Computational Structural Mechanics & Dynamics

GID Homework 1

Malik Ali A. Dawi

Seyed MohammadReza Attar Seyedi

Mohammad Mohsen Zadehkamand

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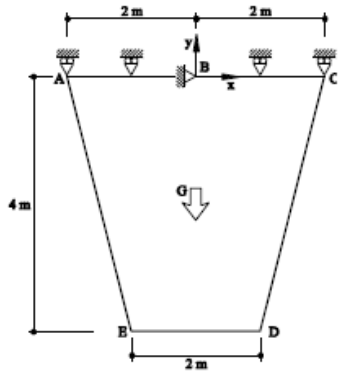
❖ Exercise-1

Analyze the thin plate shown in the figure, which is submitted to its self-weight. Compare the obtained results with the solution that is obtained when refining the mesh. Use triangular elements with 3 and 6 nodes and quadrilaterals with 4, 8 and 9 nodes.



Data

Material $\begin{cases} E = 2.1e5MPa \\ \nu = 0.30 \\ \gamma = 7000\,\frac{kg}{m^3} \\ Thickness = 0.10m \end{cases}$

Boundary conditions $\begin{cases} \text{Edge AC restricted in direction y} \\ \text{Point B restricted in direction x} \end{cases}$

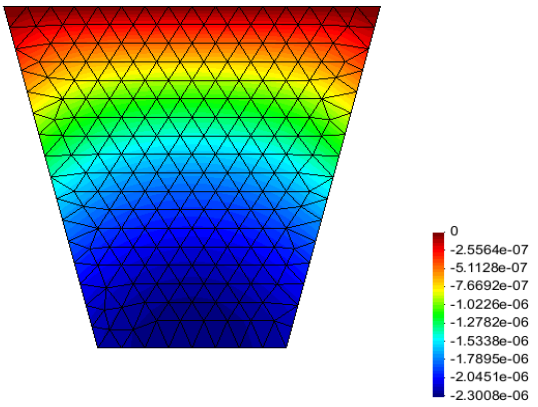


Figure 1.1- The displacement in the Y- direction with 3-noded triangular element.

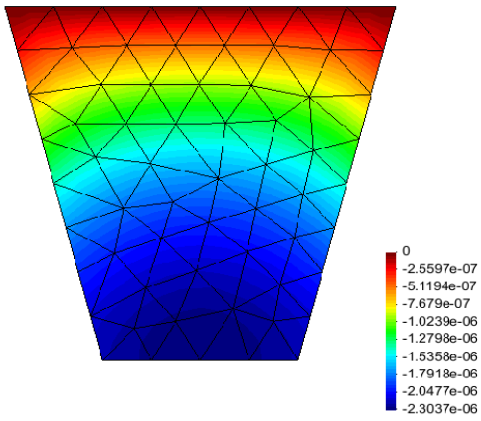


Figure 1.2- The displacement in the y-direction with 6-noded triangular element.

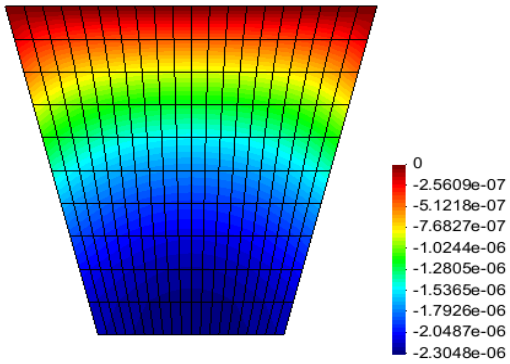


Figure 1.3- The displacement in the Y- direction with 4-noded quadrilateral element.

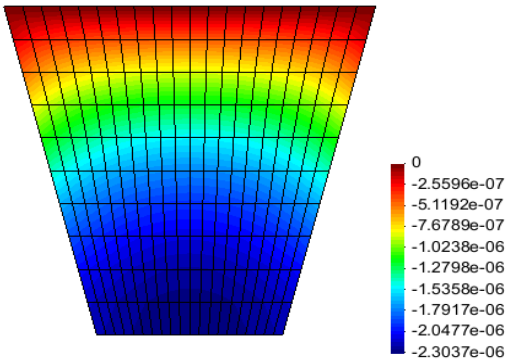


Figure 1.4- The displacement in the y-direction with 9-noded quadrilateral element

