# UNIVERSITAT POLITÈCNICA DE CATALUNYA


**Master on Numerical Methods in Engineering**

# PRACTICE 3 (SOLUTION)

Subject: Computational Structural Mechanics and dynamics

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# 1. Exercise 1: Clamped plate with a uniform load

## 1.1. Geometry

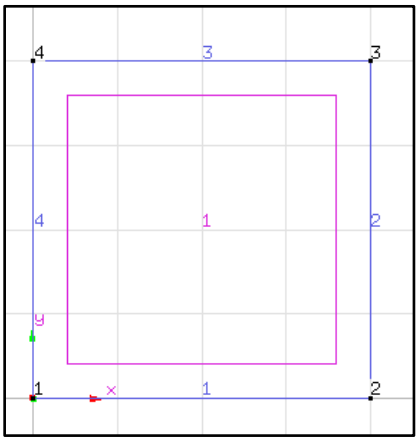


**Figure 1 : Geometry of the structure.**

## 1.2. Data

1.2.1.***Problem Type:*** Planes.

1.2.2.***Boundary conditions:*** The types of boundary conditions are the following:

- Displacements Constraints / Point Constraints: Movement in the directions Z, Thetax and Thetay y is prevented along lines 1, 2, 3 and 4 of the geometry.

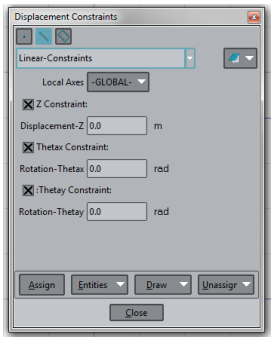


**Figure 2: Displacements Constraints.**

1.2.3.***Material***: The material with the following mechanical characteristics.

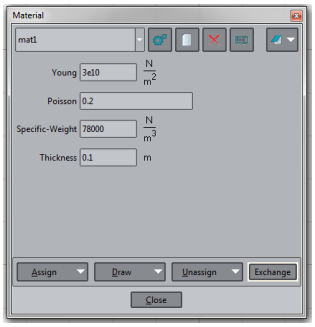


**Figure 3: Material.**

1.2.4.***Problem Data***: In this problem not consider self-weight.

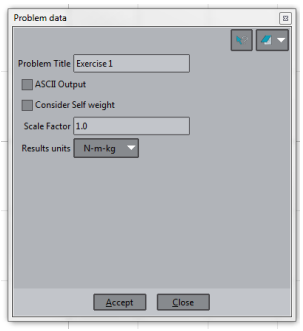


**Figure 4: Problem Data.**

1.1.1.***Loads***: In this problem following load consider to surface 1.

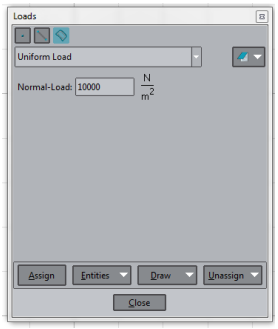


**Figure 5: Load.**

1.1.2.***Meshing***: The meshes are generated of element type: triangles (Normal and Quadratics type) and quadrilaterals (normal type).

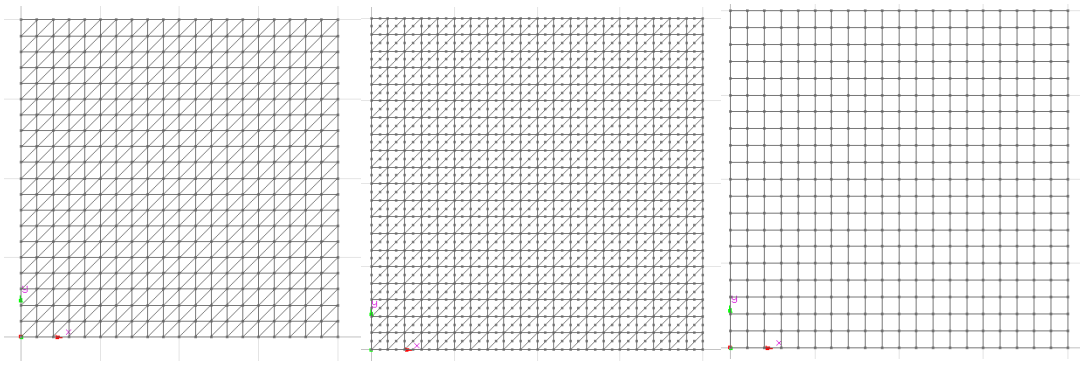

**Figure 6: Meshes of triangles and quadrilaterals.**

## 1.3. Processing

Once the mesh is generated, we proceed to calculate the problem for the different meshes proposed.

