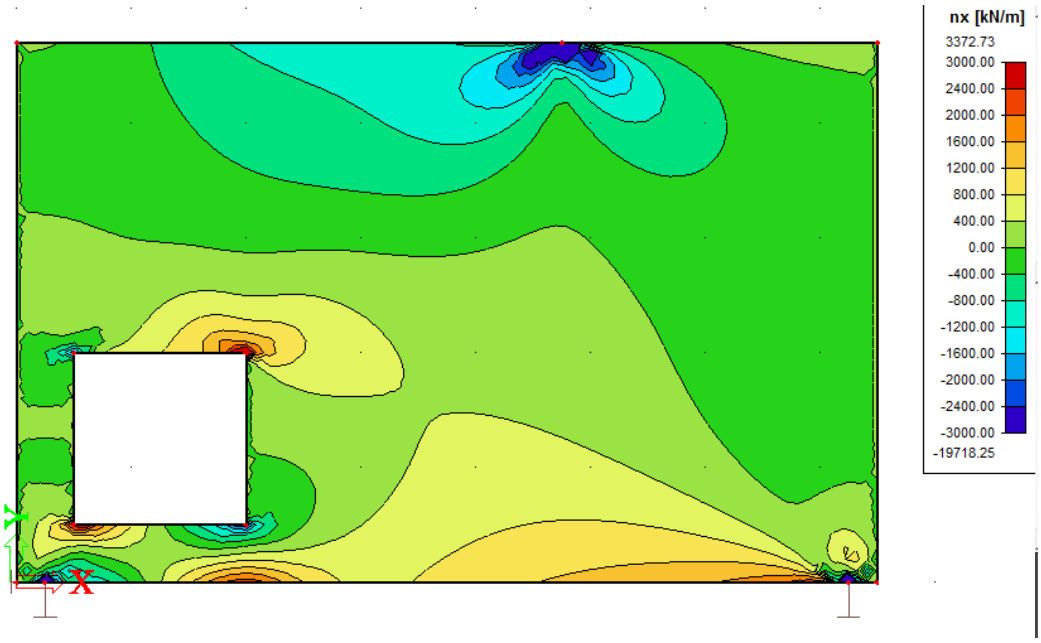
All colours are in the singularities. So we change the colour bar.