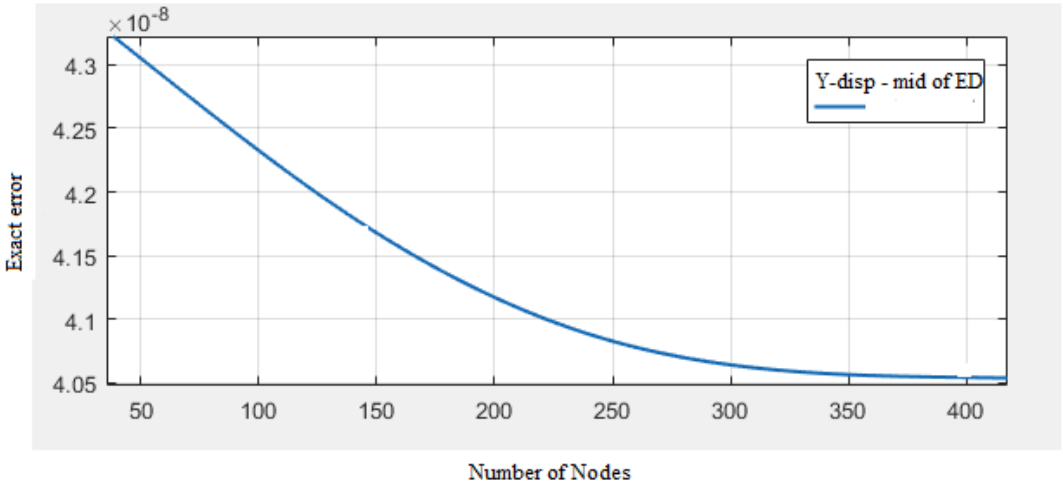
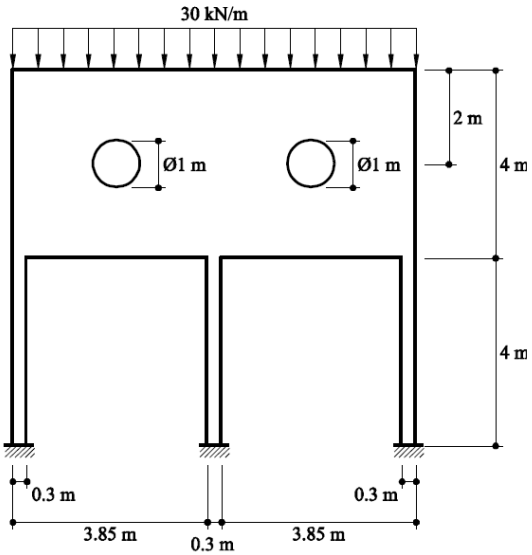


Figure 1.5- The convergence criteria using 3-noded triangular elements.

❖ Exercise-2

The structure in the figure presents a reinforced concrete plate with two holes, supported by three columns. The central column undergoes a displacement due to sag of the foundation caused by a leakage in some pipes nearby.

Analyze the distribution of the stresses that the drop of the central column produces. Assume the hypothesis of plane stress. Use triangular elements with 3 nodes for the analysis.



Data

$E = 3.0e10 \frac{N}{m^2}$

$\nu = 0.2$

$t = 0.20\,m$ (Thickness of the plate and the columns)

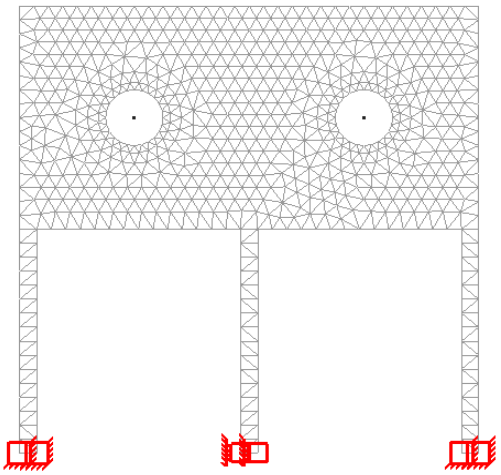


Figure 2.1- Mesh of 3-noded triangular elements. The middle column is set to be free to move in the vertical direction.

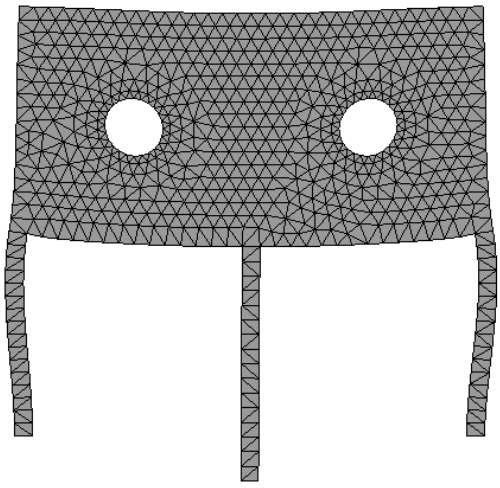


Figure 2.2- Representation of the structure after applying the load (Scale factor 1980)

