

Soaring Against The Odds



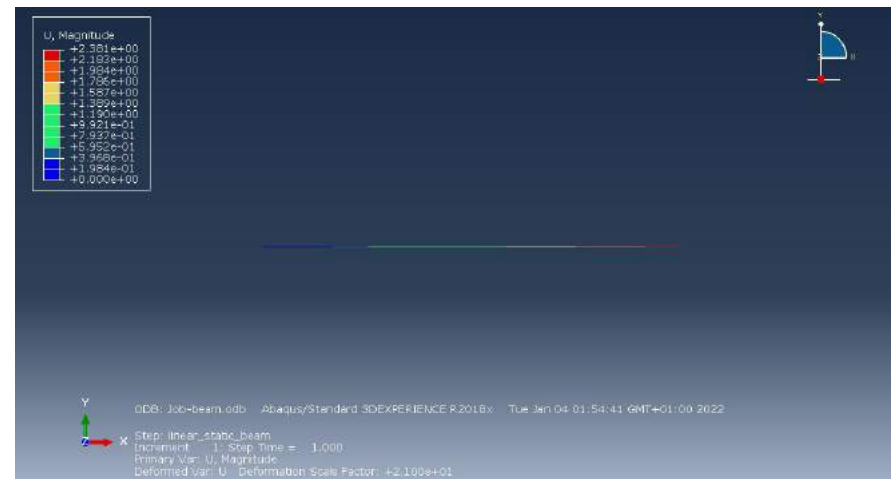
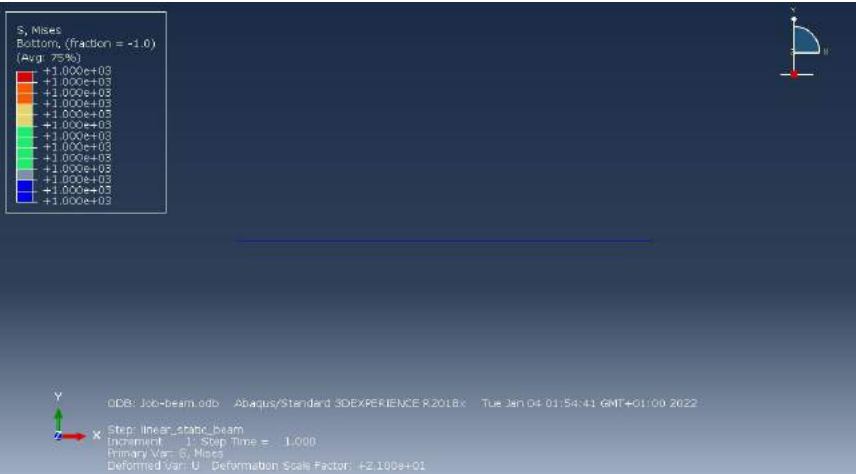
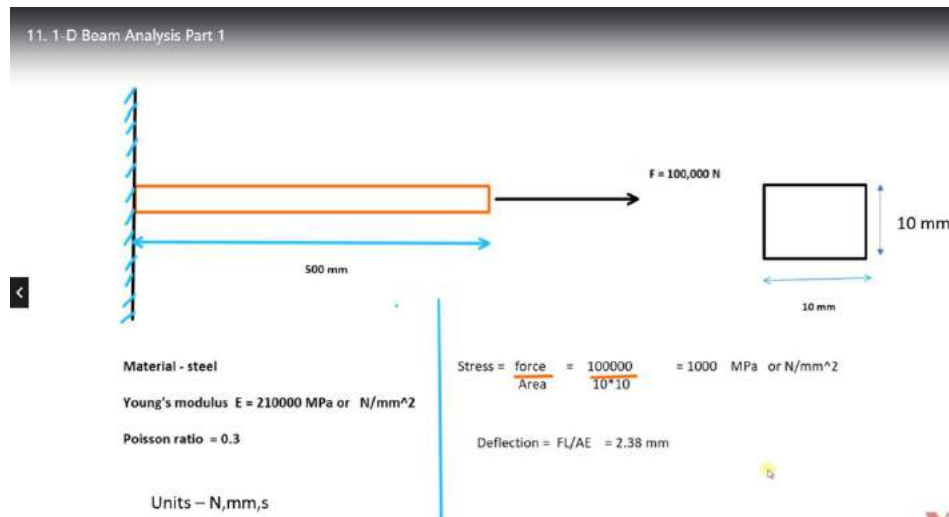
Modelling and Simulation Portfolio

With Abaqus & Ansys

Ajibuwa O. A

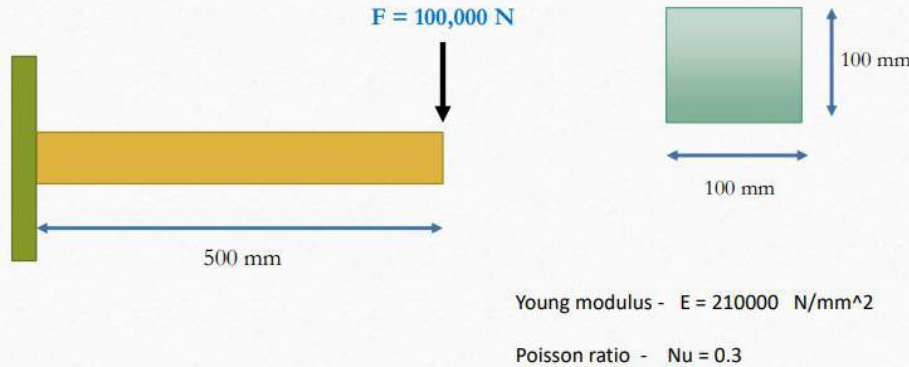
Linear Analysis

1-D Beam Analysis

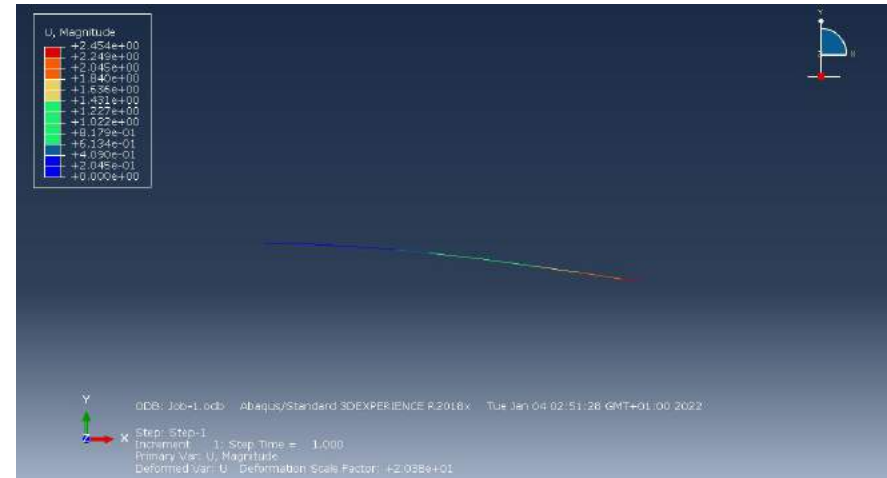
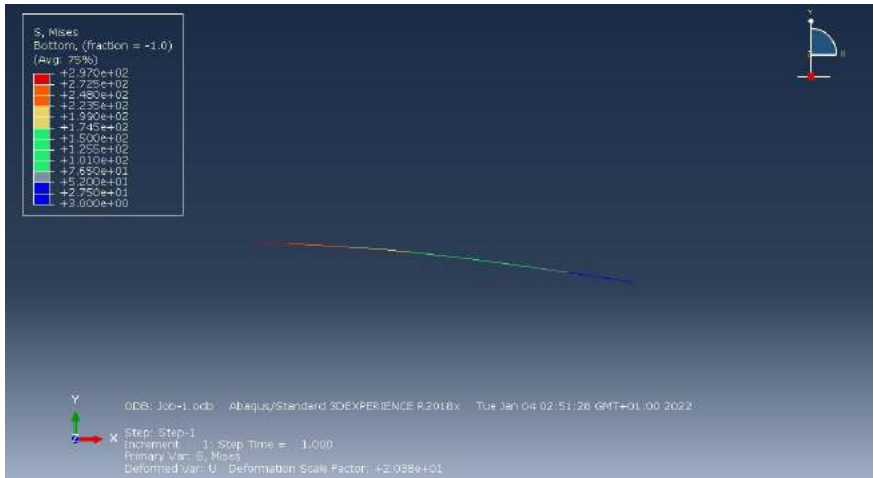


1-D Beam Analysis Assignment

Beam Bending Analysis



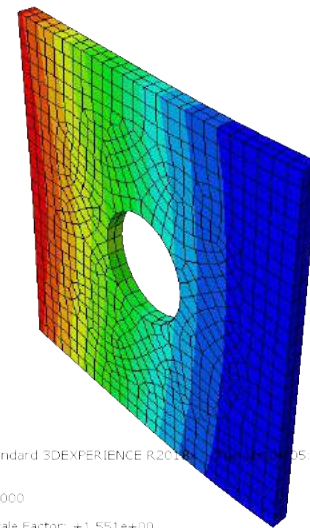
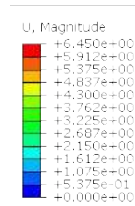
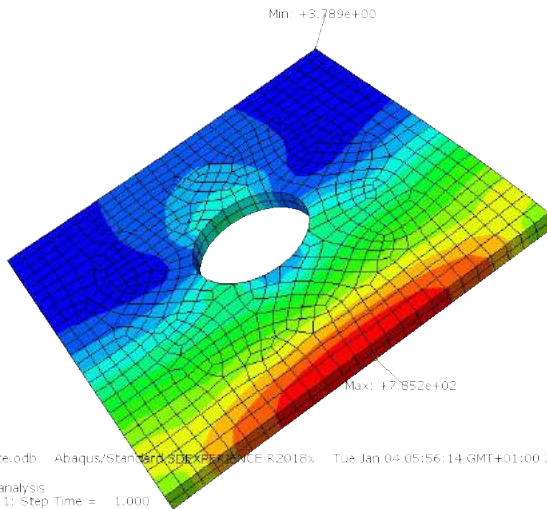
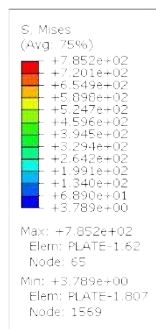
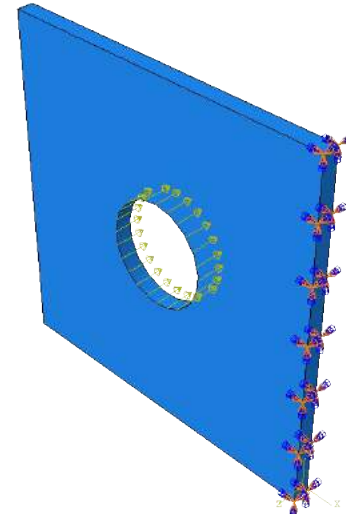
- Stress = MY/I
- Moment = $PL/4$
- Moment of inertia about neutral Axis $I = bd^3 / 12$
- $F = 100000 \text{ N}$
- $L = 500 \text{ mm}$
- $b = 100 \text{ mm}$
- $d = 100 \text{ mm}$
- $Y = d/2$
- Stress = 300 N/mm^2
- Deflection = $FL^3 / 3EI = 2.4 \text{ mm}$



Linear Static Analysis

- Find out stress distribution
- Maximum deflection due to load

- Material = Steel
- $F = 10000 \text{ N}$
- depth = 5 mm
- $l = 100 \text{ mm}$
- $b = 100 \text{ mm}$
- diameter = 30mm



ODB: Job-plate.odb Abaqus/Standard 3DEXPERIENCE R2018x Tue Jan 04 05:56:14 GMT+01:00 2022

Step: Linear_analysis
Increment: 1; Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +1.551e+00



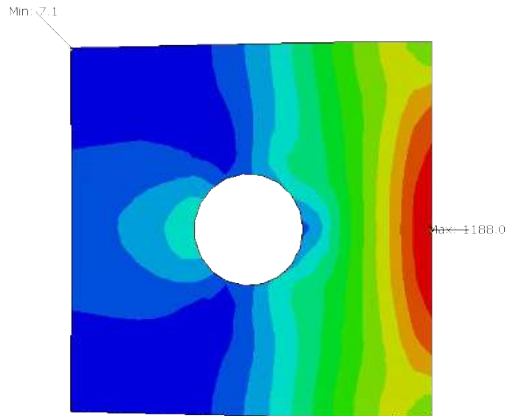
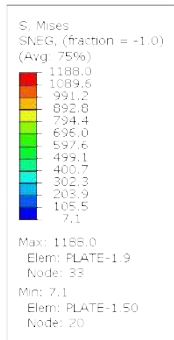
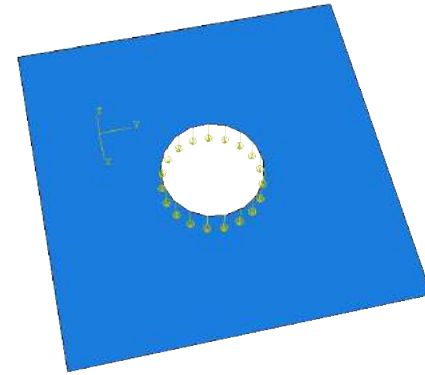
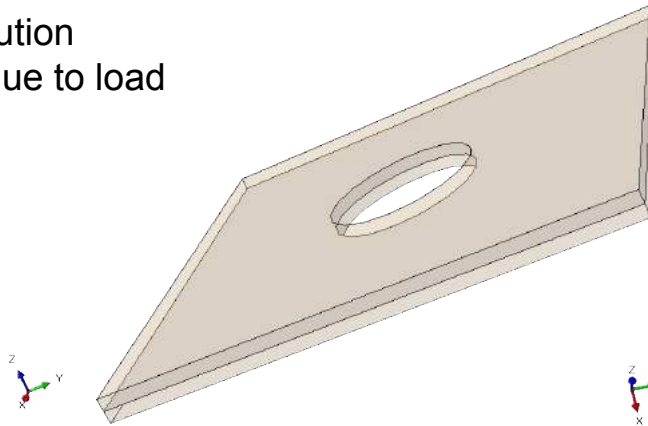
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Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.551e+00

Mid-Surfacing Analysis

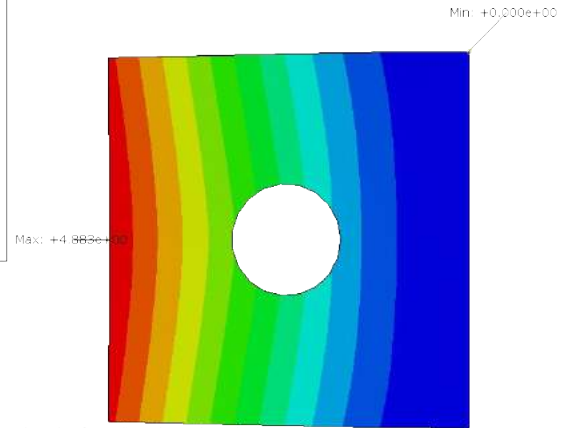
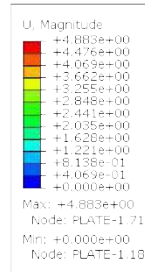
- Find out stress distribution
- Maximum deflection due to load

- Material = Steel
- $F = 10000 \text{ N}$
- depth = 5 mm
- $l = 100 \text{ mm}$
- $b = 100 \text{ mm}$
- diameter = 30mm



ODB: Job-midsurface.odb Abaqus/Standard 3DEXPERIENCE R2018x Tue Jan 04 15:06:11 GMT+01:00 2022

Step: Step-force
Increment: 1; Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +2.0e+00



