CSMD HW 1

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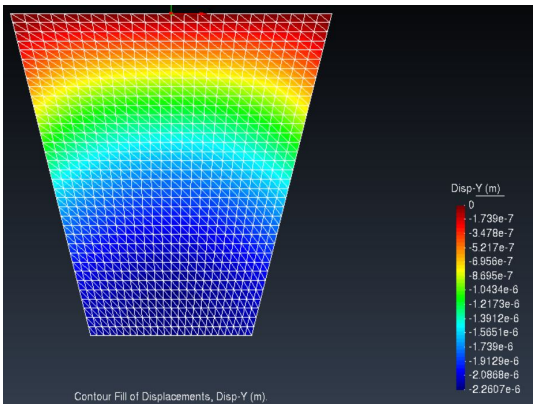
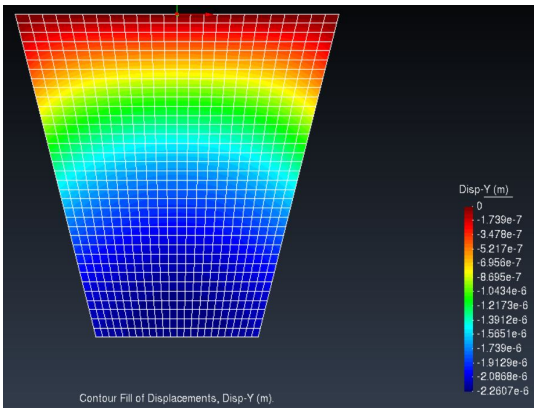
1 Problem 1

A thin plate is analyzed using different kind and number of elements in order to check the element performance.

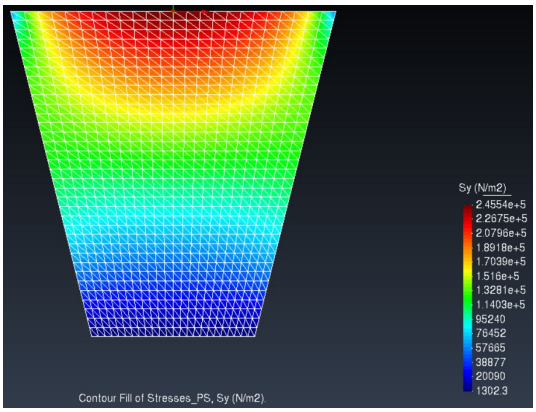


Y-disp with tri-6 elements

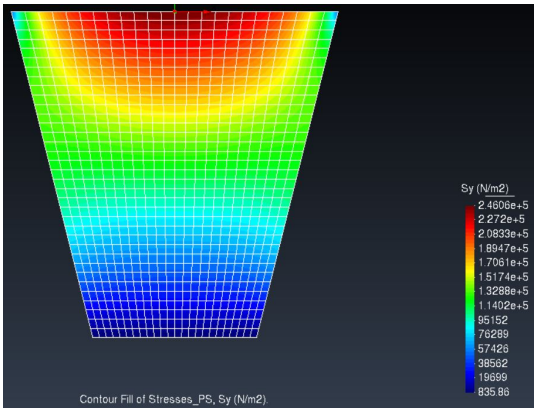


Y-disp with quad-9 elements

The above figure show the y-displacement results for the best quad and tri elements. As expected the maximum displacement is obtained in the lower surface with a value very close to the exact one.