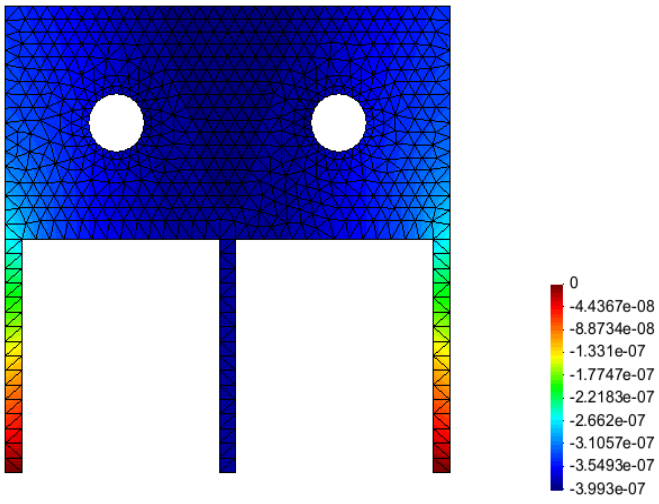


Figure 2.3- The results of the Y-direction displacement

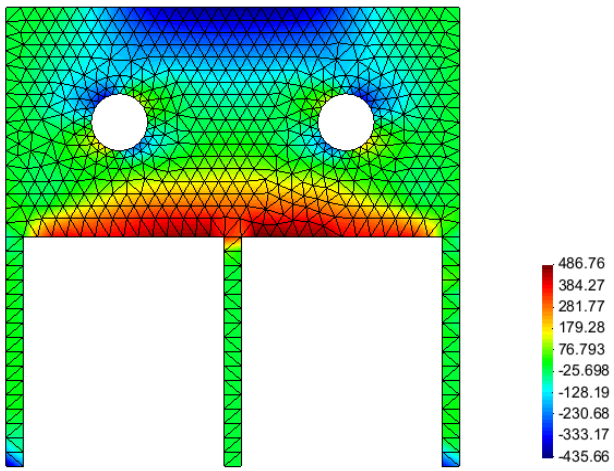


Figure 2.4- The stress distribution in the X-direction.

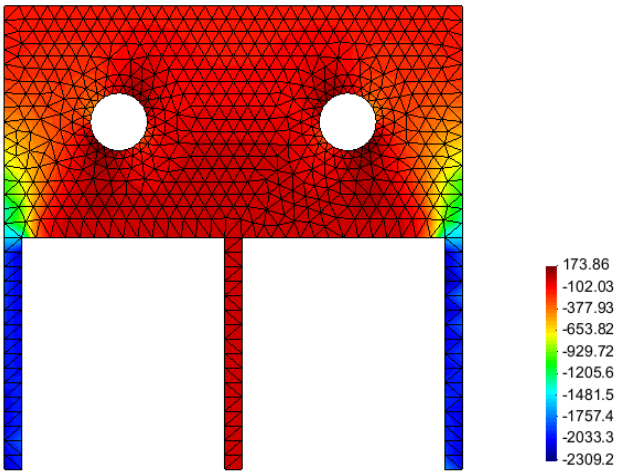


Figure 2.5- The stress distribution in the Y-direction.

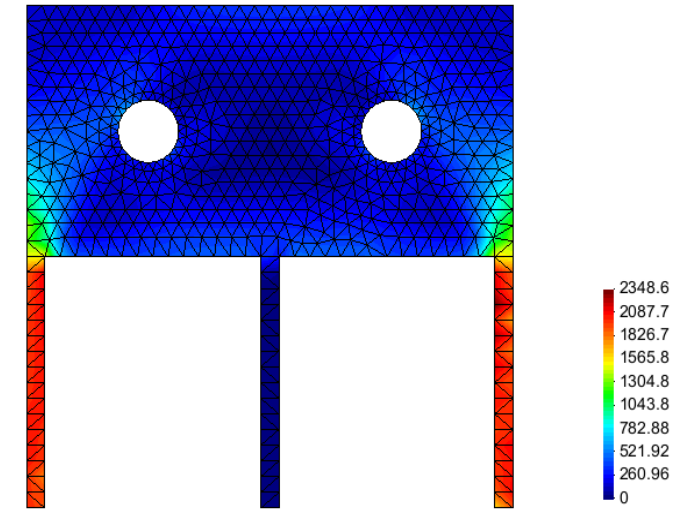


Figure 2.6- Von Mises stress distribution over the structure.

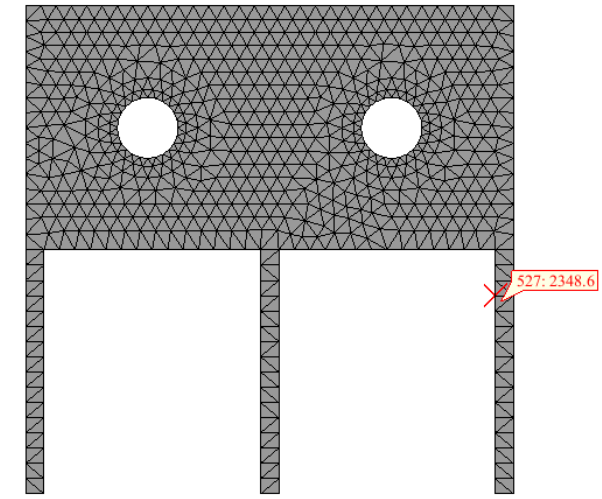
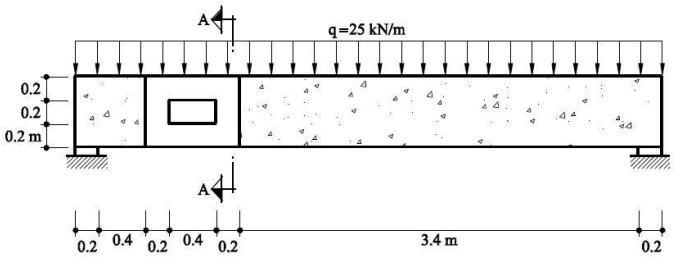
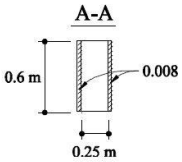