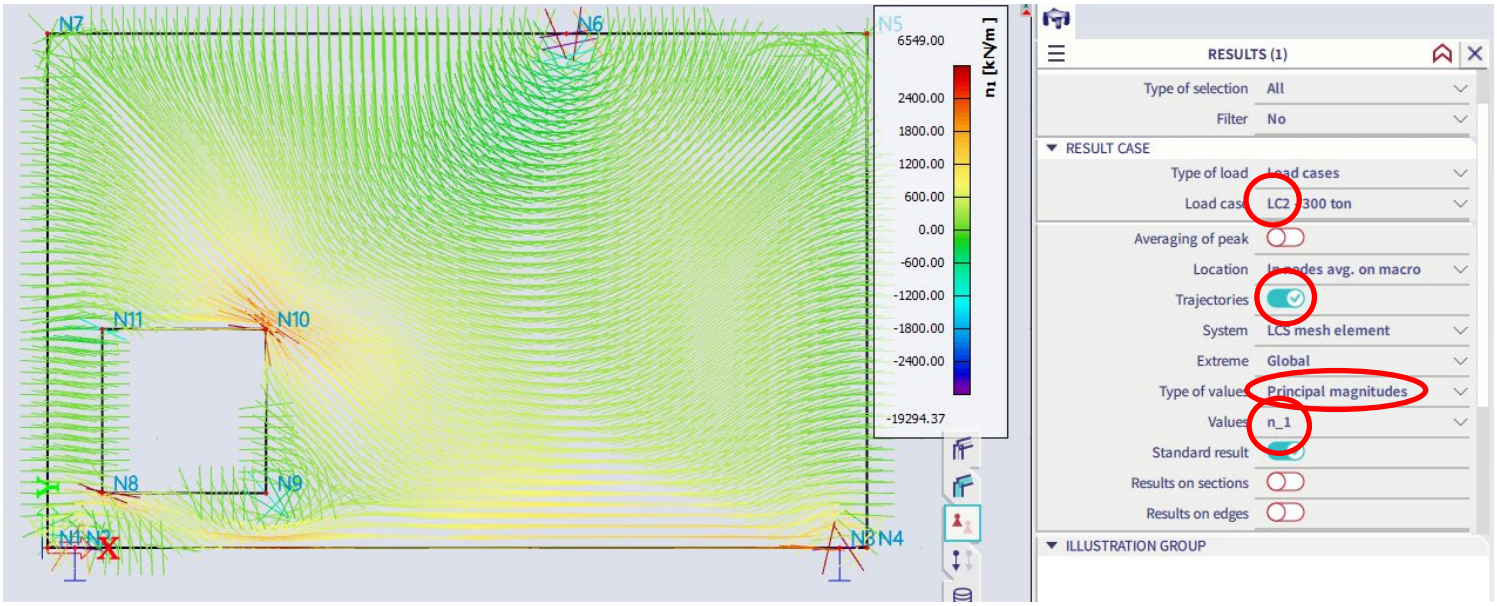


We check ourselves:

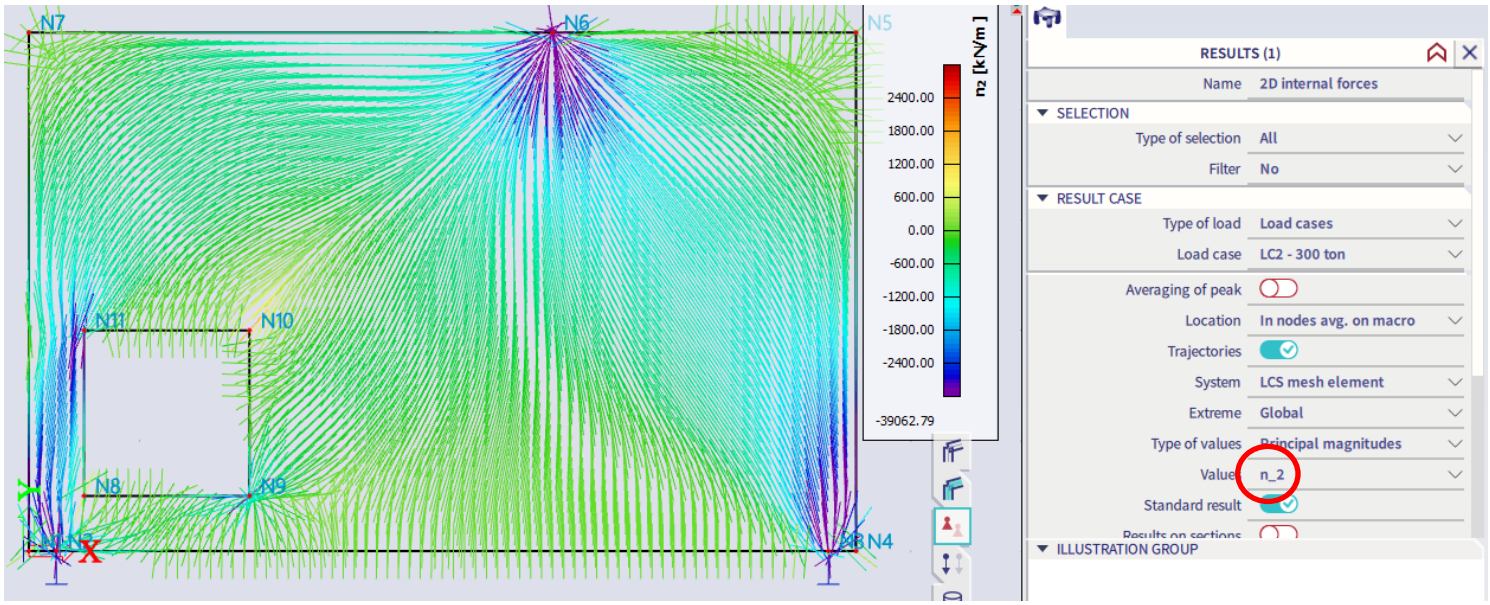
1. Is the support moving in the way we expect? ..... Yes, the right support moves to the right .... OK
2. Is the deformation in the direction of the load? ..... Yes, both are in the -y direction ..... OK
3. Is the deflection realistic? ..... 0.1 mm is small, but walls are stiff and this is just self-weight ... OK
4. Is tension in the bottom edge and compression in the top edge? ..... Yes ..... OK
5. Is nxx = 0 in the vertical edges? ..... Yes ..... OK
6. Is nxy = 0 in the vertical edges? .....
7. Is nyy = 0 in the horizontal edges? .....
8. Is nxy = 0 in the horizontal edges? .....



So, this is nxx. The same for nyy and nxy.

