MASTER OF SCIENCE IN COMPUTATIONAL MECHANICS

UNIVERSIDAD POLITÉCNICA DE CATALUÑA

Subject: Computational Structural Mechanics and dynamics
Student: ANTONIO SOLITO

Practice 1

Exercise 1: Thin plate under dead weight
Solution

Geometry

Define the geometry of the structure in the preprocessor of Gid:

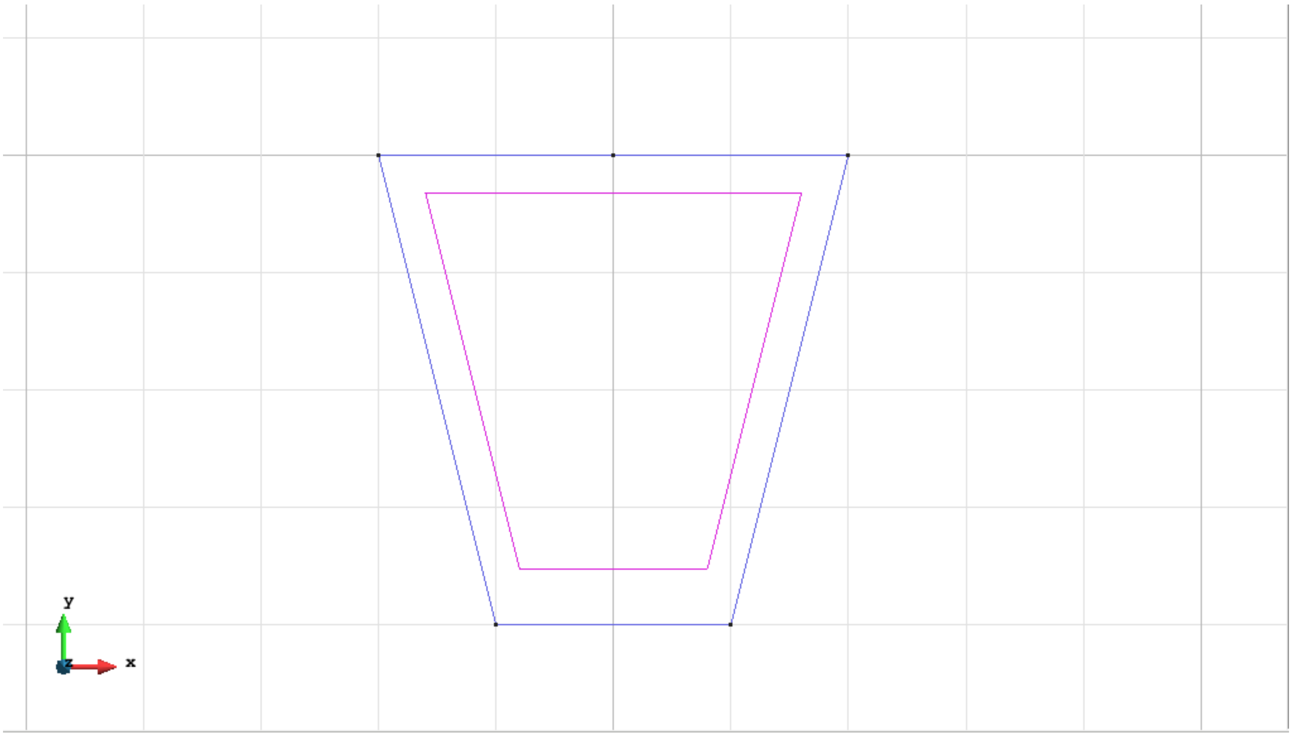

Figure 1 - Geometry of the structure

Data

Problem Type:

Once the geometry is defined, we can see which type of problem must be solved.
In this case we face a plane problem; therefore we choose the module RamSeries_Educational_2D/Plane State using the following sequence of commands:

Data / Problem Type / RamSeries_Eductional_2D / Plane State

Boundary conditions:

The types of boundary conditions that are enforced in this example are the following:

- Displacements Constraints / Point Constraints.
- Displacements Constraints / Linear Constraints.

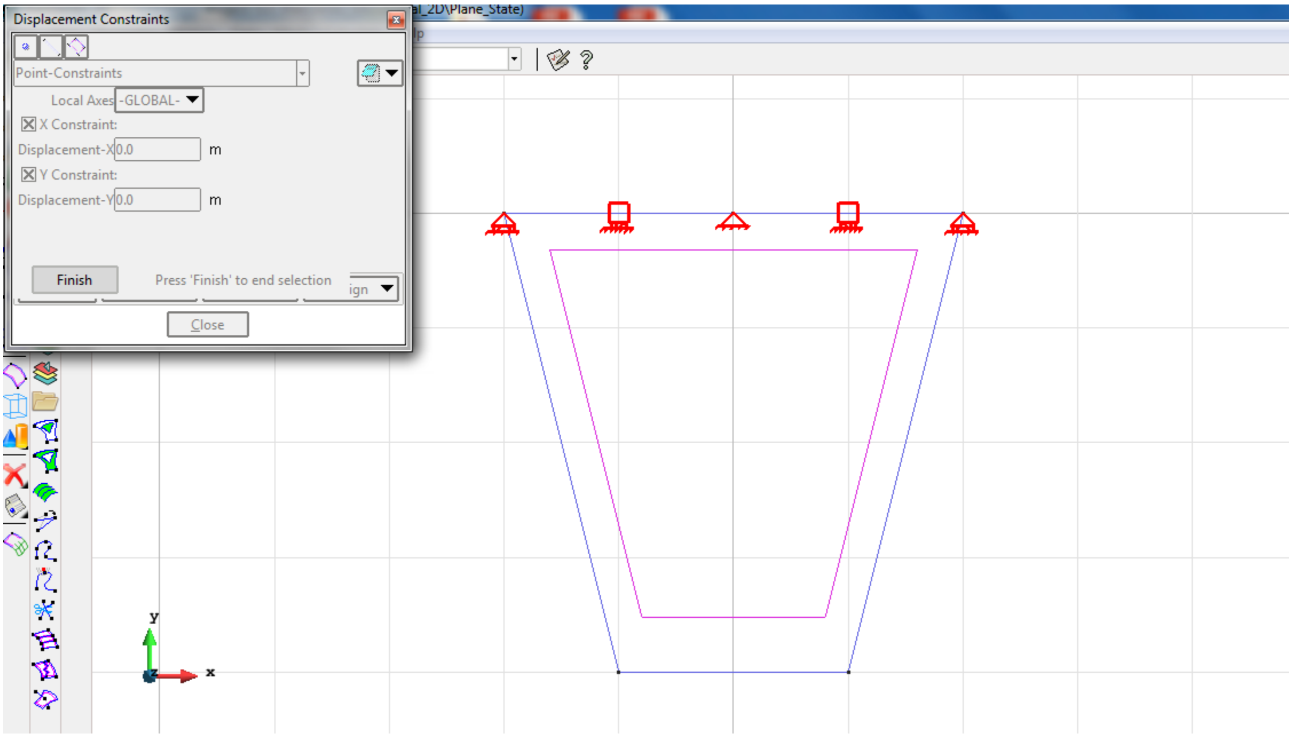

Figure 2 – Displacement Constraints

Material: We use material with the following mechanical characteristics.

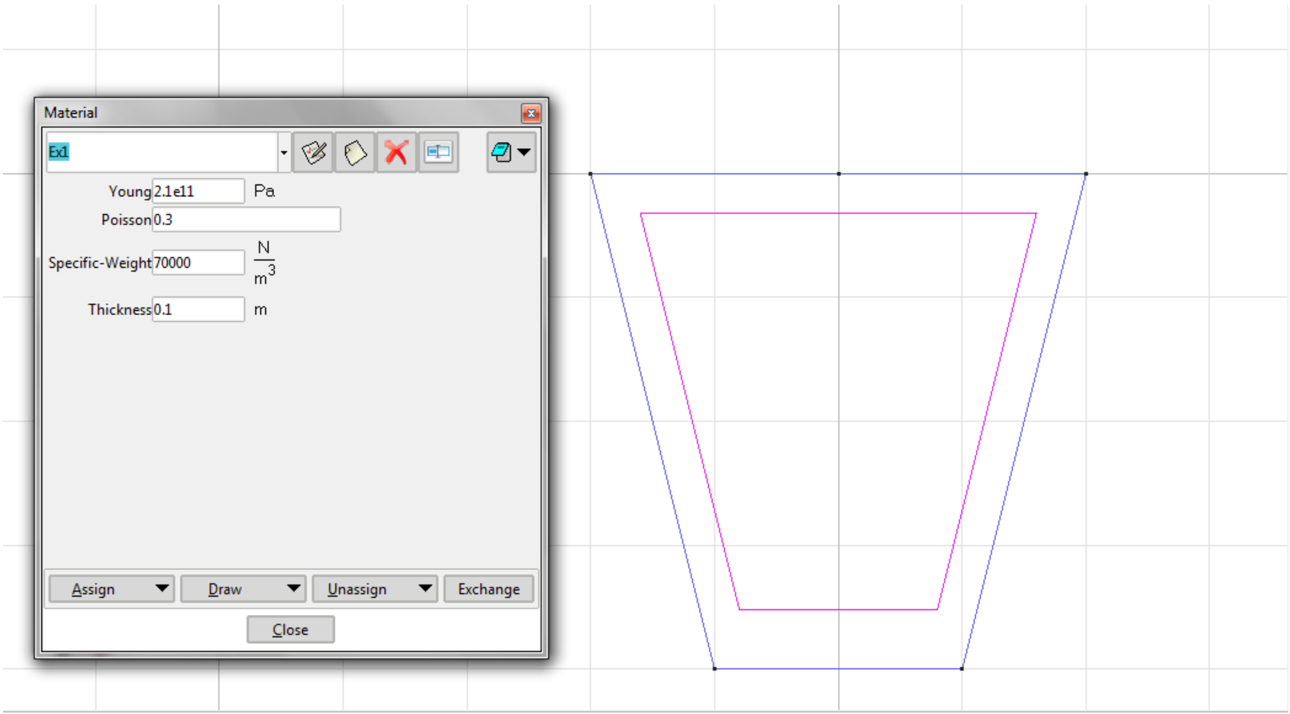

Figure 3 - Material

Problem Data: In this section we specify some data necessary for the analysis.

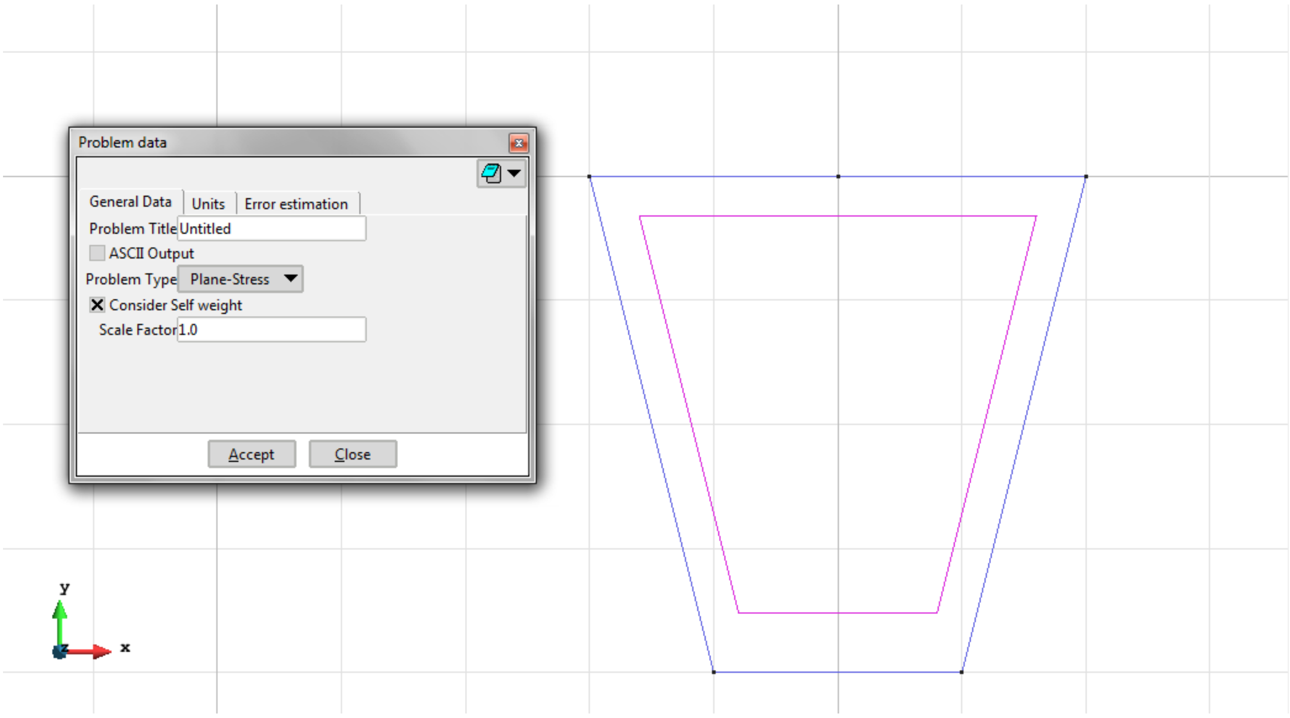

Figure 4 – Consider Self weight on the problem data

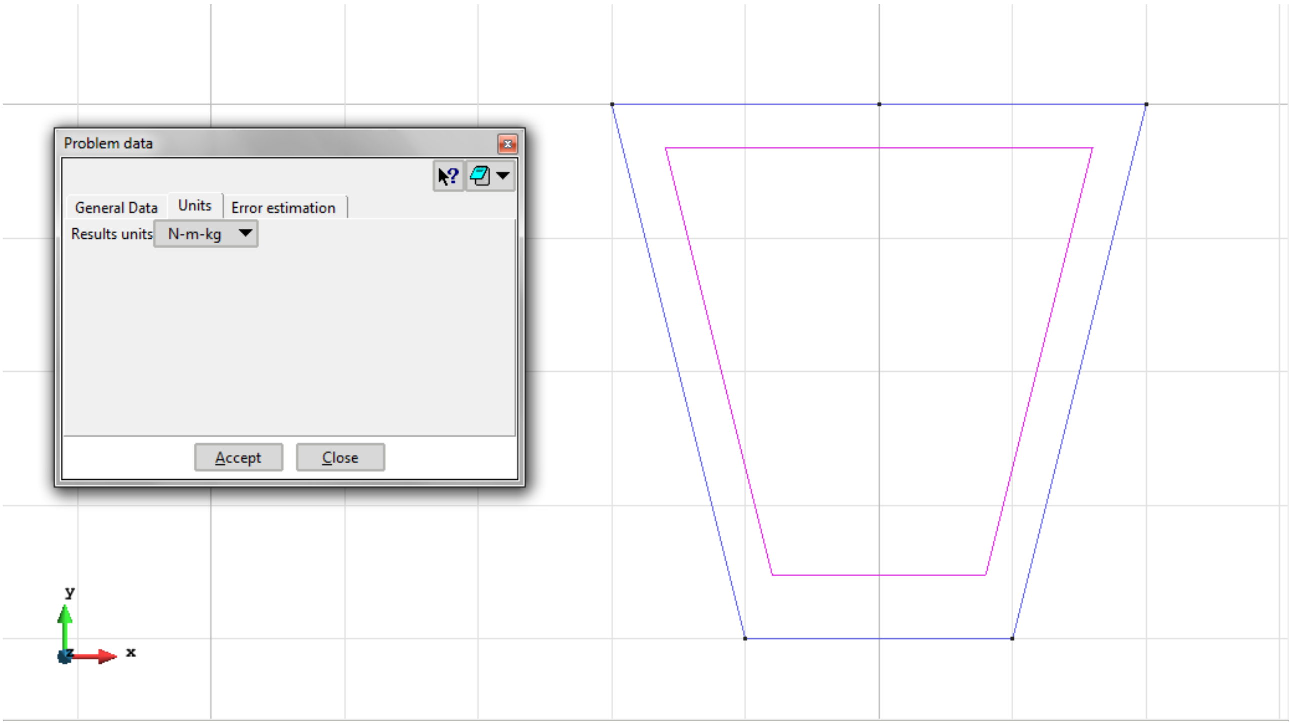

Figure 5 – Units on the problem data

Meshing / Generate To generate the mesh use the following options:

- Structured: The mesh is structured using 16 segments for the horizontal lines and 16 for the vertical lines.
- Element Type: We use a mesh of triangular (Triangle) and quadrilateral elements (Quadrilateral).
- Quadratic elements: We consider linear elements with 3 and 4 nodes (Normal) and quadratic elements with 6, 8 and 9 nodes (Quadratic and Quadratic9).