Figure 2.7- The location where the maximum Von Mises stress is located

❖ Exercise-3

The structure represents a reinforced concrete plate with simple supports. This plate possesses a hole for a ventilation pipe. This motivated the placement of a metal reinforcement sheet on both sides of the plate in the area of the hole. Analyze the state of stress in the plate and the metal reinforcement sheets. Assume the plane stress hypothesis.





$$\text{Concrete}\begin{cases} E = 3.0e10\,\frac{N}{m^2} \\ \nu = 0.2 \\ t = 0.25\,m \end{cases} \qquad \text{Steel}\begin{cases} E = 2.1e11\,\frac{N}{m^2} \\ \nu = 0.3 \\ t = 0.016\,m\ (\text{Two sheets of } 0.008m) \end{cases}$$

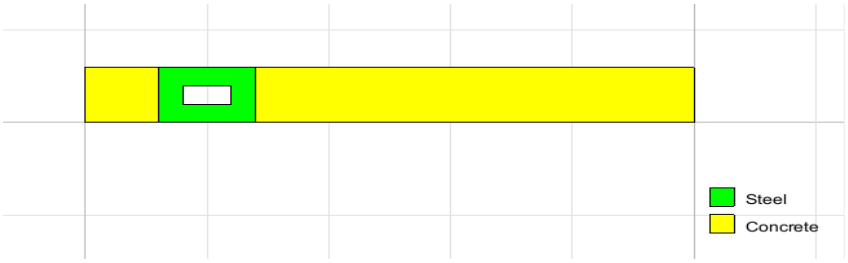


Figure 3.1- Materials.

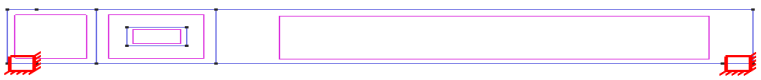


Figure 3.2- Displacement constraints.

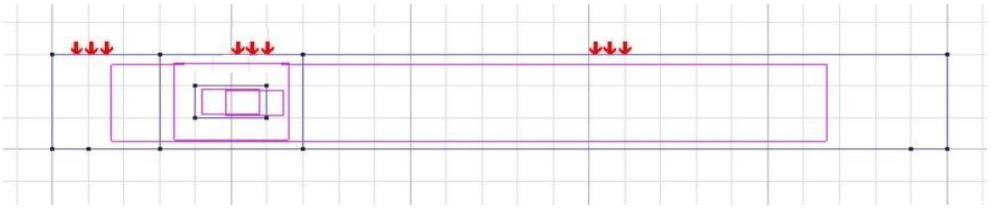


Figure 3.3- Loading.

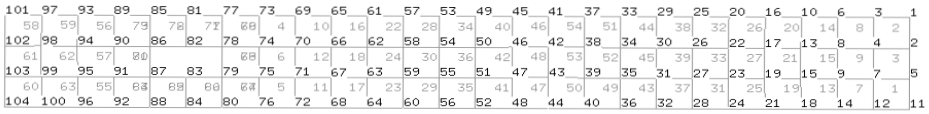


Figure 3.4- Mesh Labels.

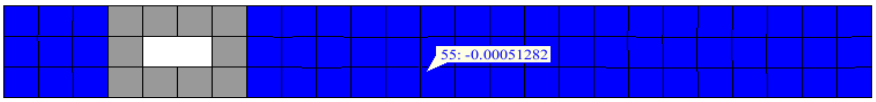


Figure 3.5- Size of mesh.

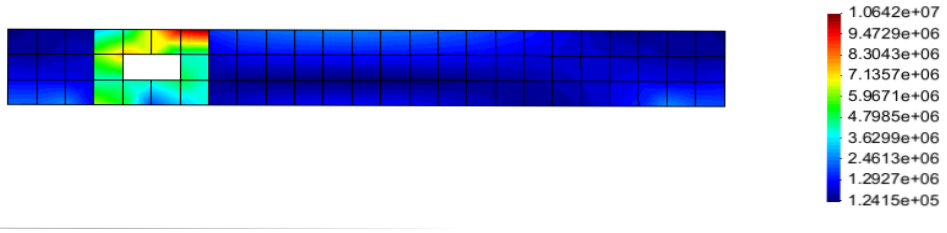


Figure 3.6- Contour for von misses stresses.