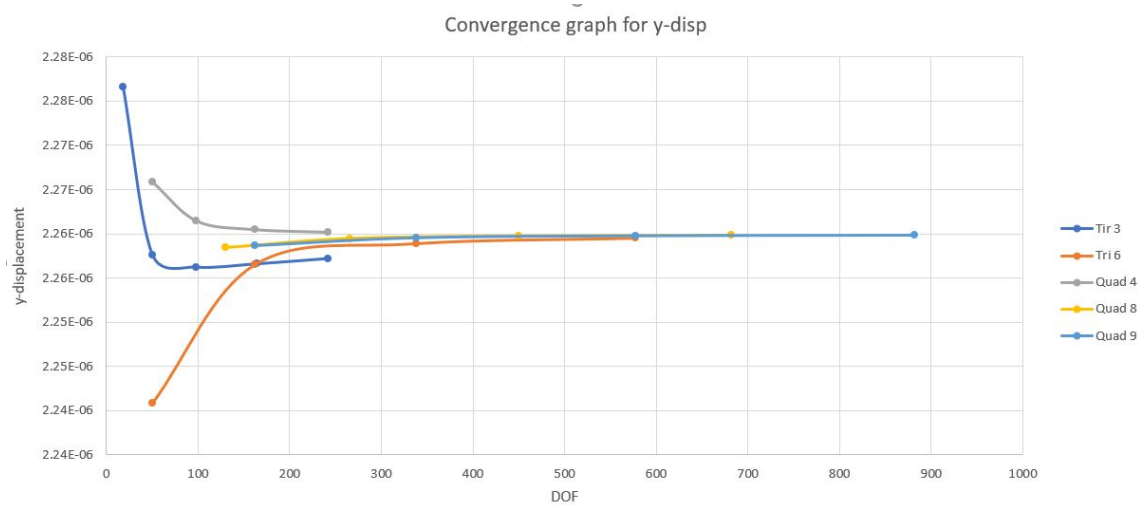


Y-stress with tri-6 elements

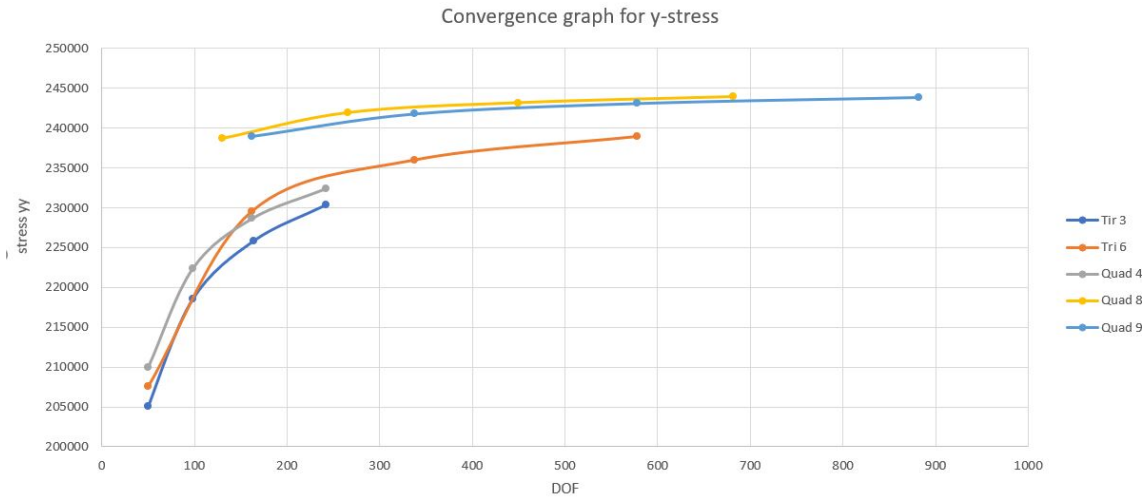


Y-stress with quad-9 elements

The above figure show the y-stress results for the best quad and tri elements. As expected we have the maximum stress are obtained in the mid of the upper surface where a fixed condition is applied having value similar to the exact one.



y-displacement convergence

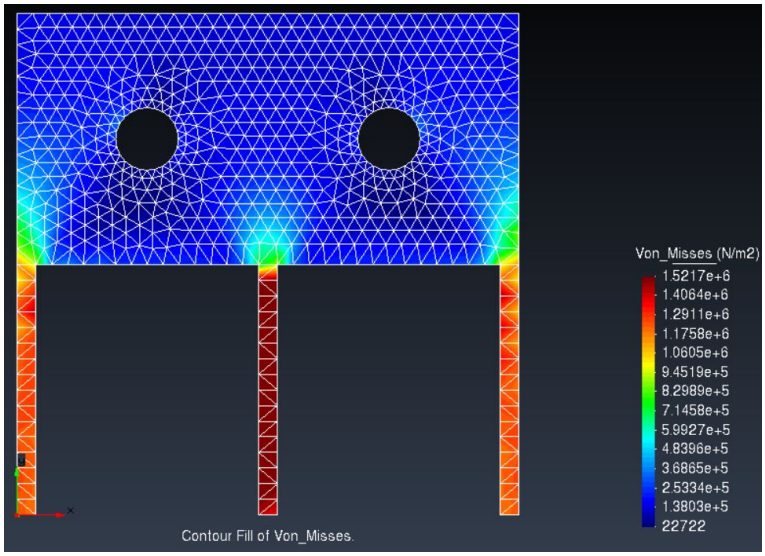


y-stress convergence

In general, it can be shown that the higher the number of elements, the better the approximation to the exact solution for all element types. The remarkable observation from the plots is that for the same degrees of freedom, higher degree elements have better approximations of the exact result than linear elements.

