Computational Structural Mechanics and Dynamics - Practice 1

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April 7th, 2016

1 Structural Analysis of a Circular Tank

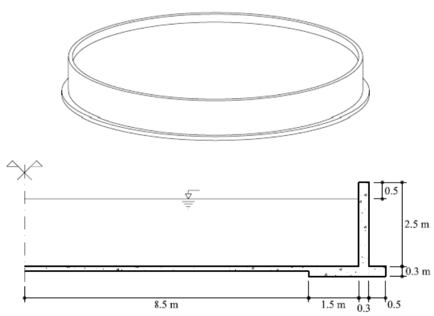


Figure 1: Problem Statement

The figure shows a circular tank made of reinforced concrete with $E = 3.0e10\frac{N}{m^2}$ and Poisson's ratio $\nu = 0.2$. It is used for the storage of water in a water purification plant. To analyse the structural behavior of the tank the problem has been simplify to a 2D problem, as it can be seen in Figure 1. So, some symmetry conditions were imposed on the left-side and also the resistance of the floor had been take into account with a Balast coefficient of $50\frac{N}{m^2}$. About the loads, two different loads were applied to represent the pressure of water. A 196200 $\frac{N}{m}$ pressure on the Y-direction but also an X-direction pressure on the right wall of the tank which increases linearly from 0 (at the level of water) until 196200 $\frac{N}{m}$ at the bottom of the tank. As requested quadrilateral elements has been used. The wight of the tank is not negligible.

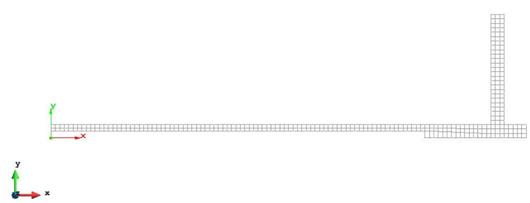
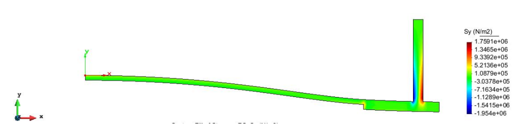
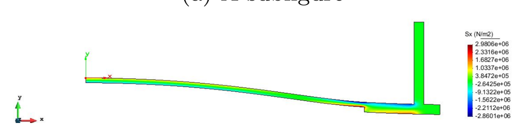


Figure 2: 2D tank's mesh

Once boundary conditions and loads were applied the simulation was run using the RAM-SERIES 2D.
On the images below we can verify that the state of the stress does not endage the tank.



(a) A subfigure



(b) A subfigure

Figure 3: A figure with two subfigures

Regarding the deformed shape and the maximum displacement we can see how important the Self-weight was as the maximum displacements occurs were the tank is heavier.

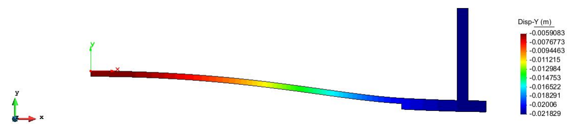


Figure 4: Deformed Shape of the tank. Y-Displacement representation.

2 Analysis of the flexion of a beam using hexahedra elements

2.1 Introduction

The beam of the Figure 5 is made of steel with Young's modulus $E = 2.1e^{11}\frac{N}{m^2}$ and Poisson's ratio $\nu = 0.2$. It is fixed in one end and on the other face there is a bending moment imposed in the model as two contrary point loads of value $P = 10000N$ at the center of the top and bottom edges. We want to study the flection of the cantilever beam using 8 and 20 noded hexahedra elements.

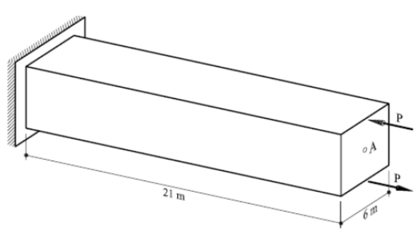


Figure 5: Problem Statement

	Nodes	Elements	Size
8-nodes	7267	6048	0.5m
20-nodes	8793	1792	0.75m

Table 1: Meshes properties.

2.2 Preprocess

The problem has been solved in the problemtype of GiD *Ramseries 3D solids*. To obtain a good shaped structured hexahedral mesh we have started the geometry from the cross section of the beam, which has been defined in two surfaces because to apply the force in the midpoint of the edges a node must be defined there. After that the cross section has been extruded along the z-axis to obtain the 3D geometry and create the 2 volumes.

Then we assigned the point loads to the mid-side nodes, as seen in Figure 6, the opposite end was restricted in all three directions and the material properties were assigned to the volumes. Finally we created two structured volume meshes (one with 8-node and the other with 20-noded hexahedra) 1.

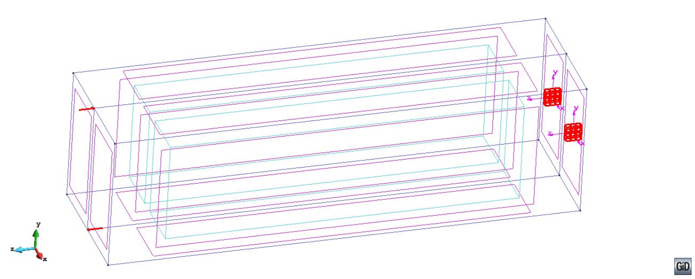


Figure 6: Geometry of the model of the cantilever beam.