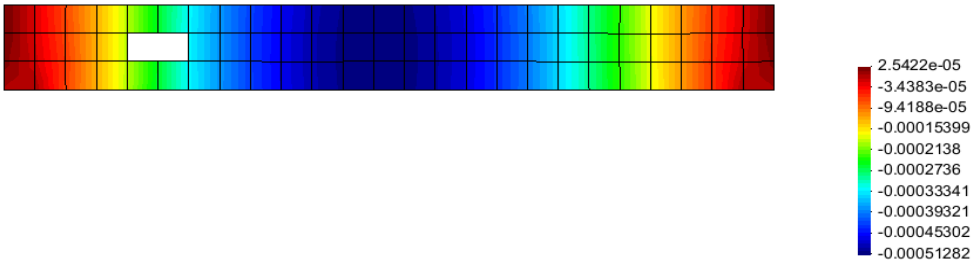


Figure 3.7- Contour for total deformation.

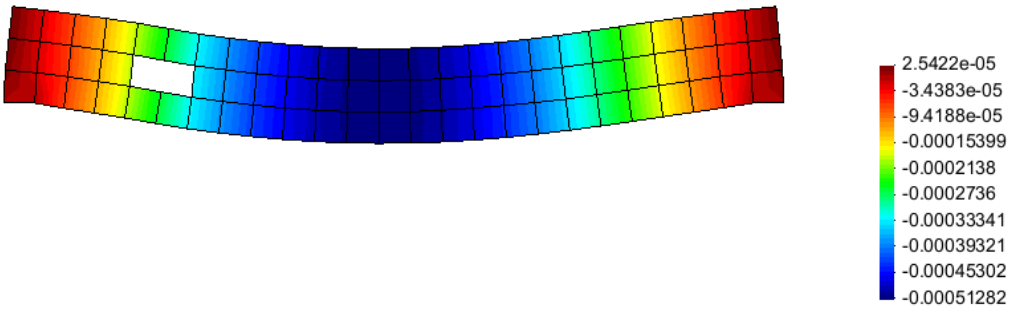
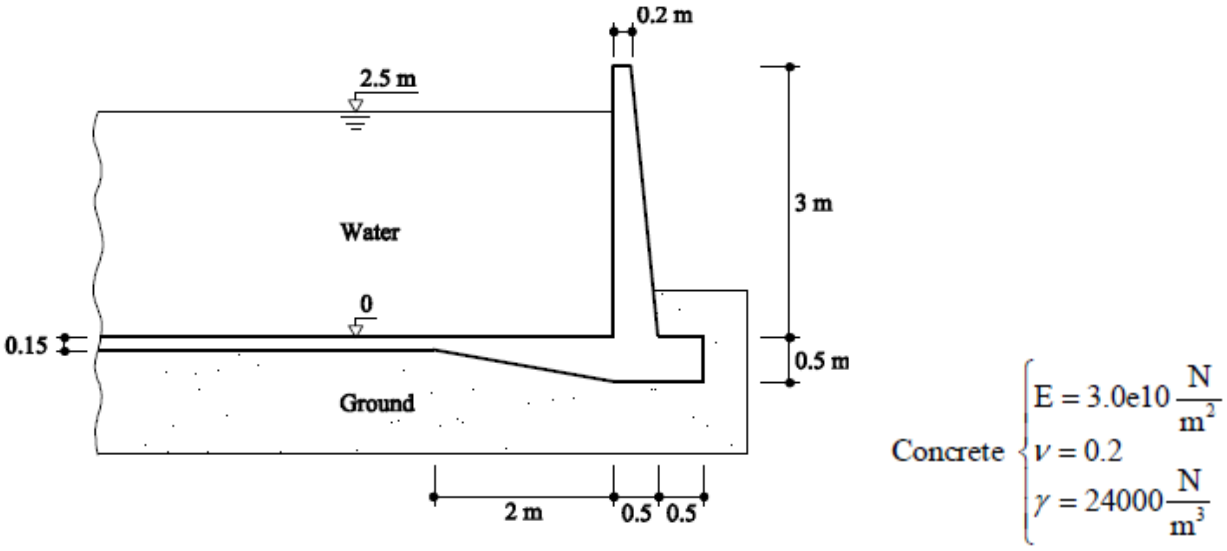


Figure 3.8- Deformed Shape.

❖ Exercise-4

The problem is about to calculation of the state of stress of the cross section of water-tank. Base slab is considered to be elastically supported by the ground (Es=50 $^{N}/_{cm^3}$).

Using hypothesis of planar deformation and input data for the material behavior, four-node quadrilateral elements has been used for modeling.