## 1.4. Post-process:

The following figures show the results:

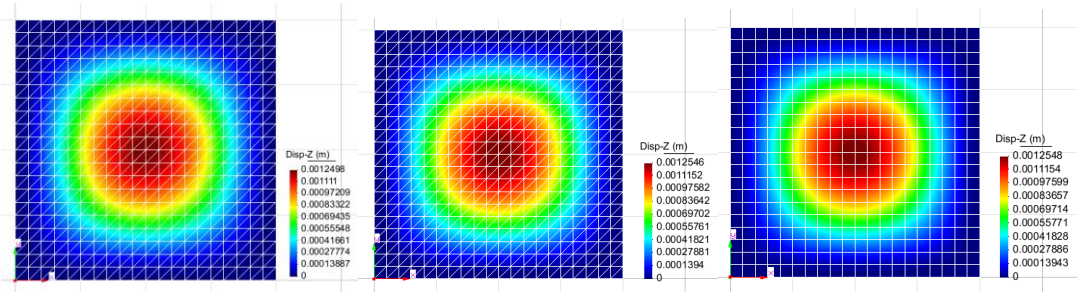


**Figure 7: Diagram of the displacement Z for the different meshes proposed.**

The displacement in the center of the plate calculated analytically is given by $0.00126\,qL^4/D$ , where $D = Et^3/(12(1-\upsilon^2))$. The comparison of the displacement z for the proposed meshes is shown in table 1.

| Element type | # nodes | # elem. | Displac. Z in the centre [m] | Error Displ. % |
|---|---|---|---|---|
| Triangle with 3 nodes | 441 | 800 | 1.25E-03 | 0.90 |
| Triangle with 6 nodes | 1681 | 800 | 1.25E-03 | 1.29 |
| Quadrilateral with 4 nodes | 441 | 400 | 1.25E-03 | 1.31 |
| Analytic | - | - | 1.24E-03 | 0.00 |

**Table 1: Displacement Z in the center.**

# 2. Exercise 2: Thin plate with internal hole

## 2.1. Geometry

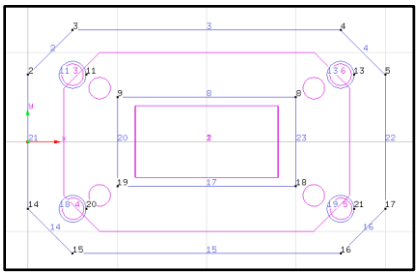

**Figure 8 : Geometry of the structure.**

## 2.2. Data

2.2.1.***Problem Type:*** Planes.

2.2.2.***Boundary conditions:*** The types of boundary conditions are the following:

- Elastic Constraints / Point Constraints: Elastic in the directions Z is applied on surfaces 3, 4, 5 and 6 of the geometry.

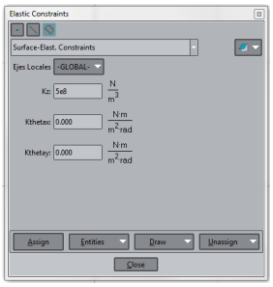


**Figure 9: Elastic Constraints.**

2.2.3.***Material***: The material with the following mechanical characteristics.

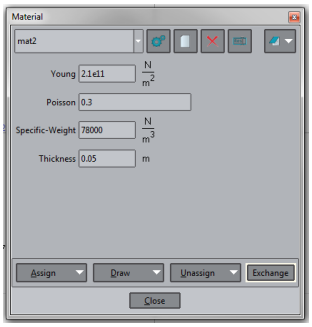


**Figure 10: Material.**

2.2.4.***Problem Data***: In this problem consider self-weight.

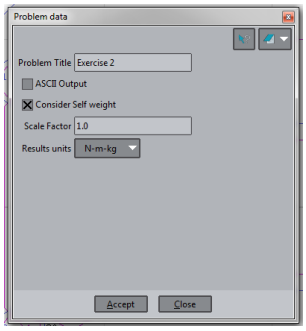


**Figure 11: Problem Data.**

1.1.3.***Loads***: In this problem following load consider to surfaces 2, 3, 4, 5 and 6.

