UNIVERSITAT POLITÈCNICA DE CATALUNYA



Master on Numerical Methods in Engineering

PRACTICE 3 (SOLUTION)

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1. Exercise 1: Clamped plate with a uniform load

1.1. Geometry

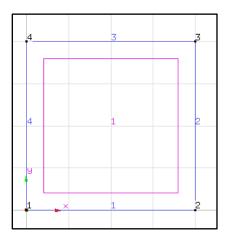


Figure 1 : Geometry of the structure.

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.

Displacement Constraints 🛛 🔤
Linear-Constraints
Local Axes -GLOBAL-
X Constraint:
Displacement-Z 0.0 m
Thetax Constraint:
Rotation-Thetax 0.0 rad
:Thetay Constraint:
Rotation-Thetay 0.0 rad
Assign Entities Draw Vunassigr V
Close

Figure 2: Displacements Constraints.

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

Material mat1	
Young 3e10	$\frac{N}{m^2}$
Poisson 0.2	
Specific-Weight 78000	$\frac{N}{m^3}$
Thickness 0.1	m
Assign	Draw V Unassign V Exchange
	Close

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.

Loads				8
Uniform Load	1			<u>-</u>
Normal-Load	10000] <u>N</u> m ²		
Assign	<u>E</u> ntities 🗸	<u>D</u> raw	- Unas	isign 🚽
	2	lose		

Figure 5: Load.

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

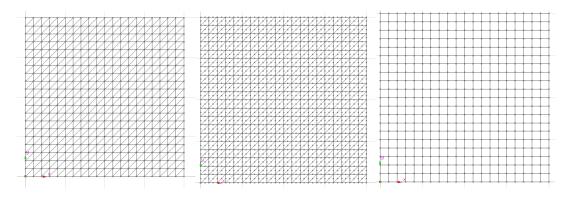


Figure 6: Meshes of triangles and quadrilaterals.

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:

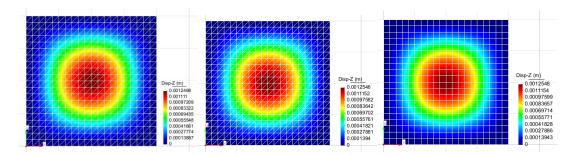


Figure 7: Diagram of the displacement Z for the different meshes proposed.

The displacement in the center of the plate calculated analytically is given by $0.00126 \ qL^4/D$, where $D = Et^3/(12(1-v^2))$. 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

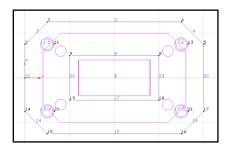


Figure 8 : Geometry of the structure.

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.

Elestic Constraints		_	(
Surface-Elest. Constraints		-	4
Ejes Locales -GLOBAL-]		
Ka: Se8) <u>N</u> m ³		
Kthetax 0.000	Nm m ² rad		
Kthetay: 0.000	$\frac{Nm}{m^2 rad}$		
Assign	s <u>D</u> raw		nassign 🔍
	Close		

Figure 9: Elastic Constraints.

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

Material	•
mat2	· 💣 📋 🗙 📼 🖉 🗸
Young 2.1e11] <u>N</u> m ²
Poisson 0.3	
Specific-Weight 78000	$\left[\frac{N}{m^3}\right]$
Thickness 0.05] m
Assign Draw	Unassign Exchange

Figure 10: Material.

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

Problem data		
		😢 🖉 🗸
Problem Title	Exercise 2	
ASCII Out	put	
X Consider	self weight	
Scale Factor	1.0	
Results units	N-m-kg 🔍	

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.

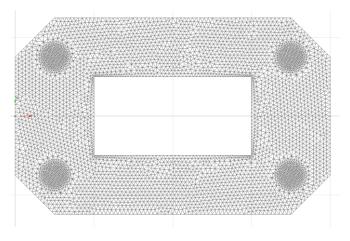


Figure 13: Meshes of triangles.

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:

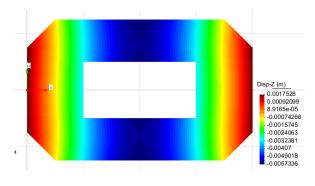


Figure 14: Diagram of the displacement Z.

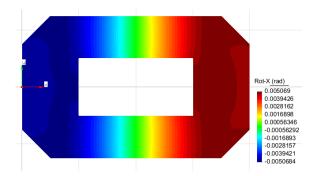


Figure 15: Diagram of the rotation X.

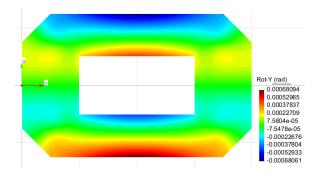


Figure 16: Diagram of the rotation Y.

3. Exercise 2: Thick circular plate with internal hole

3.1. Geometry

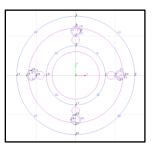


Figure 17 : Geometry of the structure.

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.

- 🖸 🛇				
Surface-Elast. Co	onstraints		•	
Ejes Locales •G	ILOBAL-			
Ka: Sel	8 <u>N</u>			
Kthetac 0.0	$\frac{N_1}{m^2}$			
Kthetay: 0.0	$\frac{N_{1}}{m^{2}r}$			
Assign	Entities	Draw	<u>U</u> n	assign 📃
		Close		

Figure 18: Elastic Constraints.

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

Material	<u>0</u>
mat3	
Young 3e10	$\frac{N}{m^2}$
Poisson 0.2	
Specific-Weight 24000	$\frac{N}{m^3}$
Thickness 0.25	m
Assign Drav	v V Unassign V Exchange
	Close

Figure 19: Material.

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

Problem data		
Problem Title	put 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.

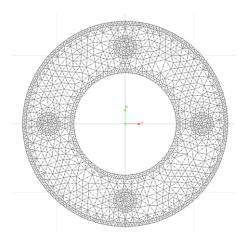


Figure 22: Meshes of triangles.

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:

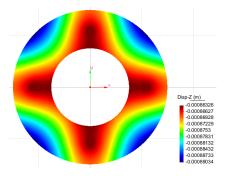


Figure 23: Diagram of the displacement Z.

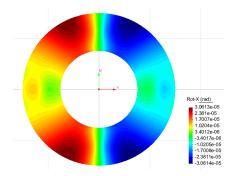


Figure 24: Diagram of the rotation X.

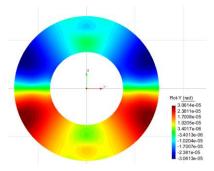


Figure 25: Diagram of the rotation Y.

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.