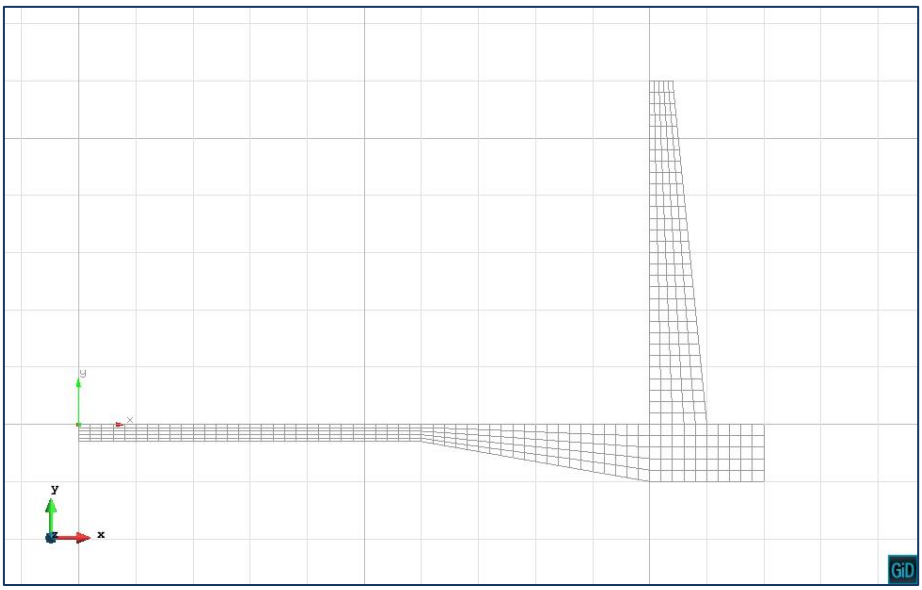


Figure 4.1- model of tank with quadrilateral mesh.

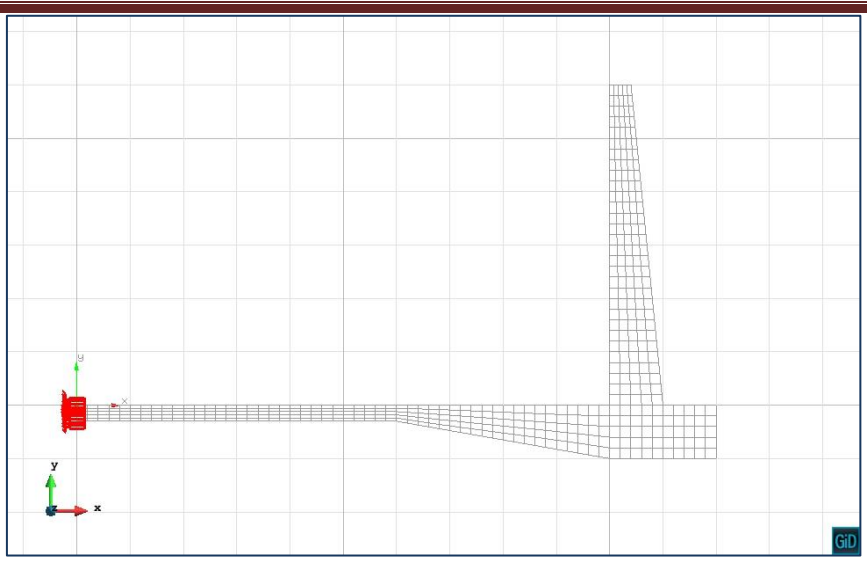


Figure 4.2- symmetric restrain for obtaining stability.

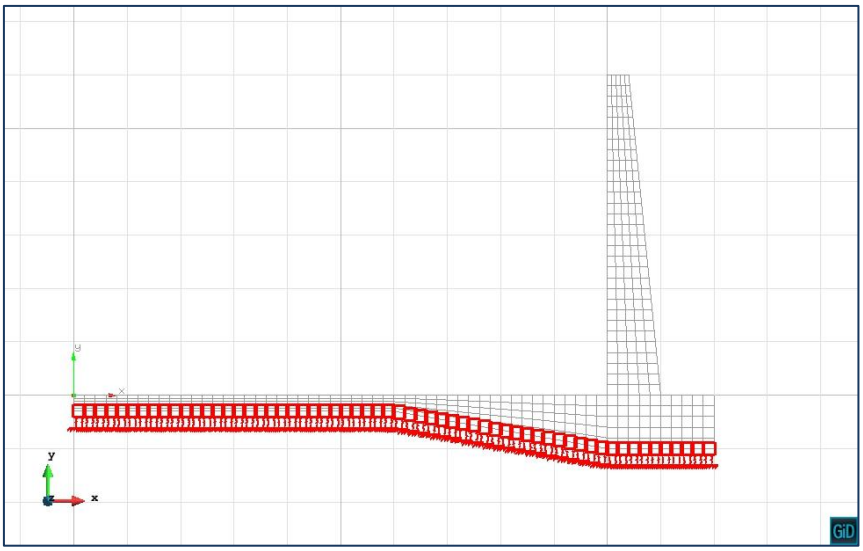


Figure 4.3- soil stiffness spring modeling.