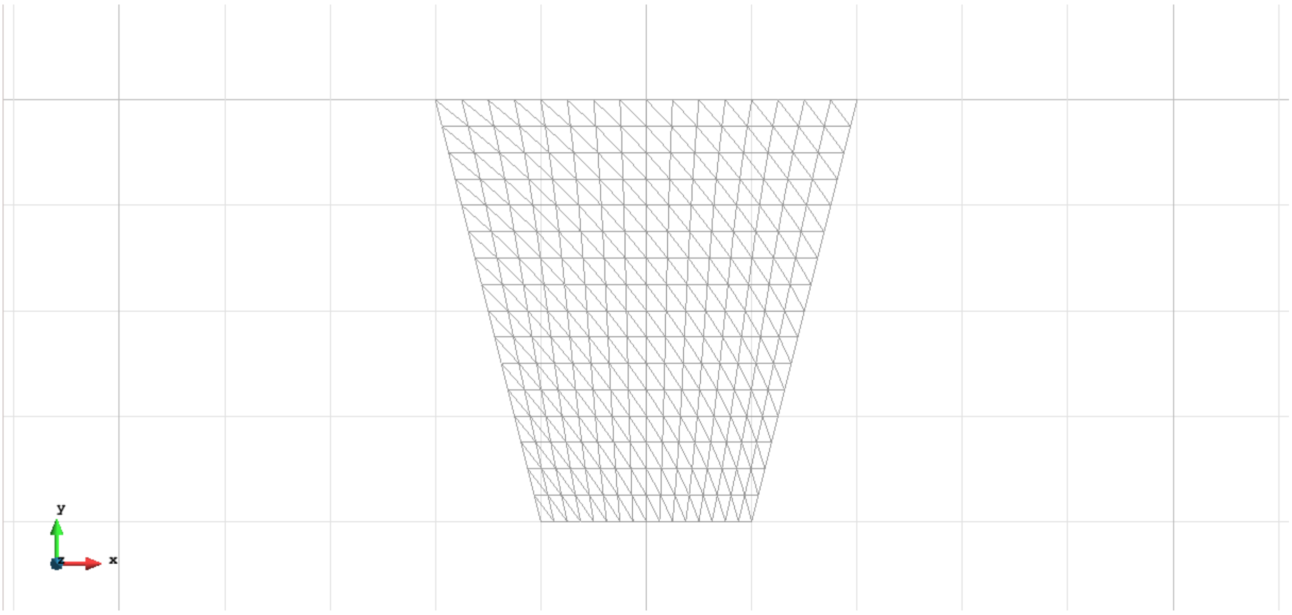

Figure 6 - Meshe of Triangles Normal

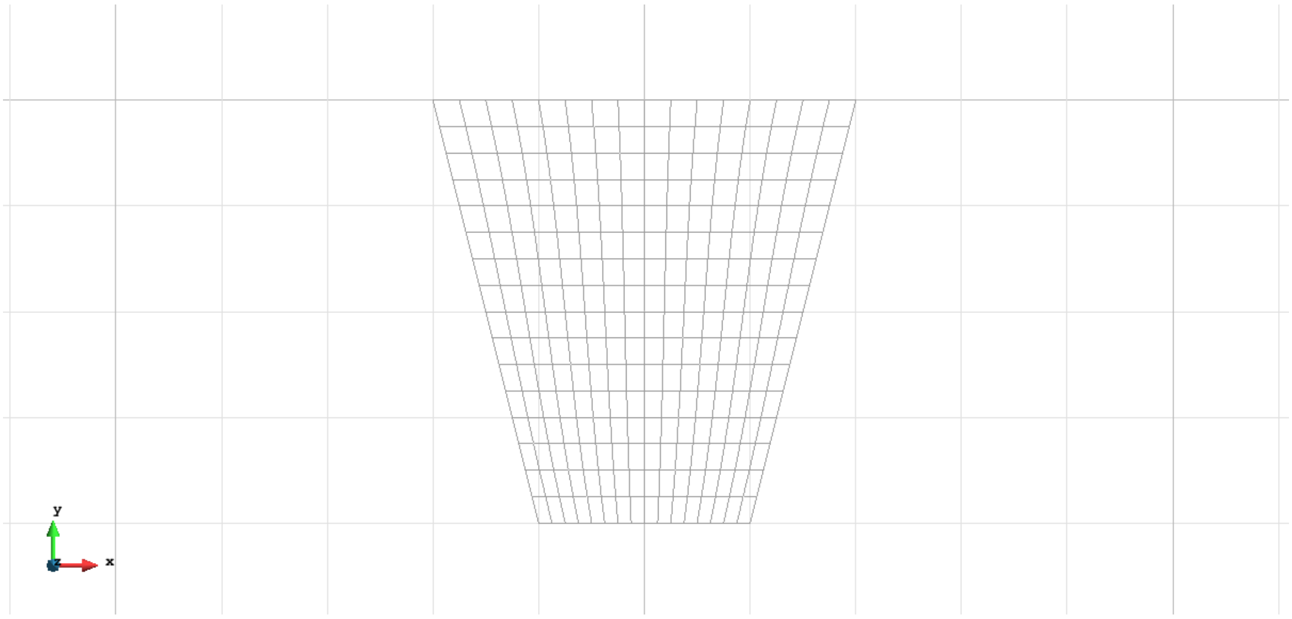

Figure 7 - Meshe of Quadrilaterals Normal

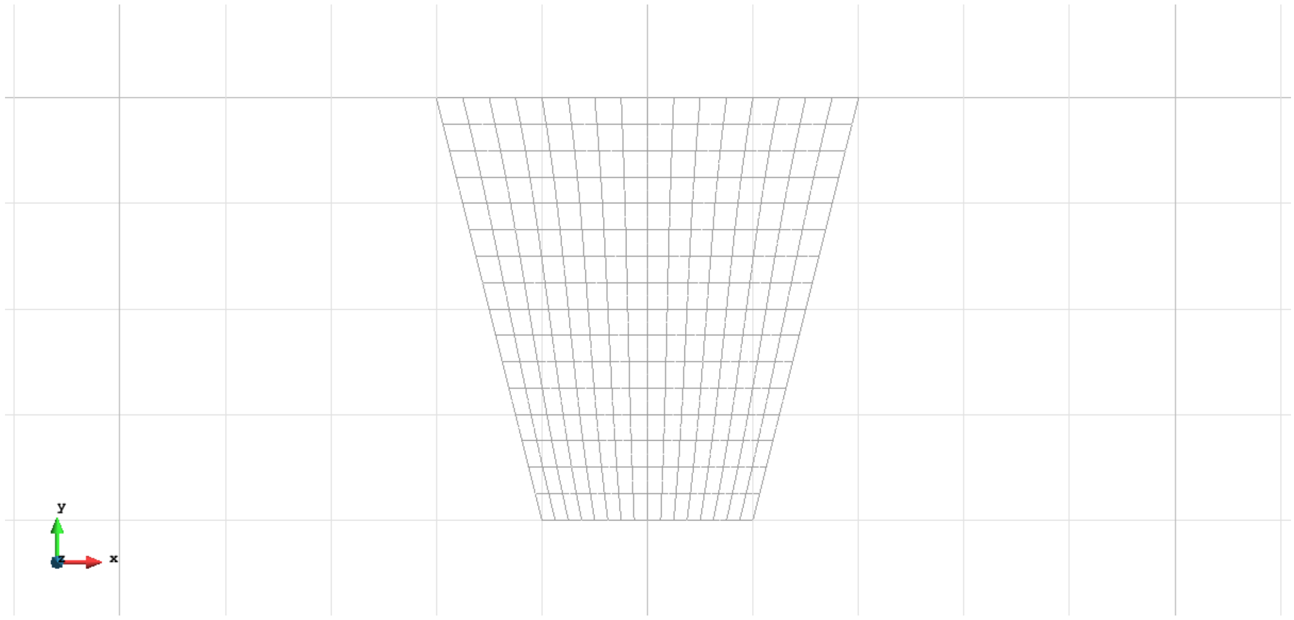

Figure 8 - Meshe of Quadrilaterals Quadratic

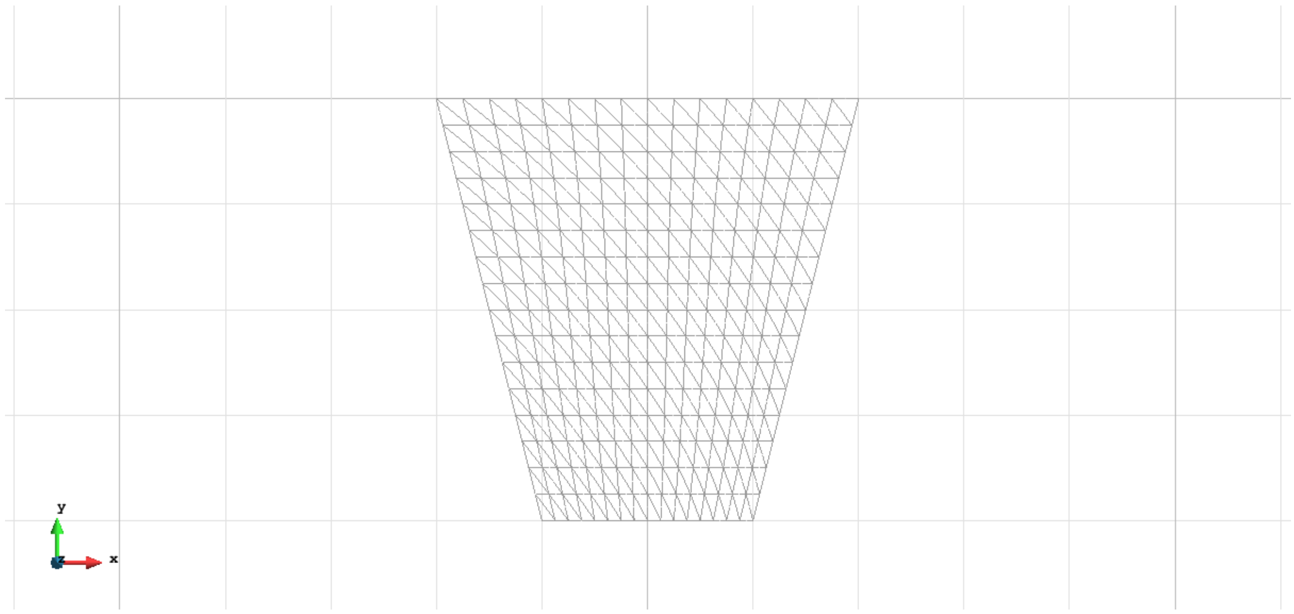

Figure 9 - Meshe of Triangles Quadratic

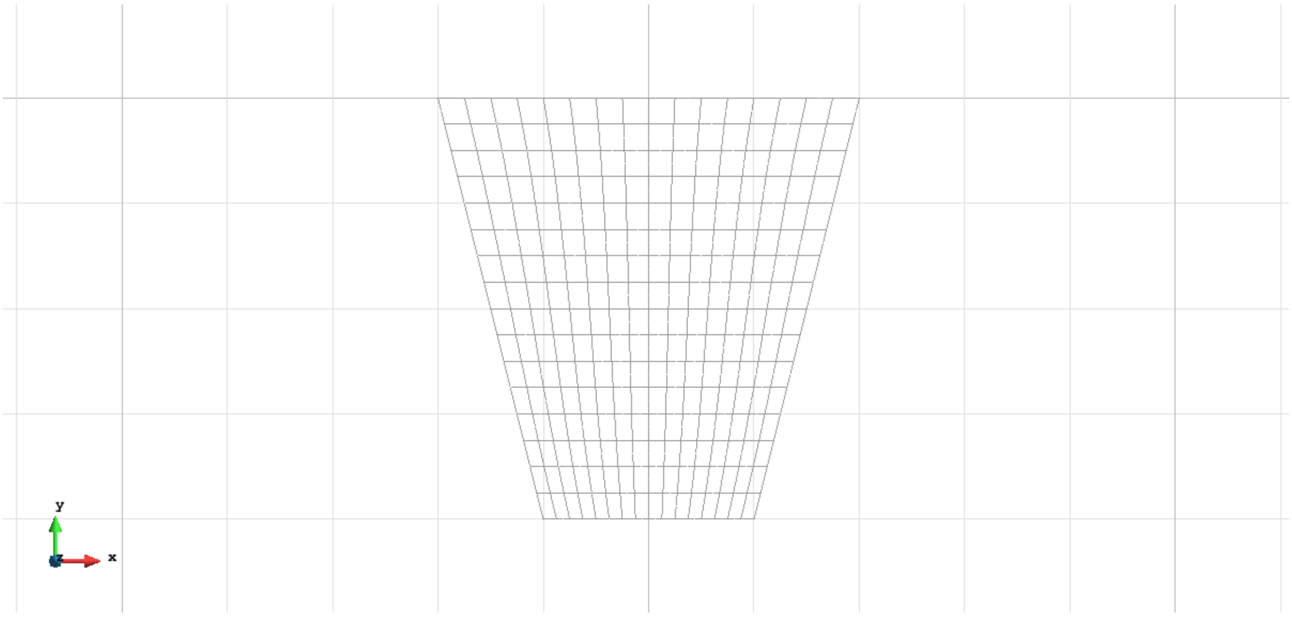

Figure 10 - Meshe of Quadrilaterals Quadratic whit 9 nodes

<u>Calculate / Calculate</u>

Once the mesh is generated, we proceed to calculate the problem for the different meshes proposed.

<u>File / Post Process</u>

The following figures show the results of the analysis sought after in this exercise.