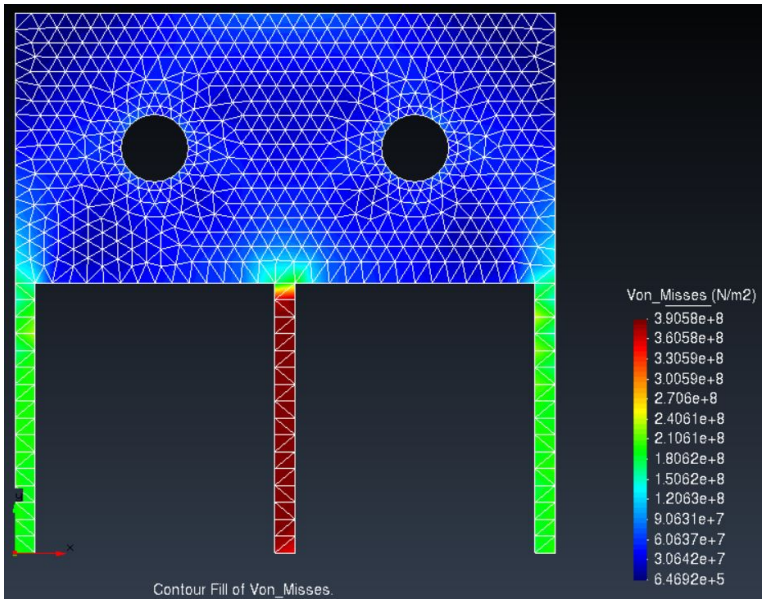
2 Problem 2

A reinforced concrete plate with two holes supported by 3 columns is analysed in order to study the effect of introducing a prescribed y-displacement, a high value to notice the difference, in the mid column. A uniform disturbed load is applied in the upper surface. 3-node triangular elements are used for the mesh.



Von Mises stress for case 1

In the normal case without displacement, maximum stresses were obtained in the 3 columns being higher in the middle one but with a small difference between them compared to the next case.



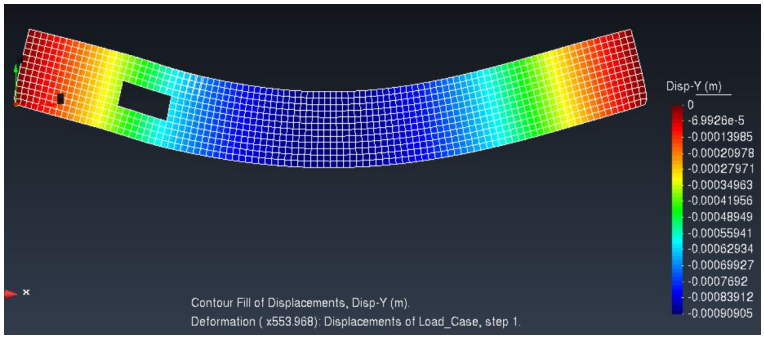
Von Mises stress for case 2

Due to the prescribed displacement applied, high stresses are obtained in the whole structure. Although the middle column still suffer maximum stresses, the new displacement condition increase the stress ratio between the middle and the other columns.

3 Problem 3

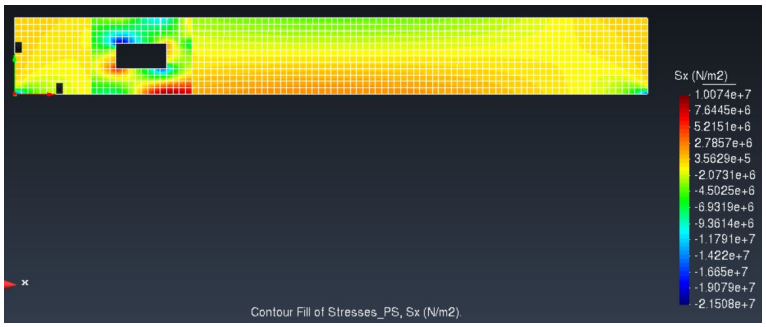
In this problem, a reinforced concrete plate with reinforcement steel sheets around a hole is studied. It has been implemented as a plane stress problem using 4-node quadrilateral elements. A uniform distributed load is applied in the upper surface.