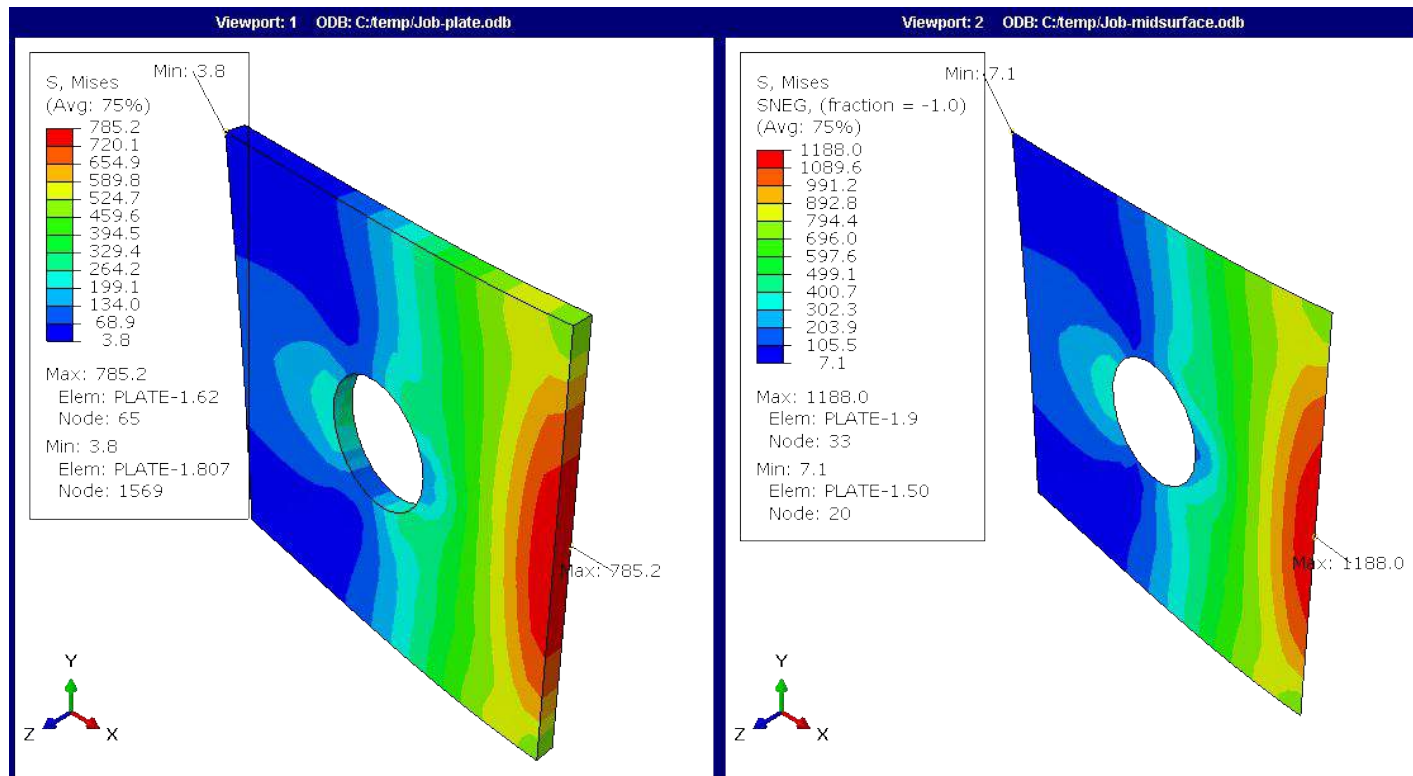
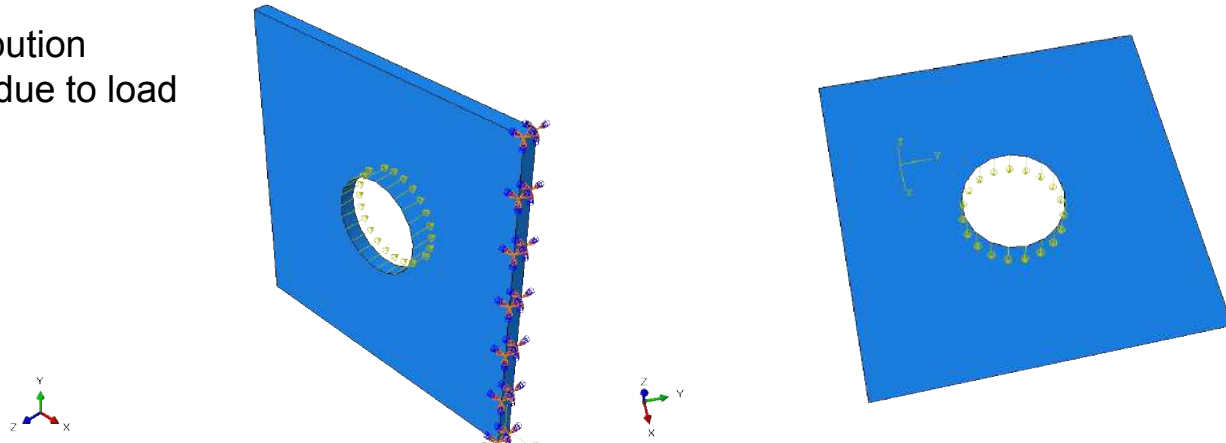
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Step: Step-force
Increment: 1; Step Time = 1.000
Primary var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +2.045e+00

Comparison of 3D-plate and mid-surface-plate

- Find out stress distribution
- Maximum deflection due to load

- Material = Steel
- $F = 10000 \text{ N}$
- depth = 5 mm
- $l = 100 \text{ mm}$
- $b = 100 \text{ mm}$
- diameter = 30mm

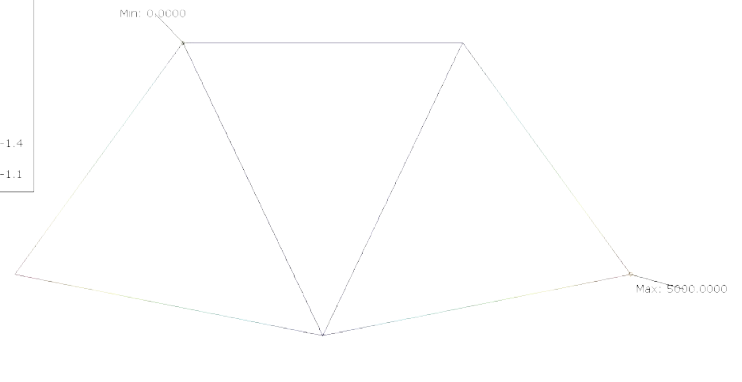
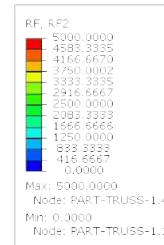
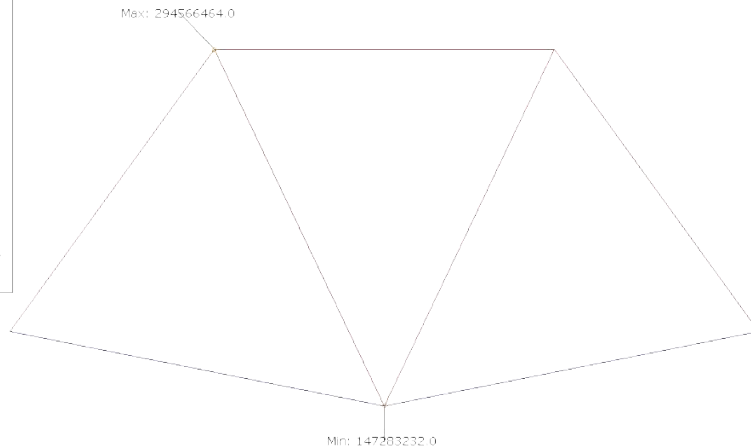
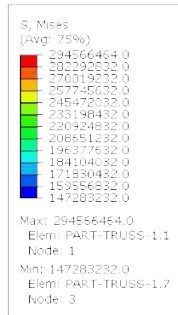
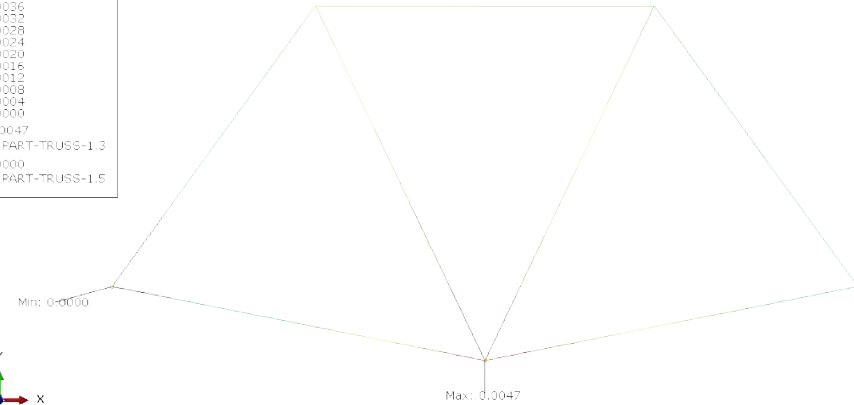
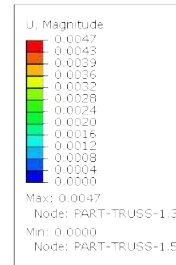
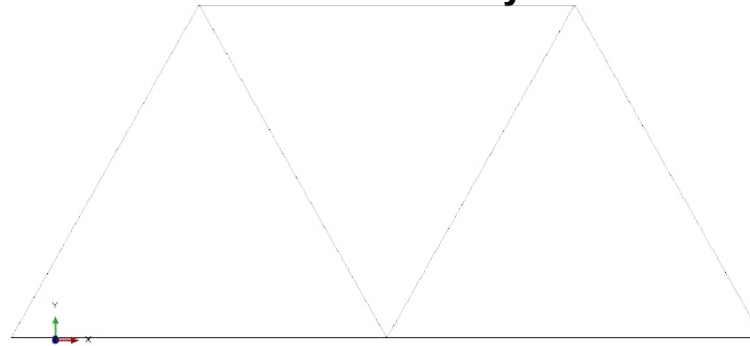


Truss Analysis

Find:

- Stress
- Displacement
- Reaction force

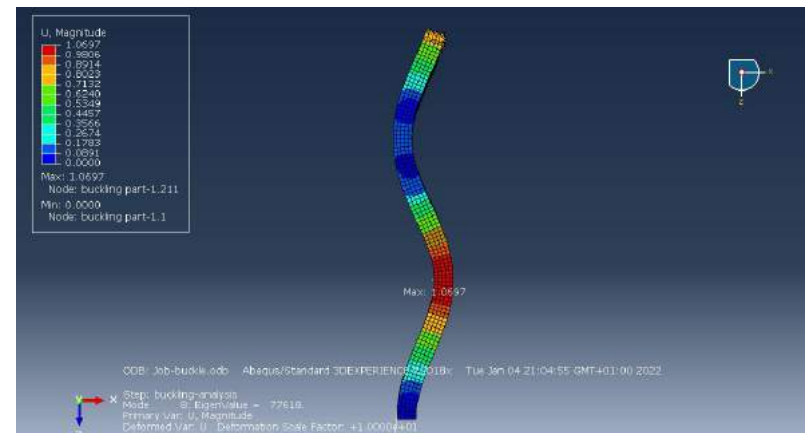
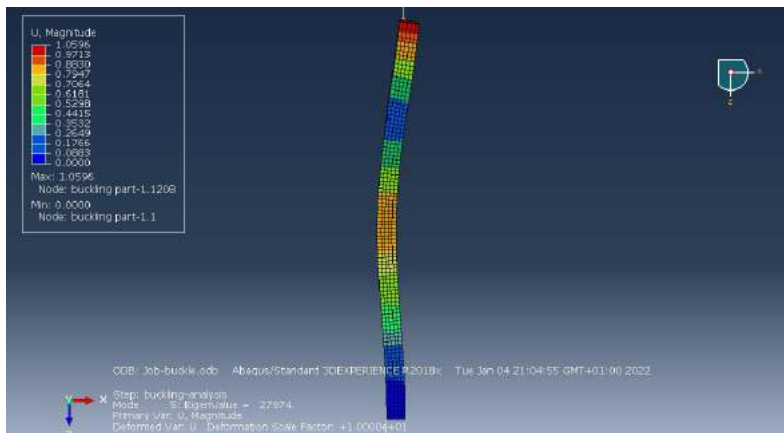
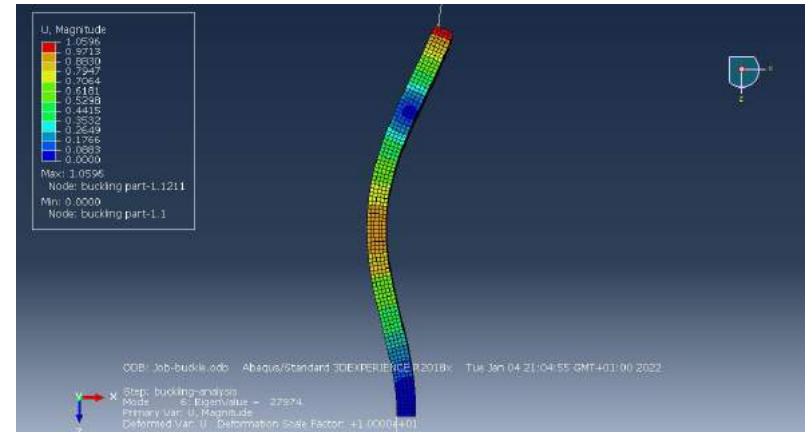
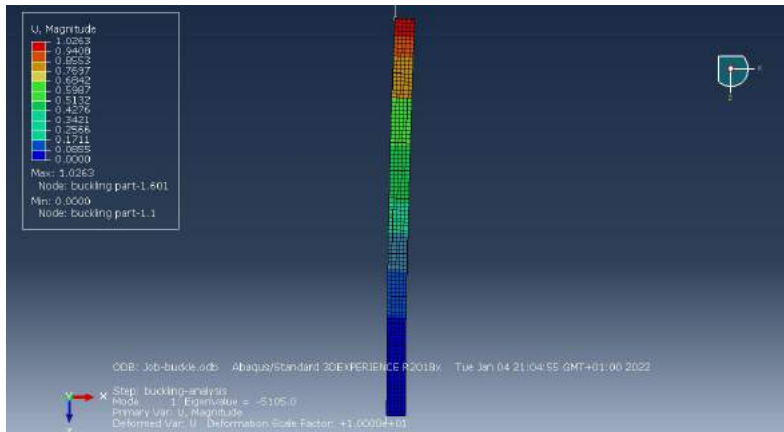
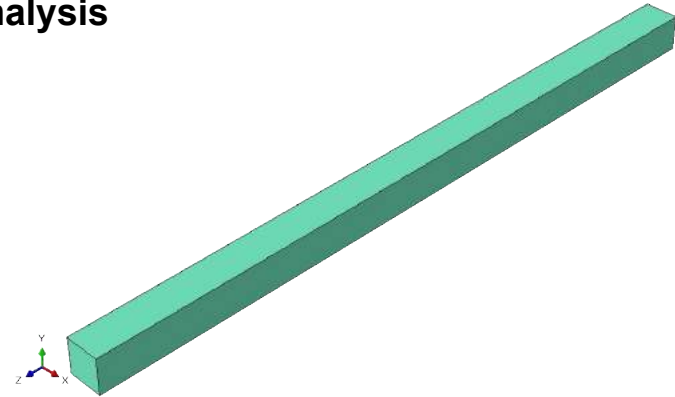
- Material = Steel
- Circular_steel_rods of diameter = 5mm
- $E = 200 \text{ Gpa}$ ($200e9 \text{ N/m}^2$)
- $F = 10000 \text{ N}$
- $l = 1 \text{ mm}$
- $b = 1 \text{ mm}$
- density= 7850 kg/m^3



Buckling Analysis

Find:

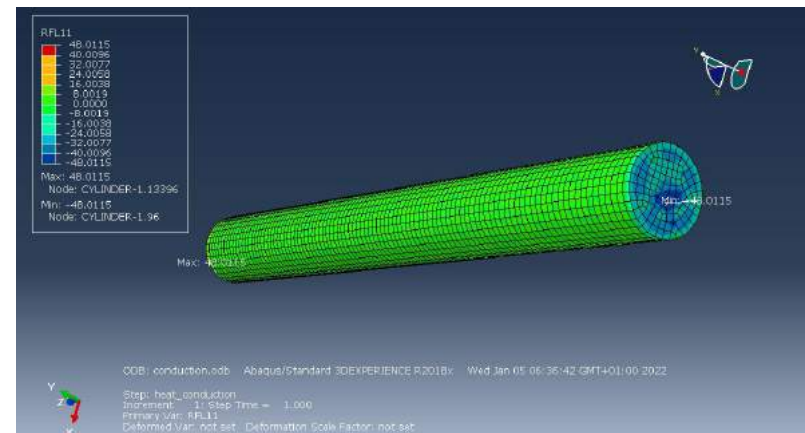
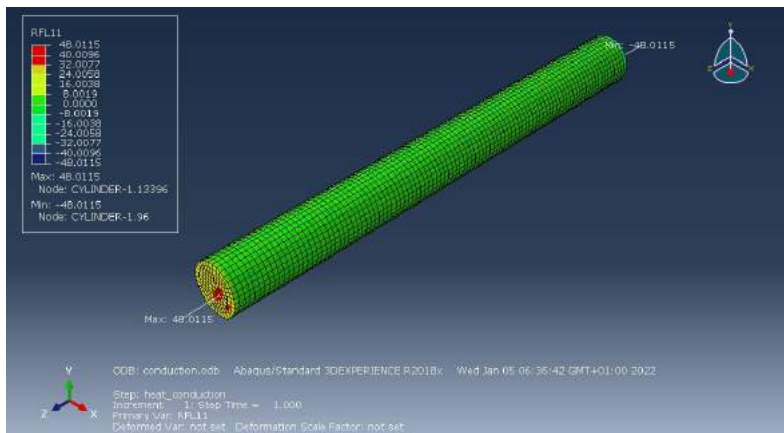
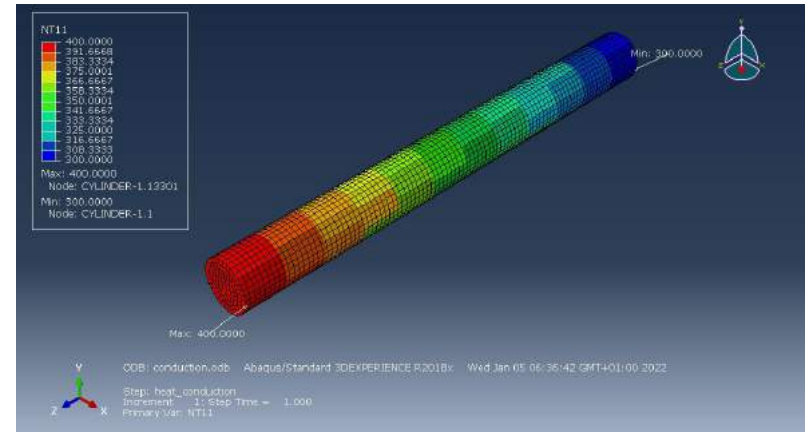
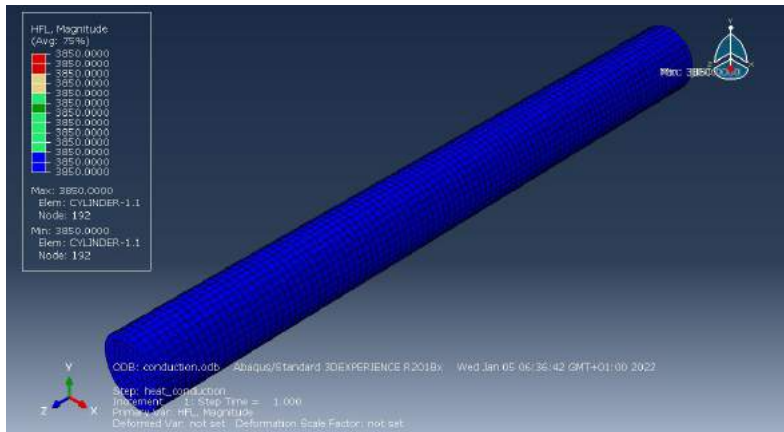
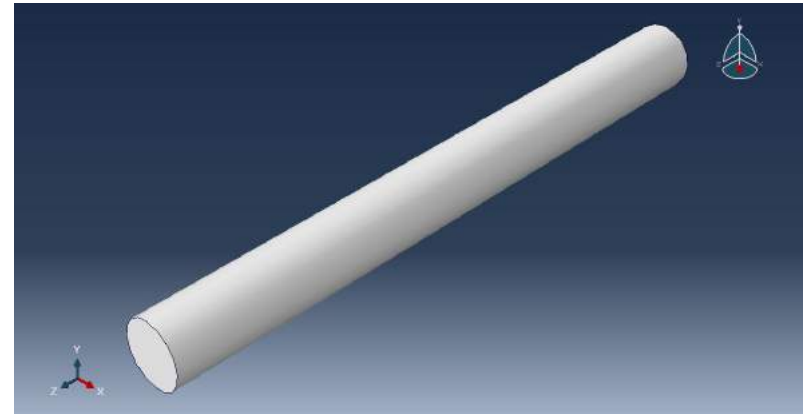
- critical buckling load
- Material = Steel
- $E = 210000 \text{ Mpa}$
- poisson's ratio = 0.3
- $F = 1000 \text{ N}$
- $F(\text{ref}) = 1 \text{ N}$
- $h = 100 \text{ mm}$, $l = 5 \text{ mm}$, $b = 5 \text{ mm}$



Heat Transfer (conduction) Analysis

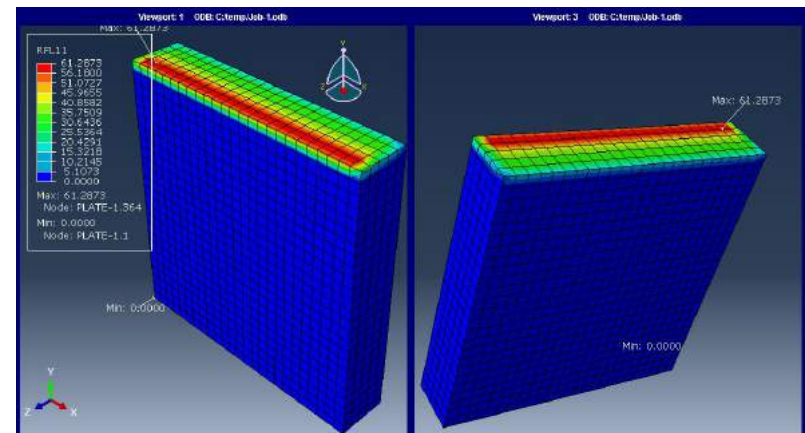
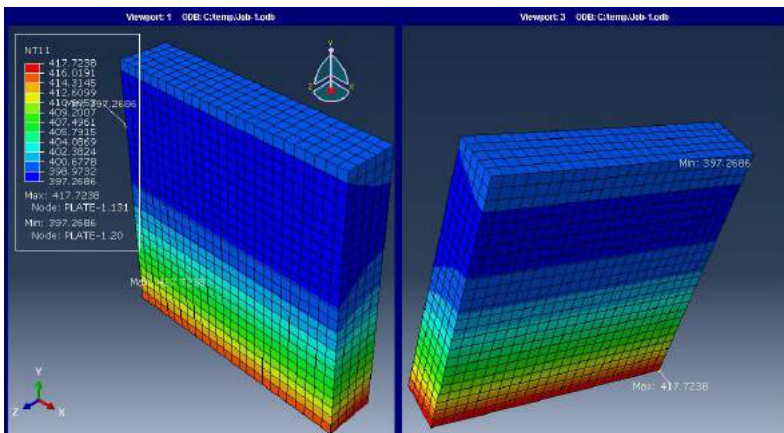
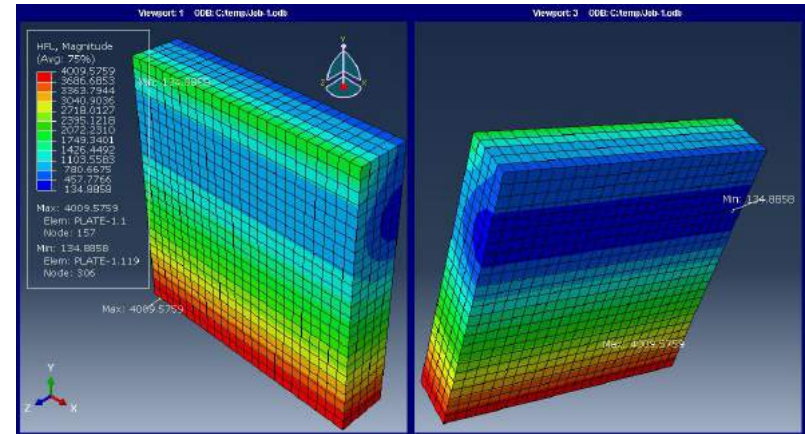
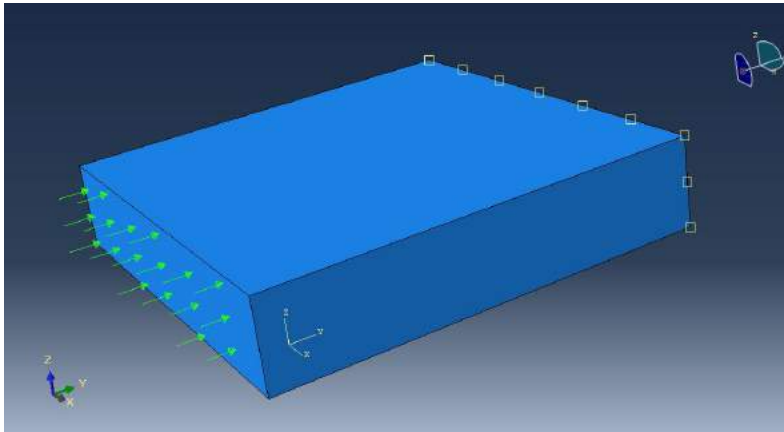
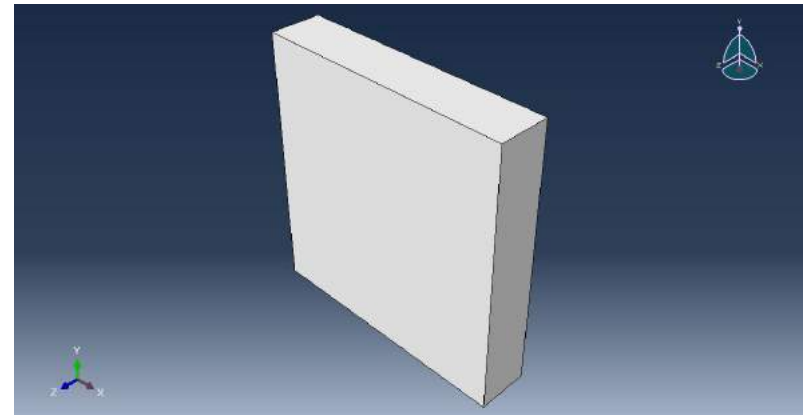
Find:

- temperature distribution in the cylinder
- Material = Copper
- Thermal conductivity = 385 (W/mK)
- $T_1 = 400$ K
- $T_2 = 300$ K
- $R = 0.5$ m, $l = 10$ m



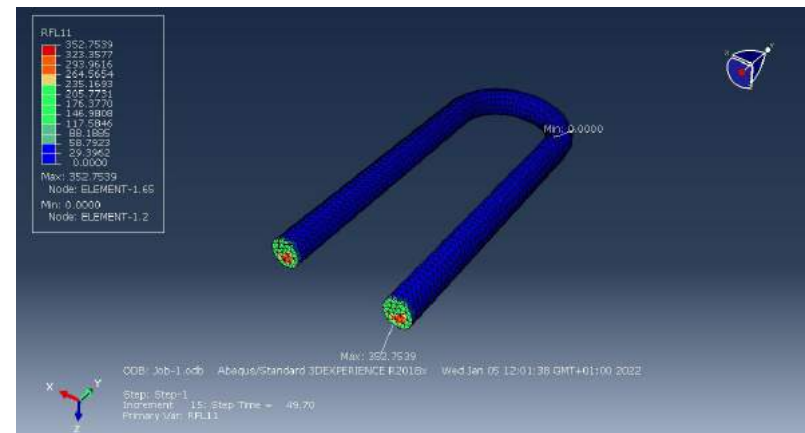
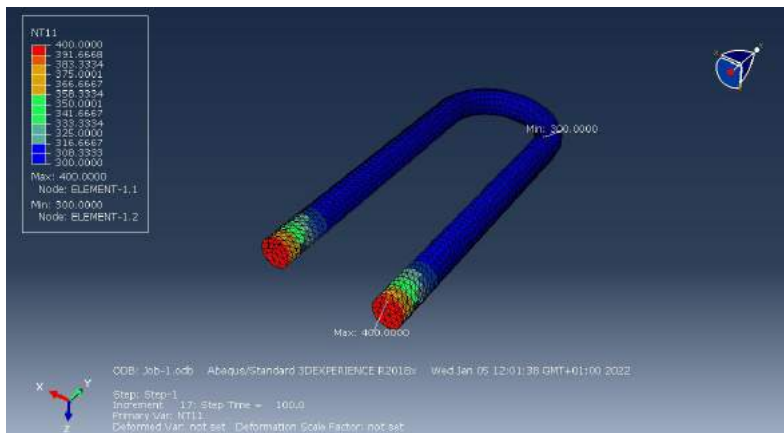
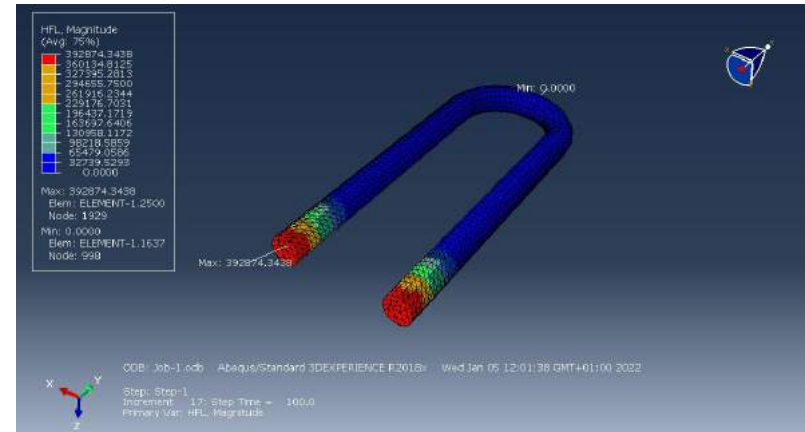
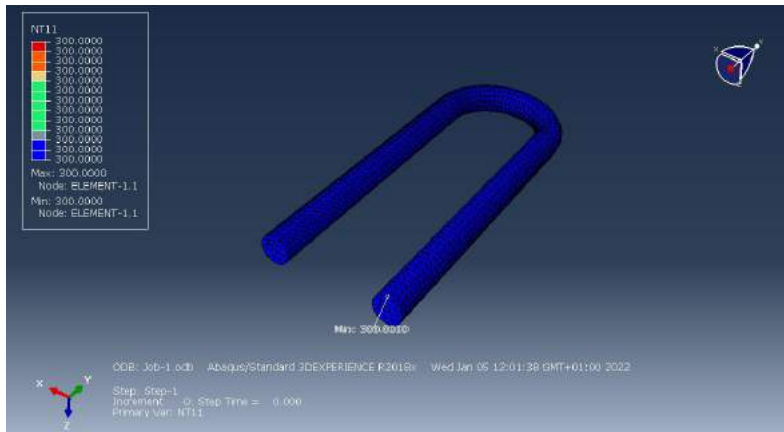
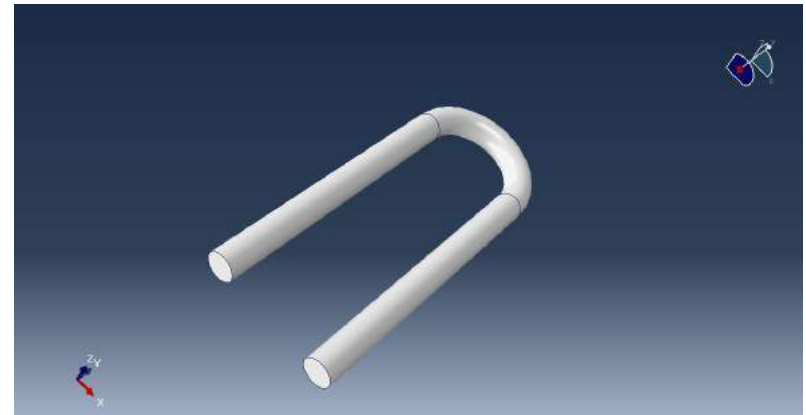
Heat Transfer (convection) Analysis

- Find: heat and temperature distribution on the plate
- Material = Copper,
- Fluid = Air, $h(\text{Air}) = 10 \text{ W/m}^2\text{K}$
- Thermal conductivity = 385 (W/mK)
- $T = 400 \text{ K}$
- Ambient Temperature = 298 K
- Heat flux = $4000 \text{ W/m}^2 = Q$
- plate size = $(5 * 5 * 1) \text{ m}^3$



