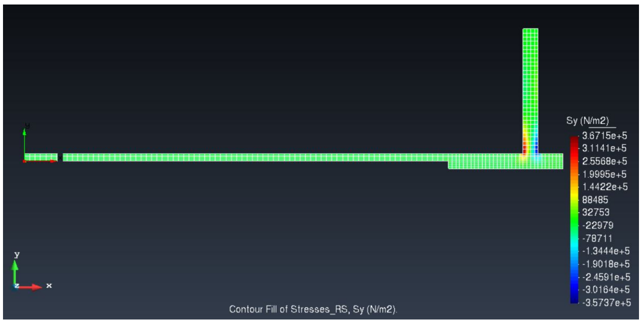
CSMD HW 2

Garcia Albela, Cristina
Youssef, Aly
Hanna, John

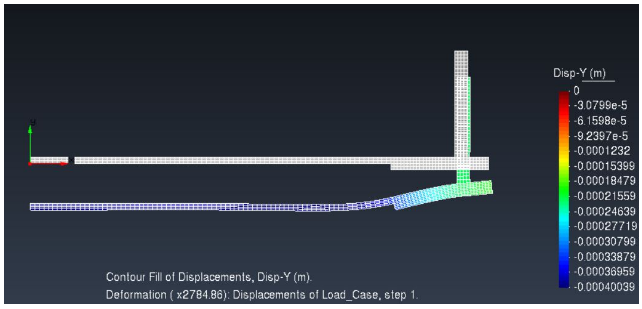
1 Problem 1

A circular tank made of reinforced concrete and subjected to hydrostatic pressure is being analyzed. Due to the tank's geometry, an axisymmetry analysis can be applied to make a 2d problem instead of 3d problem reducing the computational cost.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.

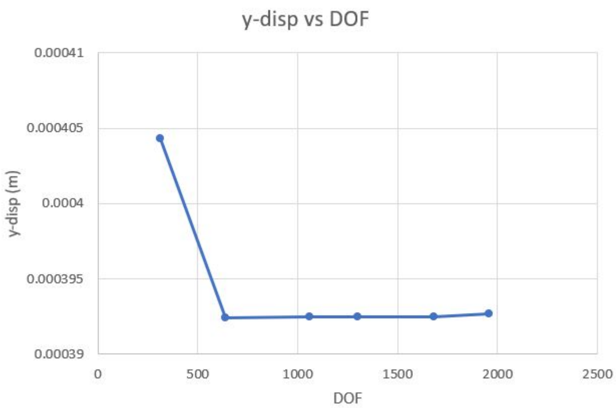


Y-stress with quad-4 elements

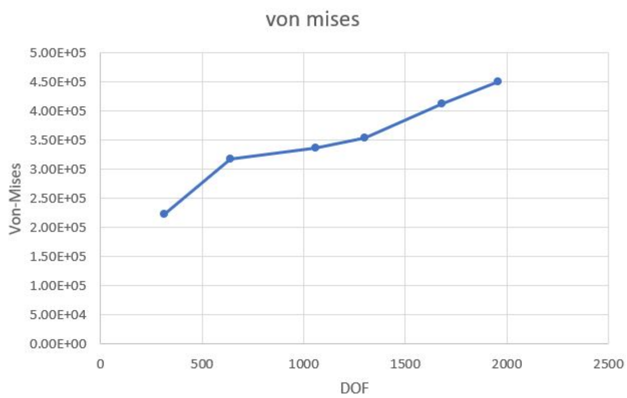


Y-disp with quad-4 elements

The above figures show the y-stress and the y-displacement with the best mesh. The second image has the deformed and undeformed shapes to understand better the general behaviour of the structure. As can be seen, the maximum y-stress is achieved where the vertical and horizontal loads are applied. Whereas, the highest displacement appears in the symmetry points as expected.



