PRACTICE 1

EXERCISE 1: Thin plate under dead weight

The stresses and displacements of the plate will be analyzed in the following parts for different meshing. Triangular and quadrilateral elements will be used to analyze both results.

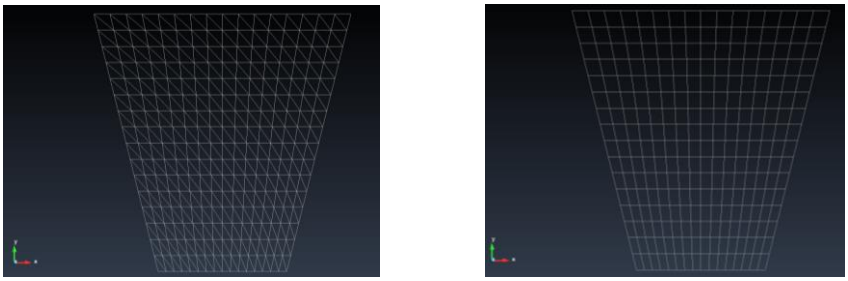

Figure 1. 1 Meshing

- TRIANGULAR ELEMENTS:

These plots show that the results are very similar for both cases and they meet with the given solution in the assignment. There is not any visual difference between the displacement patterns, however there is a small difference in the upper-left corner of the stress plot.

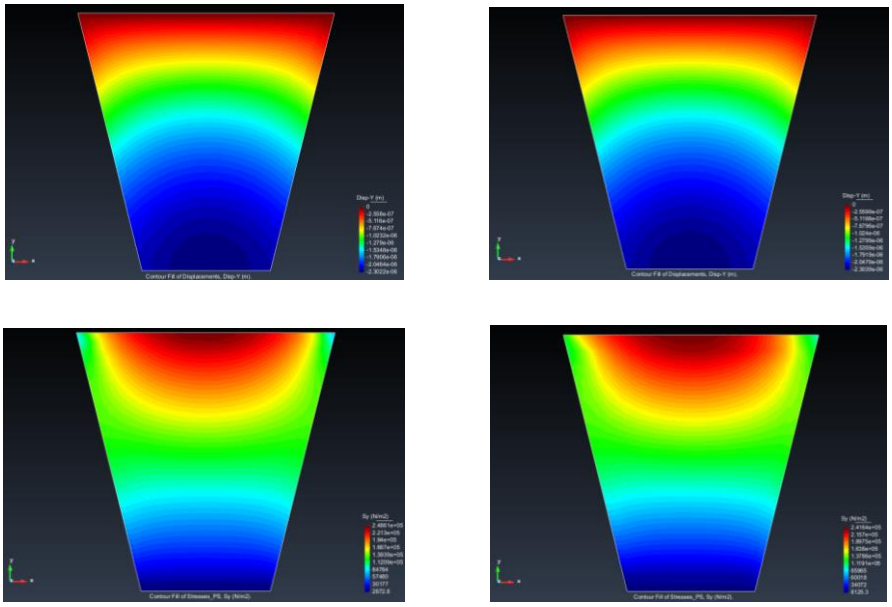

Figure 1. 2 Displacements and stresses on the 3 node element (left) and 6 node element (right)

In the following table are sumarized the numerical results of the displacement and the stresses at the middle point. The values are very similar, which shows that it is not necessary to remesh the plate.

TRIANGULAR ELEMENTS				
Results	**3 nodes**		**6 nodes**	
	X	**Y**	**X**	**Y**
Coordinates (m)	2	2	2	2
Stresses (N/m2)	2248.6	117220	2687.7	116960
Displacements (m)	5.3238E-10	-1.7561E-06	-9.94E-11	-1.76E-06

- QUADRILATERAL ELEMENT:

Apparently, there is not any difference between the stress and the displacement patterns and they are very similar to the results obtained for triangular elements.