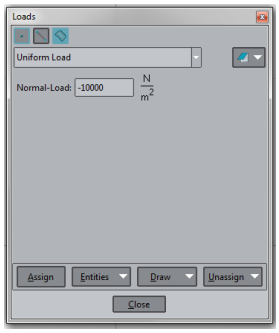


**Figure 12: Load.**

1.1.4.***Meshing***: The meshes are generated of element: triangles (normal type). Mesh with 4624 nodes and 8834 elements.

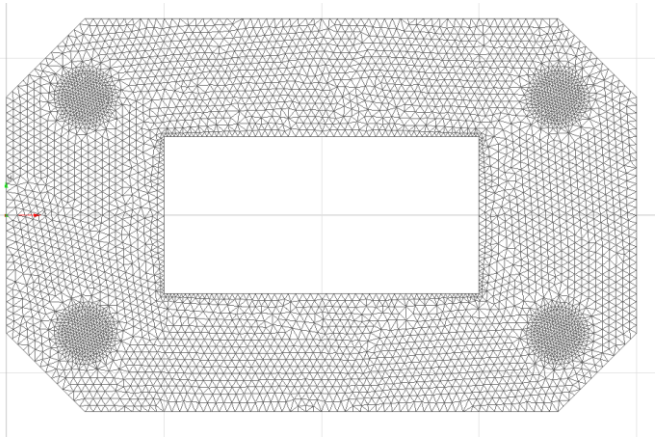

**Figure 13: Meshes of triangles.**

## 2.3. Processing

Once the mesh is generated, we proceed to calculate the problem for mesh proposed.

## 2.4. Post-process:

The following figures show the results:

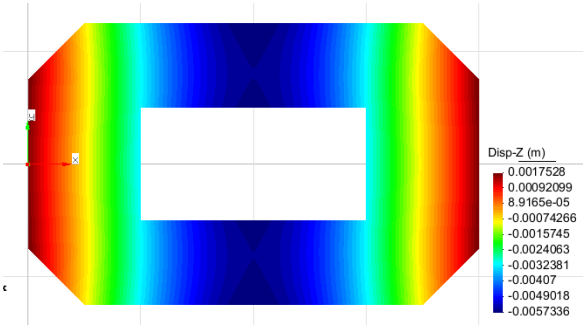


**Figure 14: Diagram of the displacement Z.**

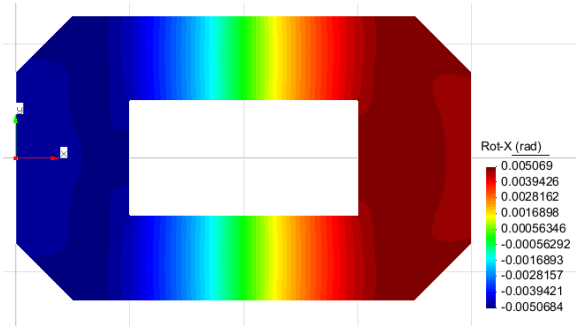


**Figure 15: Diagram of the rotation X.**

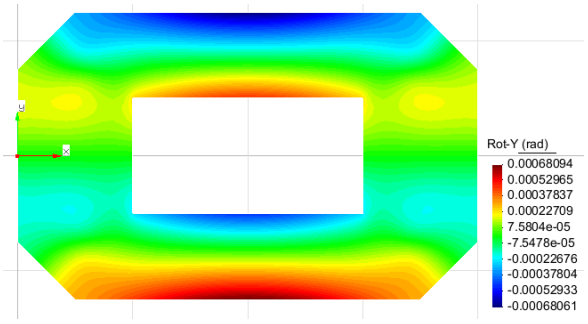


**Figure 16: Diagram of the rotation Y.**

# 3. Exercise 2: Thick circular plate with internal hole

## 3.1. Geometry

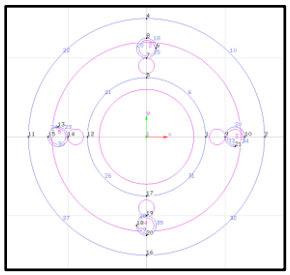

**Figure 17 : Geometry of the structure.**

## 3.2. Data

3.2.1.***Problem Type:*** Planes.

3.2.2.***Boundary conditions:*** The types of boundary conditions are the following:

- Elastic Constraints / Point Constraints: Elastic in the directions Z is applied on surfaces 2, 3, 4 and 5 of the geometry.