Y-disp convergence

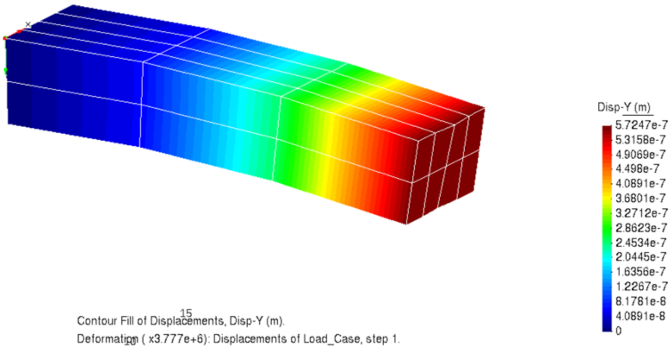


Von-Mises convergence

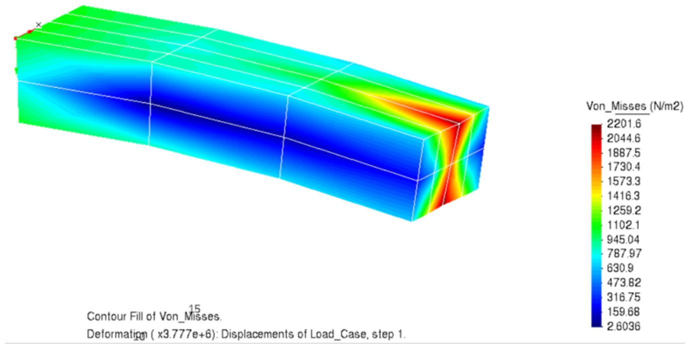
The above figures show the convergence analysis for the displacement and Von-Mises stress at 2 different points. From the first one, it is clear that the exact value is almost obtained using about 250 elements and increasing the number of elements will not affect the results much. For the stress convergence, the difference between stress values is less for higher number of elements used. However, the convergence is not obtained probably due to mesh refinement was not only localized near this point, and we are limited by 1000 nodes.

2 Problem 2

A linear elastic cantilever beam with moment applied at the far end is being studied. 8 and 20-node hexahedral elements are being used to analyze the problem.

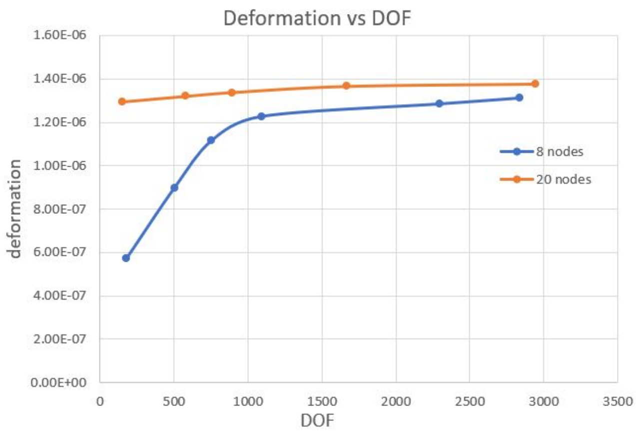


Y-stress with quad-4 elements

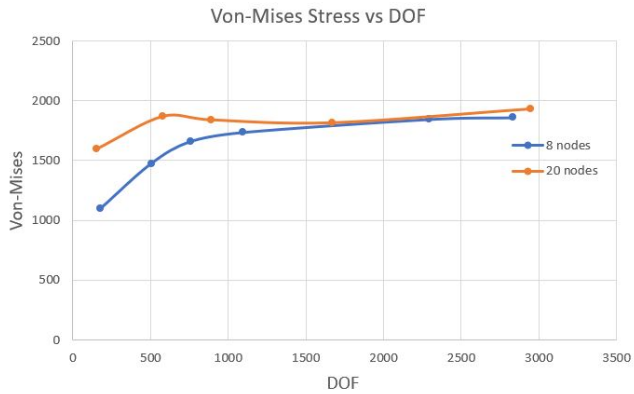


Y-disp with quad-4 elements

The figures above show the results using 20-node hexahedral elements. Due to the software limited number of nodes, a coarse mesh is used. As expected, the displacement is maximum at the free end point having a value close to the one using beam theory. The maximum stresses are obtained where the couple load is applied.



Y-disp convergence



Von-Mises convergence

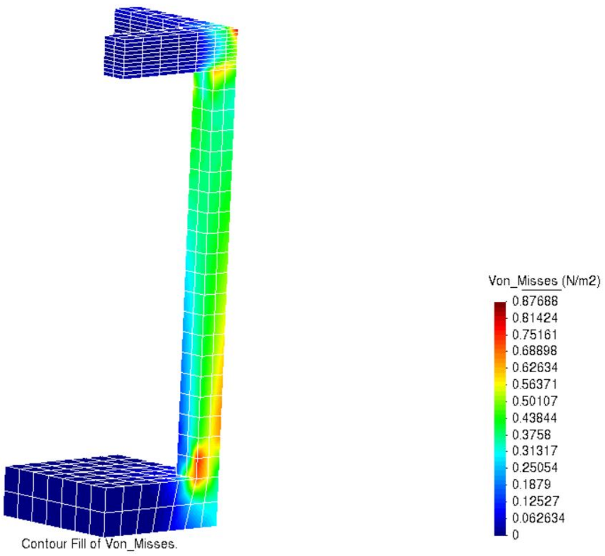
The above figures show the convergence in displacement and Von-Mises stress for both element types. In the first figure, as the number of DOF is increased, the displacement values become closer to the exact value. The 20-node elements reach very close value at a very low number of elements. In the second graph, the same behaviour appears.