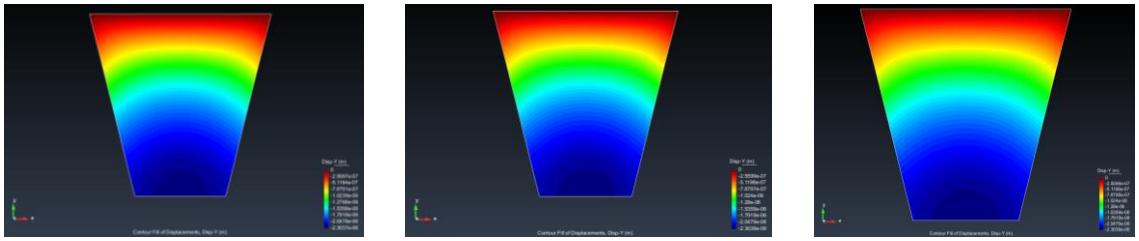

Figure 1. 3 Vertical displacement 4 nodes, 8 nodes and 9 nodes element

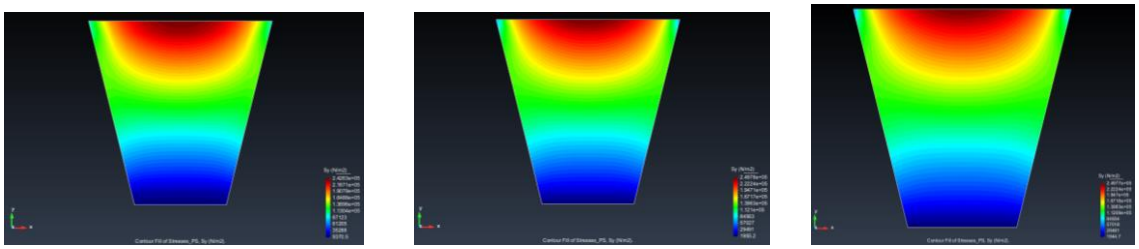

Figure 1. 4 Stress Y on 4 nodes, 8 nodes and 9 nodes elements

The numerical results are very similar between them, especially between the 8 nodes and 9 node elements. This equality shows that adding new nodes increase the computational cost but it does not improve significantly the results.

QUADRILATERAL ELEMENTS						
Results	**4 nodes**		**8 nodes**		**9 nodes**	
	X	**Y**	**X**	**Y**	**X**	**Y**
Coordinates (m)	2	2	2	2	2	2
Stresses (N/m2)	2627.3	117000	2675.4	116930	2674.4	116930
Displacements (m)	-7.093E-14	-1.76E-6	-4.2094E-12	-1.7598E-06	-4.2972E-12	-1.7598E-06

EXERCISE 2: Plate with two sections

The concrete structure is supported by three columns and the central pile has a δ = 0.3 meter displacement. The stresses are expected to concentrate in the central column due to the displacement.

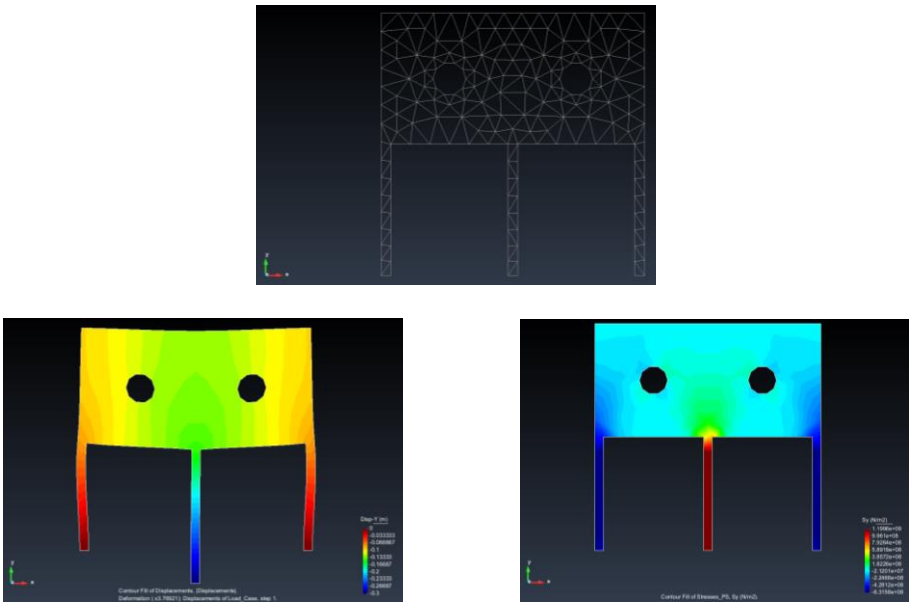

Figure 2. 1 Plate with two holes

In fact, the stresses in the exterior columns are negative (compression) because the drop of the middle column push down the structure. By contrast, the middle column is subjected to tension loading due to the sag of the foundation. This stress distribution matches with the displacement pattern.

EXERCISE 3: Plate with ventilation hole

The critical parts of the beam would be on the supports, in the middle part of the beam and in the corners of the hole. In order to analyze the effect of the steel plate, it has been modelled the beam with and without the plate.

- Without the steel plate:

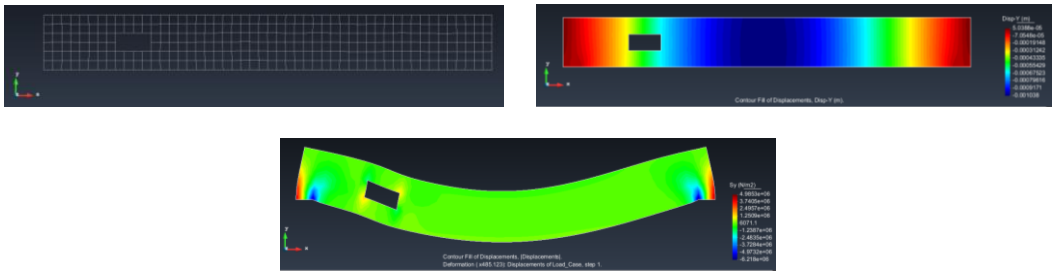

Figure 3. 1 Plate without steel plate

The figures shows where are located the maximum stresses and displacements. As it has been supposed, the maximum stresses are in the support and the maximum displacements in the center of the beam. At the corners of the hole, there are also greater stresses because of the change of section.