Transient Heat Transfer (conduction) Analysis

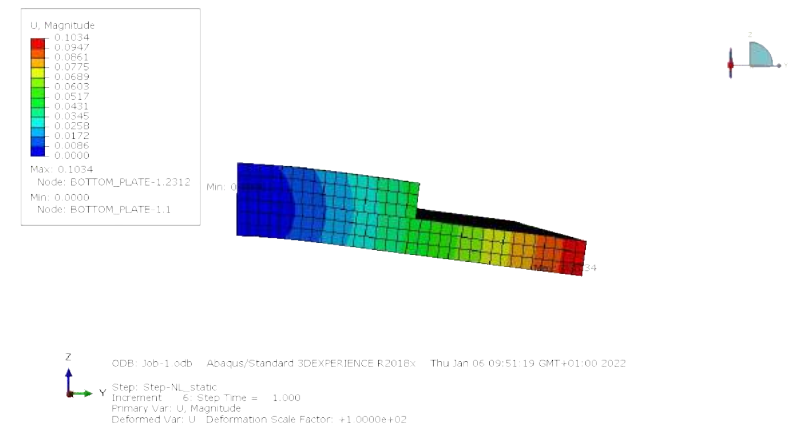
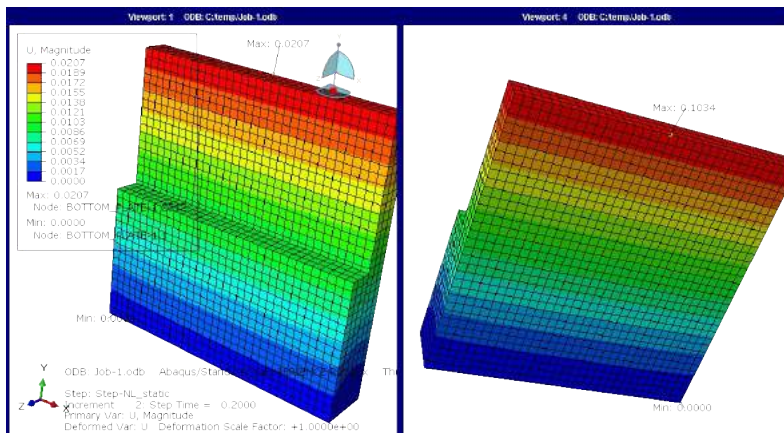
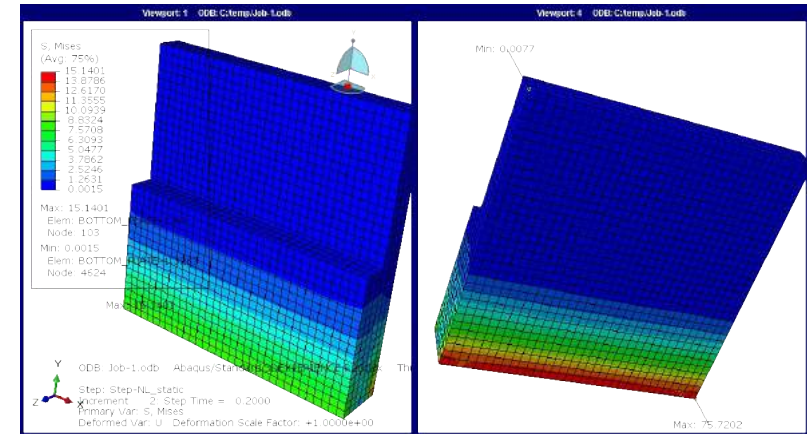
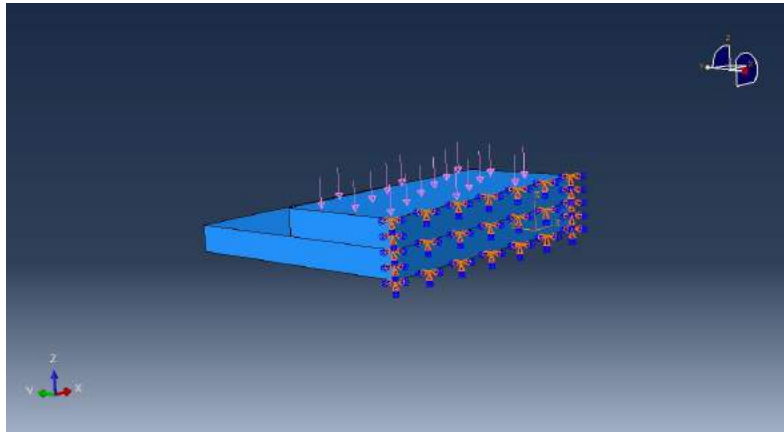
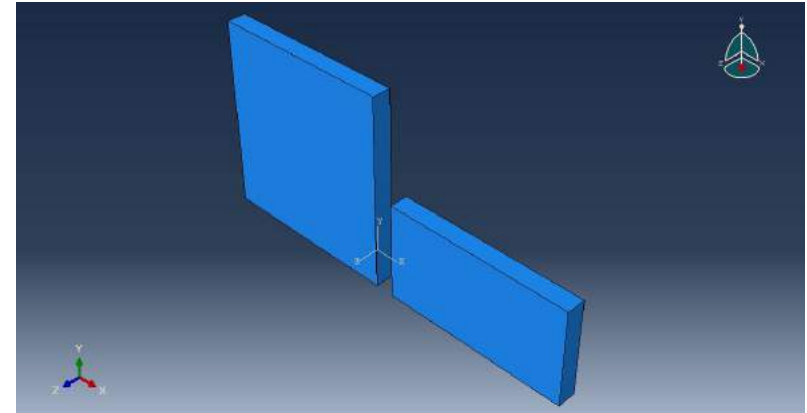
- Find: heat and temperature distribution on the plate
- Material = Copper, $l = 1\text{m}$, $b = 0.4\text{m}$, $R = 0.05\text{m}$
- Density = $8800\text{ (Kg/m}^3\text{)}$
- Thermal conductivity = 490 (W/mK)
- Temp. = 400 K
- Specific heat = 1000 (J/Kg.K)
- Heat flux = 7500 W/m^2
- Initial temp. of body = 300 K



Nonlinear Analysis

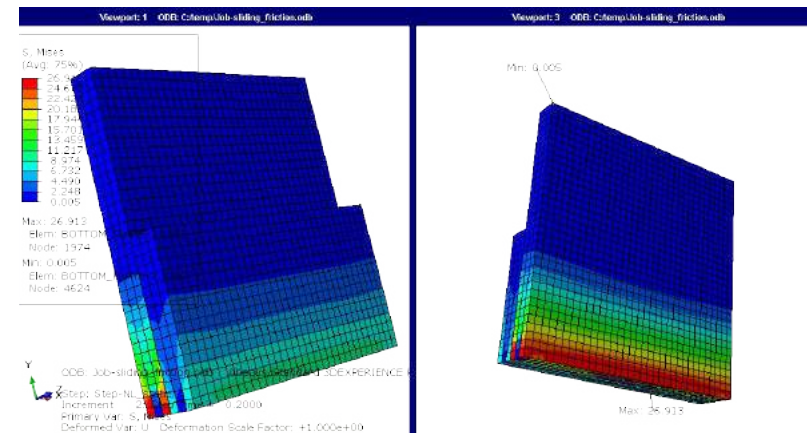
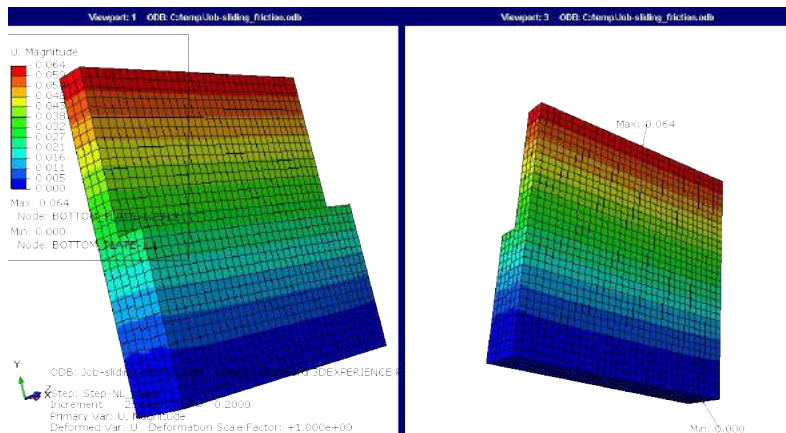
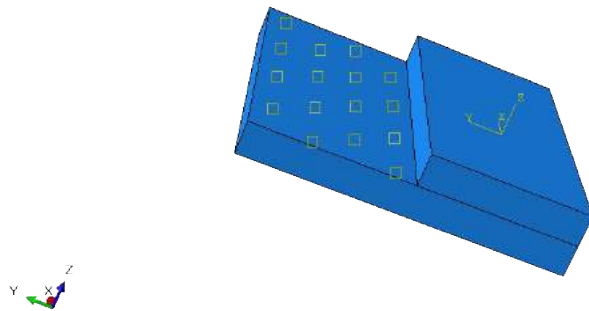
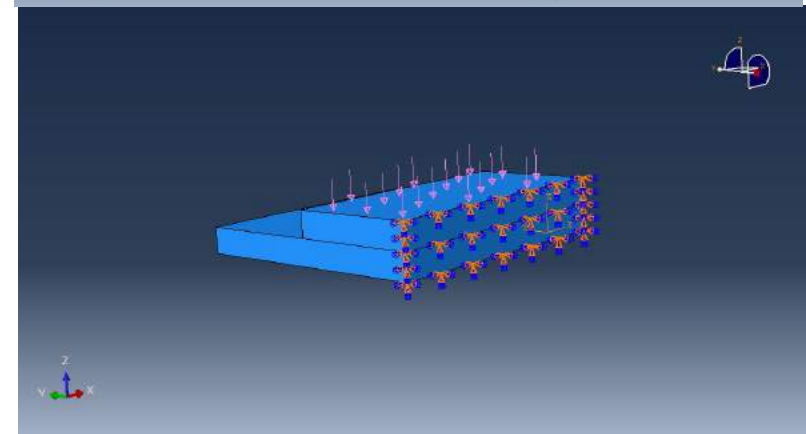
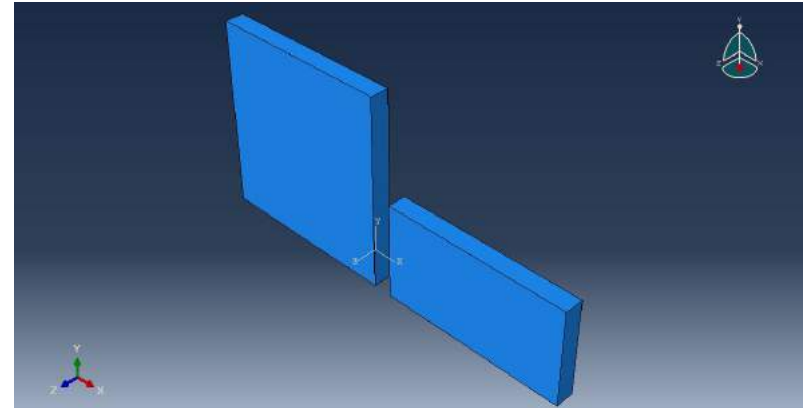
Tie Contact Analysis

- Find: stress/effect of the top plate to the bottom plate
- Mat.1 = Steel, $l = b = 100\text{mm}$, thickness = 10mm
- Mat.2 = Aluminium, $l = 100$, $b = 50$, $w = 10$
- Pressure = 4 (Mpa)
- BCs = material, geometric and contact nonlinearity
- $E(\text{steel}) = 210,000 \text{ Mpa}$, $E(\text{aluminium}) = 70,000 \text{ Mpa}$
- poisson's ratio: steel = 0.3, aluminium = 0.32



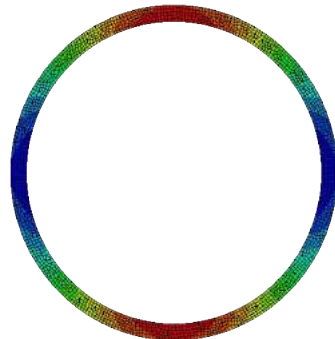
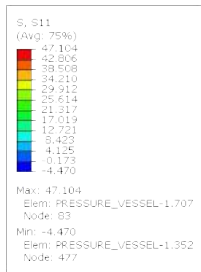
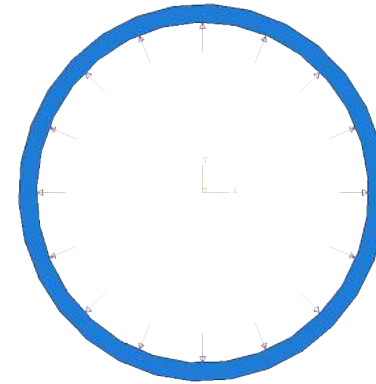
Sliding Contact Analysis

- Find: stress/effect of the top plate to the bottom plate
- Mat.1 = Steel, $l = b = 100\text{mm}$, thickness = 10mm
- Mat.2 = Aluminium, $l = 100$, $b = 50$, $w = 10$
- Pressure = 4 (Mpa), friction = 0.2
- BCs = material, geometric and contact nonlinearity
- $E(\text{steel}) = 210,000\text{ Mpa}$, $E(\text{aluminium}) = 70,000\text{ Mpa}$
- poisson's ratio: steel = 0.3, aluminium = 0.32

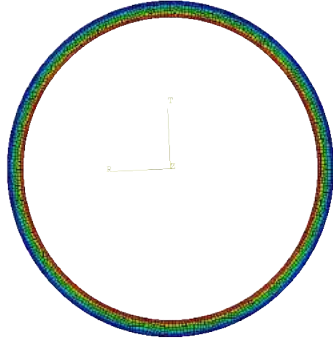
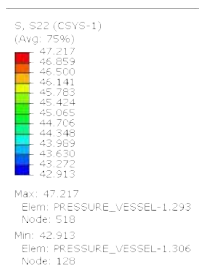
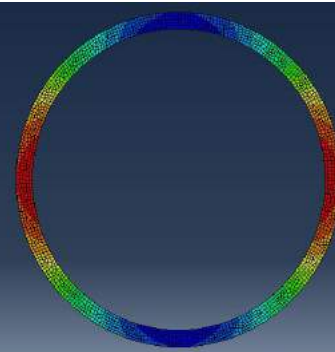
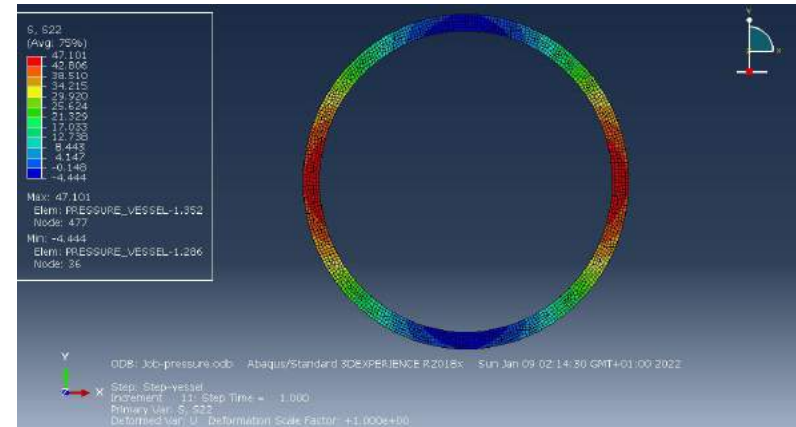


Pressure Vessel Analysis

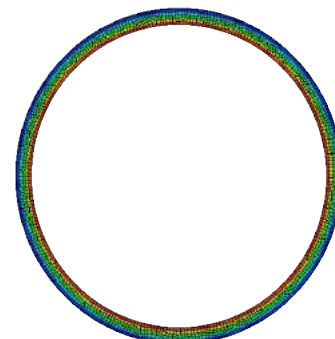
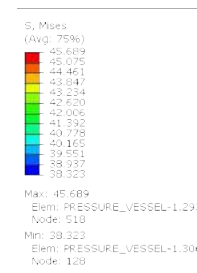
- Find: change in geometry by the pressure
- Material = Steel, outer diameter = 500mm, thickness = 25mm
- Pressure = 5 (Mpa)
- $E(\text{steel}) = 210,000 \text{ Mpa}$, poisson's ratio: steel = 0.3
- Hoop stress (calculated) = 50 (Mpa)



Y
X
ODB: Job-pressure.odb - Abaqus/Standard 3DEXPERIENCE R2018x - Sun Jan 09 02:14:30 GMT+01:00 2022
Step: Step-vessel
Increment: 11; Step Time = 1.000
Primary Var: S, S11
Deformed Var: U - Deformation Scale Factor: +1.000e+00