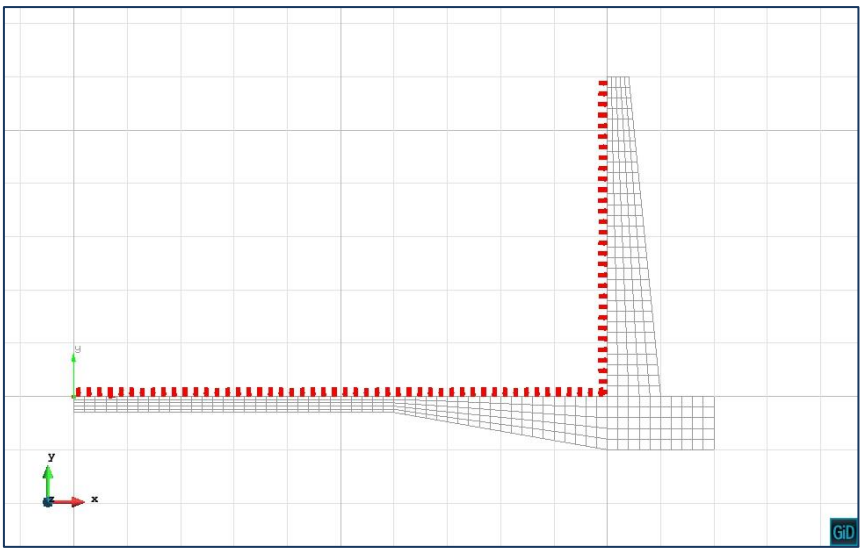


Figure 4.4- Loading assignment (uniform on bottom and gradient on water side)

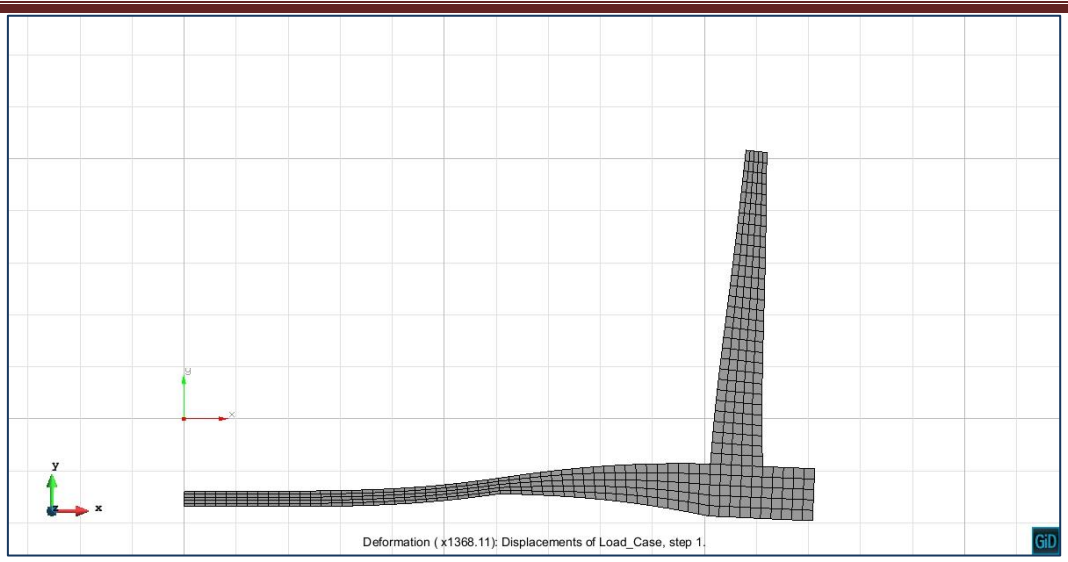


Figure 4.5- deformed shape.