QUADRILATERAL ELEMENTS WITH 4 NODES

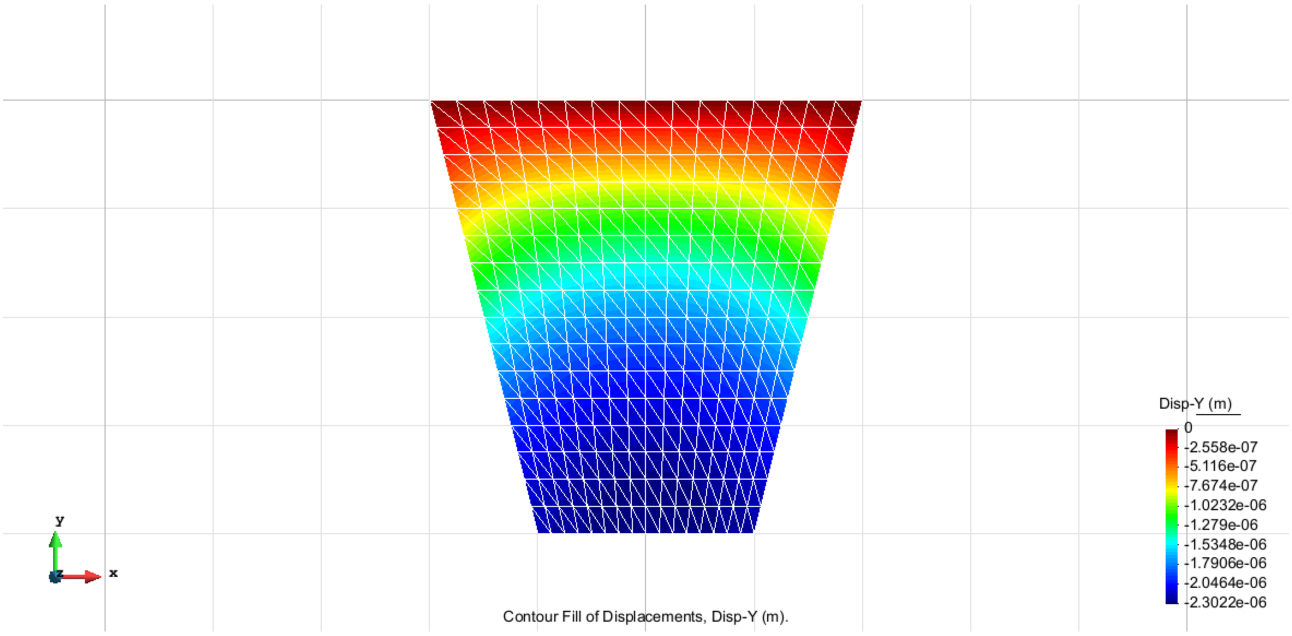

Figure 11 – Displacements on axis y

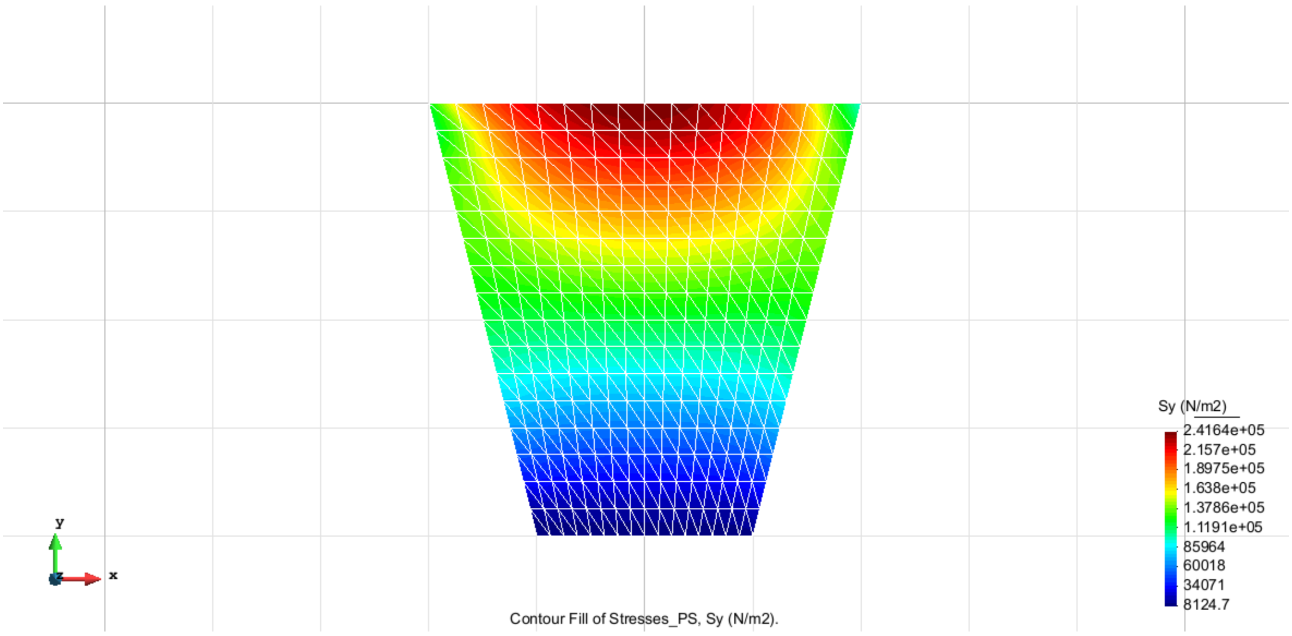

Figure 12 – Stress on axis y

TRIANGULAR ELEMENTS WITH 3 NODES

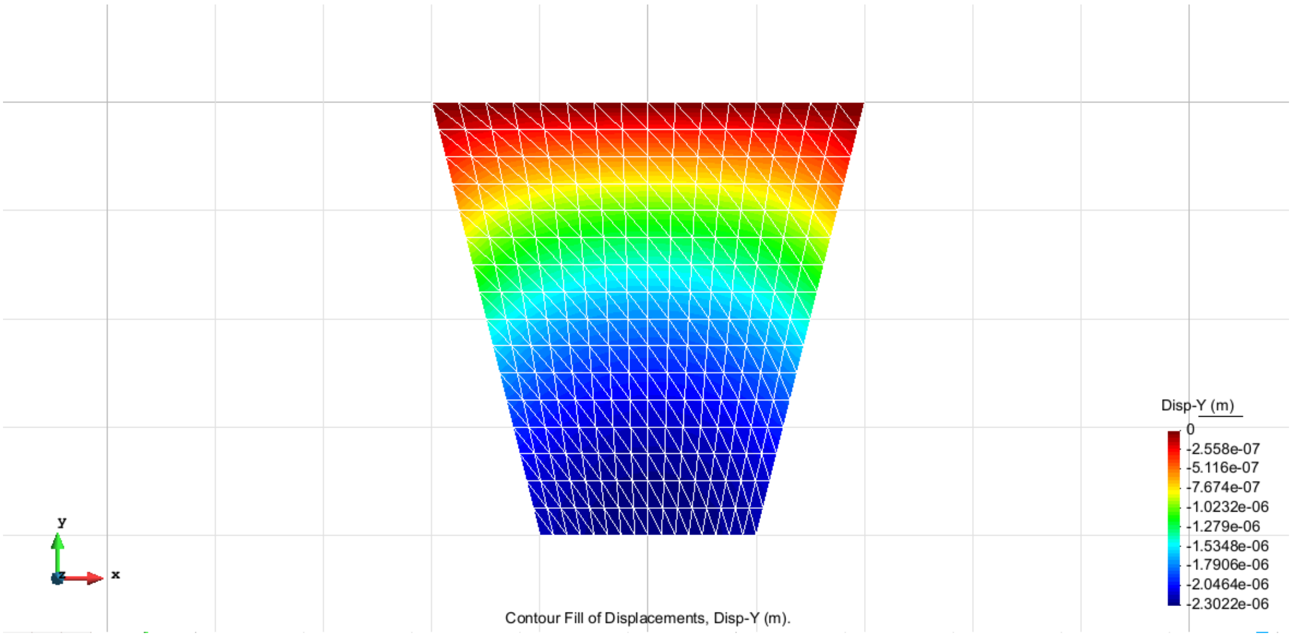

Figure 13 – Displacements on axis y

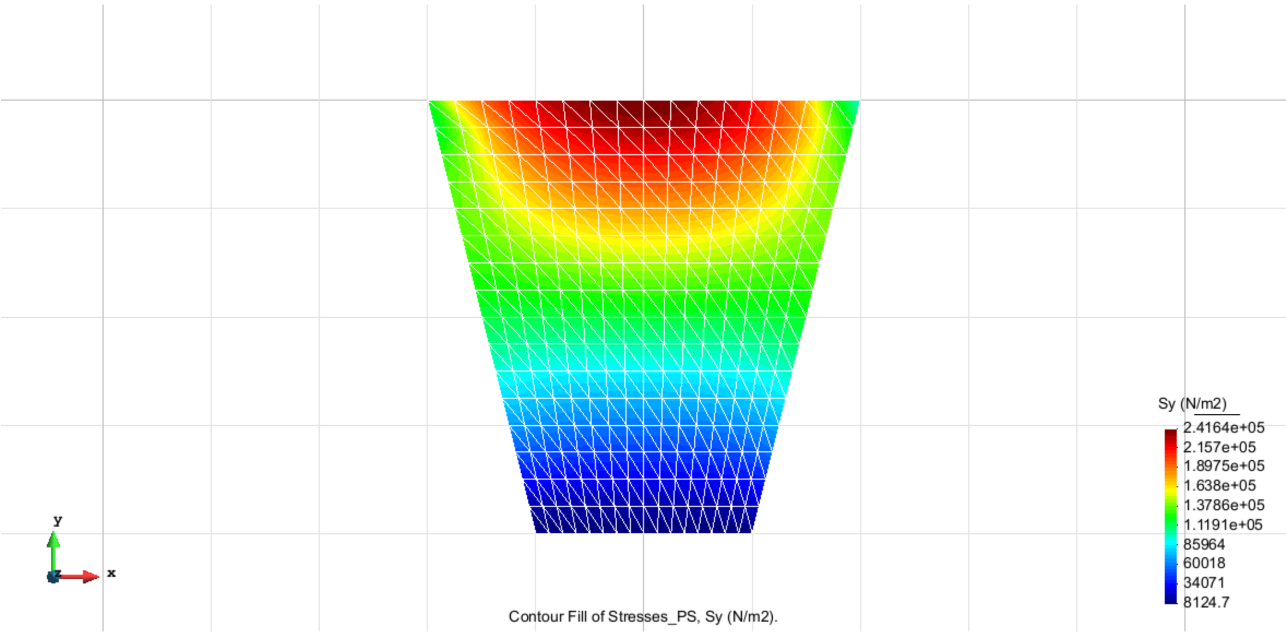

Figure 14 – Stress on axis y

TRIANGULAR ELEMENTS WITH 6 NODES

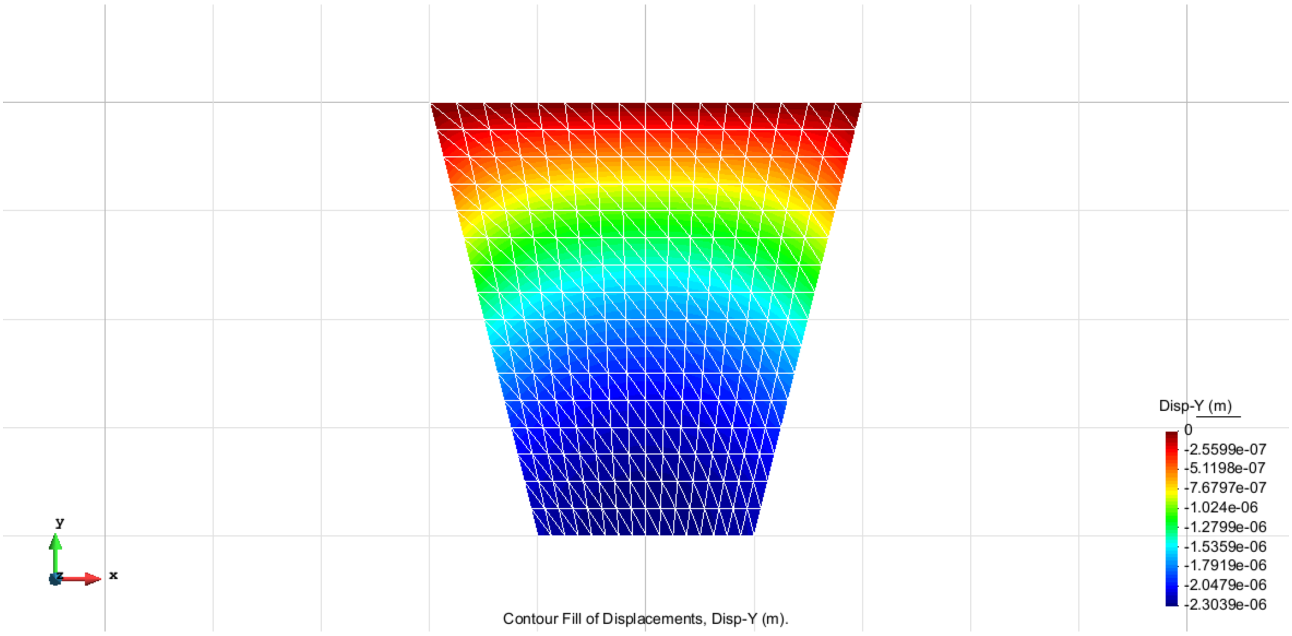

Figure 15 – Displacements on axis y

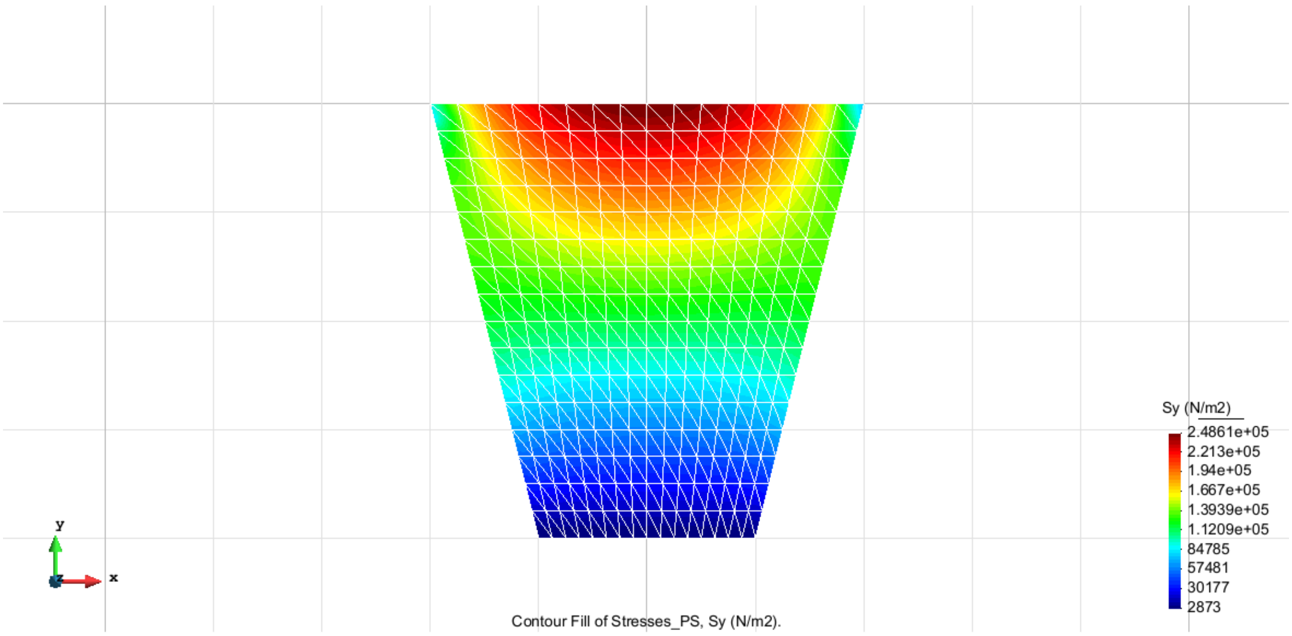

Figure 16 – Stress on axis y

QUADRILATERAL ELEMENTS WITH 8 NODES

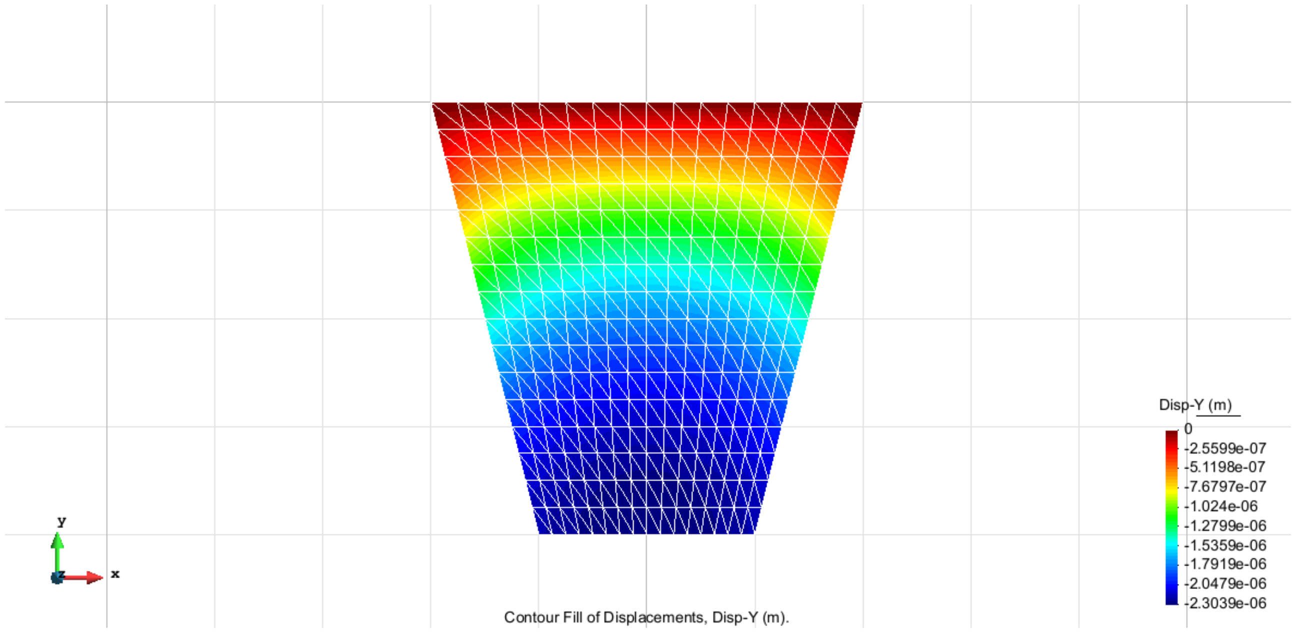

Figure 17 – Displacements on axis y

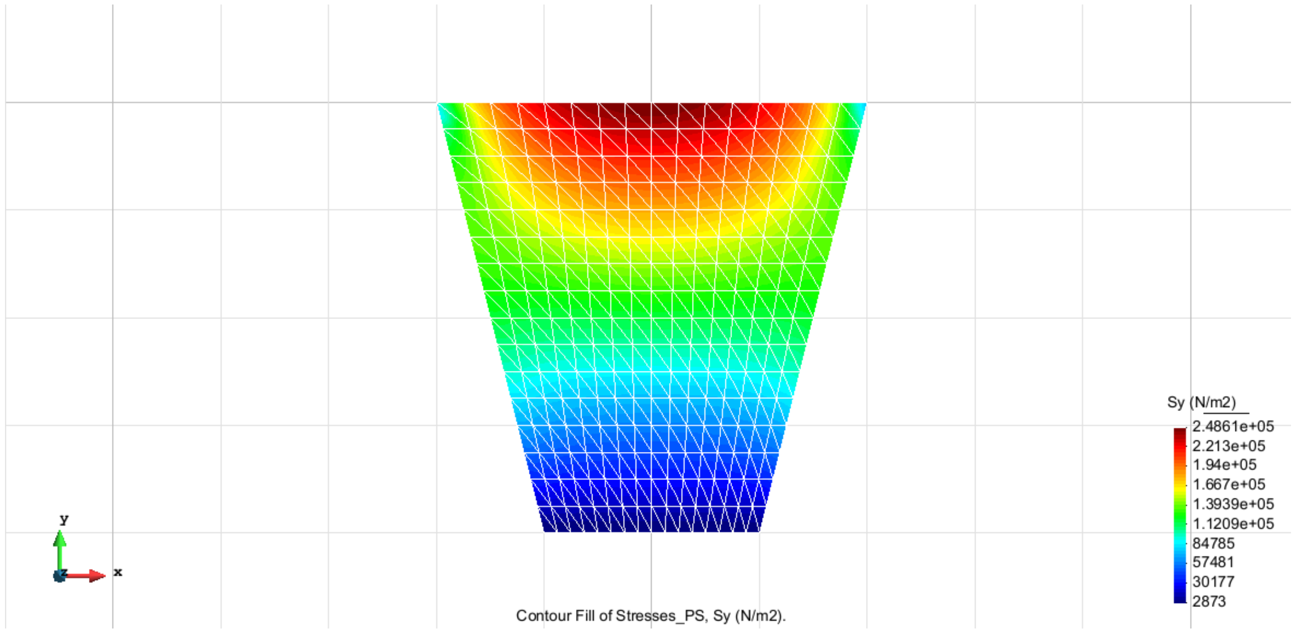

Figure 18 – Stress on axis y

QUADRILATERAL ELEMENTS WITH 9 NODES

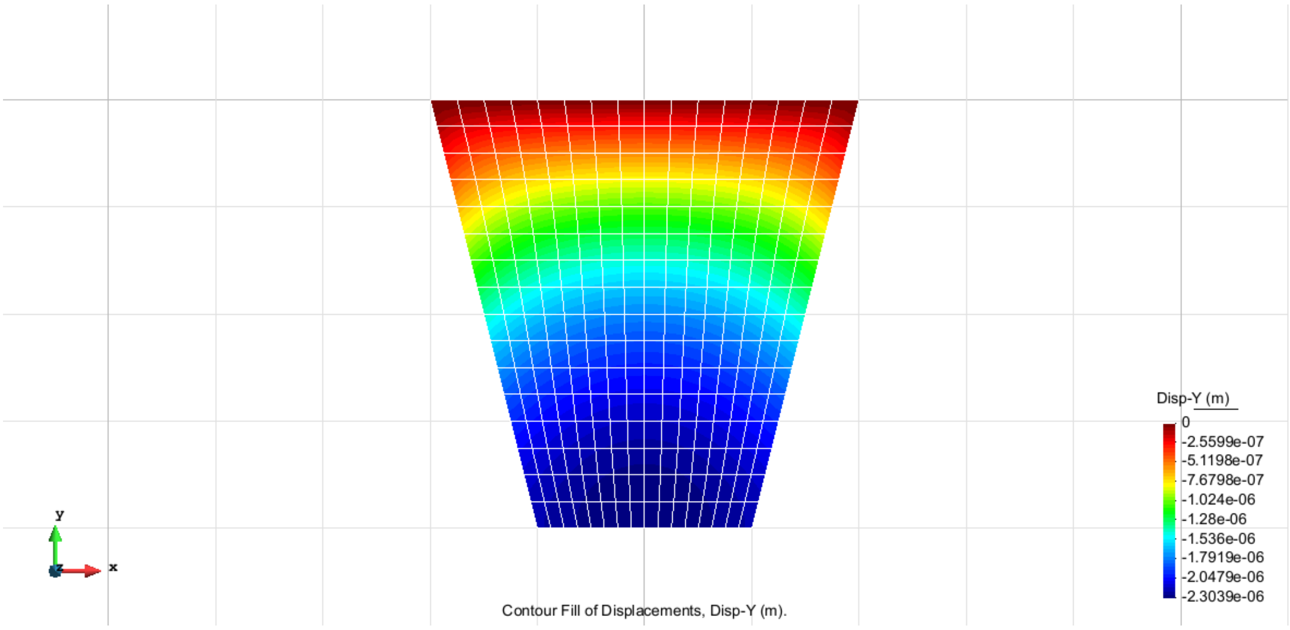

Figure 19 – Displacements on axis y

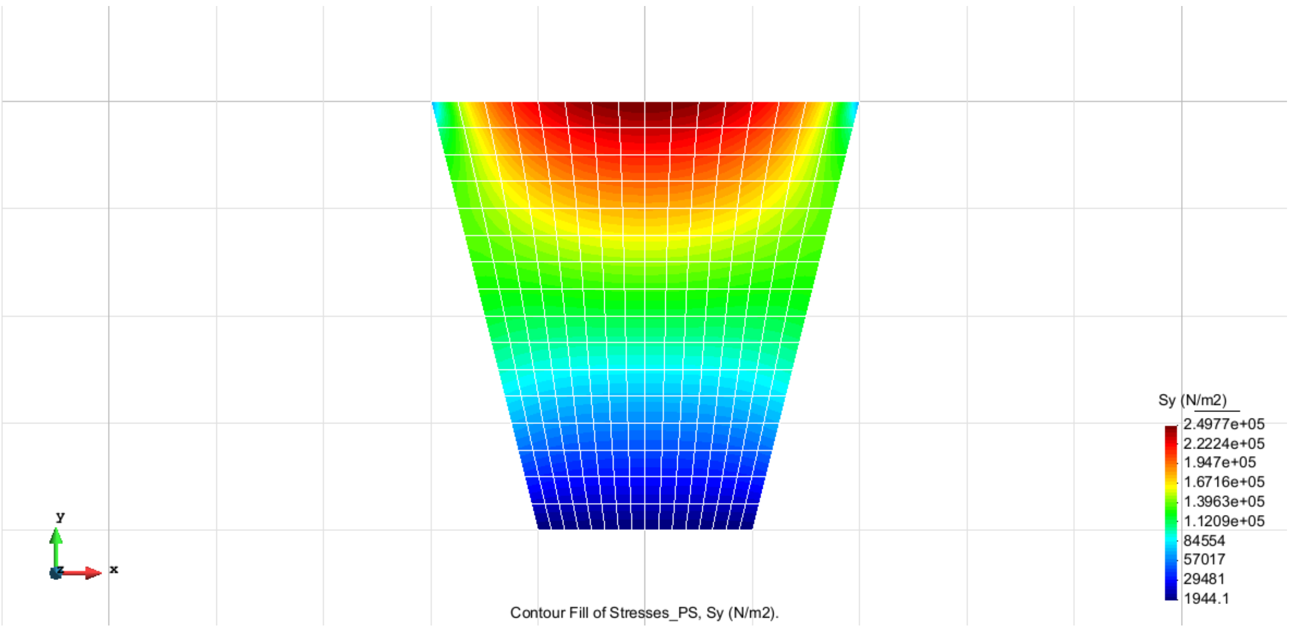

Figure 20 – Stress on axis y

<u>Comparison of the results</u>

Using the results of the analysis with the different types of elements, the following comparison table was set up:

Element type	Degrees of freedom	Stress in B [MN/m2]	Displacement y in the centreof the side ED	err Displ y %	err Stress y %
Triangle with 3 nodes	289	0.24164	-2.3022E-06	-1.87	2.17
Triangle with 6 nodes	1089	0.24861	-2.3022E-06	-1.87	-0.65
Quadrilateral with 4 nodes	289	0.24164	-2.3022E-06	-1.87	2.17
Quadrilateral with 8 nodes	833	0.24861	-2.3022E-06	-1.87	-0.65
Quadrilateral with 9 nodes	1089	0.24977	-2.3022E-06	-1.87	-1.12

Exercise 2: Plate with two sections

Solution

Geometry

Define the geometry of the structure in the preprocessor of Gid:

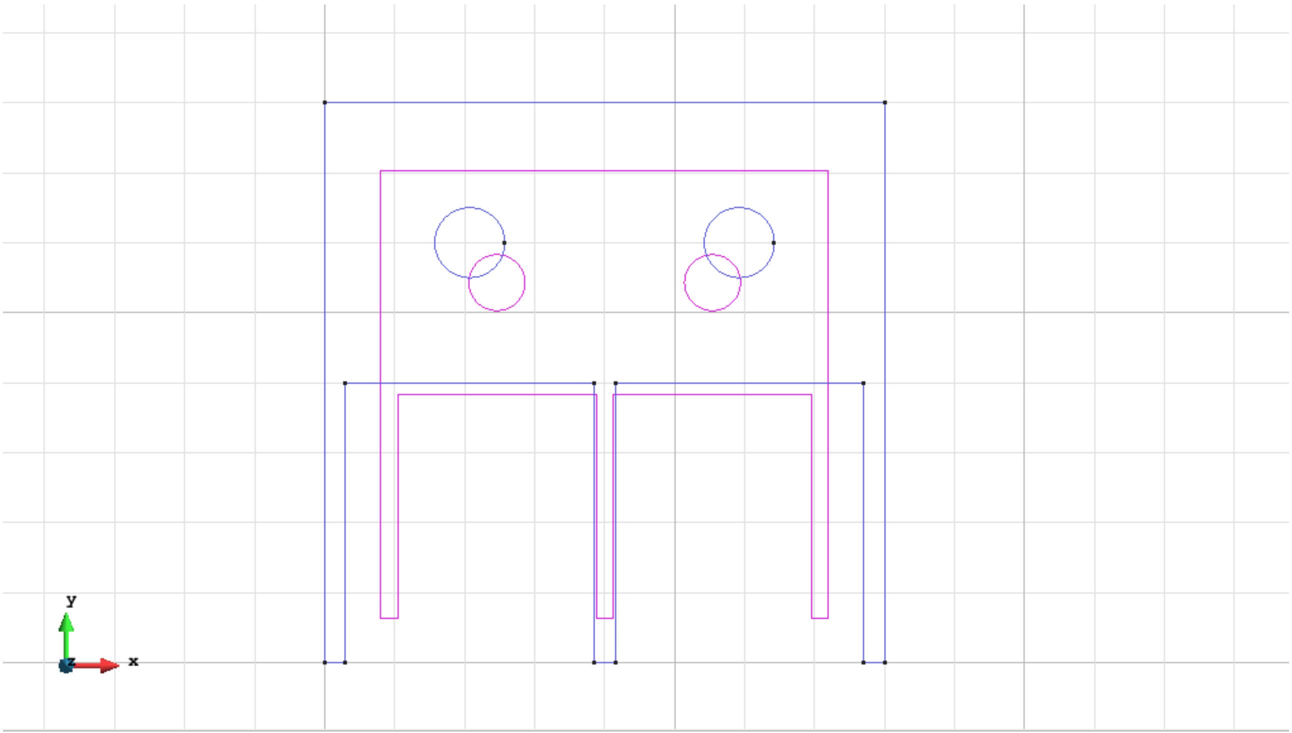

Figure 21 - Geometry of the structure

Data

Problem Type:

Once the geometry is defined, we can see which type of problem must be solved. In this case we face a plane problem; therefore we choose the module RamSeries_Educational_2D/Plane State using the following sequence of commands:

Data / Problem Type / RamSeries_Eductional_2D / Plane State

Boundary conditions:

The types of boundary conditions that are enforced in this example are the following:

- Displacements Constraints / Linear Constraints.