$$u_z = \frac{ML^2}{2EI}$$

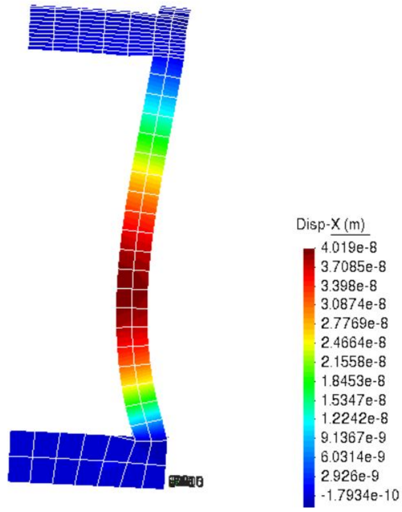
Comparing the obtained results with the exact value from beam theory, the solution using 8-node elements reaches the exact value ($u_z = 1.31e^{-}6$) with about 930 elements. However, the 20-node elements have a bit higher value than the exact result maybe due to the coarse mesh used.

3 Problem 3

In this problem, a corner column with its foundation is being studied. Symmetry is applied to the top ends since the column is part of a bigger structure. The ground is modelled once as a fixed support and once having an elastic stiffness. A load is applied at the top of the corner Column, modelled as a uniform pressure on a small surface. 8-node hexahedral elements are being used to analyze the problem having more refinement in the column itself to capture the high deformation.

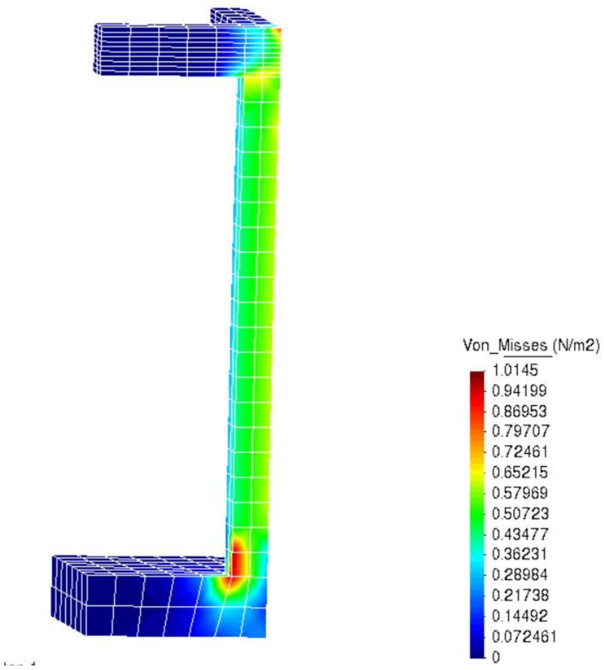


Von-Mises

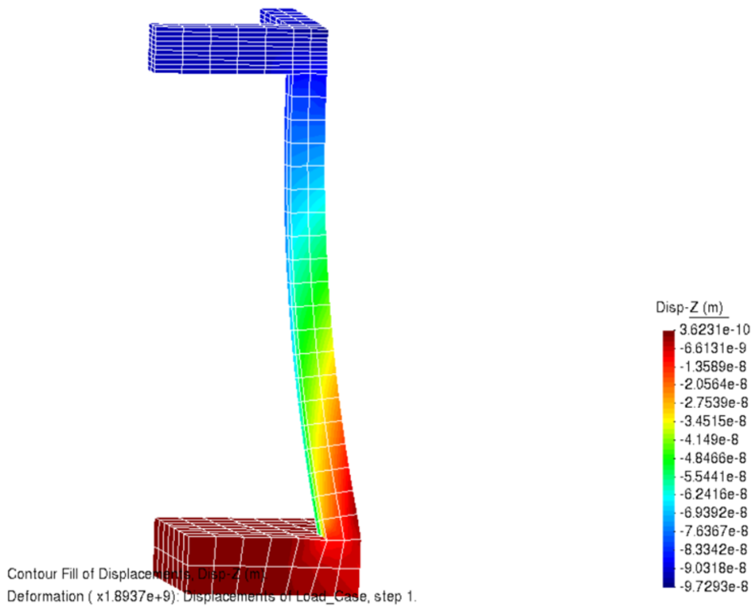


Deformation

The above figures show the results of Von-Mises stress and the deformation working with fixed ground. Due to this condition, buckling appears in the column, with the highest deformation close to the middle point. Since the vertical load is applied directly on the top surface of the column, the maximum stresses appear in the column itself.



Von-Mises



Deformation

The above figures show the results of Von-Mises stress and the deformation working with an elastic ground. Buckling appears as well but in a less severe way. That's because the slap is lifted up due to the elastic condition as shown in the z-displacement scale. The behaviour of the stresses is similar as in the previous case.