CalculiX Simulation

For

Circular Plate Bending

Version 1.0

Published: January 9, 2022

Table of Contents

Revision history

Version Number	Comments
1.0	Original Publication

Special things to learn:

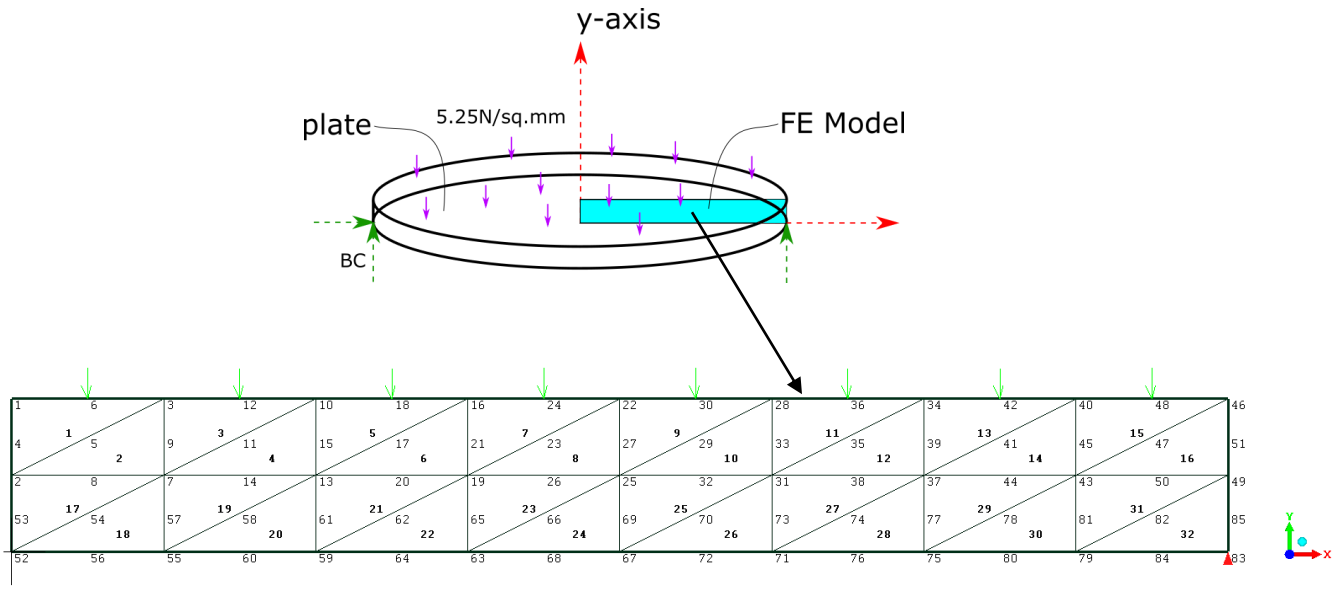
- Generating surfaces and applying a pressure load to the surface
- Using axisymmetric elements (CAX6)

1. Project Description

The project pertains to the simulation of a simply supported circular plate with radius 80mm and thickness 10 mm subjected to a uniform pressure load of 5.25 N/mm^2. The results are compared with an analytical solution.

2. Model Description

The plate is modeled using axisymmetric elements such that a section of the plate is considered as a model as shown below.