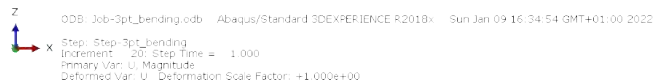
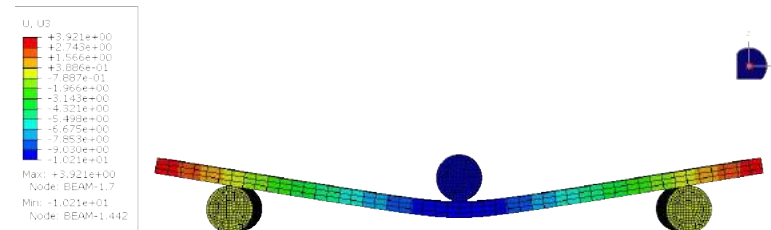
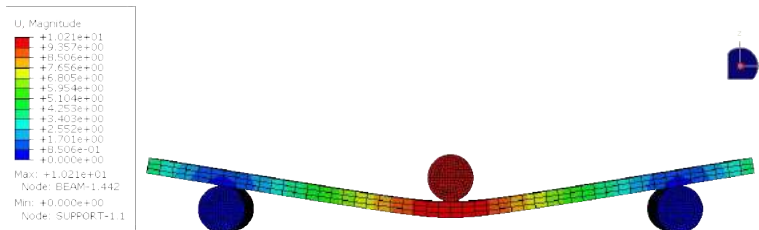
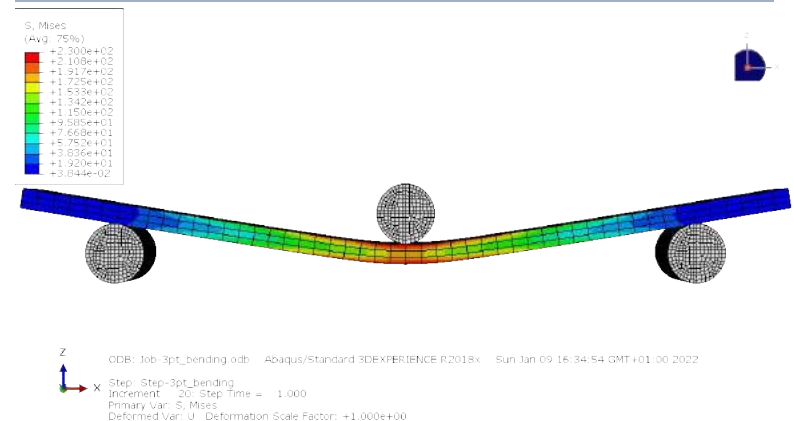
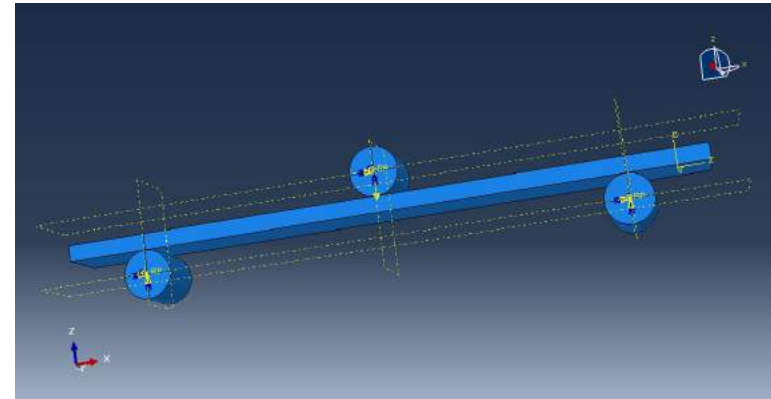
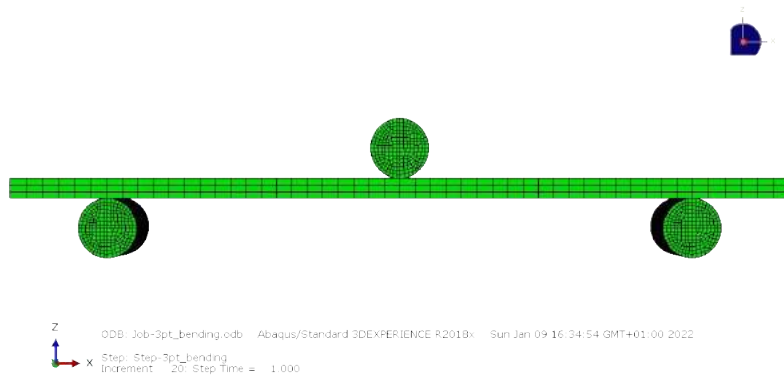
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X
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Step: Step-vessel
Increment: 11; Step Time = 1.000
Primary Var: S, S22 (CSYS-1)
Deformed Var: U - Deformation Scale Factor: +1.000e+00



Y
X
ODB: Job-pressure.odb - Abaqus/Standard 3DEXPERIENCE R2018x - Sun Jan 09 02:14:30 GMT+01:00 2022
Step: Step-vessel
Increment: 11; Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U - Deformation Scale Factor: +1.000e+00

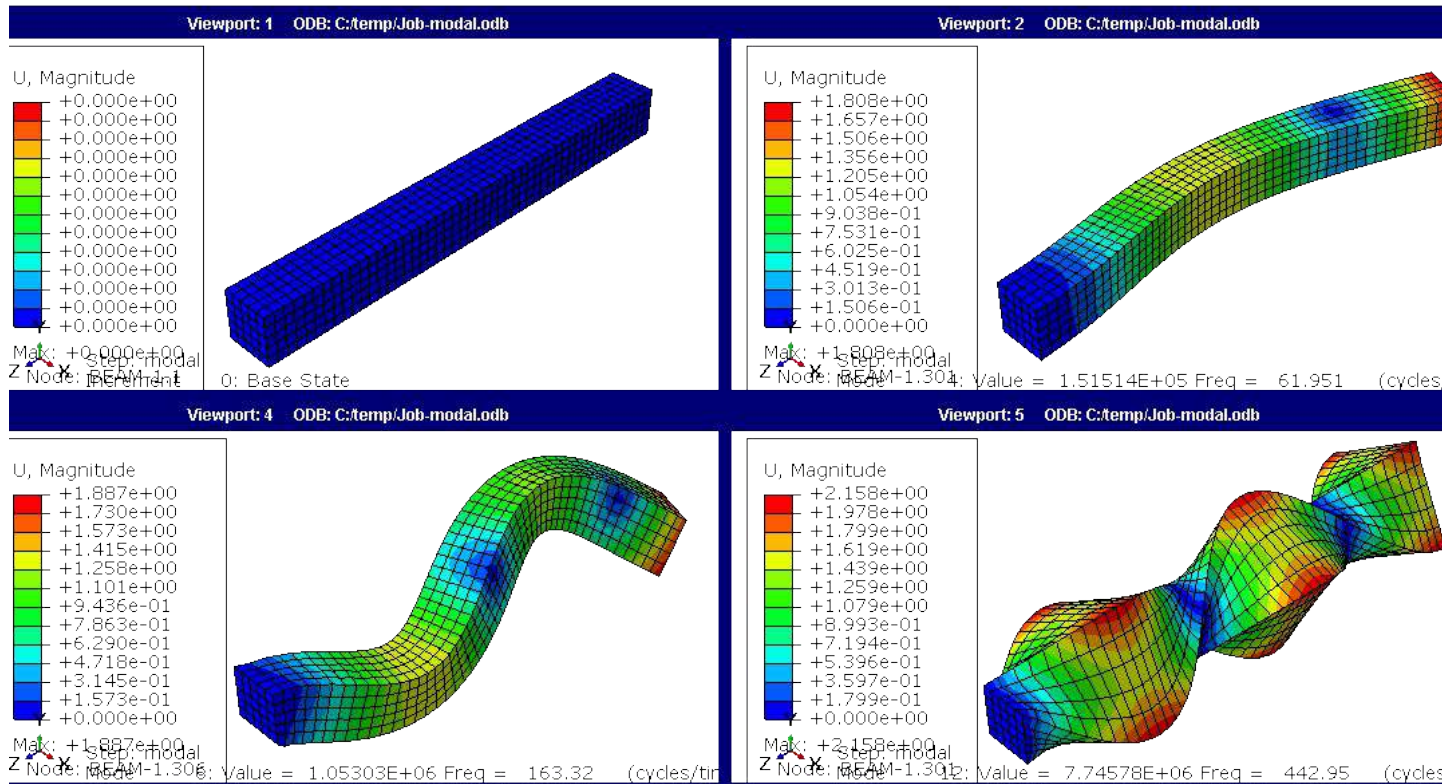
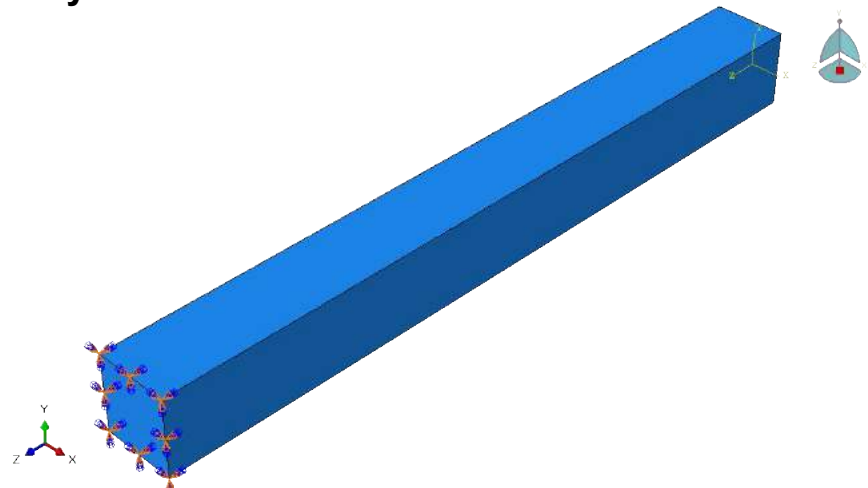
3-point Bending Analysis

- Find: change in geometry by the pressure
- Material = nonlinear material
- Rigid support diameter = 15mm
- Beam dimensions = 200* 20* 5 mm
- $E = 200,000 \text{ Mpa}$, poisson's ratio = 0.3
- Density = $7.85e-6 \text{ (Kg/mm}^3\text{)}$



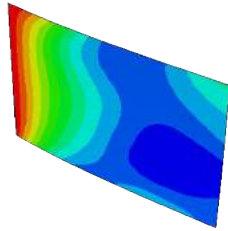
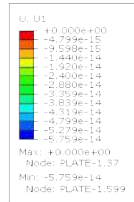
Modal Analysis

- Material = Steel
- Beam length = 250mm
- Cross-section = 25* 25 mm
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7.85e-6 (Kg/mm3)



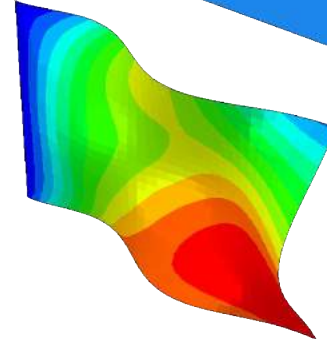
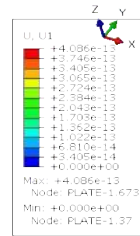
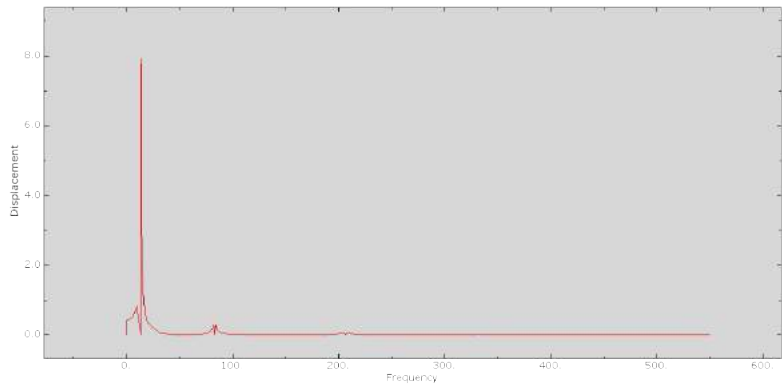
Frequency Response Analysis

- Material = Steel
- Plate dimensions = 0.36*0.24 m, thickness = 2 mm
- Cross-section = 25* 25 mm
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7850 (Kg/m3)
- Force = 1000 N



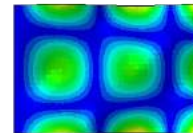
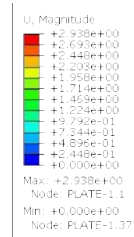
ODB: Job-FRF.odb Abaqus/Standard 3DEXPERIENCE R2018x Mon Jan 10 03:07:49 GMT+01:00 2022

Step: Step-2
Increment: 9 Frequency = 9.4205E-06
Primary Var: U1, Complex: Real
Deformed Var: U1 Deformation Scale Factor: +8.068e-02



ODB: Job-FRF.odb Abaqus/Standard 3DEXPERIENCE R2018x Mon Jan 10 03:07:49 GMT+01:00 2022

Step: Step-2
Increment: 209 Frequency = 550.0
Primary Var: U1, Complex: Real
Deformed Var: U1 Deformation Scale Factor: +6.675e+00

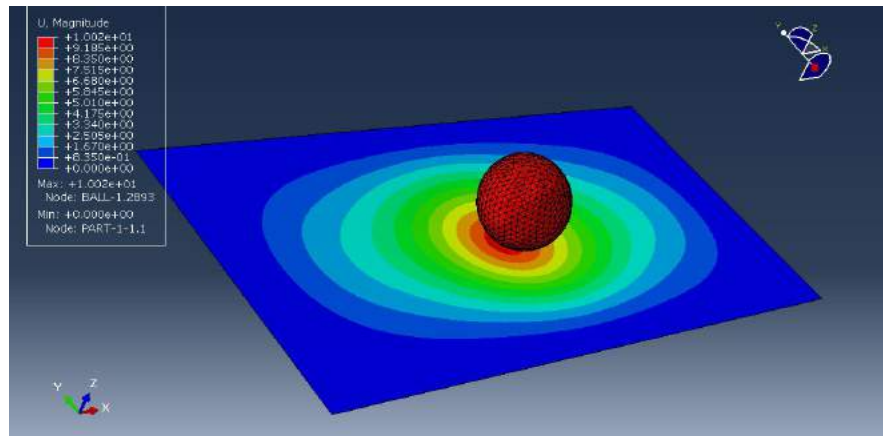
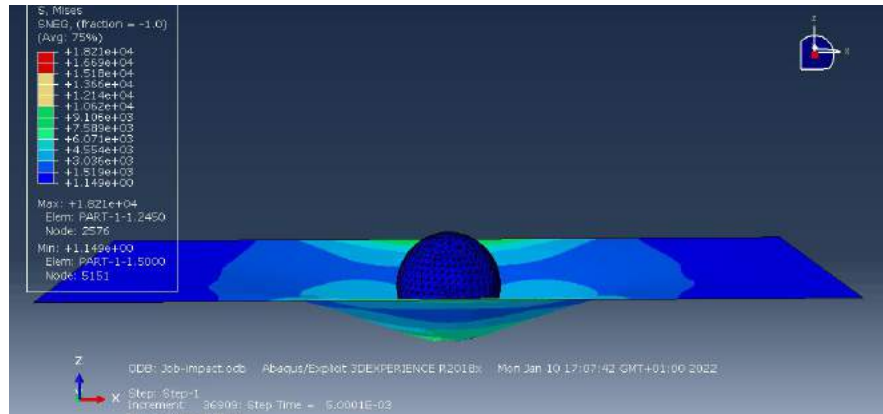
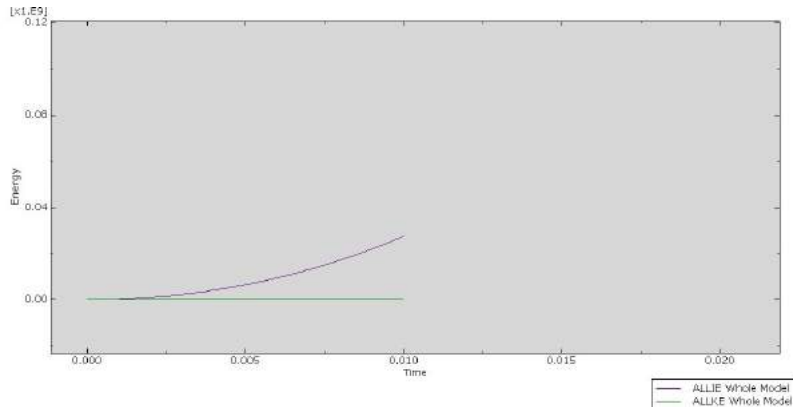
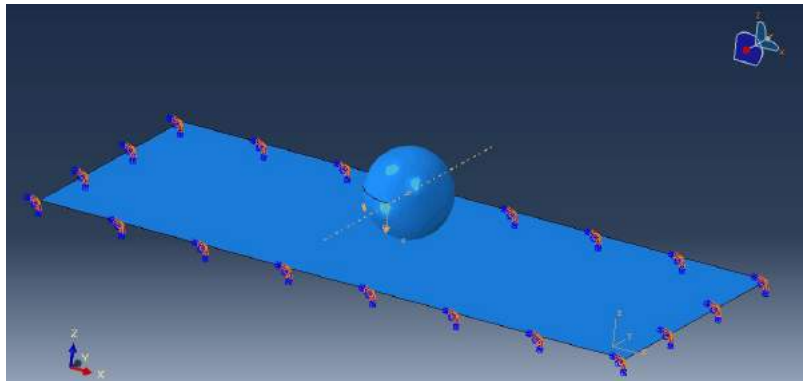
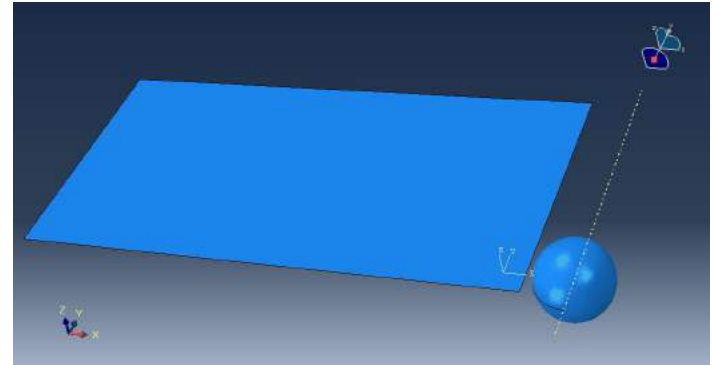