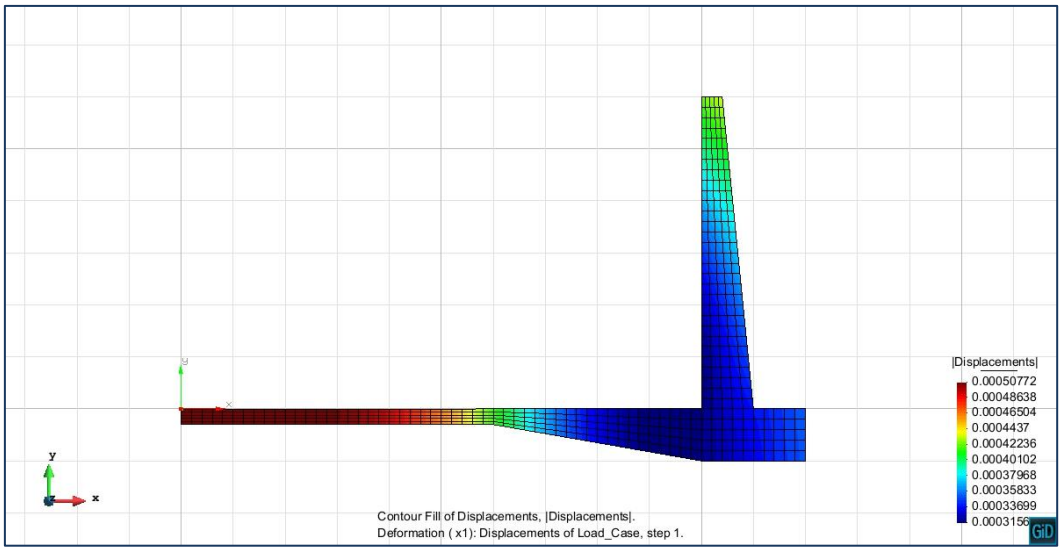


Figure 4.6- Contour for total deformation (m.).

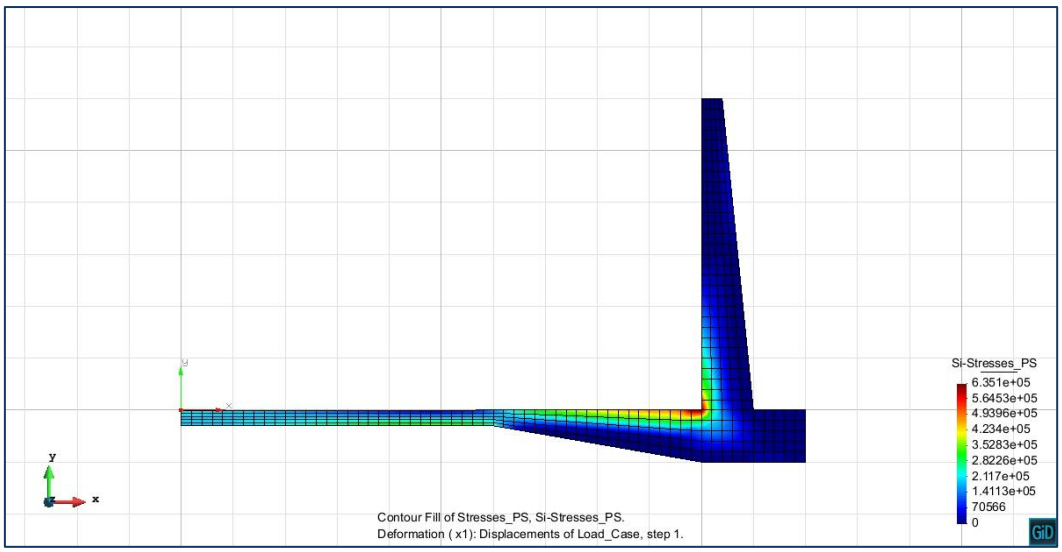


Figure 4.7- Contour for tensile stress (sigma1 – Pa.)

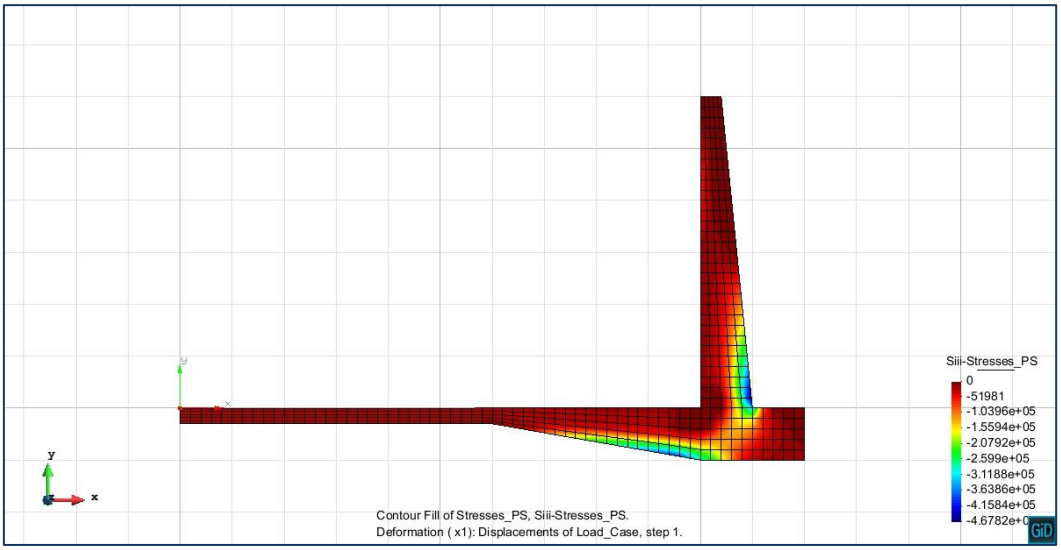


Figure 4.8- Contour for pressure stress (sigma 3 – Pa.)