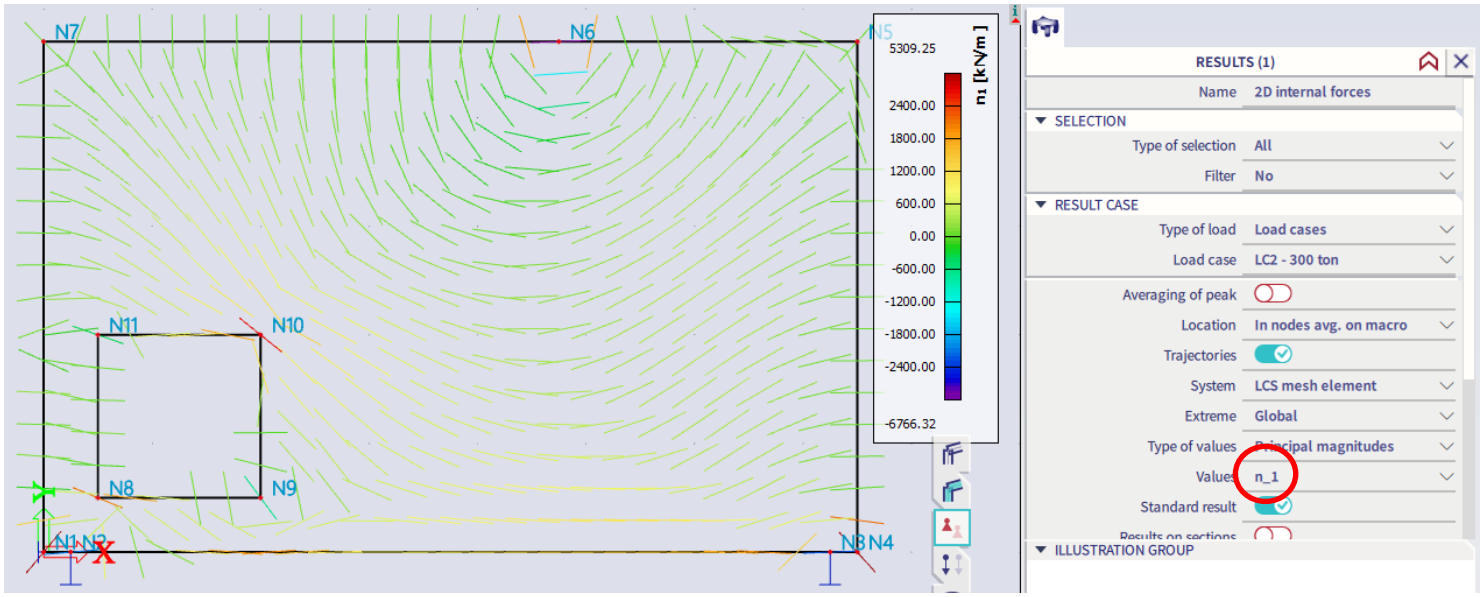


This is the preferred direction of the reinforcing bars. Note that we only need to reinforce tension (positive values) not compression.



So, this is the preferred direction of the compression struts.

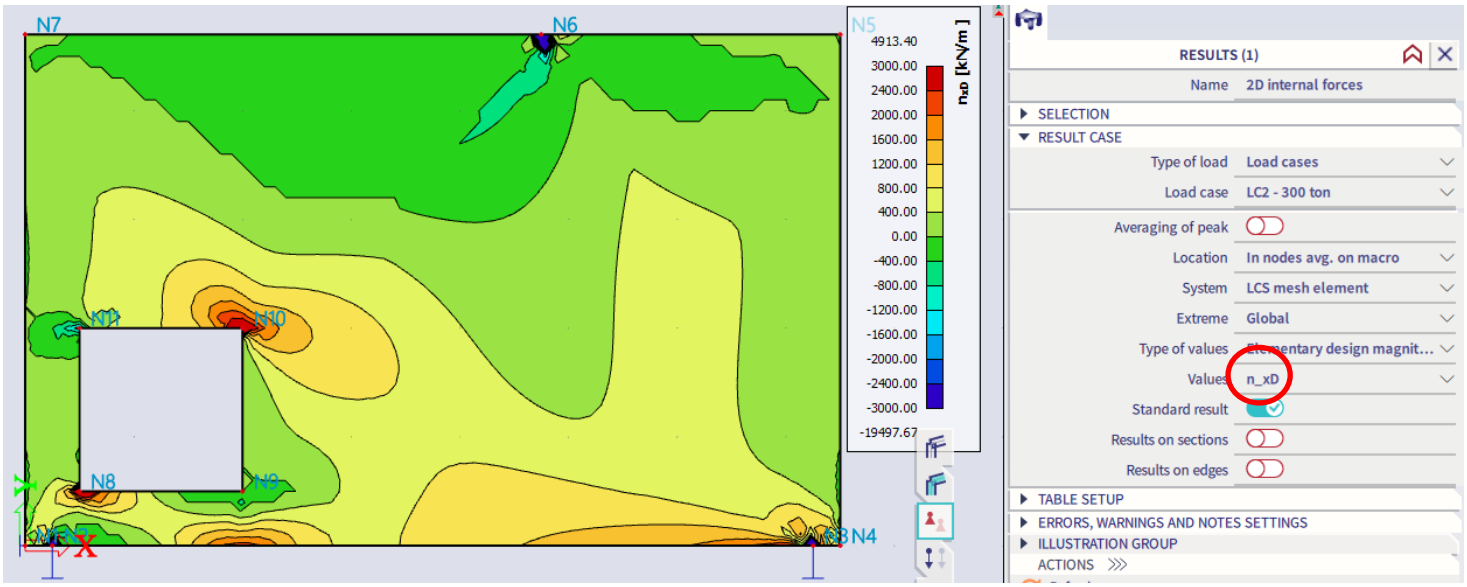
If we choose larger elements it may become clearer. For example 0.3 m:



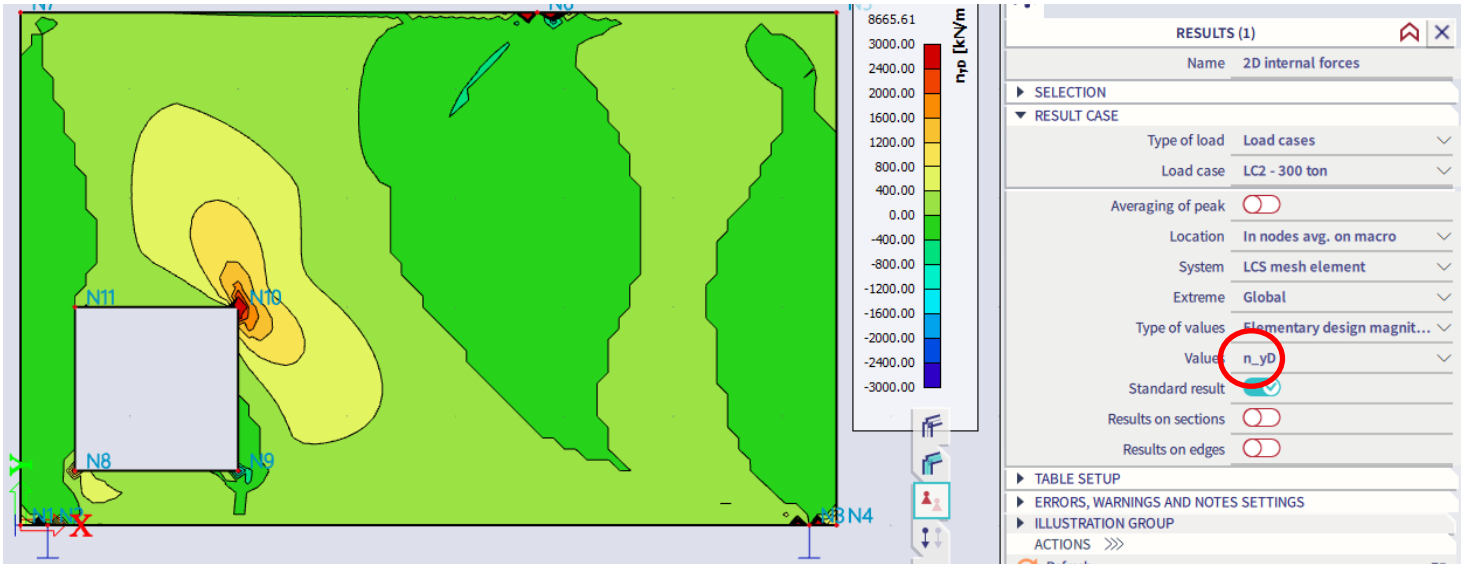
Instead of the strut-and-tie method, we can ask the software for the minimally required reinforcement in the x and y directions.

n_xD = nxx + |nxy|

n_yD = nyy + |nxy|



So, this is the force that the rebars in the x direction need to carry.



This is the force that the rebars in the y direction need to carry.

In the above results, self-weight is switched off. This is not correct because self-weight of this wall is very large. However, in your deep beam, self-weight is small compared to the load.

If the above reinforcement is provided, below is shown the membrane force in the concrete. Divide it by the thickness and you know the stress. This stress needs to be smaller than the compressive strength of the concrete that you are going to make. Usually, not a problem.