ODB: Job-modal.odb Abaqus/Standard 3DEXPERIENCE R2018x Mon Jan 10 02:10:23 GMT+01:00 2022

Step: modal
Mode: 10 Value = 1.04849E+07 Freq = 515.35 (cycles/time)
Primary Var: U1 Magnitude
Deformed Var: U1 Deformation Scale Factor: +1.355e-03

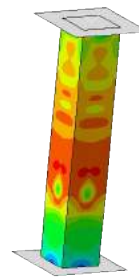
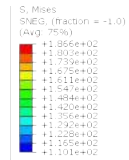
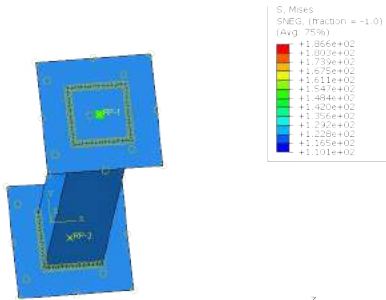
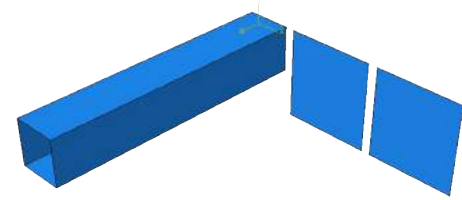
Ball-plate Impact Analysis

- Plate mat. = Steel, dimensions = 500* 250* 5 mm
- Ball mat. = aluminium, diam. = 70 mm, velocity = 10 m/s
- E (steel) = 210,000 Mpa, poisson's ratio = 0.3
- E (aluminium) = 70,000 Mpa, poisson's ratio = 0.33
- Density = 7850 (Kg/m3)

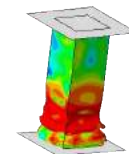
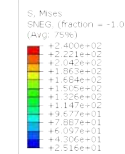


Impact Analysis of Automotive Crash box

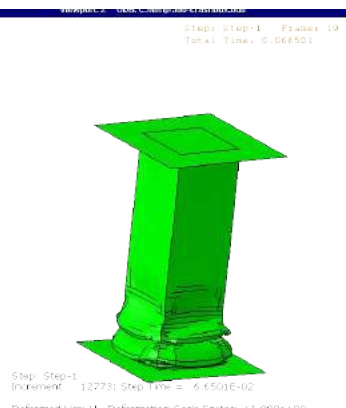
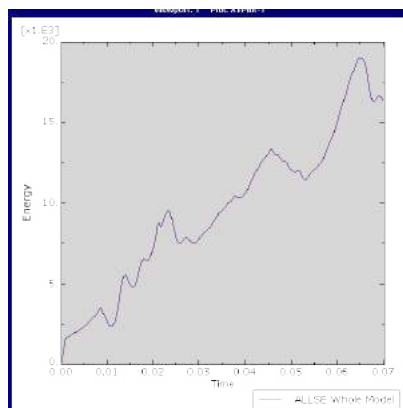
- Crash box mat. = Aluminium, cross-section = 25*25 mm, length = 150 mm
- Rigid-wall, dimension = 50*50 mm, mass = 100 kg
- Thickness = 1 mm
- E (aluminium) = 69,000 Mpa, poisson's ratio = 0.29
- Density = 2900 (Kg/m³)



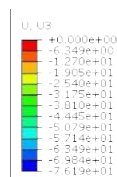
ODB: Job-crashbox.odb Abaqus/Explicit 3DEXPERIENCE R2018x Mon Jan 10 22:21:41 GMT+01:00 2022
Step: Step-1
Increment: 580 Step Time = 7.0052E-03
Primary Var: S, Mises



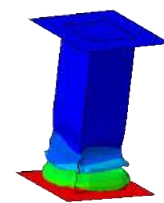
ODB: Job-crashbox.odb Abaqus/Explicit 3DEXPERIENCE R2018x Mon Jan 10 22:21:41 GMT+01:00 2022
Step: Step-1
Increment: 13704 Step Time = 7.0000E-02
Primary Var: S, Mises
Performance: 11 Performance Scale Factor: 1.000e+00



Step: Step-1
Increment: 12773 Step Time = 6.4501E-02
Performance: 11 Performance Scale Factor: 1.000e+00

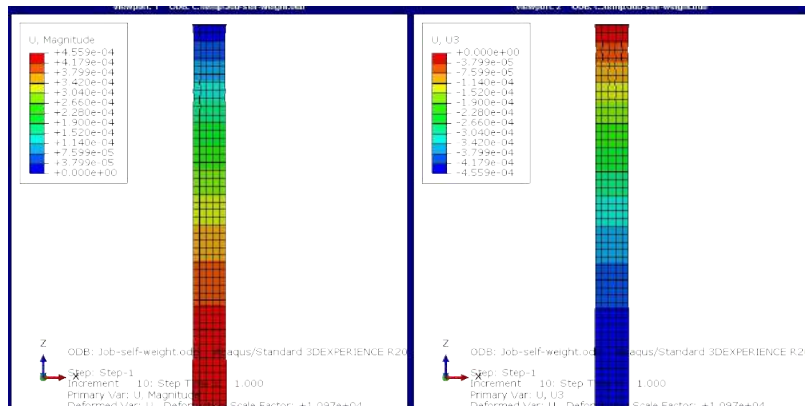
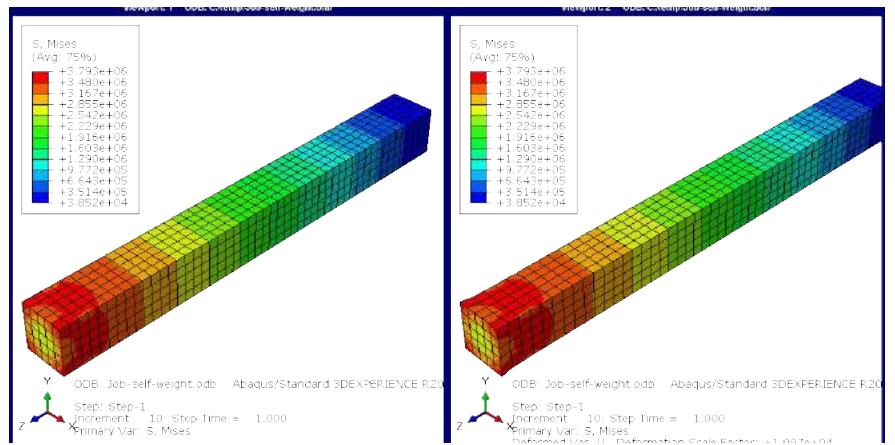
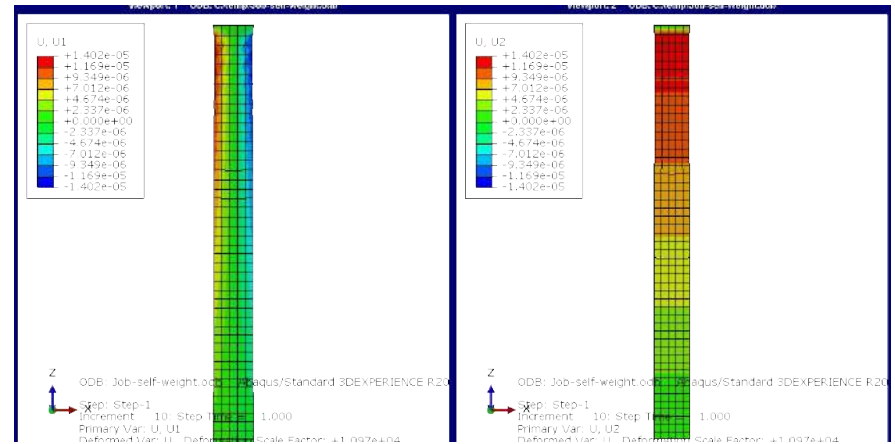


ODB: Job-crashbox.odb Abaqus/Explicit 3DEXPERIENCE R2018x Mon Jan 10 22:21:41 GMT+01:00 2022
Step: Step-1
Increment: 13734 Step Time = 7.0000E-02
Primary Var: U, U3
Performance: 11 Performance Scale Factor: 1.000e+00



Deflection due to Self-weight

- Beam mat. = Steel, cross-section = 5*5 m, depth =50 m
- mass = 100 kg
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7850 (Kg/m3)



Deflection due to Self-weight 2

- Beam mat. = Steel, cross-section = 5*5 m, depth =50 m
- mass = 100 kg
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7850 (Kg/m³)
- Extra mass = 100,000 Kg

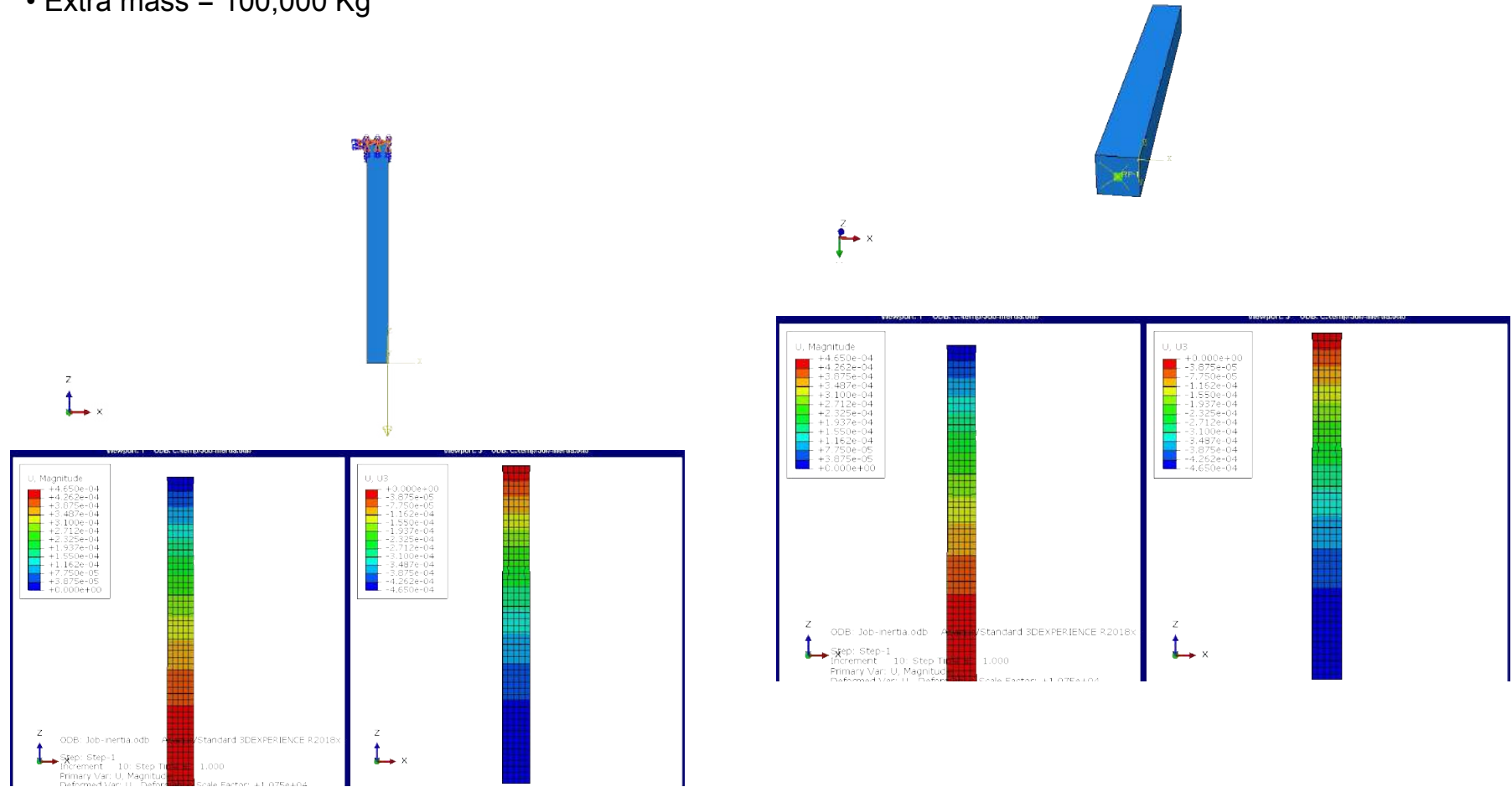


Plate with Time-dependent Load

- Plate mat. = Steel, dimension = 100 * 50 *2 mm
- Force = 1000 N
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7850 (Kg/m³)

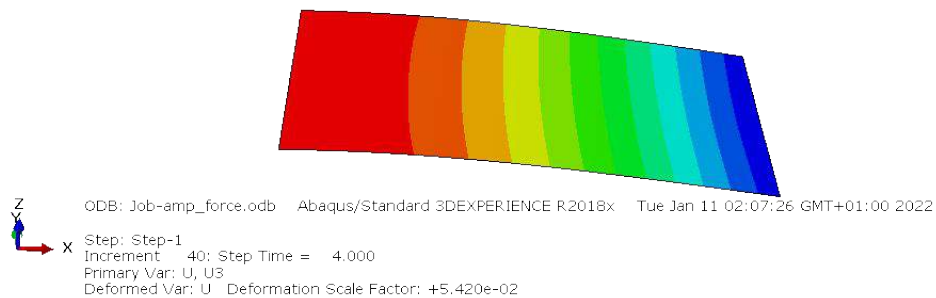
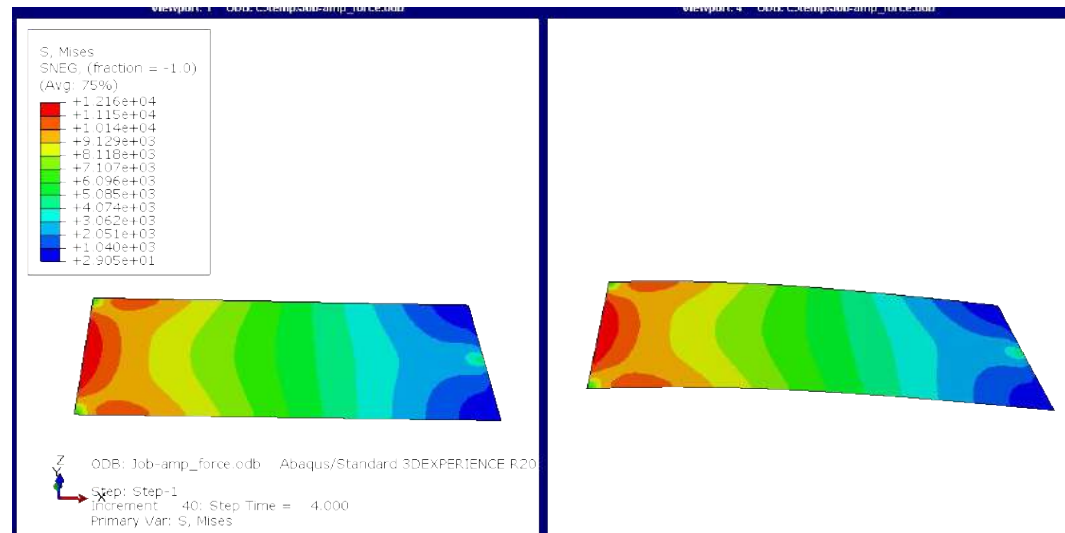
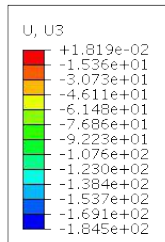
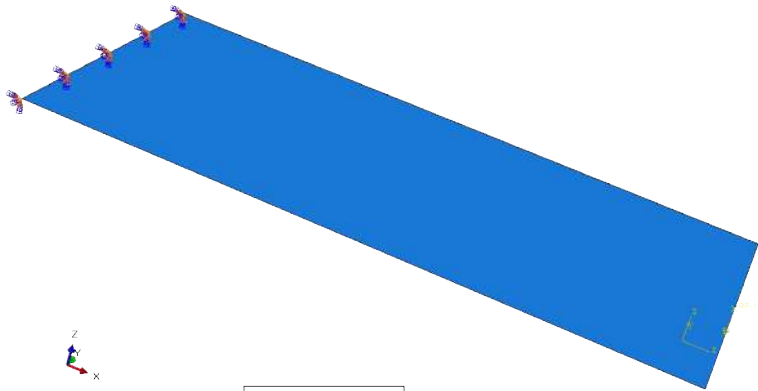
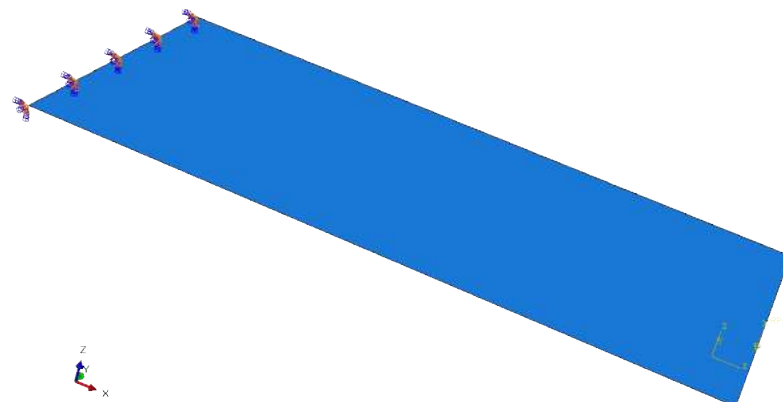
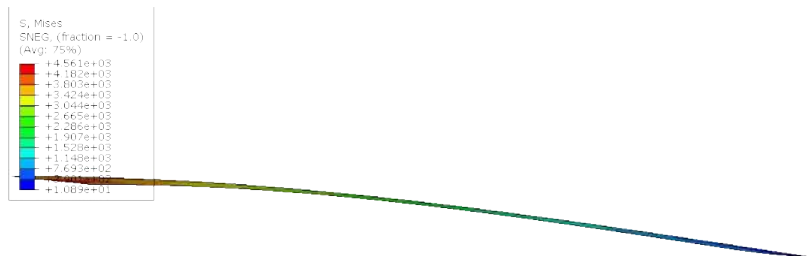
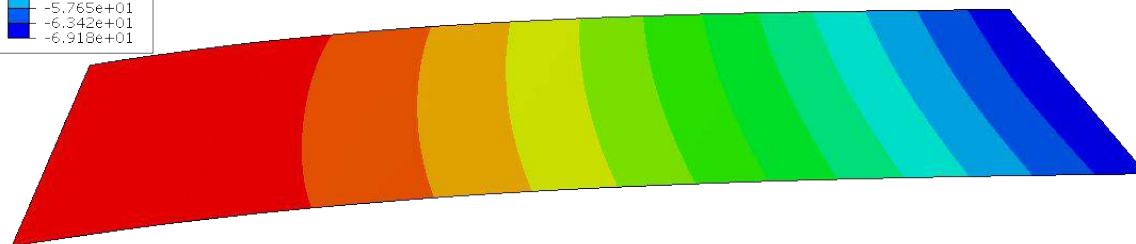
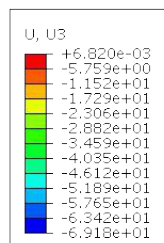