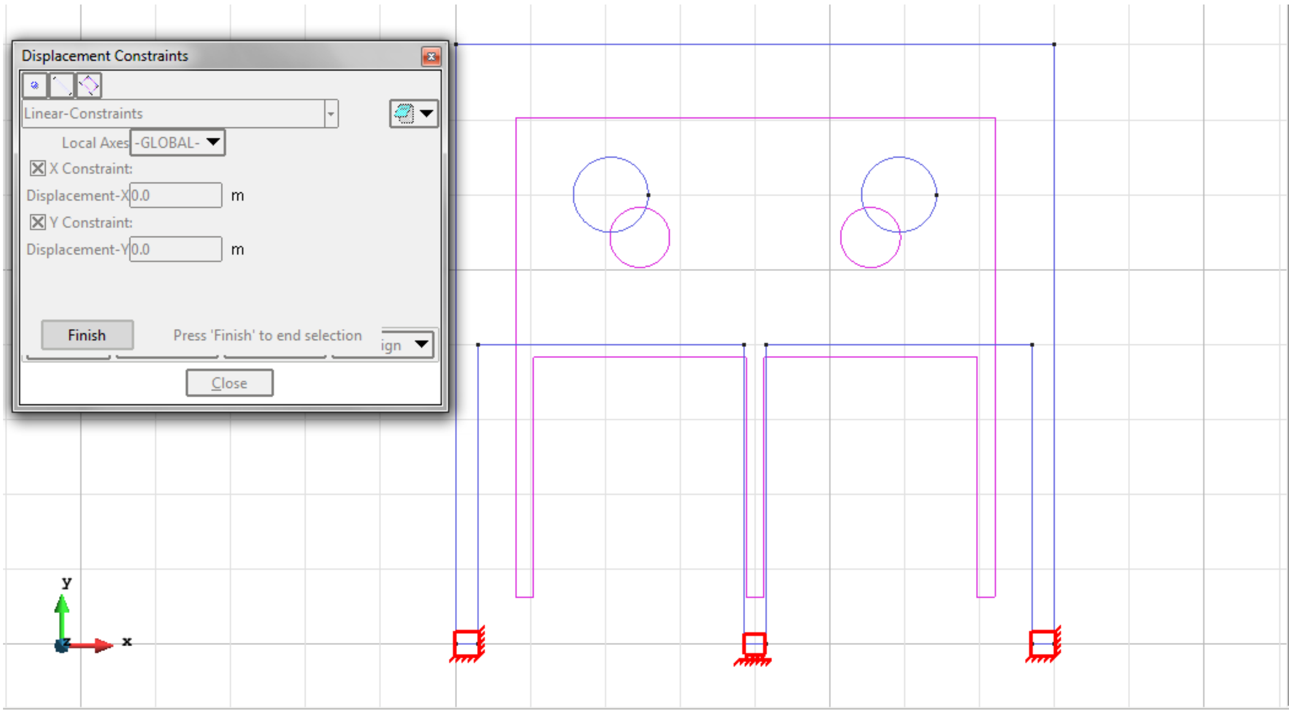

Figure 22 – Displacement Constraints

- Loads / Line loads / Uniform loads.

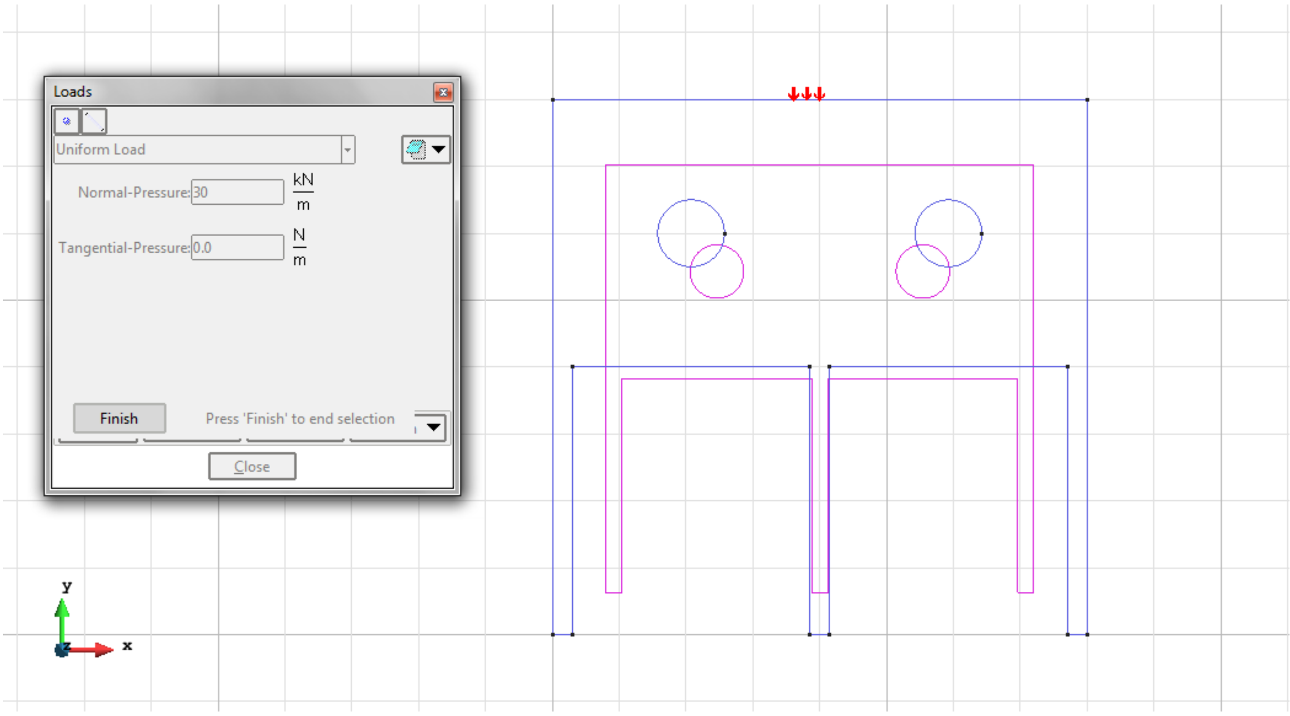

Figure 23 – Uniform loads

Material: We use material with the following mechanical characteristics.

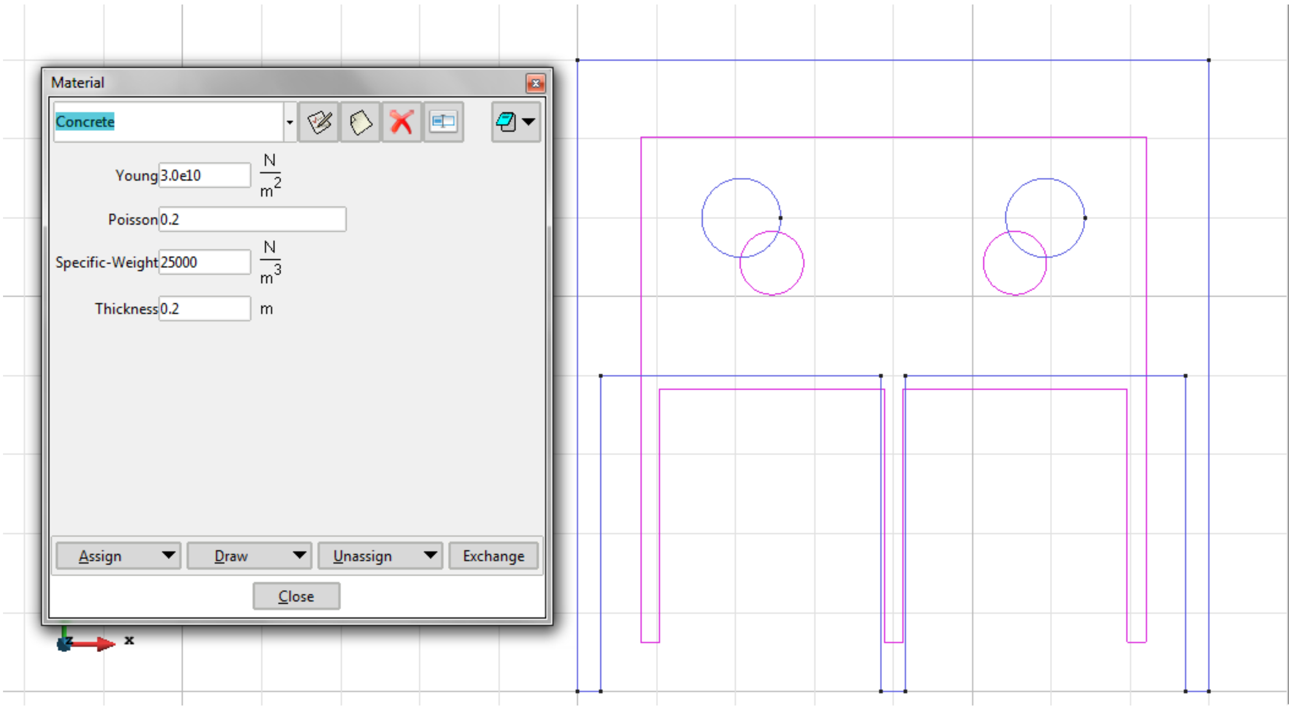

Figure 24 - Material

Problem Data: In this section we specify some data necessary for the analysis.

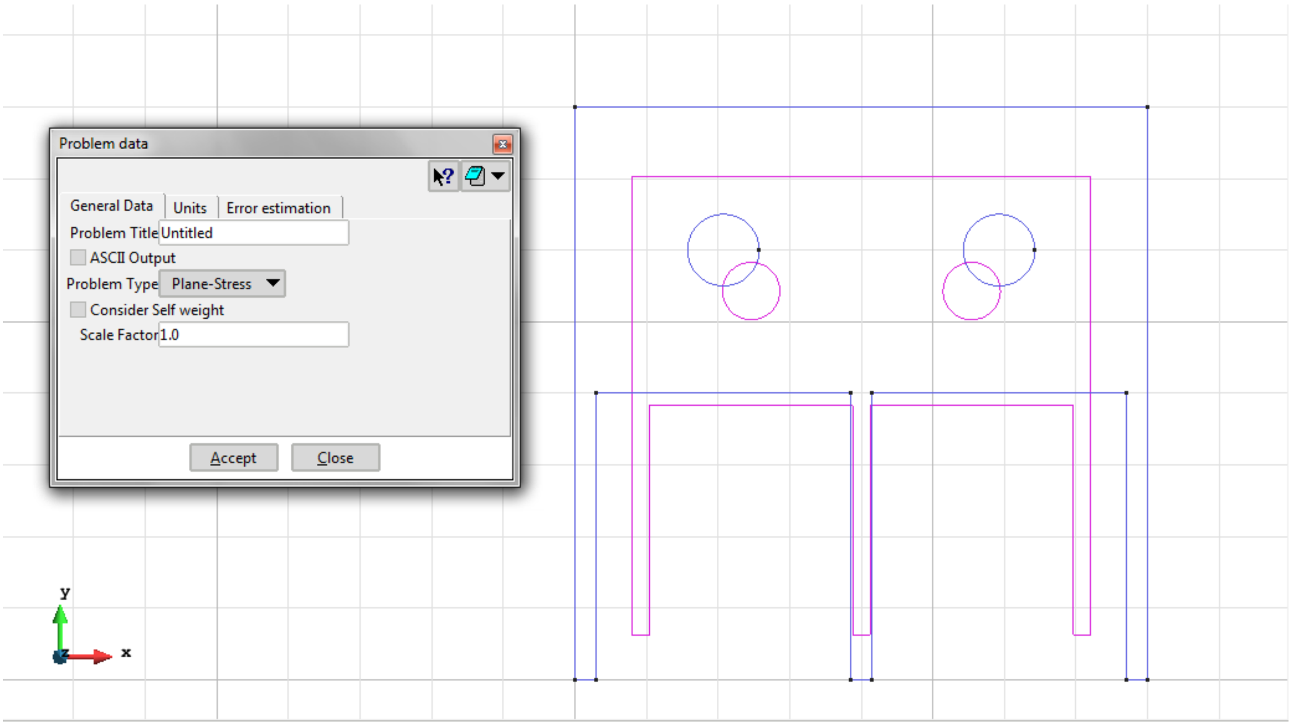

Figure 25 – General data

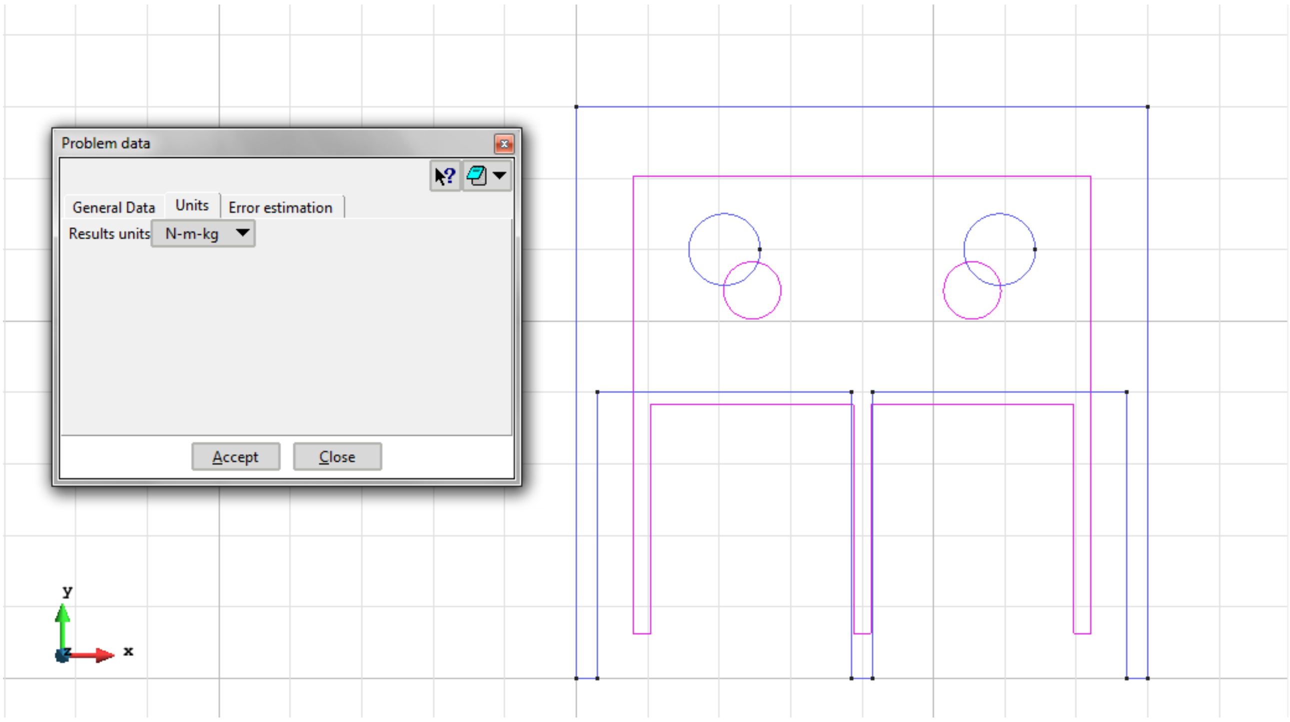

Figure 26 – Units for the problem data

Meshing / Generate To generate the mesh use the following options:

- Element Type: We use a mesh of triangular (Triangle).
- Quadratic elements: We consider linear elements with 3 (Normal).

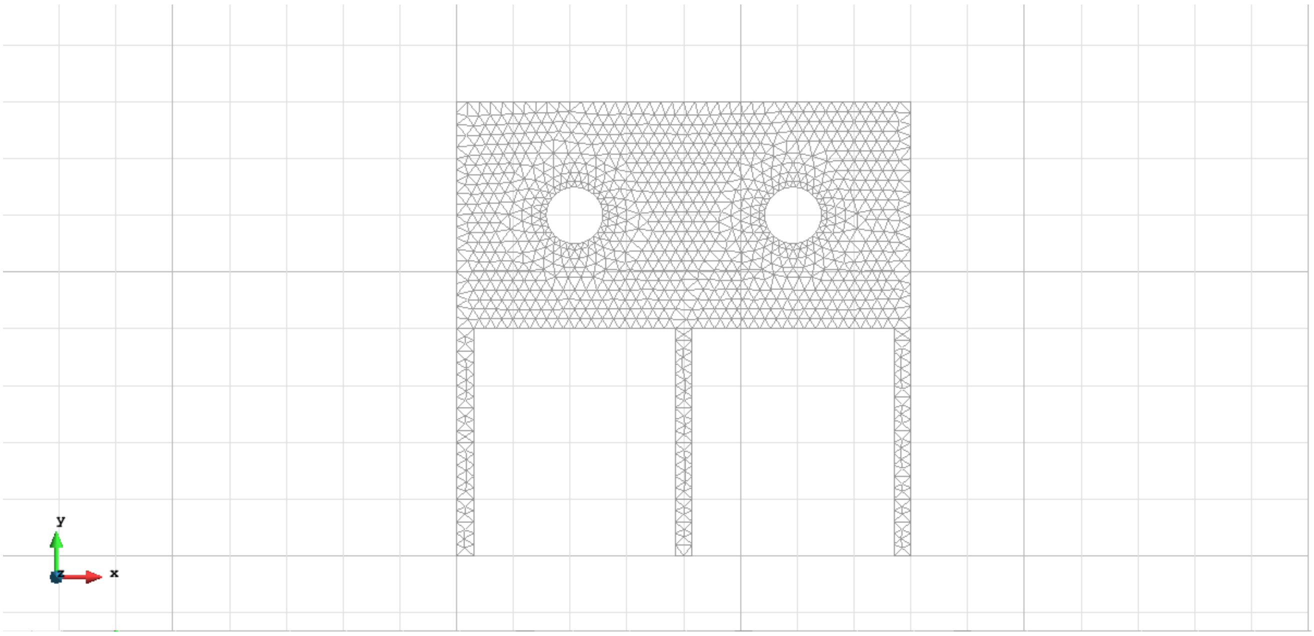

Figure 27 - Meshe of Triangles Normal

<u>Calculate / Calculate</u>

Once the mesh is generated, we proceed to calculate the problem for the meshe proposed.

File / Post Process

The following figures show the results of the analysis sought after in this exercise.