3. Material Data

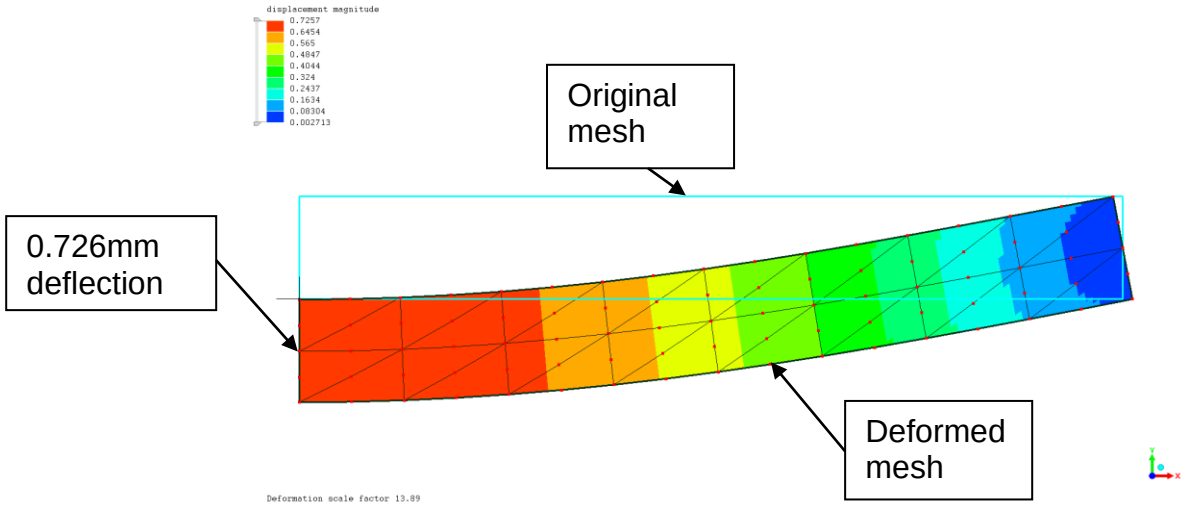
We are using Steel as or material

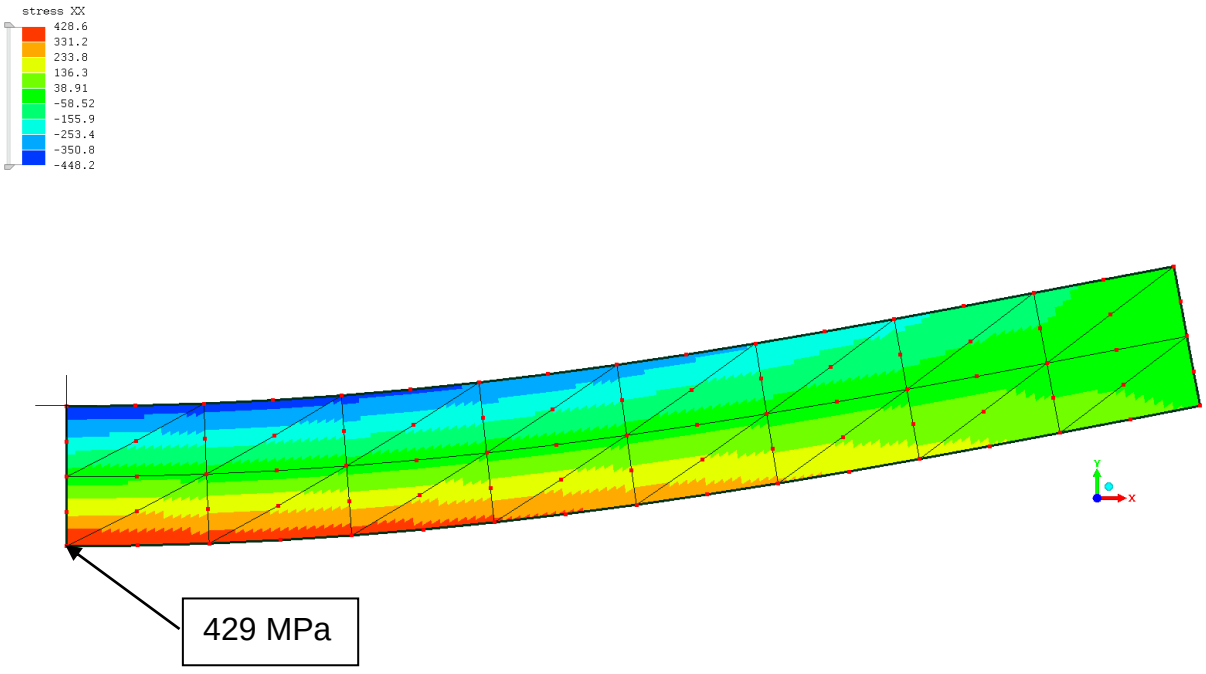
$$E = 210 \times 10^3 MPa$$

$$\nu = 0.3$$

4. Simulation results

The simulation results are shown below



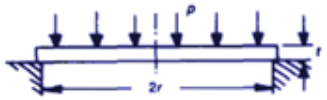


5. Hand calculation

Circular plate under uniform load

r = radius of circular plate, (m, in)
p = uniform loading, (N/m^2, lbs/in^2)
v = Poisson's ratio (assumed to be 0.3)
E = Young's modulus, (N/m^2, lbs/in^2)
t = plate thickness, (m, in)
σ_m = maximum stress, (N/m^2, lbs/in^2)
y_m = maximum deflection, (m, in)

Circular plate, uniform load, edges simply supported equation and calculator.



Stress At Center

$$\sigma_m = \frac{3(3+v)pr^2}{8t^2} = \frac{1.238pr^2}{t^2}$$

Deflection at center, v = 0.3

$$y_m = \frac{(5+v)pr^4}{64(1+v)D} = \frac{0.696pr^4}{Et^3}$$

D = flexural rigidity= $Et^3/(12 * (1 - v^2)$

Inputs

$$p := 5.25 \frac{N}{mm^2}$$

$$t := 10\ mm$$

$$E := 210\ GPa$$

$$r := 80\ mm$$

Results

$$y_m := \frac{0.696 \cdot p \cdot r^4}{E \cdot t^3} = 0.7127\ mm$$

$$\sigma_{max} := \frac{1.238 \cdot p \cdot r^2}{t^2} = 415.968\ MPa$$

6. Conclusion

The plate was successfully modeled and the simulation and hand calculations are very close.

Modeling approach	Deflection (mm)	Stress (MPa)
Simulation	0.726	429
Hand calculation	0.713	416

7. Appendix

```
**
**   Structure: disk under uniform load modeled with
**   CAX6 elements
**
*NODE,NSET=Nall
1,0.00000e+01,1.00000e+01,0.00000e+01
...
85,8.00000e+01,2.50000e+00,0.00000e+01
*ELEMENT,TYPE=CAX6,ELSET=Eall
1,1,2,3,4,5,6
...
32,49,79,83,82,84,85
*Elset, elset=TOPELEMENTS, generate
1,15,2
*SURFACE, TYPE=ELEMENT, NAME=TOPSURFACE, internal
TOPELEMENTS, S3
*BOUNDARY
83,2,2
*MATERIAL,NAME=EL
*ELASTIC
210000.,.3
*SOLID SECTION,ELSET=Eall,MATERIAL=EL
0.01
**
*STEP
*STATIC
*Dload
TOPSURFACE, P, 5.25
*NODE PRINT,NSET=Nall
U
*EL PRINT,ELSET=Eall
S
*NODE FILE
U
*EL FILE
S
*END STEP
```