Plate with Time-dependent Load 2

- Plate mat. = Steel, dimension = 100 * 50 *2 mm
- Force = 1000 N
- E = 210,000 Mpa, poisson's ratio = 0.3
- Density = 7850 (Kg/m3)



ODB: Job-cos_periodic.odb Abaqus/Standard 3DEXPERIENCE R2018x Tue Jan 11 02:39:31 GMT+01:00 2022
 Step: Step-1
 Increment: 60 Step Time = 6.000
 Primary Var: S, Mises
 Deformed Var: U Deformation Scale Factor: +1.445e-01

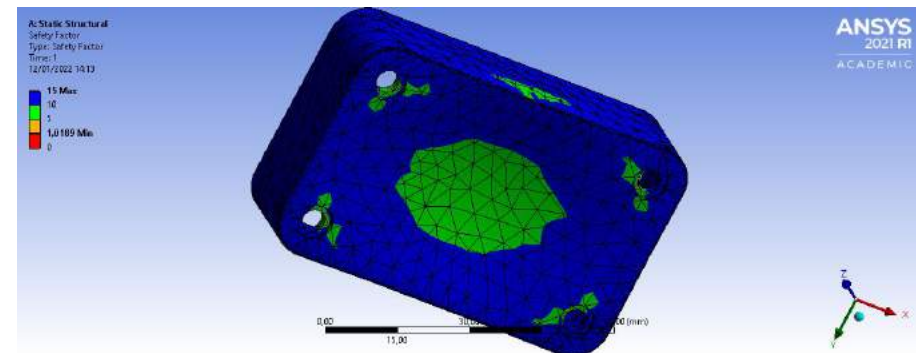
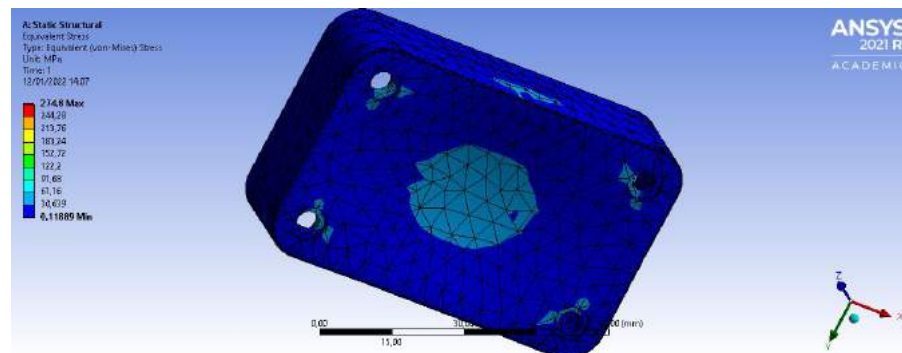
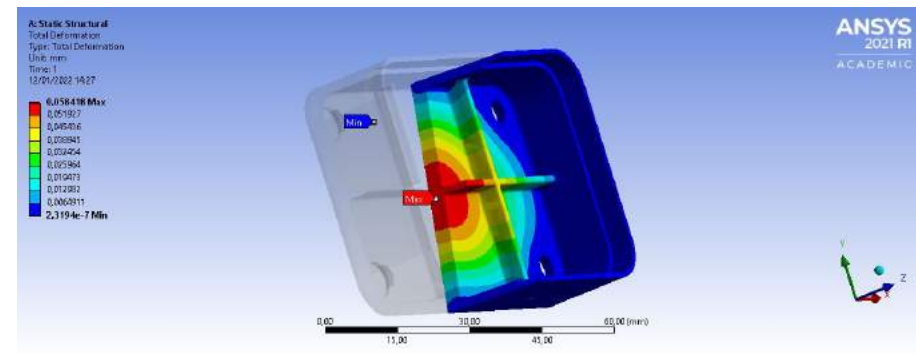
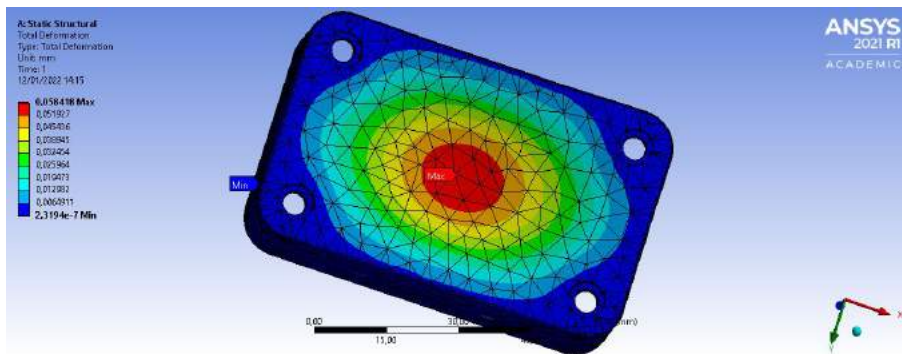
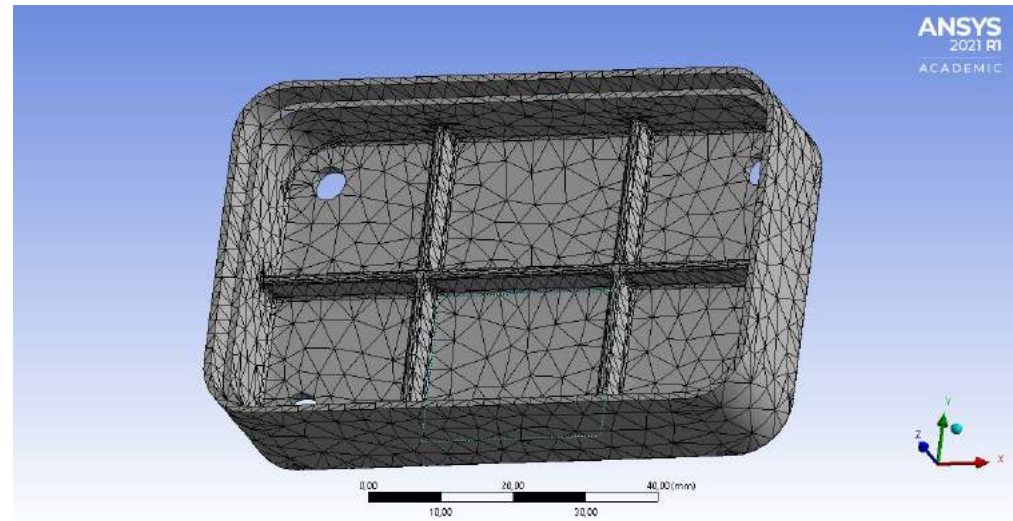


ODB: Job-cos_periodic.odb Abaqus/Standard 3DEXPERIENCE R2018x Tue Jan 11 02:39:31 GMT+01:00 2022
 Step: Step-1
 Increment: 60 Step Time = 6.000
 Primary Var: U, U3
 Deformed Var: U Deformation Scale Factor: +1.445e-01

Aluminium Cab Pressure Analysis

Applied External pressure = 1.0 Mpa

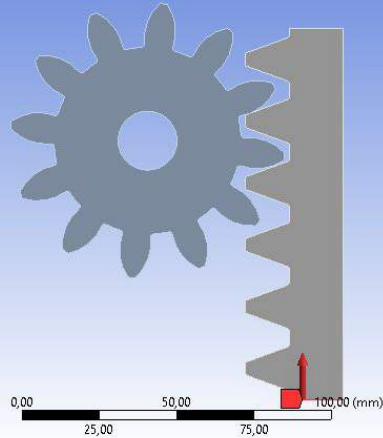
Find: Total deformation
Von Mises Stress
Safety factor



Force Reaction Calculation of a Gear

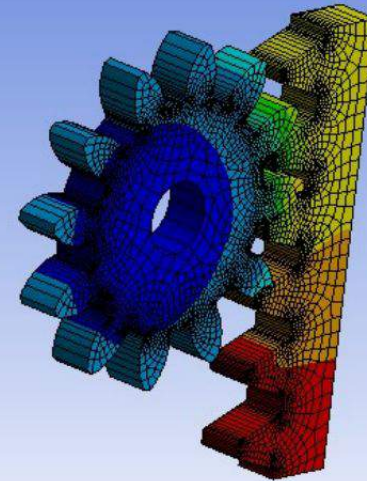
Force delivered on the Rack is 2500 N

Find: Total deformation & Moment reaction on the gear

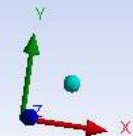
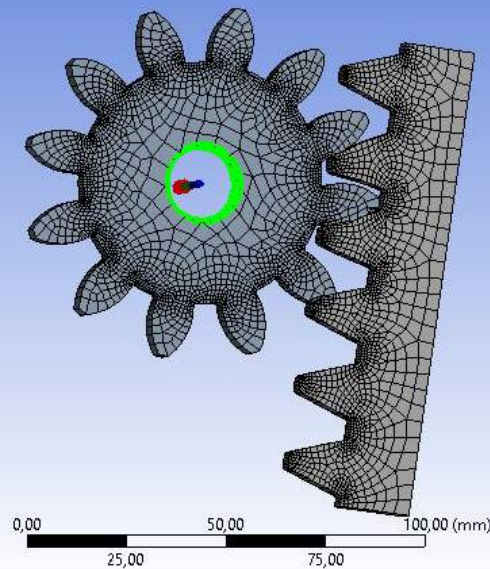


A: Static Structural
Figure
Type: Total Deformation
Unit: mm
Time: 1
12/01/2022 16:55

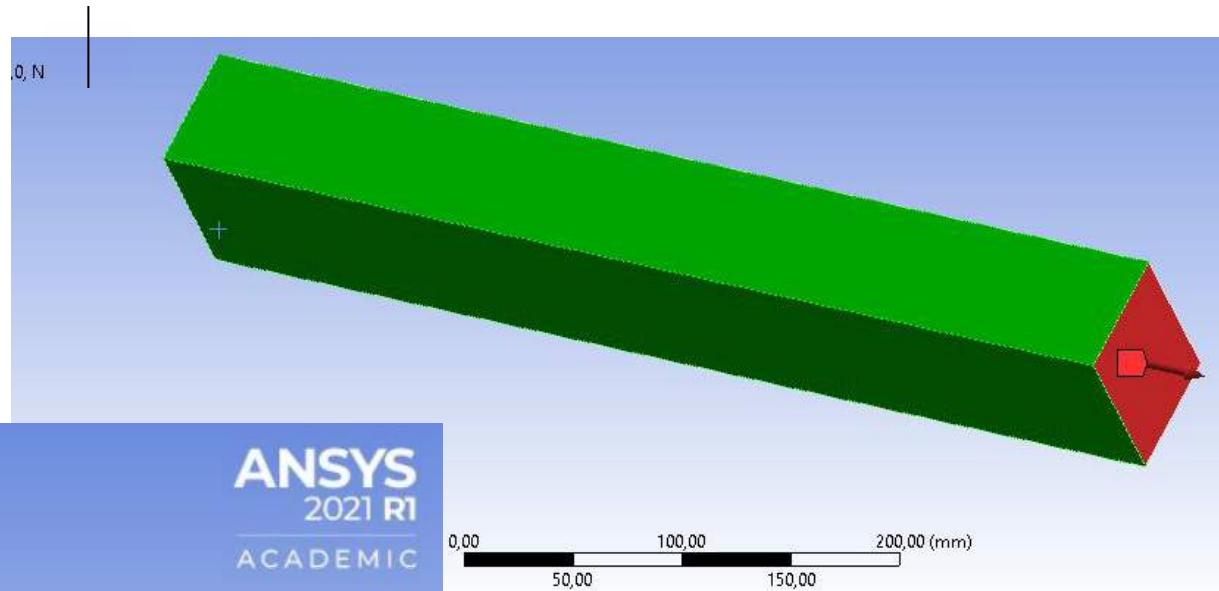
0,015888 Max
0,014132
0,012376
0,010619
0,0088634
0,0071072
0,0053511
0,003595
0,0018389
8,2763e-5 Min



A: Static Structural
Moment Reaction
12/01/2022 16:42



Static structural Analysis of a Beam



A: Static Structural

Figure

Type: Equivalent (von-Mises) Stress

Unit: MPa

Time: 1

12/01/2022 20:25

ANSYS
2021 R1
ACADEMIC

0,1295 Max
0,12123
0,11297
0,10471
0,096447
0,088185
0,079922
0,07166
0,063398
0,055136 Min