TRIANGULAR ELEMENTS WITH 3 NODES

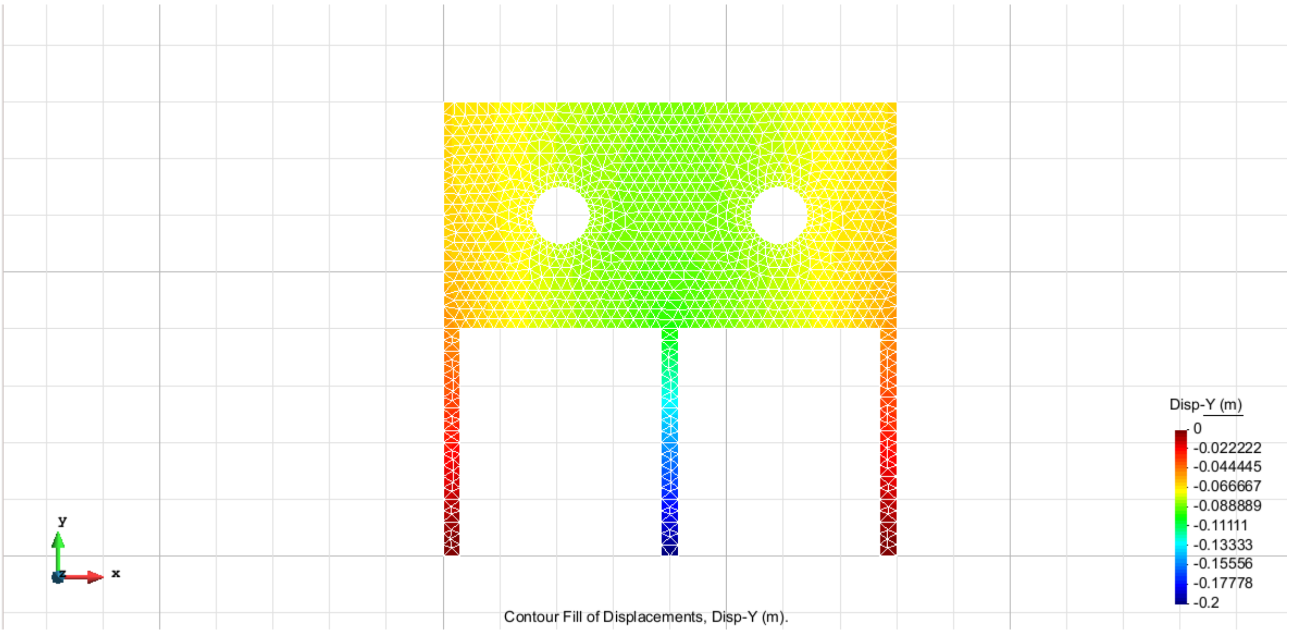

Figure 28 – Displacements on axis y

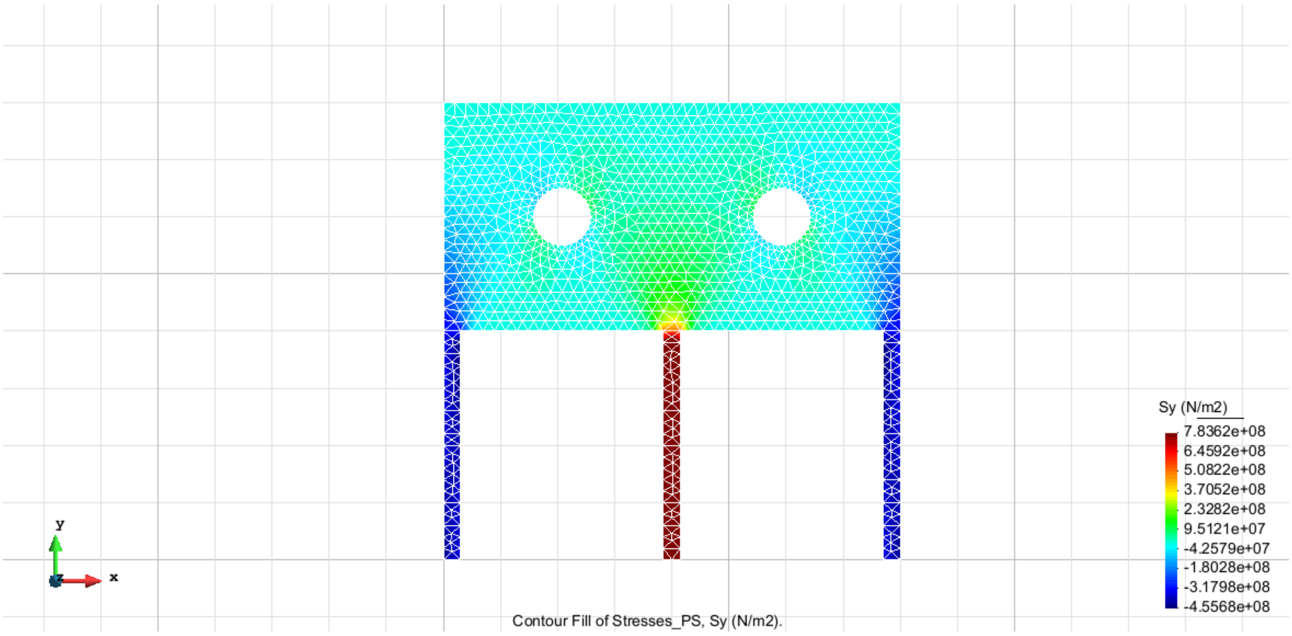

Figure 29 – Stress on axis y

Element type	Degrees of freedom
Triangular with 3 nodes	1179

Exercise 3: Plate with ventilation hole

Geometry

Define the geometry of the structure in the preprocessor of Gid whit 2 layers:

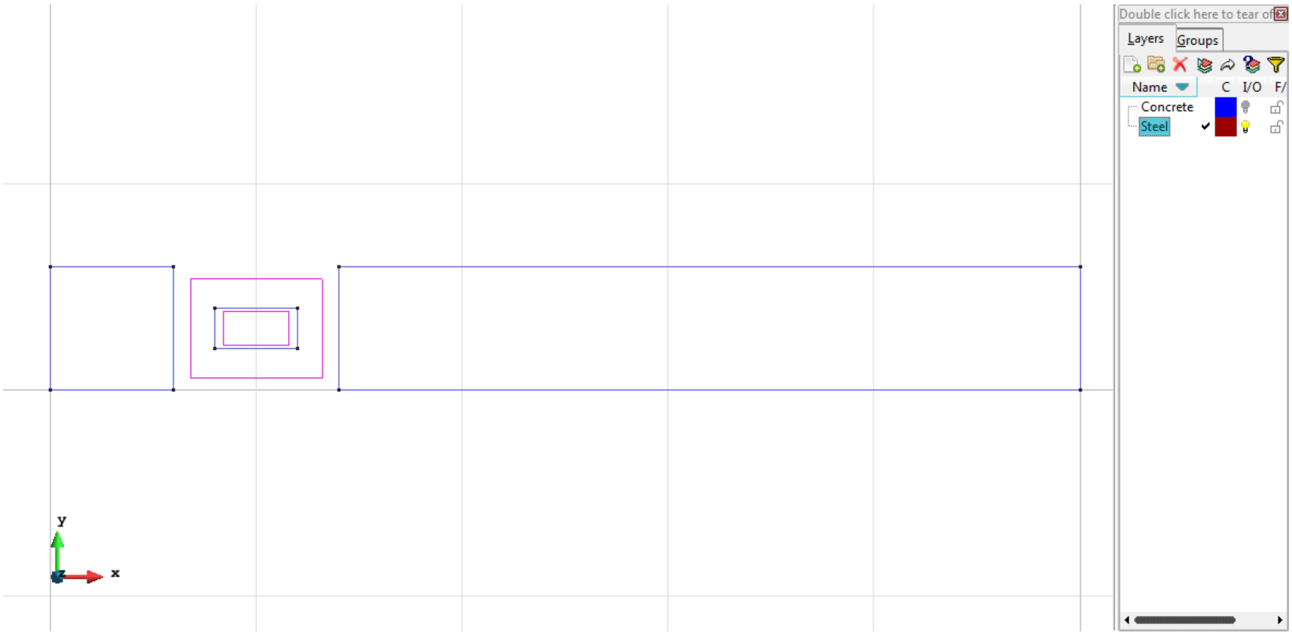

Figure 30 - Layer for Steel

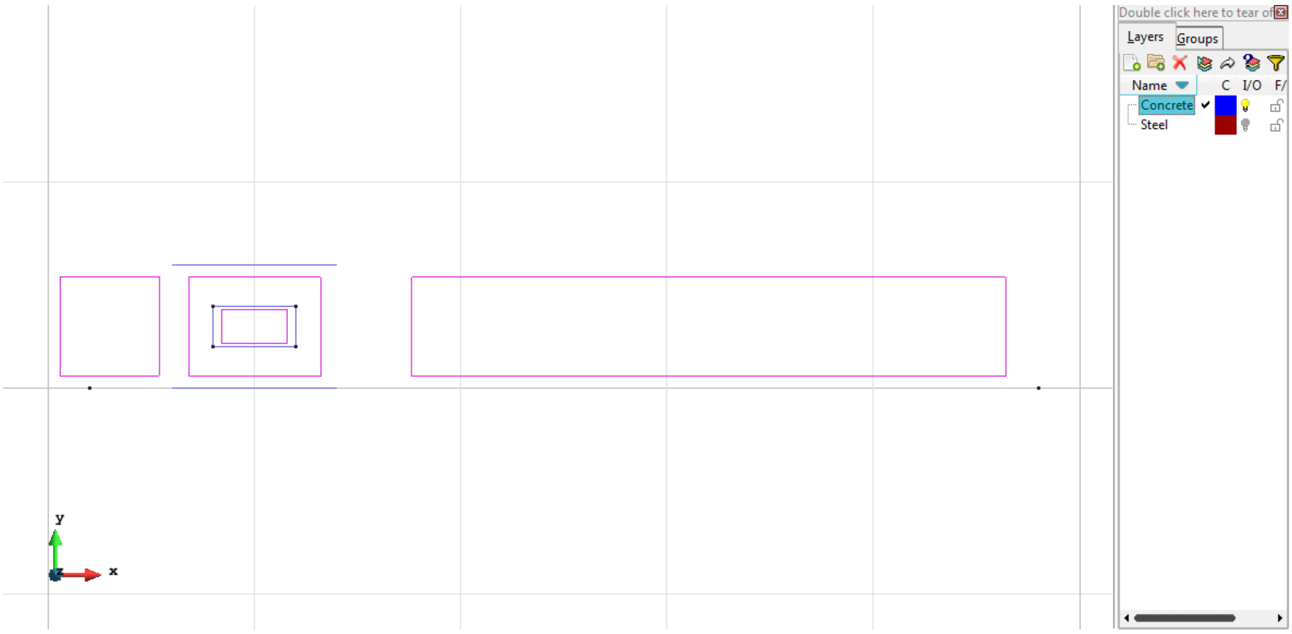

Figure 31 - Layer for Concrete.

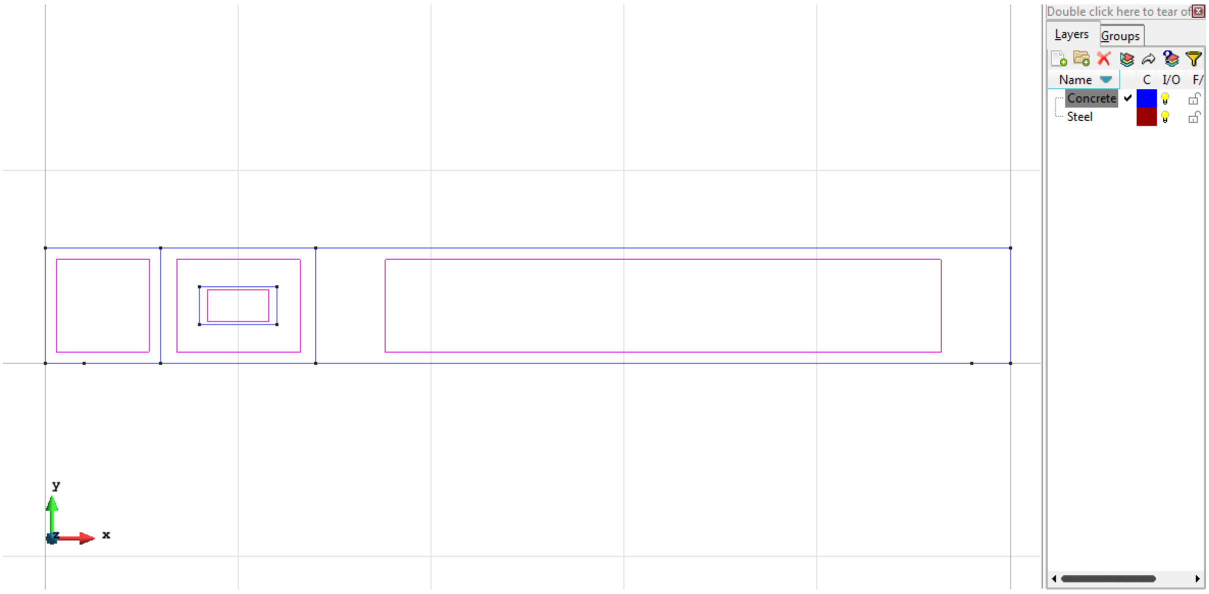

Figure 32 - The combination of the two layers.

Data

Problem Type:

Once the geometry is defined, we can see which type of problem must be solved. In this case we face a plane problem; therefore we choose the module RamSeries_Educational_2D/Plane State using the following sequence of commands:

Data / Problem Type / RamSeries_Eductional_2D / Plane State

Boundary conditions:

The types of boundary conditions that are enforced in this example are the following:

- Displacements Constraints / Linear Constraints.

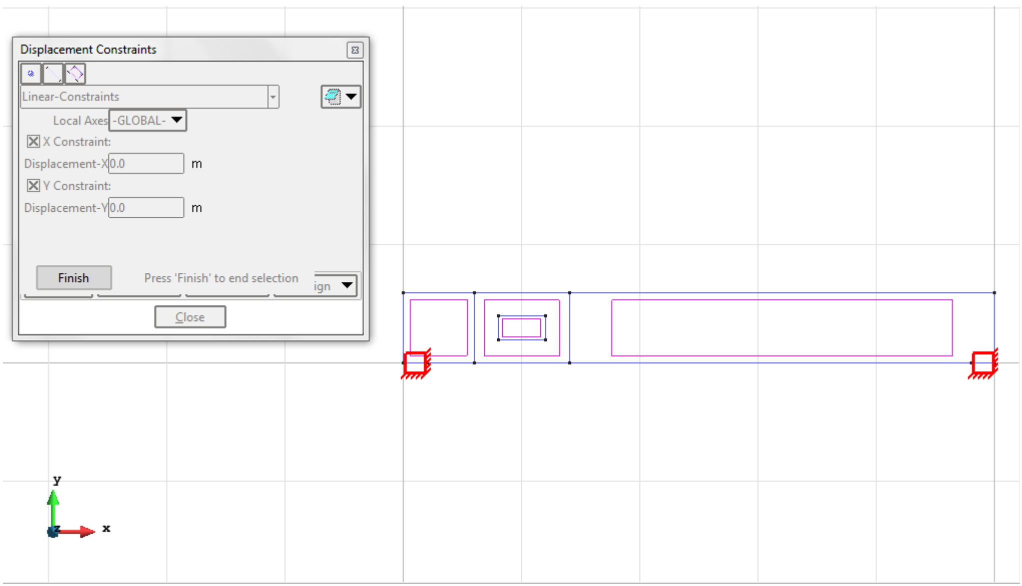

Figure 33 – Displacements Constraints

- Loads / Line loads / Uniform loads.

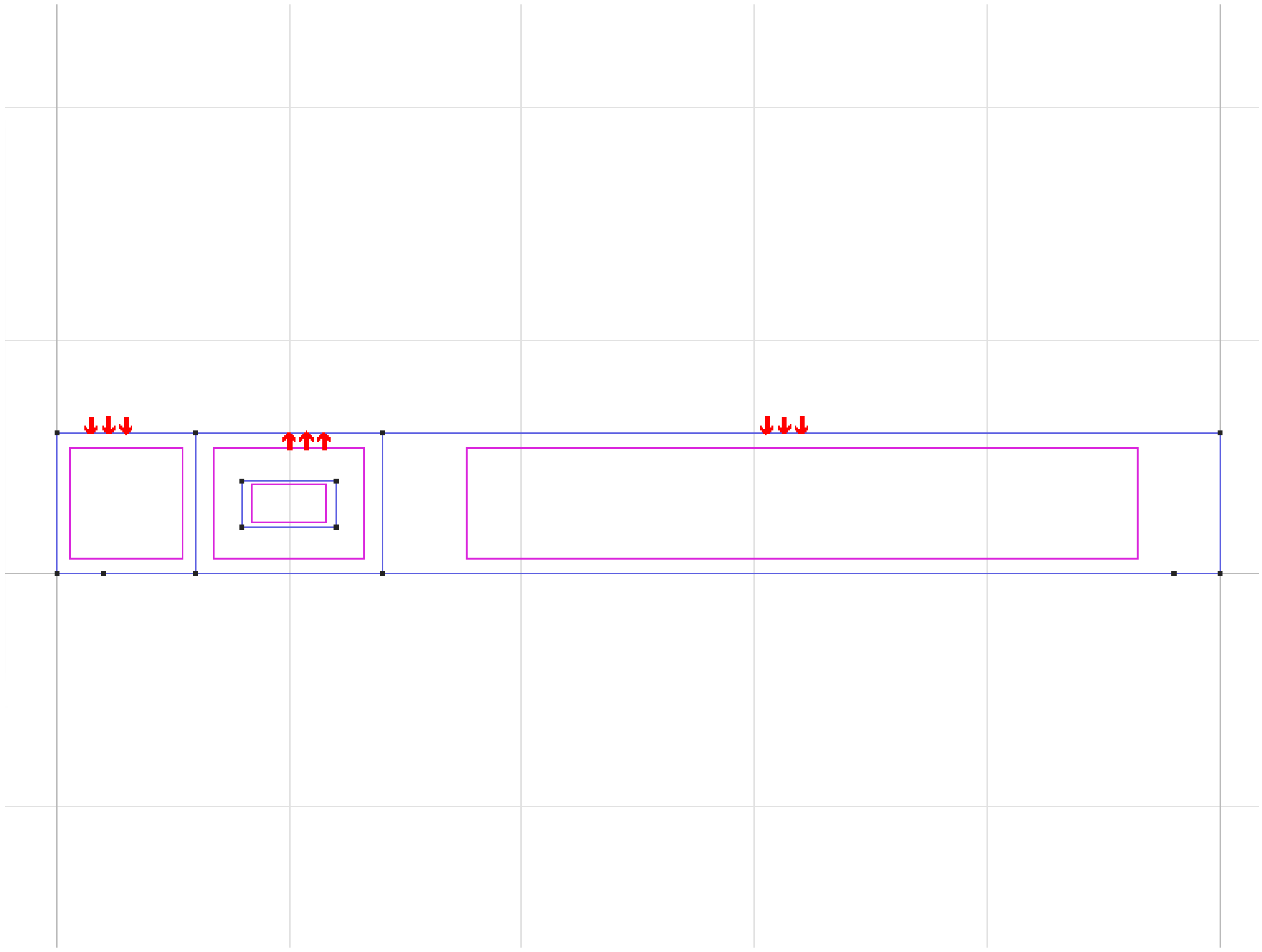

Figure 34 – Uniforms loads

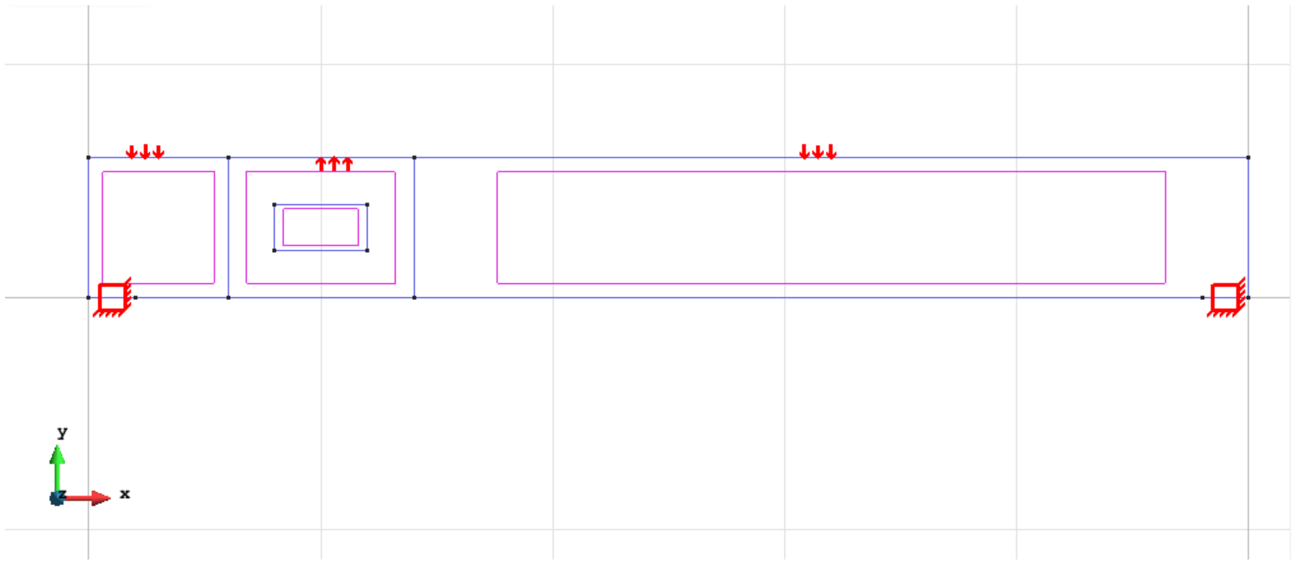

Figure 35 - Displacements Constraints + Uniform loads

Material: We use material with the following mechanical characteristics.