After this the two projects were sent for cal-

Method	Max. y-disp	Error
Analytical	1.67 $10^{-7}m$	0m
8-noded elements	6.95 $10^{-7}m$	5.28 10 ^{-7}m
20-nodes elements	7.67 $10^{-7}m$	6.00 $10^{-7}m$

Table 2: Caption

culations using Ramseries 3D solids.

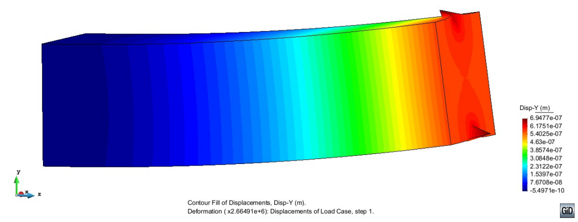
2.3 Results

The first thing we realise from the deformed geometries is that the point forces applied to force the moment at the end of the beam produces a concentrated displacement (7a and 7b). This behaviour doesn't correspond with the continuous solution of the beam theory where the moment is applied in all the surface, not in two points as in the model.

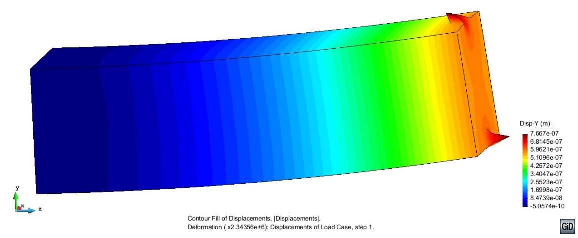
To check the results obtained with the models we have calculated the analytical solution of the vertical displacement of a beam with a moment at the end, which is given by the expression (1):

$$w_{max} = \frac{ML^2}{2EI} \tag{1}$$

The comparison of y-displacements between the different meashes and analytical ones is shown in Table **??**. There we can see that the error is of order $10^{-7}m$ what for a so small displacement is quite large.



(a) Displacements of the 8-nodes mesh.



(b) Displacements of the 20-nodes mesh.

Figure 7: Displacements in the y asix of the beam for the different meshes.

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3 Foundation of a corner column

3.1 Introduction

We have studied the effect of the self weight and a specific load on the foundation of the next corner column:

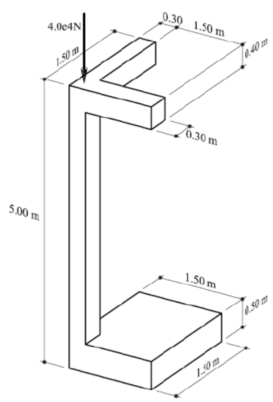

Figure 8: Problem Statement

3.2 Preprocess

It is remarkable that the load has been implemented into the problem as 16 punctual loads located on the nodes of the square area where the load is acting in the problem statement image. We have done this because the option "Uniform pressure" of the software was not working properly (It would have been easier to use). Our solid has been done using hexaedrons of 8 nodes each one, up to 1800 elements in the full model.

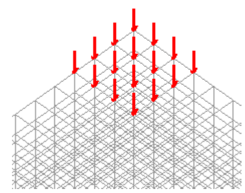

Figure 9: Load distribution and mesh

3.3 Results

After some runs, we can extract some conclusions from the results:

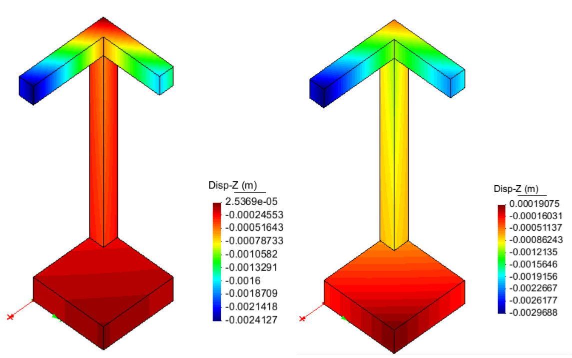

Figure 10: Displacement Fields: No load/Loaded

Subcase	Max Displacement
Not Loaded	-0.0024127
Loaded	-0.0029688

We can see that the displacement field is slightly different for the two cases. When loaded, we get displacement in the central part of the column, whereas in the not loaded case that area remained almost in the same place. However, the load is not an issue in this problem. The main issue is the momentum caused by the weight of the supports. If we analyse the stress field - first principal stress because of the fragile materials failure theory - we can appreciate that this momentum affects directly the area of the column that can be seen in the image. This area should be reinforced or at least studied further so it does not break during the life of our structure.

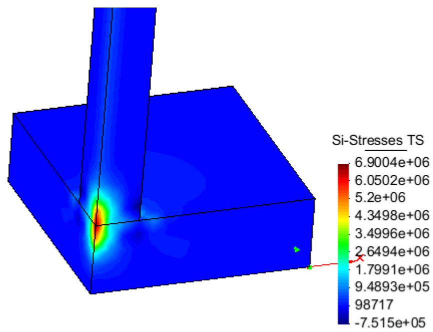

Figure 11: 1st principal stresses distribution