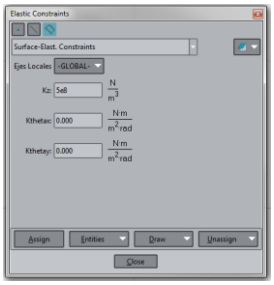


**Figure 18: Elastic Constraints.**

3.2.3.***Material***: The material with the following mechanical characteristics.

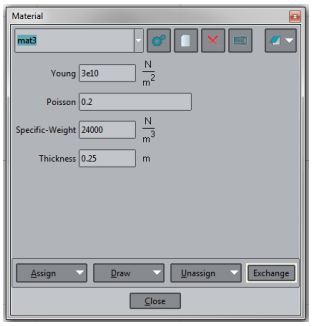


**Figure 19: Material.**

3.2.4.***Problem Data***: In this problem consider self-weight.

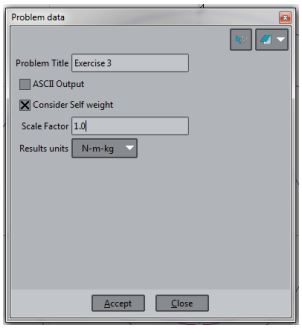


**Figure 20: Problem Data.**

1.1.5.***Loads***: In this problem following load consider to surfaces 1,2,3,4 and 5.

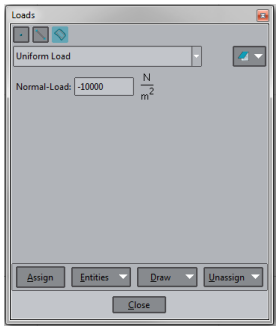


**Figure 21: Load.**

1.1.6.***Meshing***: The meshes are generated of element: triangles (Quadratic type). Mesh with 4060 nodes and 1894 elements.

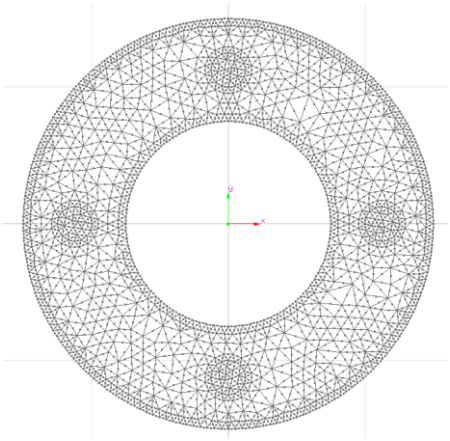

**Figure 22: Meshes of triangles.**

### 3.3. Processing

Once the mesh is generated, we proceed to calculate the problem for mesh proposed.

### 3.4. Post-process:

The following figures show the results:

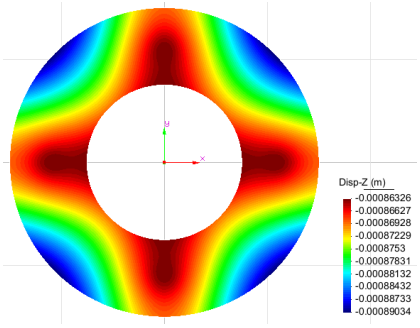


**Figure 23: Diagram of the displacement Z.**

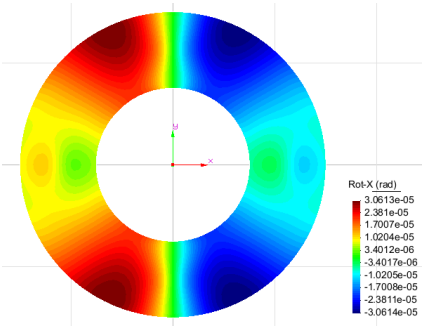


**Figure 24: Diagram of the rotation X.**

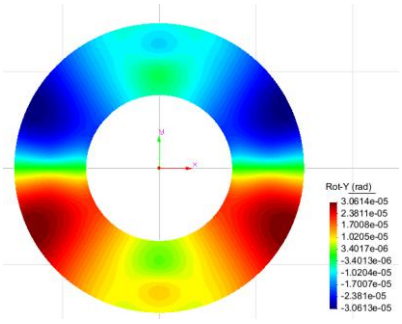


**Figure 25: Diagram of the rotation Y.**

# 4. References

[1] C.E. İmrak and İ. Gerdemeli , “An Exact Solution for the Deflection of a Clamped Rectangular Plate under Uniform Load”

[2] Example 1

[3] COMPASS, RamSeries tutorial.