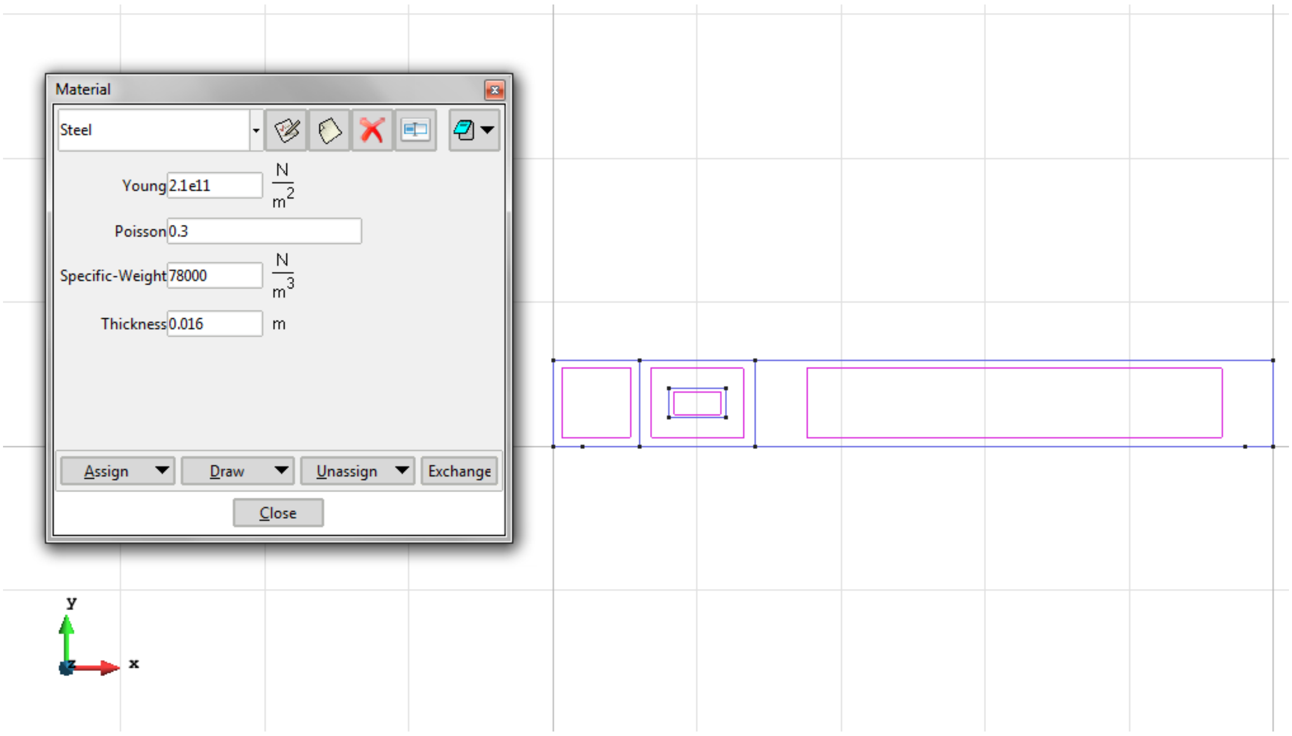

Figure 36 - Characteristics for the Steel

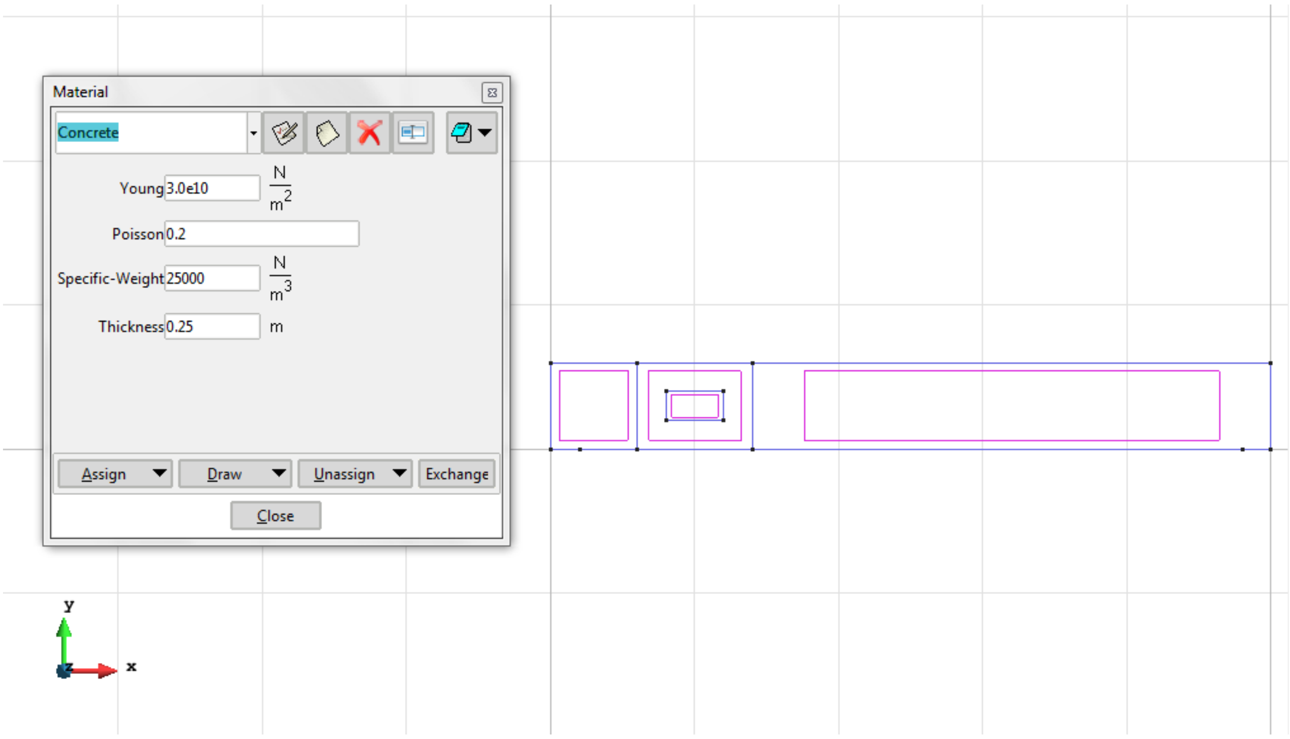

Figure 37 - Characteristics for the Concrete

Problem Data: In this section we specify some data necessary for the analysis.

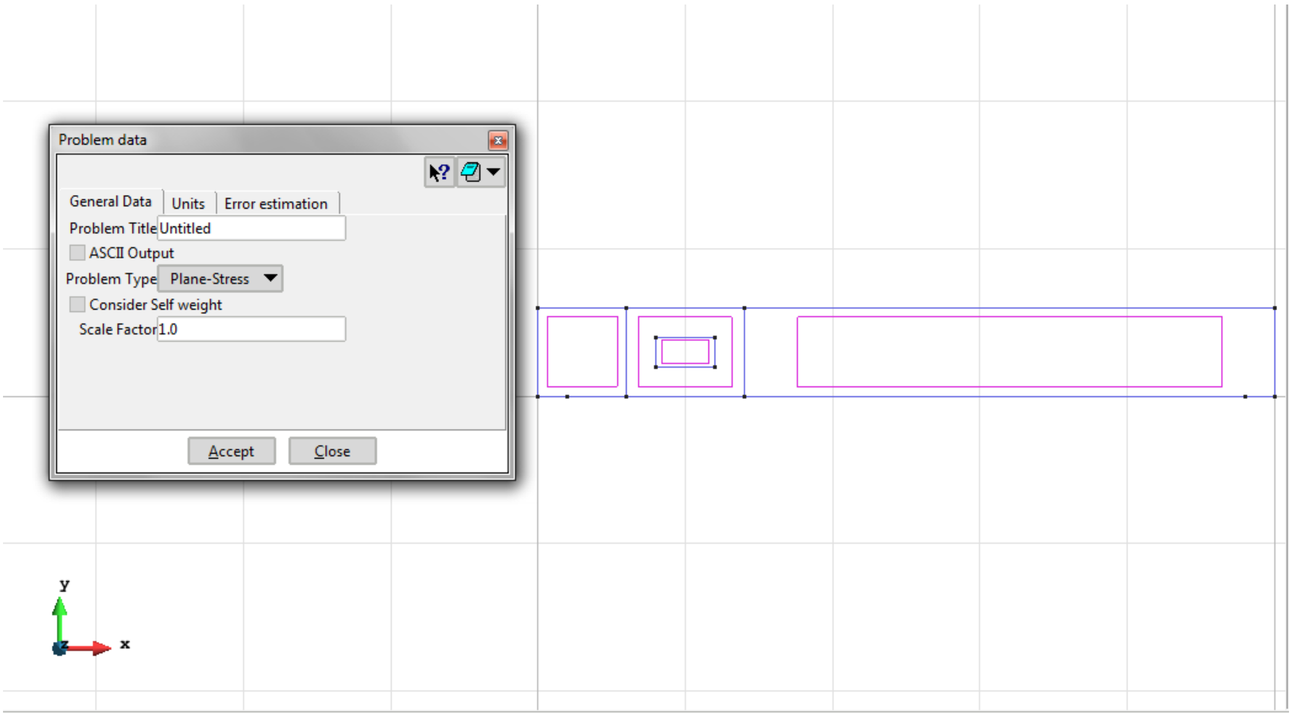

Figure 38 – Problem data

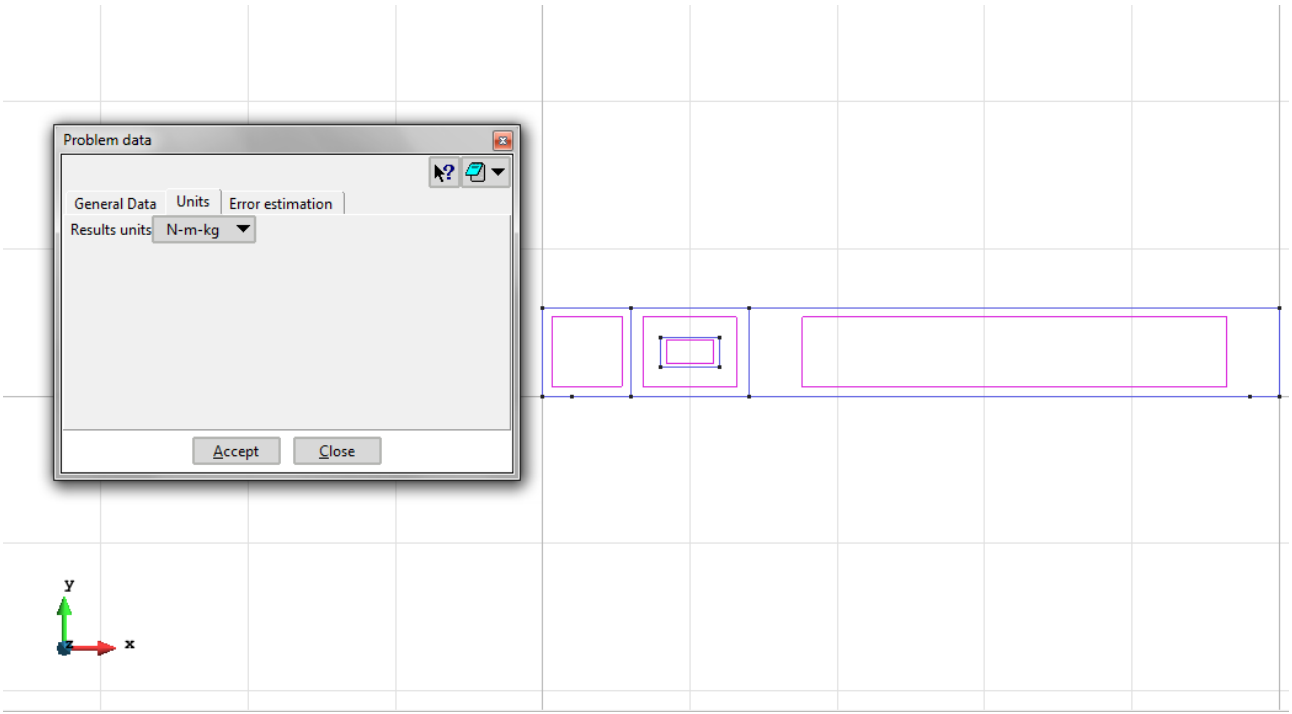

Figure 39 – Units for the problem data

Meshing / Generate To generate the mesh use the following options:

- Element Type: We use a mesh of quadrilateral elements (Quadrilateral).
- Quadratic elements: We consider linear elements with 4 nodes (Normal).

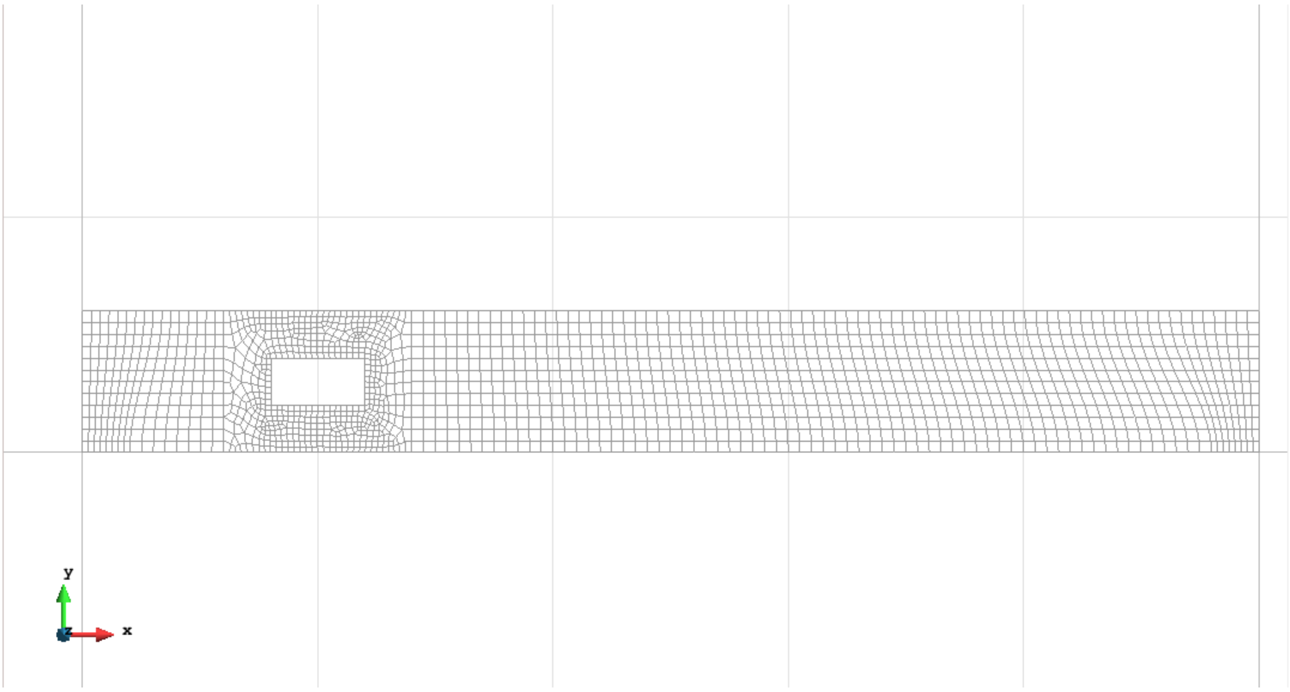

Figure 40 - Meshe of Quadrilaterals Normal

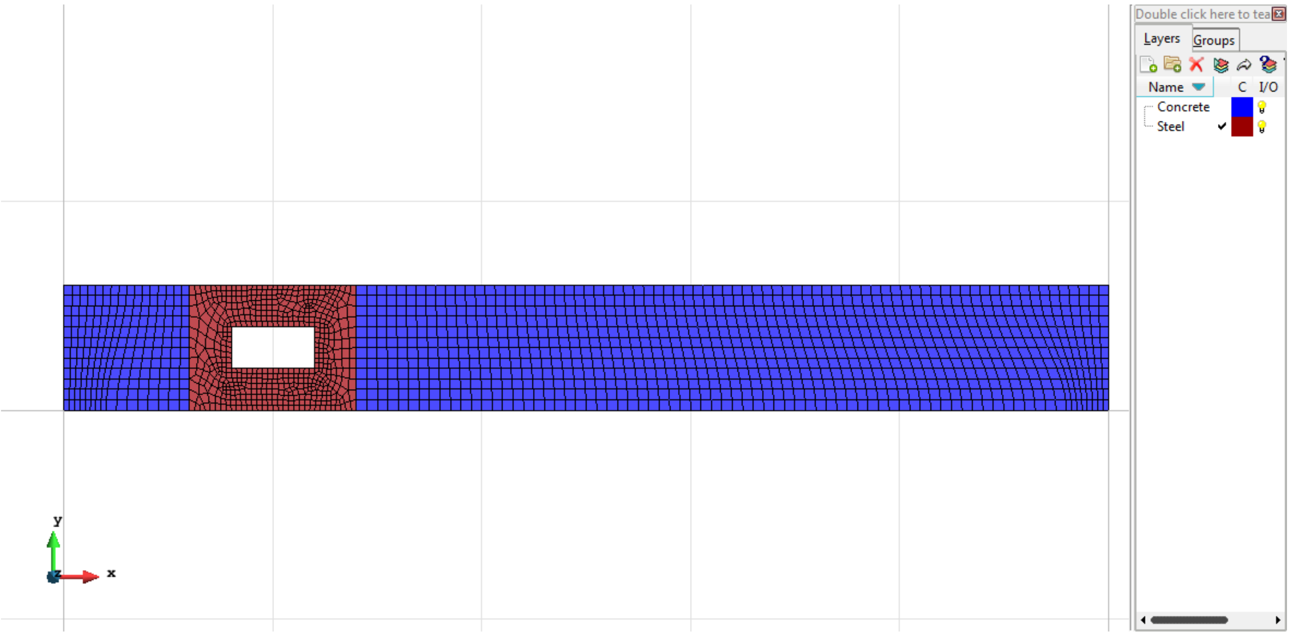

Figure 41 - Meshe of Quadrilaterals Normal (Visual Flat)

<u>Calculate / Calculate</u>

Once the mesh is generated, we proceed to calculate the problem for the meshe proposed.

<u>File / Post Process</u>

The following figures show the results of the analysis sought after in this exercise.