Beam without steel plate						
	Mid point		Supporting point		Down-left corner	
	X	Y	X	Y	X	Y
Stresses (N/m2)	3.01E+06	86916	-1.48E+05	49807	6.40E+05	1.44E+06
Displacement (m)	-2.92E-06	-0.0010354	0	0	2.81E-05	-0.00035261

- With the steel plate:

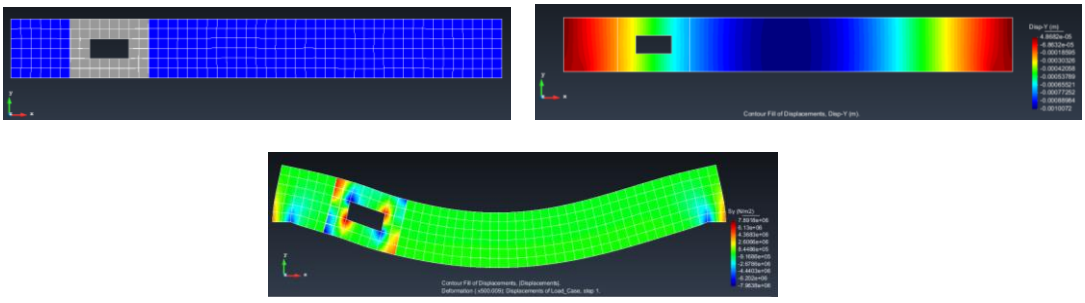

Figure 3. 2 Plate with steel plate

Although the displacement follows the same patterns as in the previous case, their values are slightly smaller. However, the stress distribution is different. There is another maximum on the edge of the steel plate.

Beam with steel plate

	Mid point		Supporting point		Down-left corner	
	X	**Y**	**X**	**Y**	**X**	**Y**
Stresses (N/m2)	2.98E+06	86678	-1.57E+05	25129	7.12E+06	7.89E+06
Displacement (m)	-9.34E-07	-0.0010046	0	0	2.28E-05	-0.0003447

Analyzing the results of the down-left corner of the hole, there is significant difference regarding the displacement of 10 % between both cases. The midpoint is another interesting point to analyze the effect of the plate. In this point the displacement has been reduced a 3%. Lastly, there is a huge difference in the stresses on the support, which shows a 50% difference between both beams.

EXERCISE 4: Prismatic water tank

The tank is modelled as a plane structure and the hydrostatic loading is introduced as a constant loading upon the bottom and a triangular loading in the vertical wall. The surrounding ground is defined with the elastic coefficient.

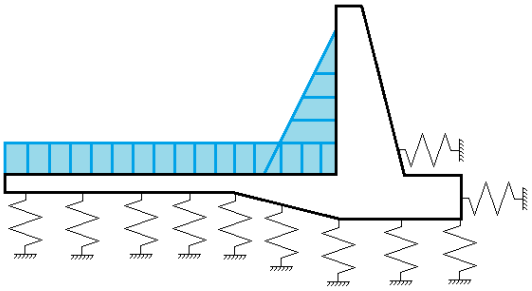

Figure 4. 1 Tank

The greatest displacements are at the wall due to the weight of the dam and the bending generated by the hydrostatic loading. However, the stresses are greater in the slab than in the wall because of the section change of the slab.

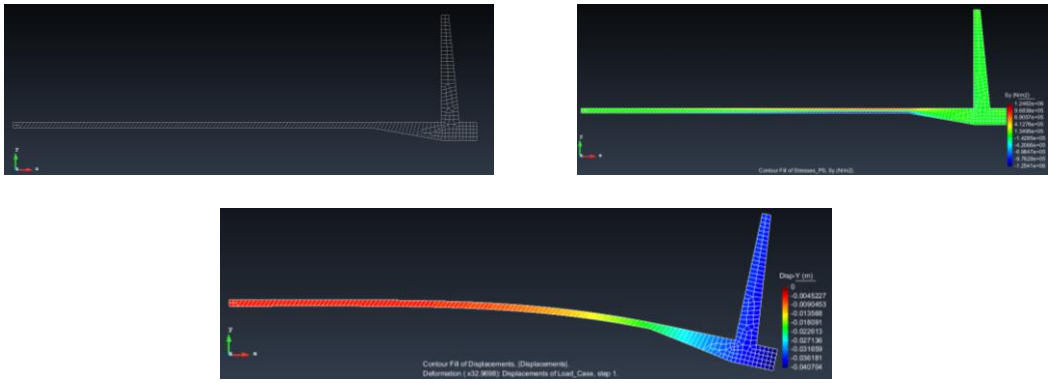

Figure 4. 2 Stresses and displacements