To create the model, two layers were created to distinguish between the different materials. They were meshed separately, then a process of collapse was applied to the nodes to be sure they have the same node, and thus, the continuity condition between different elements is satisfied.



Deformed shape with y-disp

As it's shown in the figure, the maximum deformation is obtained around the middle point. However, it's minimum near the fixed supports. The effect of the hole is negated by the presence of the steel sheet making the problem almost symmetric.



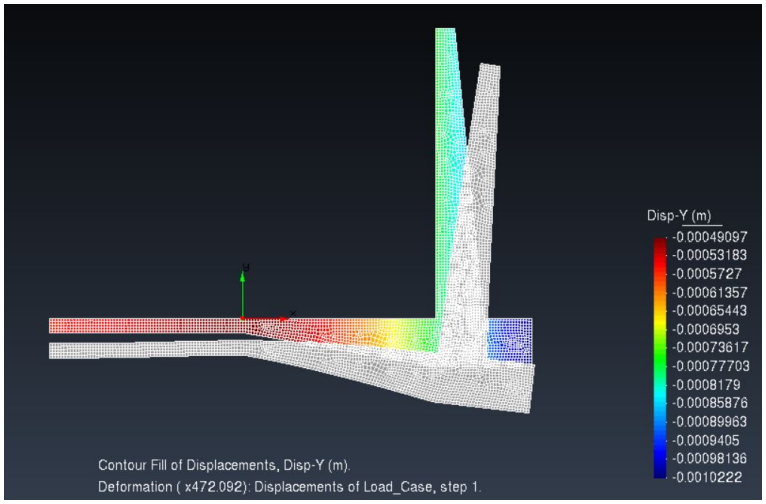
x-stress

A discontinuous stress field is obtained becuase of the presence of two different materials. Large stresses in the x-direction are obtained near the end parts due to the higher moment. However, the maximum values are obtained in the steel sheet as expected due to the higher modulus of elasticity.

4 Problem 4

In this problem, there is a long dam subjected to hydrostatic pressure. Therefore, it can be modelled as a plane strain problem in which a symmetry condition can be applied in order to reduce the calculation. The ground is modelled as an elastic constraint knowing the load coefficient. While the pressure is modelled as a uniform load in the x-direction and a linear distribution in the y-direction.

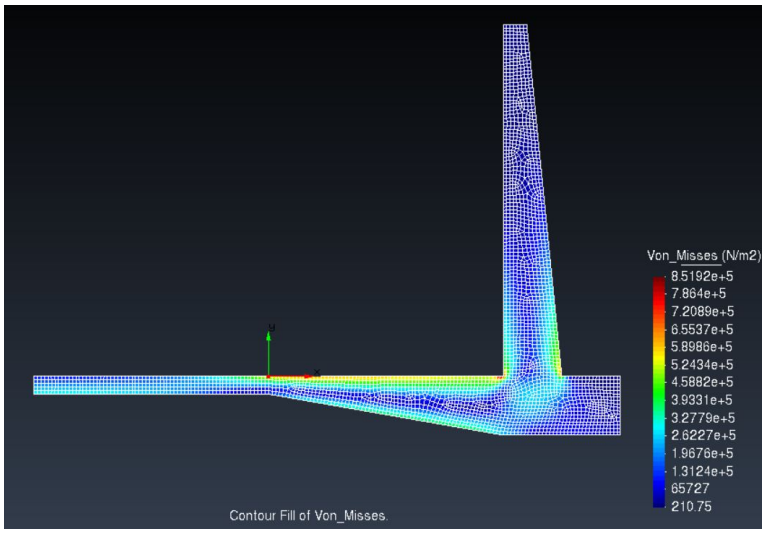
A 4-node quadrilateral elements are used in the mesh. The material of the dam is assumed to be linear elastic having a self weight taken into consideration as a body force.



x-stress

The displacement in the x-direction was obtained as expected. It's zero at the symmetry condition. The highest values are at the top of the vertical wall due to the linear hydrostatic pressure effect acting on the wall.

The displacement in the y-direction was obtained as expected. The maximum values are obtained in the thin section and then the values are reduced as we go to the right side.



Von Mises Stress

The highest values of the stress are obtained in the sharp edge where the uniform and linear loads meet. The stresses are uniform far from that point due to the uniform pressure applied.