QUADRILATERAL ELEMENTS WITH 4 NODES

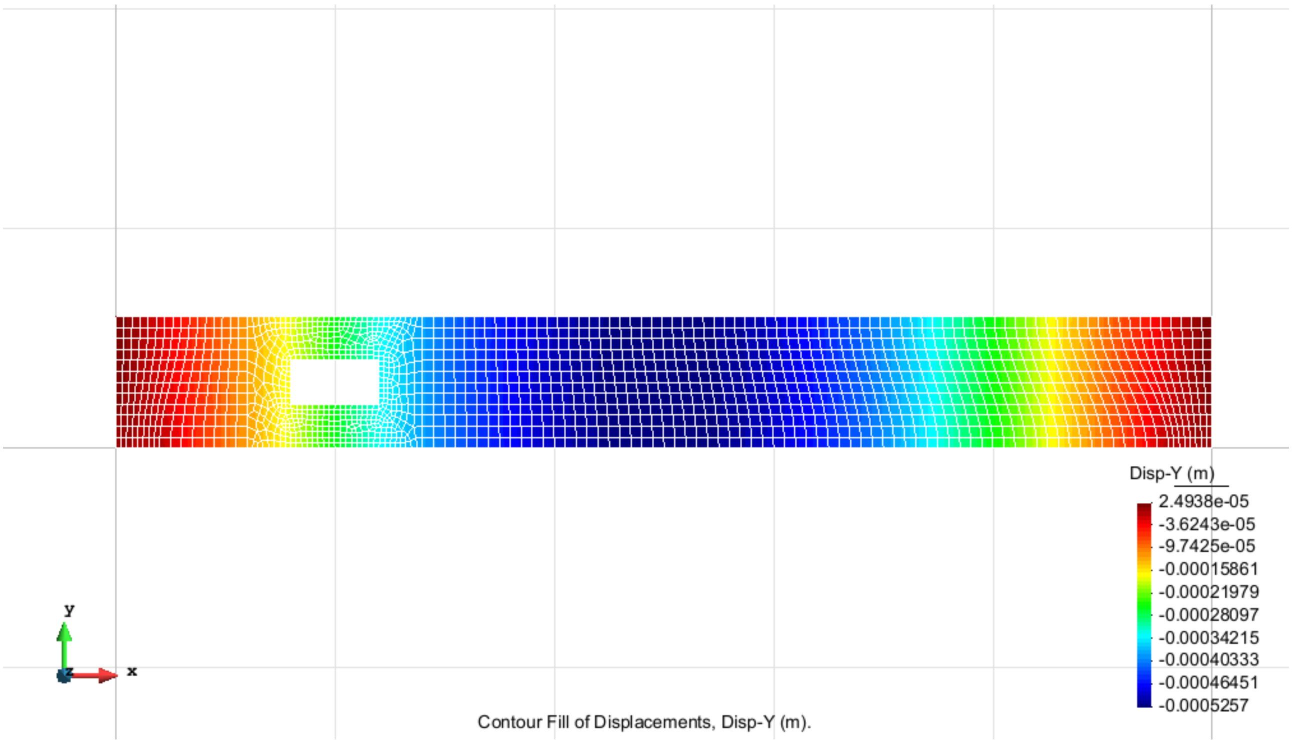

Figure 42 – Displacements on axis y

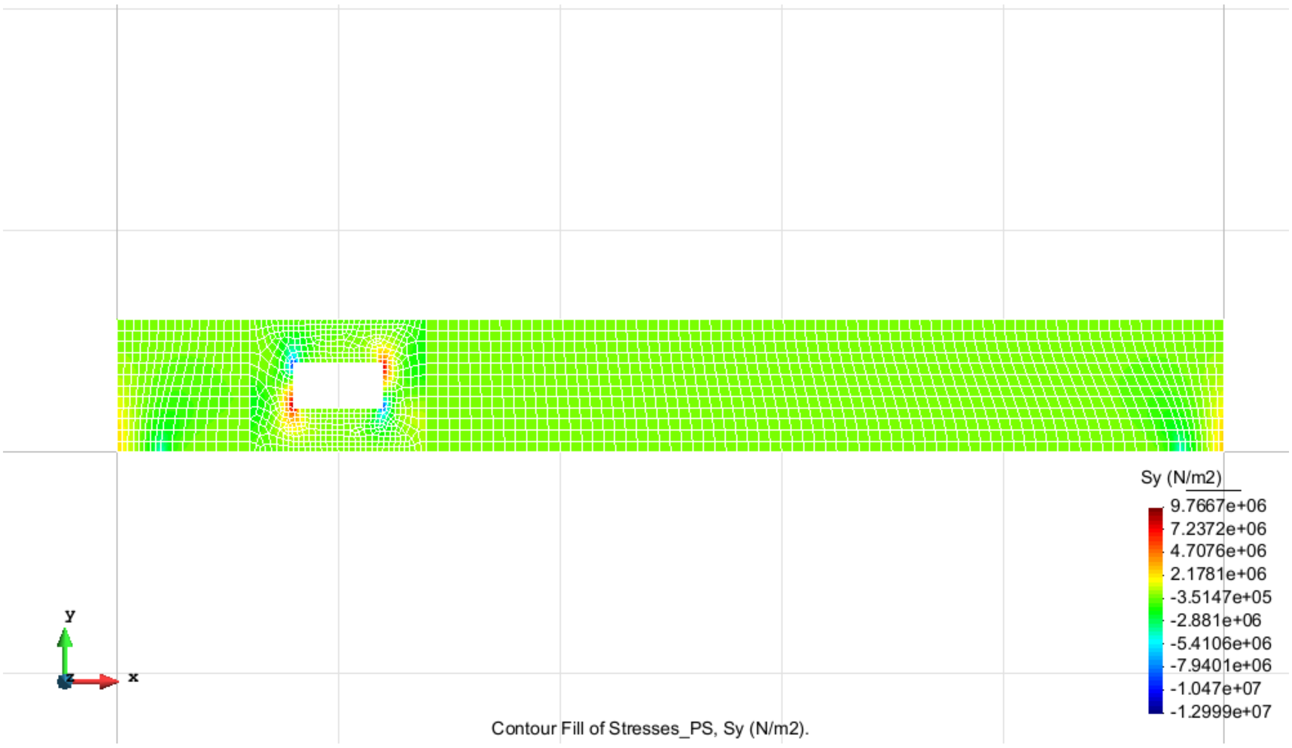

Figure 43 – Stress on axis y

Element type	Degrees of freedom
Quadrilateral with 4 nodes	2332

Exercise 4: Prismatic water tank

<u>Geometry</u>

Define the geometry of the structure in the preprocessor of Gid:

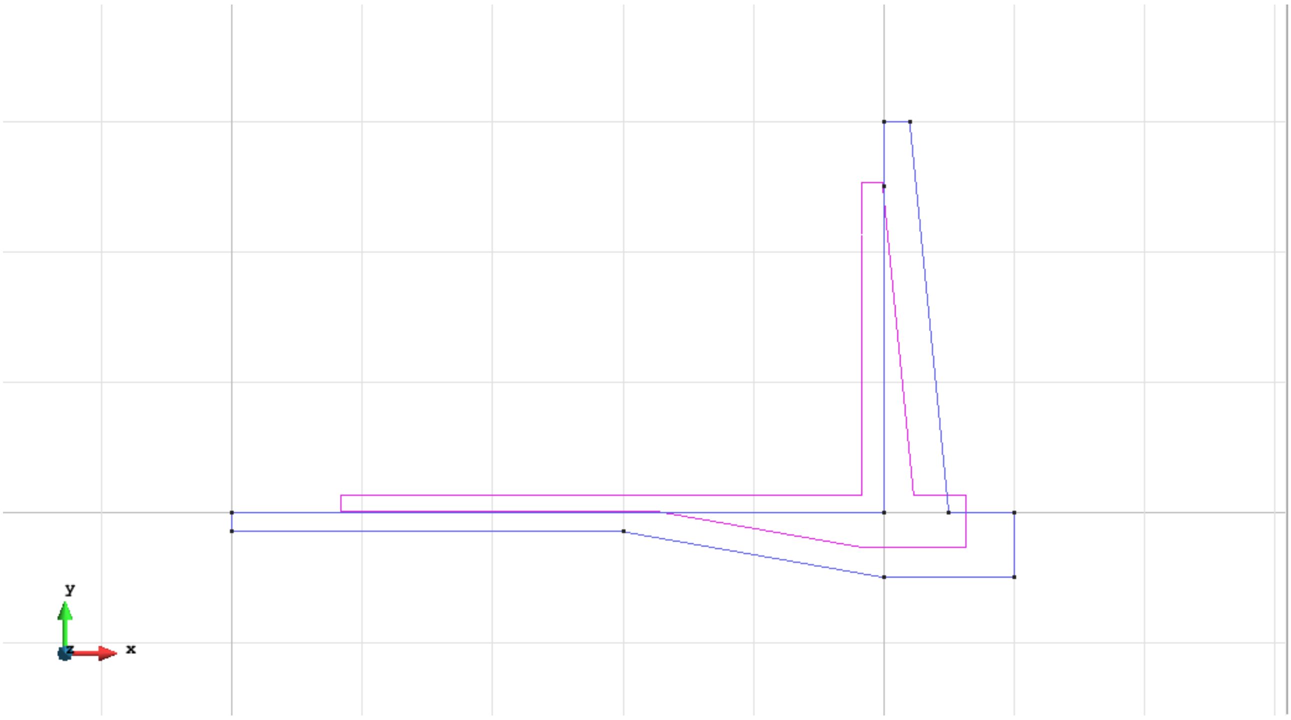

Figure 44 - Geometry of the structure

<u>Data</u>

Problem Type:

Once the geometry is defined, we can see which type of problem must be solved.
In this case we face a plane problem; therefore we choose the module RamSeries_Educational_2D/Plane State using the following sequence of commands:

Data / Problem Type / RamSeries_Eductional_2D / Plane State

Boundary conditions:

The types of boundary conditions that are enforced in this example are the following:

- Elastic Constraints (for the ground).

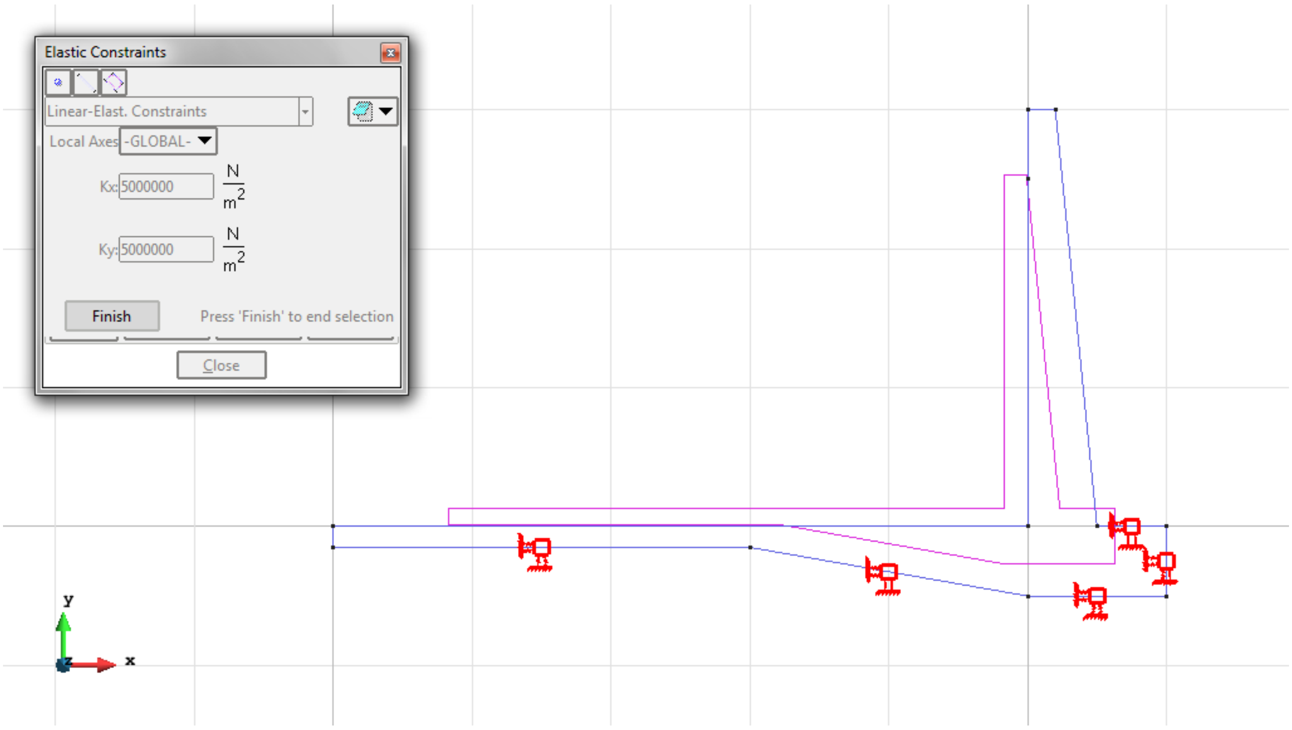

Figure 45 – Elastic Constraints

- Loads / Line loads / Uniform loads. On the bottom of the platform there is a uniform pressure, while in the lateral bulkhead there is calculated a triangular pressure and arranged as seen in figure.

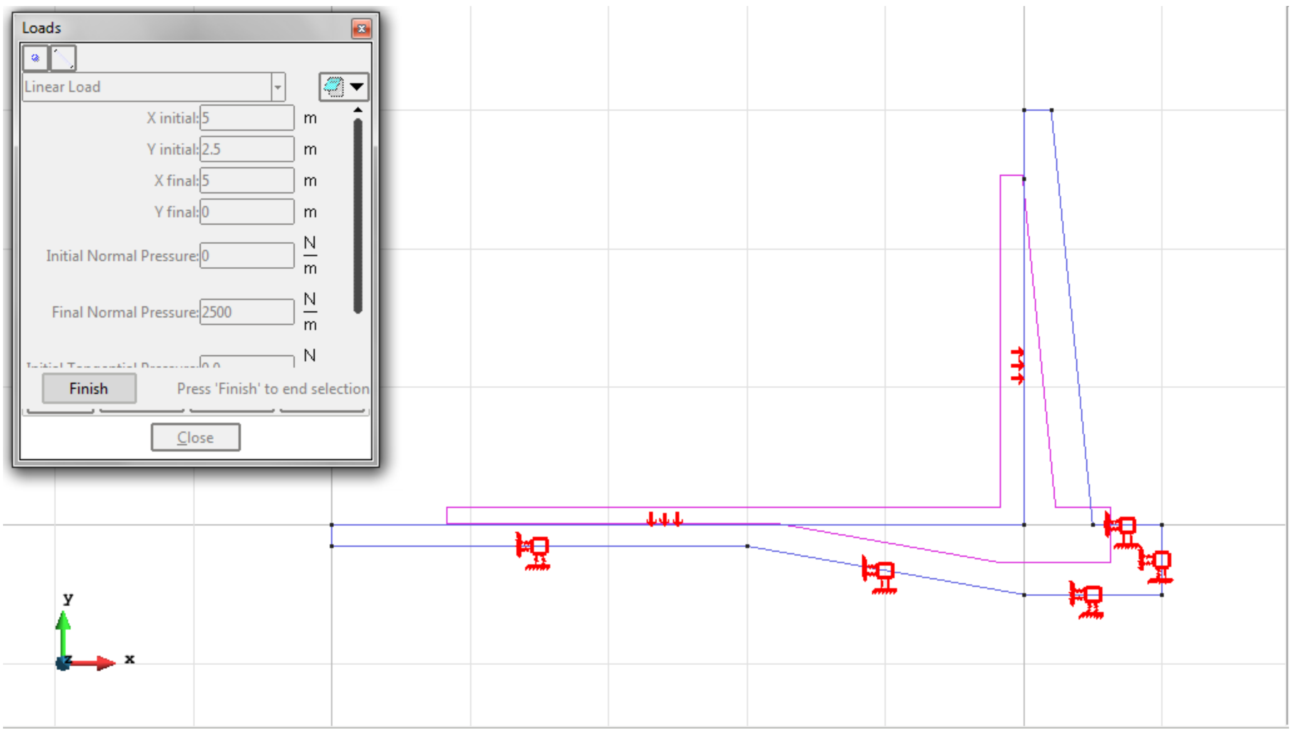

Figure 46 – The uniform load on the bottom plus the triangular load on the lateral bulkhead (in the box there are the settings for the triangular load)

Material: We use material with the following mechanical characteristics.

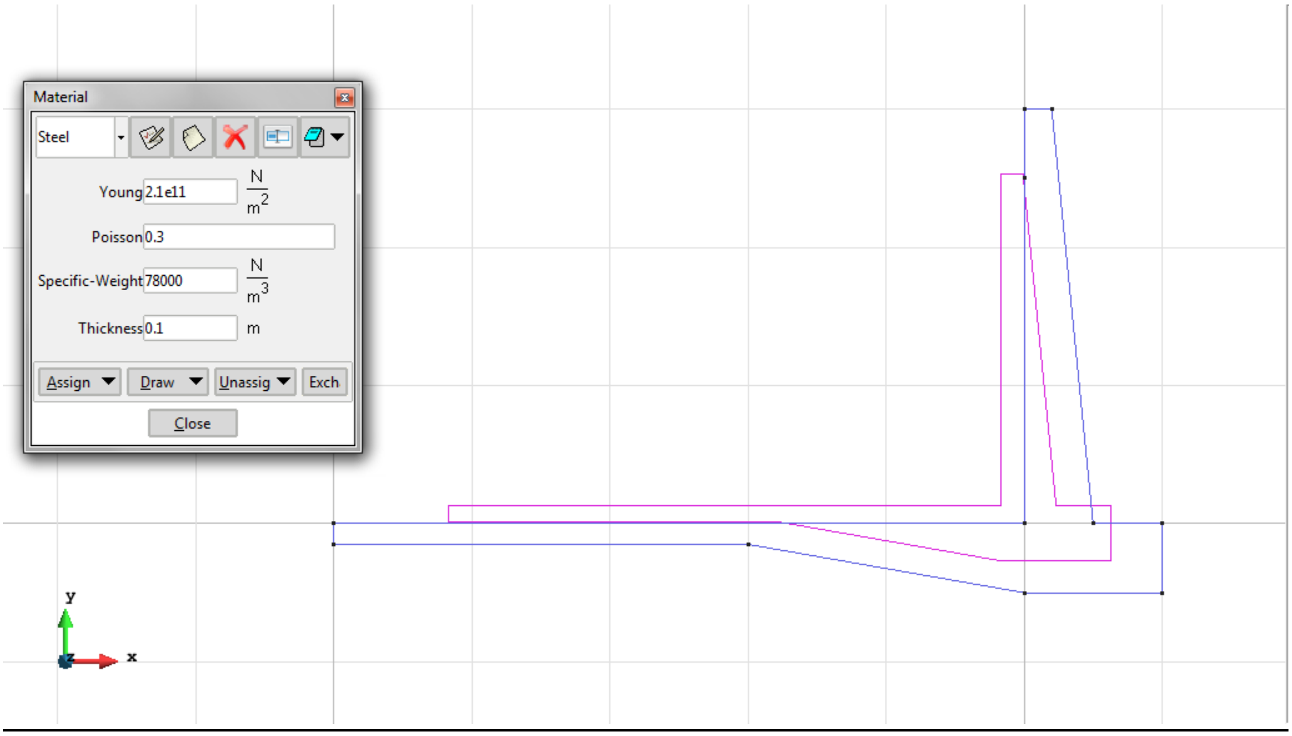

Figure 47 - Material

Problem Data: In this section we specify some data necessary for the analysis.

