UNIVERSITY OF SCIENCE AND TECHNOLOGY OF HANOI

BACHELOR OF SPACE SCIENCE AND SATELLITE TECHNOLOGY

DEPARTMENT OF SPACE AND APPLICATIONS

MIDTERM PRODUCT DESIGN II

Duong Thu Phuong
22BI13362

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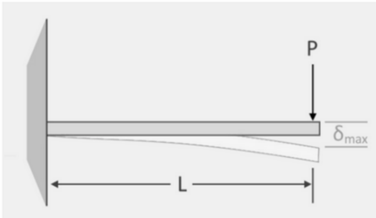
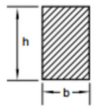
0.1 Problem

Consider the cantilever beam L = 1.2 (m), as shown in the Figure. The beam is fixed at one end. The beam undergoes static deflection by a load P = 15 (kN); rectangular cross section of the beam b = 45(cm), h = 20(cm), and the beam is made of aluminum. Young's modulus of the aluminum E = 70000 (MPa), Poisson's ratio ν = 0.3.





Using Abaqus in 1D:

- Calculate the maximum deflection of the beam. Compare with the different mesh (coarse, medium and small) and analytical solution.
- Determine the maximum moment and maximum shear force.
- Determine the maximum value of compressive stress and tensile stress.
- Do again question 1) in 3D with about 500-1000 elements.

0.2 Solution

0.2.1 Calculate the analytical result and compare with difference mesh

Using formula:

$$I = \frac{bh^3}{12}$$
$$\delta_{max} = \frac{PL^3}{3EI}$$

Steps:

- Create part: 2D, wire $\rightarrow$ draw a line, set dimension = 1.2 (unit is M in this case)
- Create material: mechanical/ elastic, Young's modulus E = 70000 (MPa), Poisson's ratio $\nu = 0.3$
- Create section: beam, rectangular, type in b, h
- Assign Beam Orientation
- Create instance
- Create step: static, general
- Create load: concentrated (0, -1000) at end point
- Create boundary: Symmetry/Antisymmetry$\rightarrow$ ENCASTRE (U1=U2=U3=UR1=UR2=UR3=0)
- Create Mesh: by number 100
- Run job
- Create new mesh: by number: 1000
- Run job
- Create new mesh: by number 10000
- Run job
- Get data
- Compare with analytical result by calculating error with formula:

$$error = \frac{Analytical - Numerical}{Analytical}$$

0.2.2 Determine the maximum value of compressive stress and tensile stress and where are these positions located

- To determine the maximum stress we open the S mises in the result
- Look at the number and graph

0.2.3 Do almost the same as previous.

- Create part: 3D
- Section: solid, homogenous
- Create mesh
- Use reference point
- Create set as a node on the point, create another set as a geometry on the edge
- Constrain it as coupling
- Load the force to the point (so now it will be distributed)
- Run the job
- Repeat for difference mesh

UNIT:

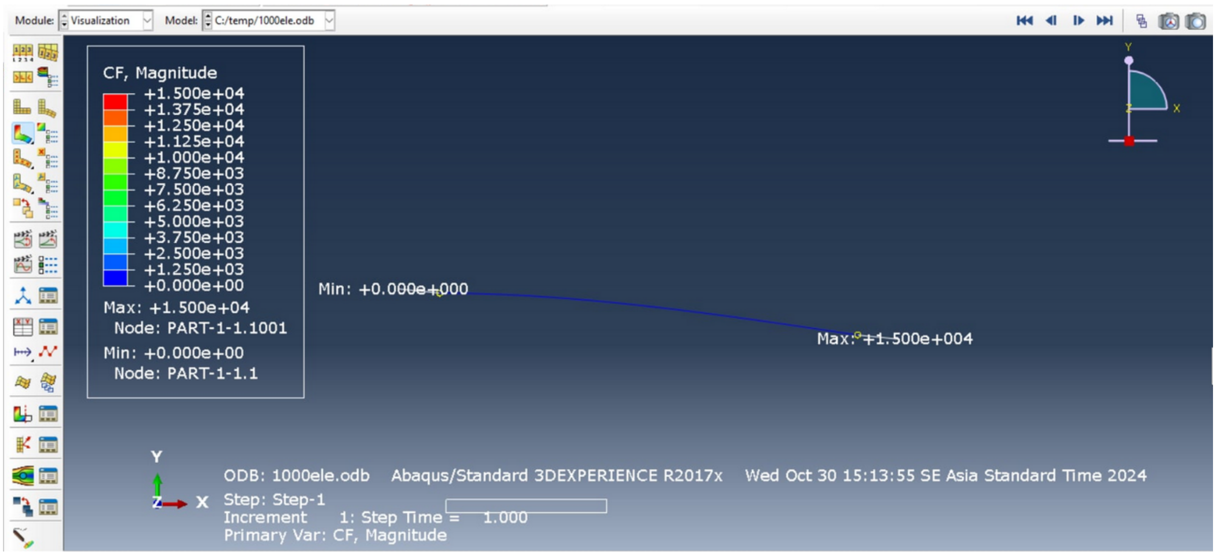
- Dimension: m
- Young modulus: Pa
- Bending moment: Nm
- Shear force: N
- Stress: Pa

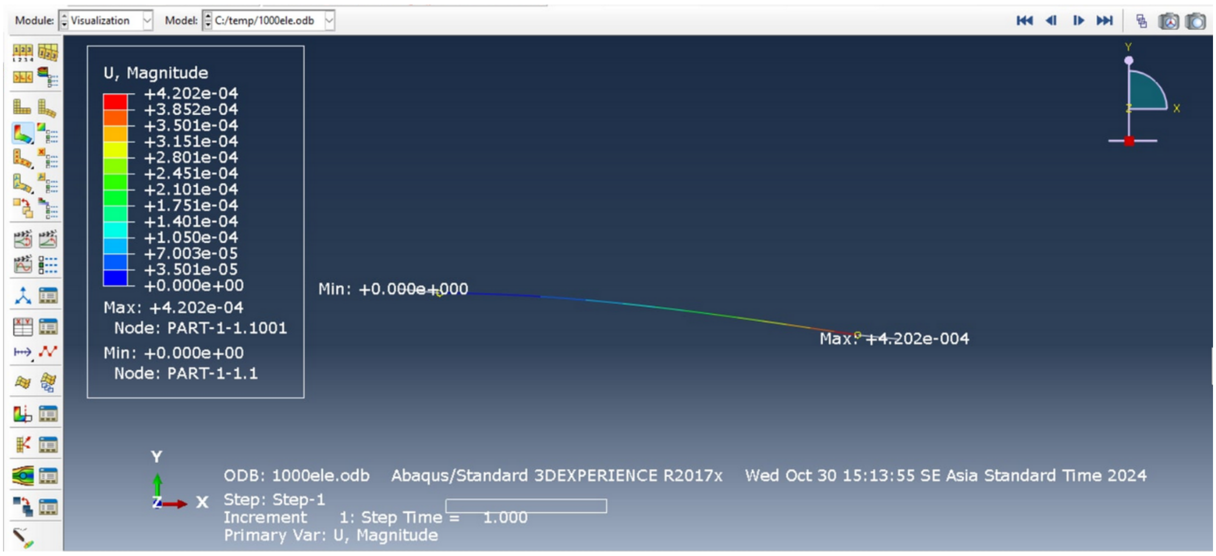
0.3 Result

Analytical:

$$\delta_{max} = \frac{PL^3}{3EI} = \frac{15000 \times 1.2^3}{3 \times 70 \times 10^9 \times 0.0003} = 6.171 \times 10^4 \text{ (m)}$$

Mesh numbers = 1000





Maximum deflection of the beam is: 4.202e-004 (m).

The error is:

$$\frac{6.171 - 4.202}{6.171} \times 100\% = 31.9\%$$

Continue similarly for other mesh sizes...