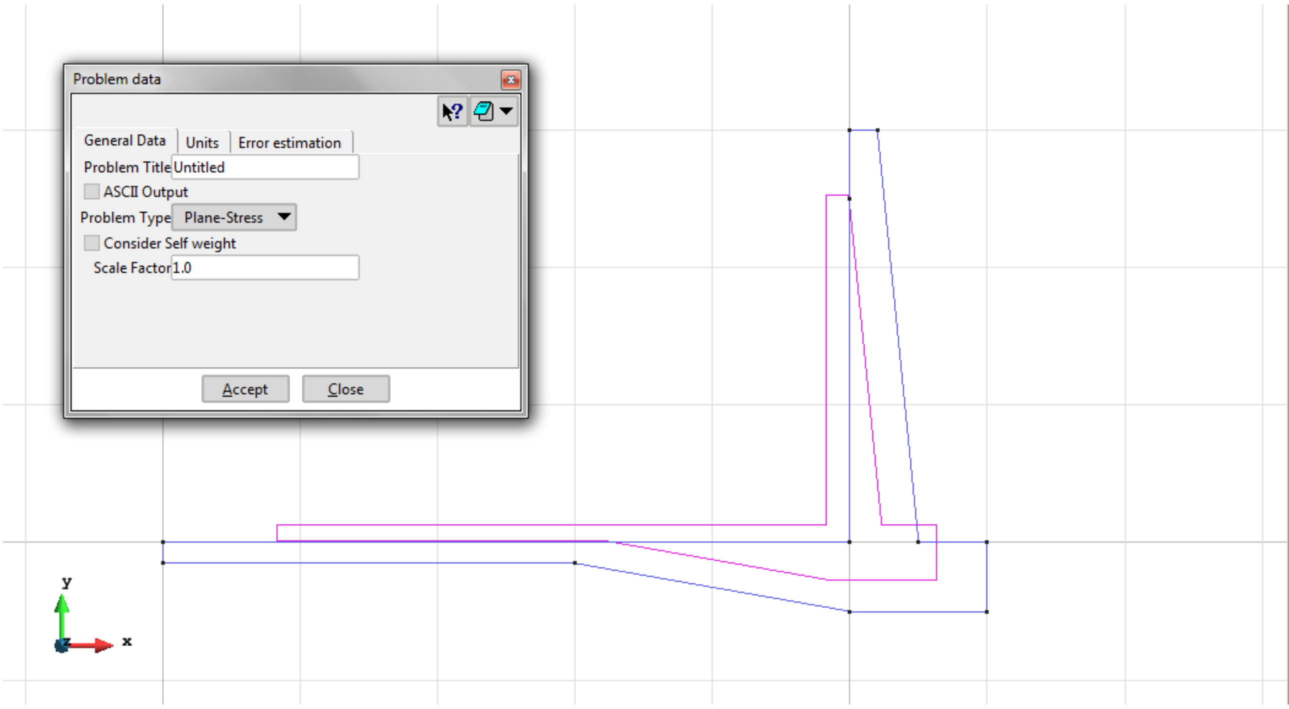

Figure 48 – Problem data

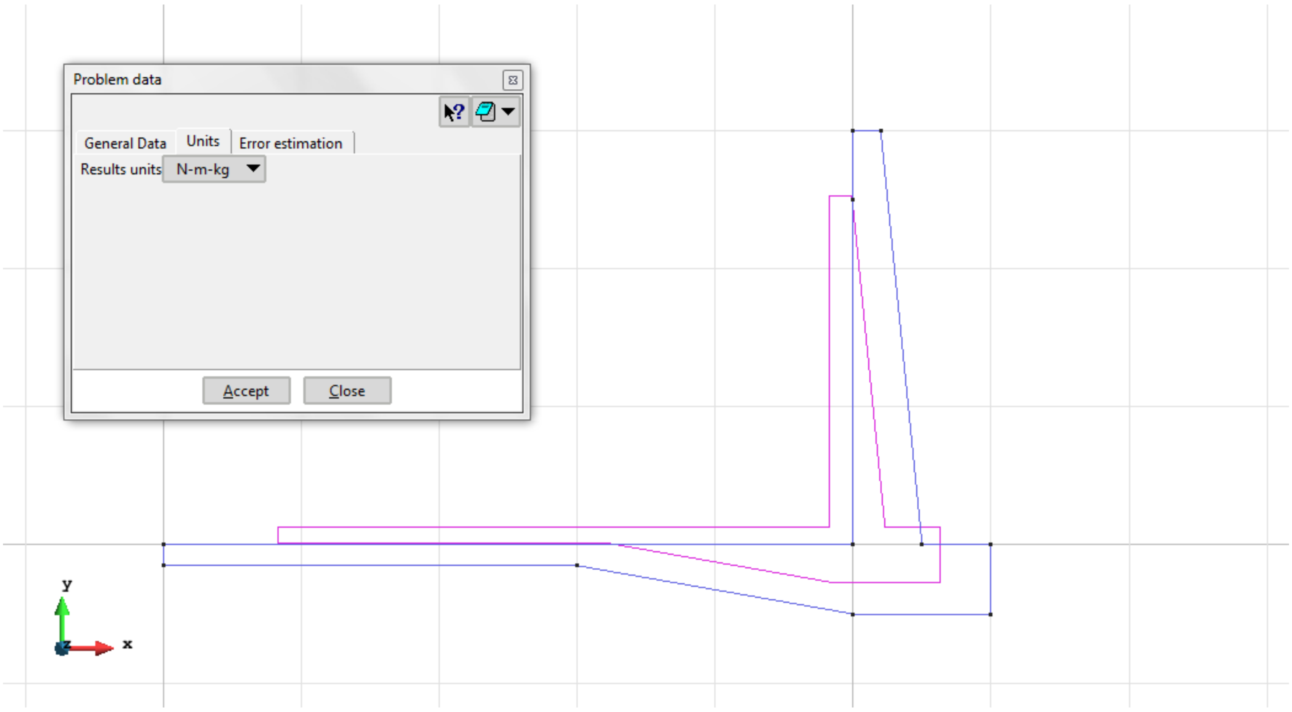

Figure 49 – Units for the problem data

Meshing / Generate To generate the mesh use the following options:

- Element Type: We use a mesh of quadrilateral elements (Quadrilateral).
- Quadratic elements: We consider linear elements with 4 nodes (Normal).

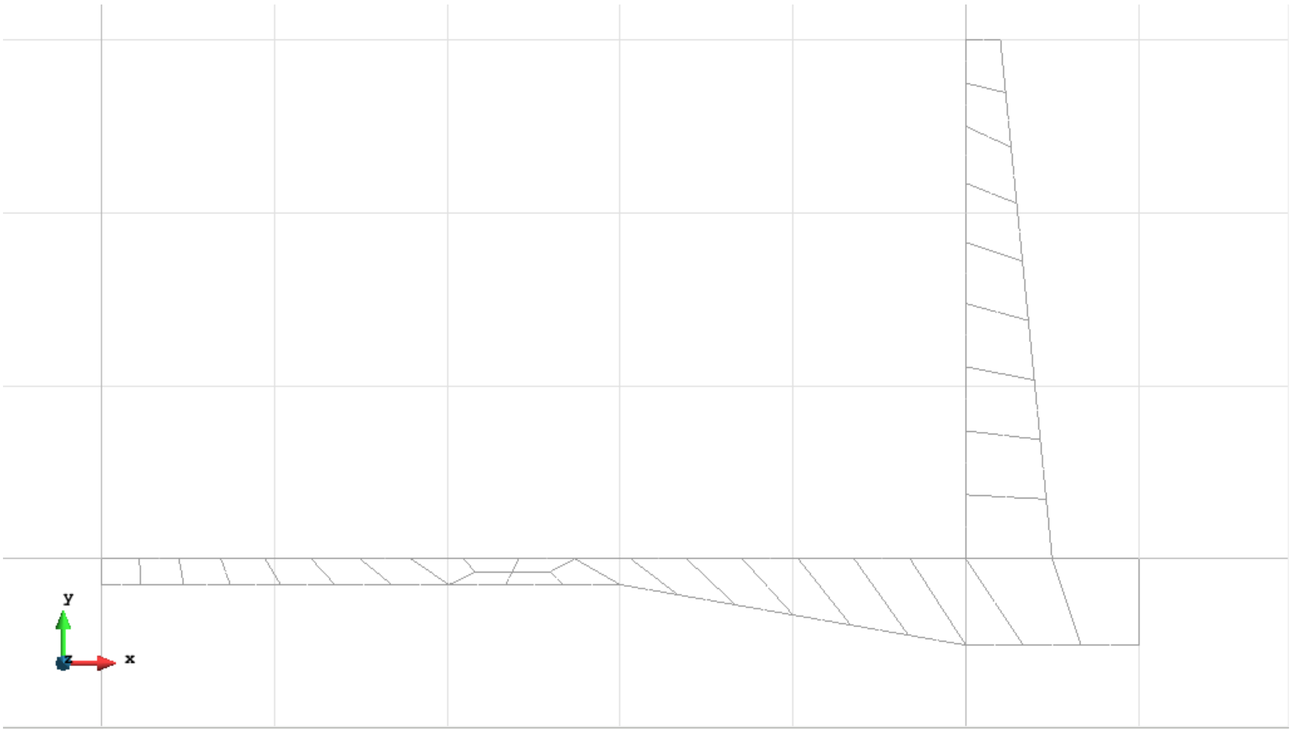

Figure 50 - Meshe of Quadrilaterals Normal

Calculate / Calculate

Once the mesh is generated, we proceed to calculate the problem for the meshe proposed.

File / Post Process The following figures show the results of the analysis sought after in this exercise.

QUADRILATERAL ELEMENTS WITH 4 NODES

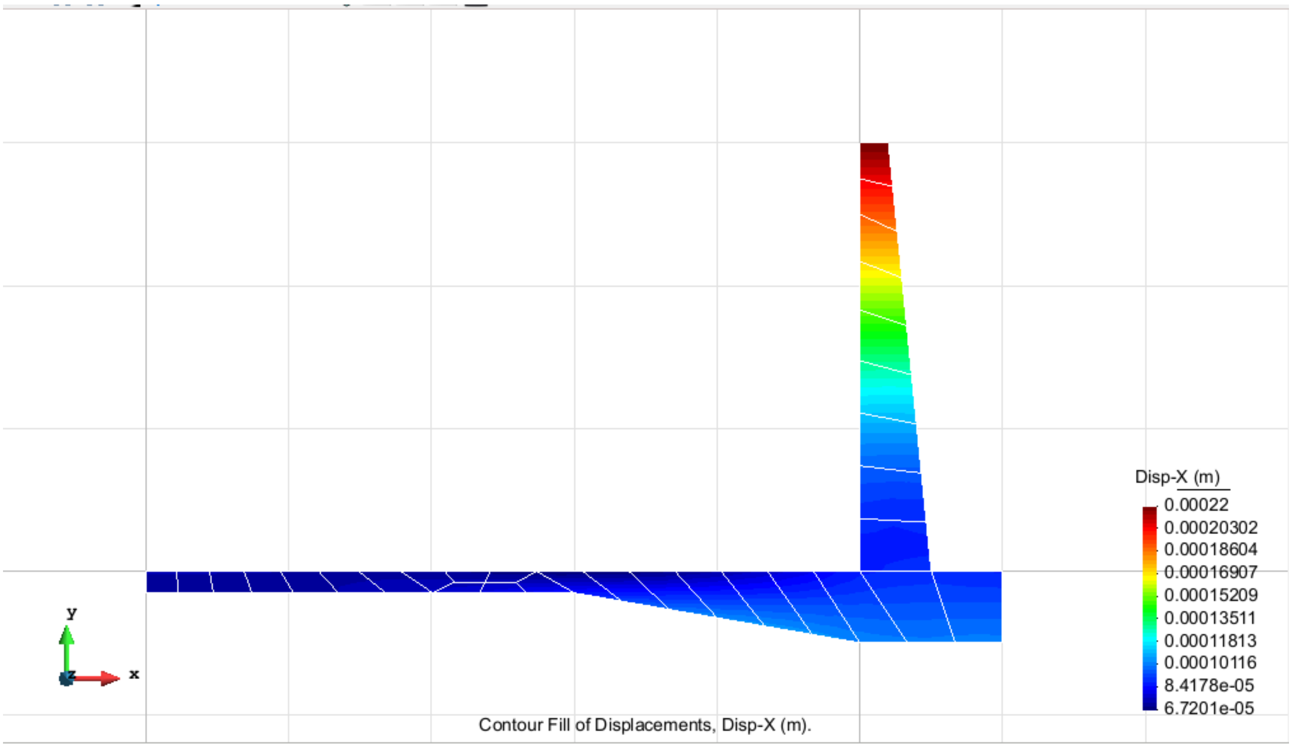

Figure 51 – Displacements on axis x

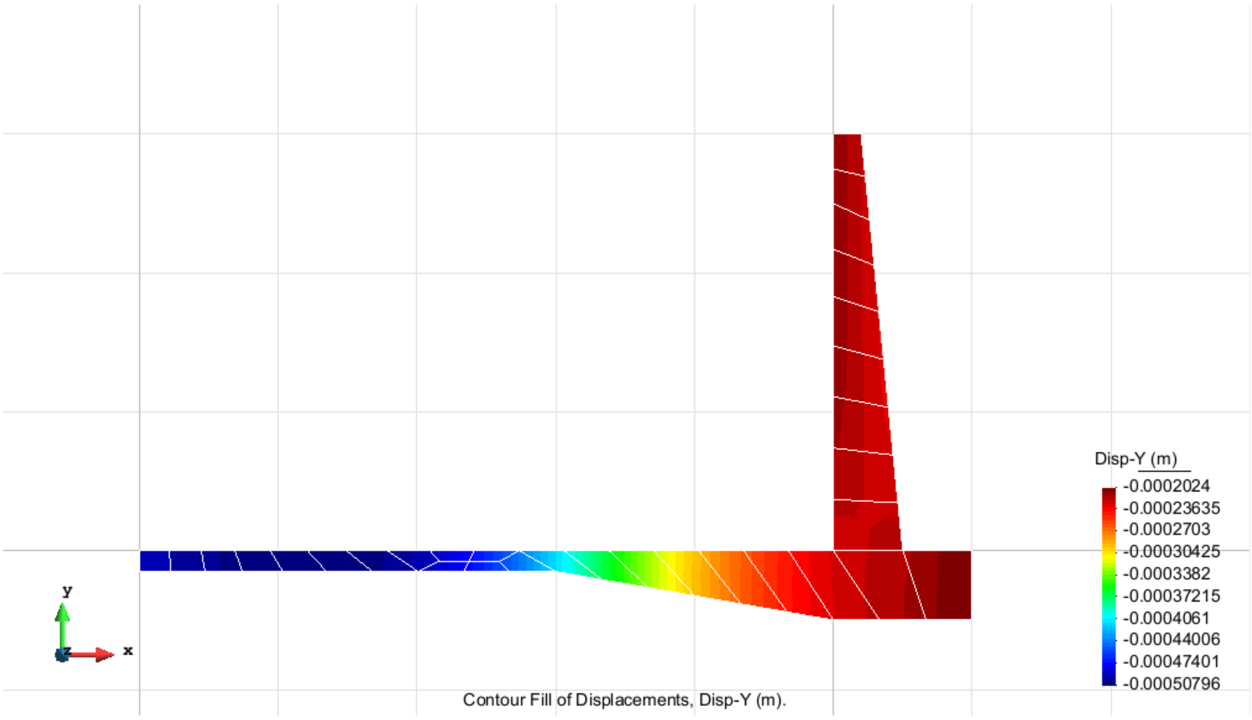

Figure 52 – Displacements on axis y

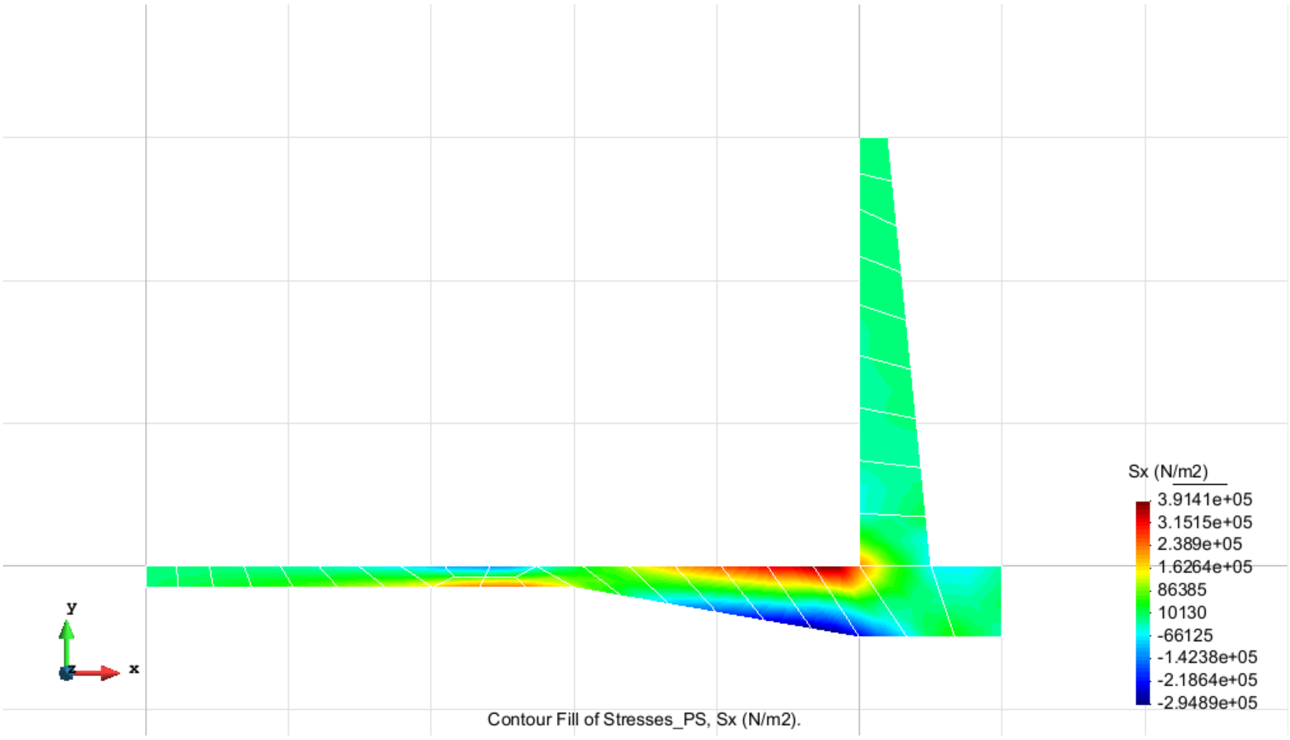

Figure 53 – Stress on axis x

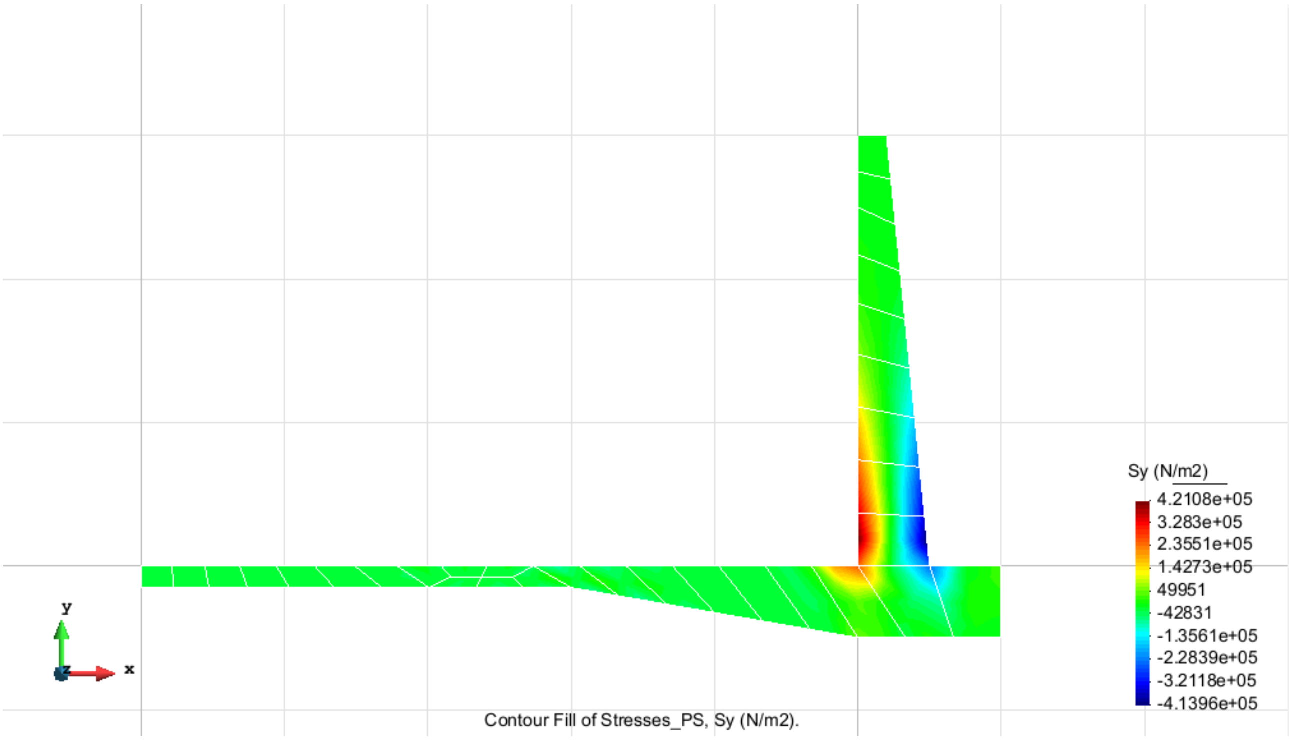

Figure 54 – Stress on axis y

Element type	Degrees of freedom
Quadrilateral with 4 nodes	152