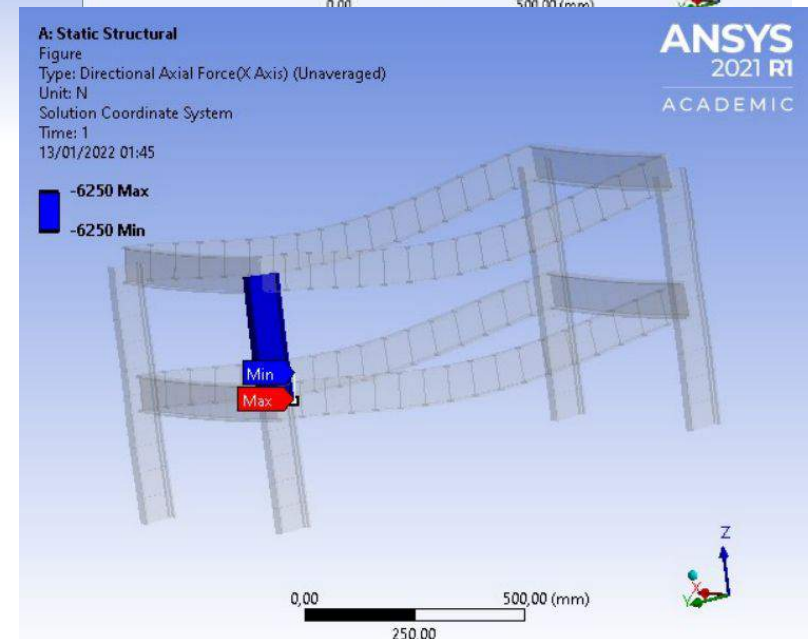
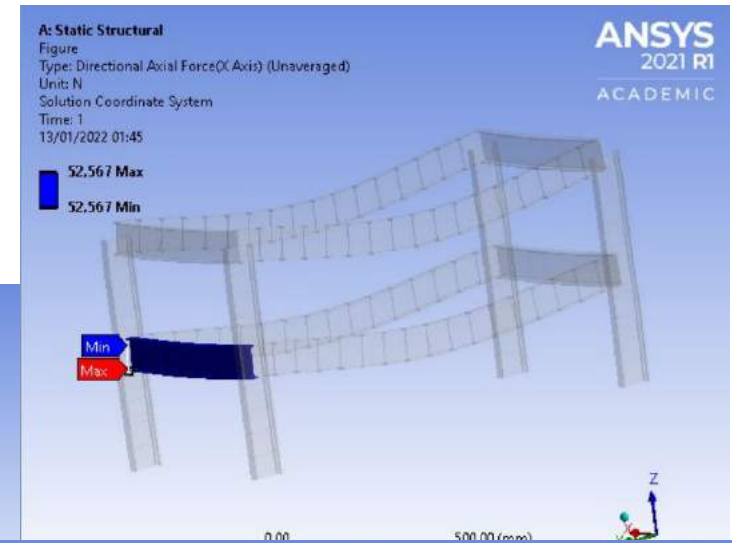
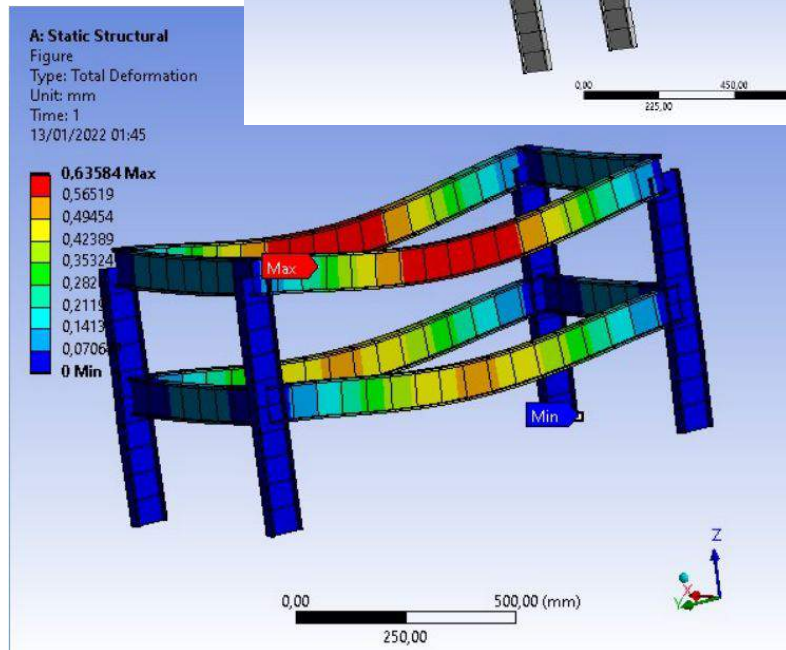
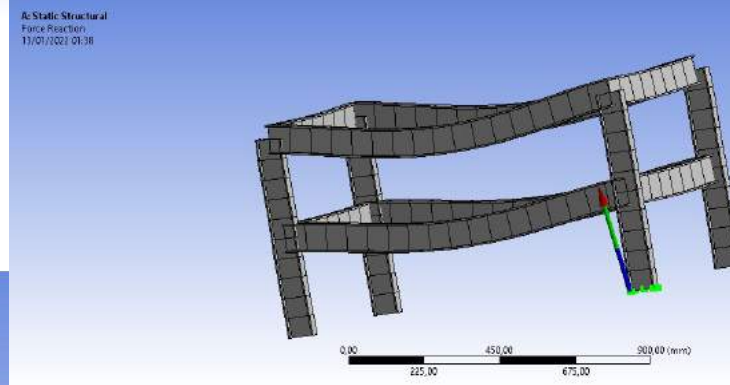
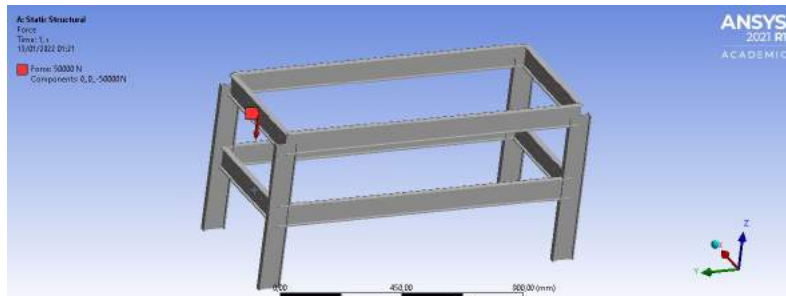
0,00 100,00 (mm)
50,00



Static structural Analysis of a Line -Body Table

Force delivered in z-direction is 50,000 N

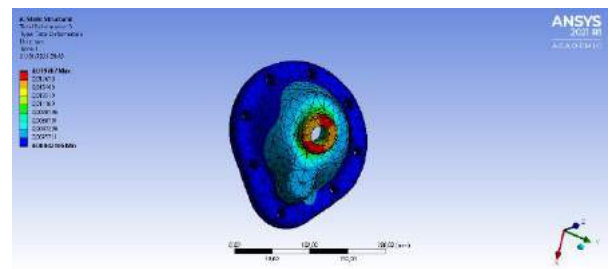
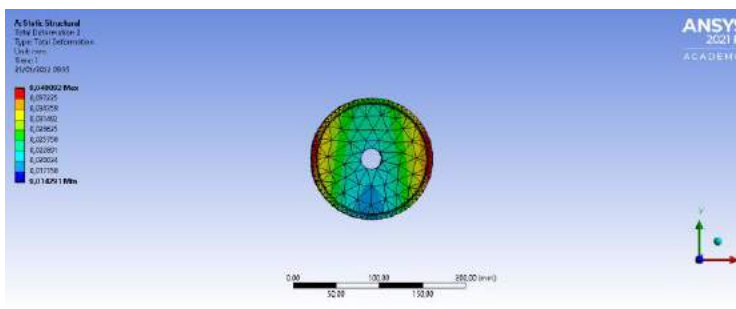
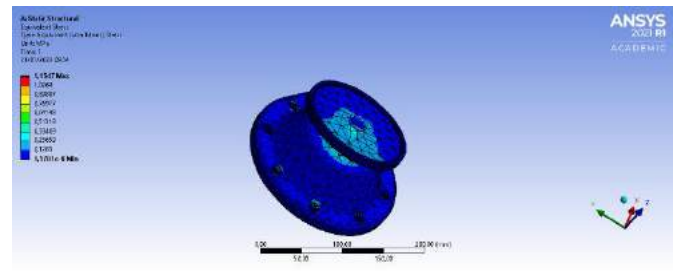
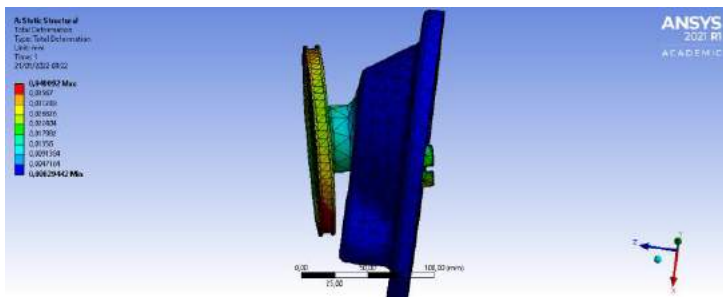
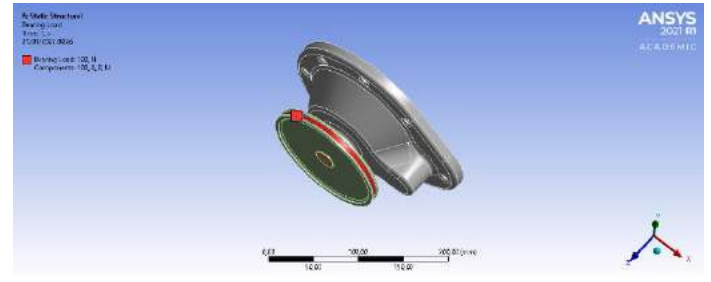
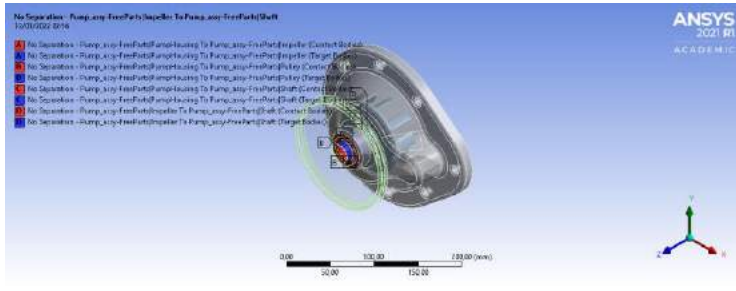
Find: Total deformation, Force reaction & Axial forces



Bearing Load Analysis of Belt Pulley

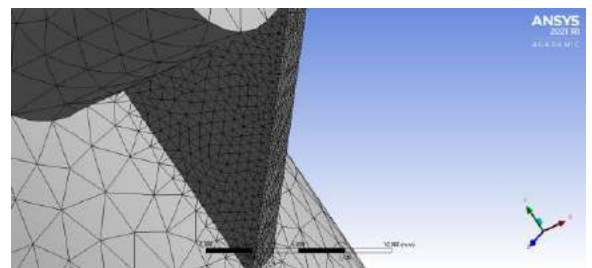
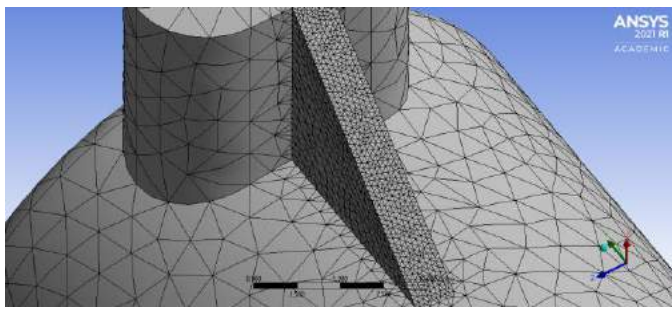
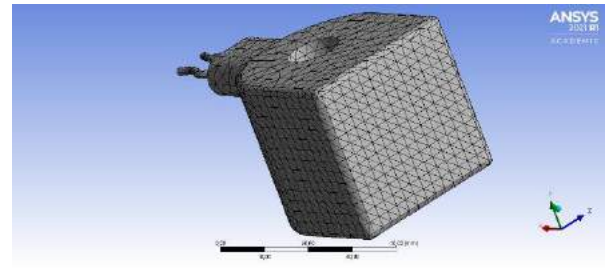
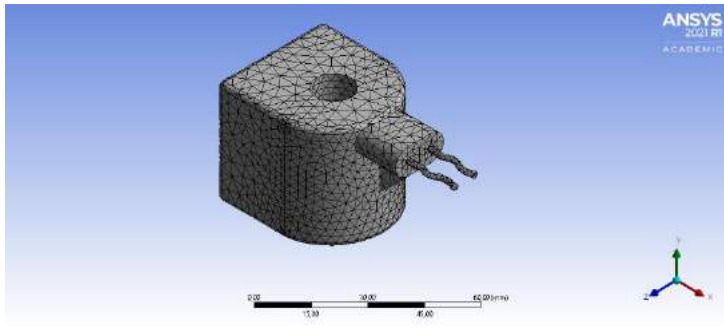
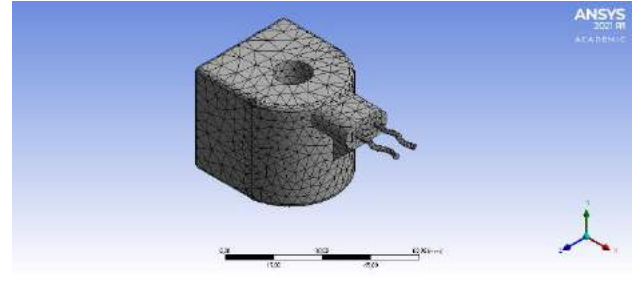
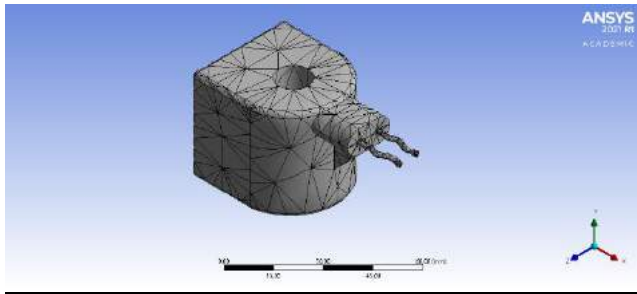
Bearing load (x-component) = 100 N

Find: Total deformation (on the: bearing/pulley part and deformed top plate), Equivalent stress.



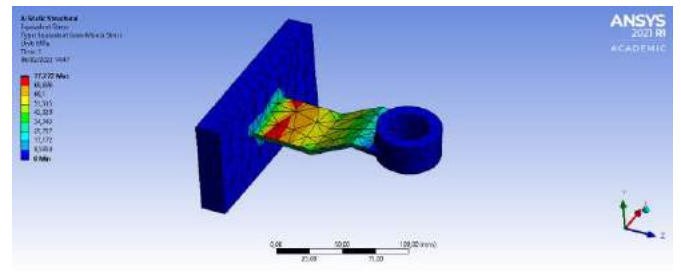
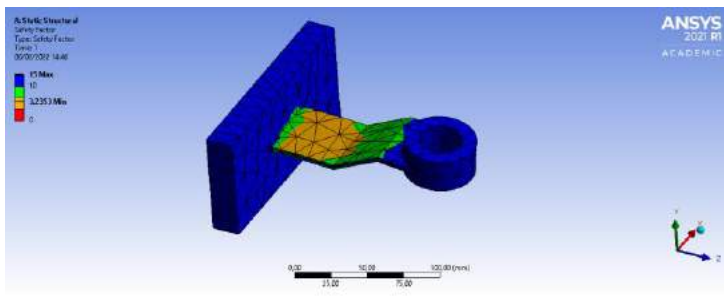
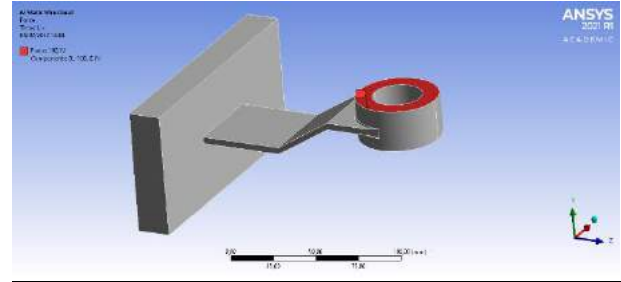
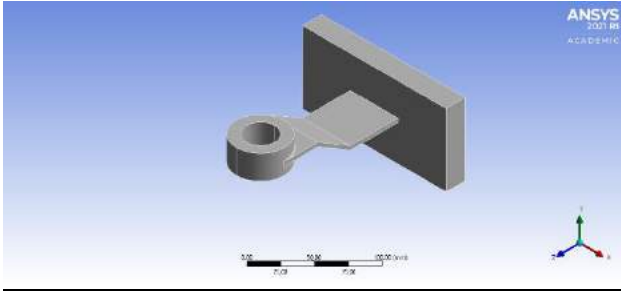
Creating a Mesh Model (Solenoid plug)

- Improving the mesh model

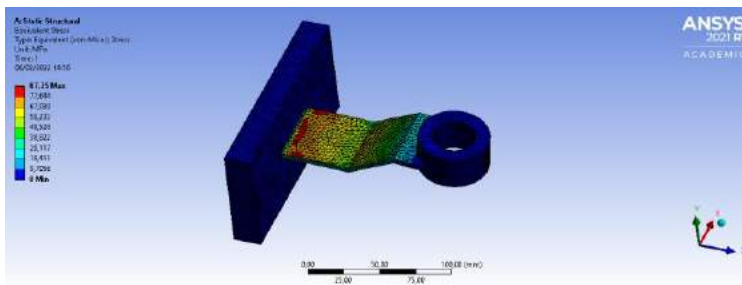


Static Structural Analysis of a Bracket Part

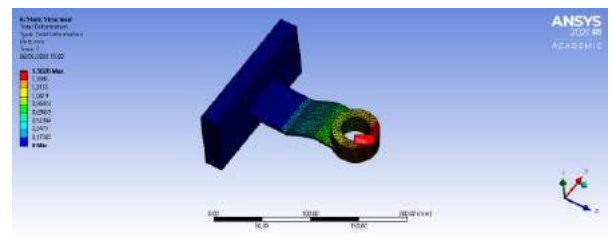
Material = Steel, Yield Strength = 230 MPa | Find: Safety factor, equivalent stress, total deformation.
Force = -100 N (y-component)



Equivalent stress before mesh refinement



Equivalent stress after mesh refinement

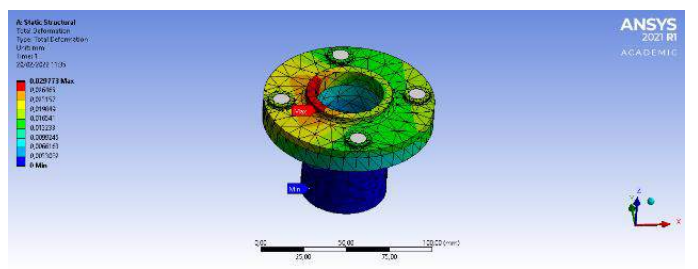
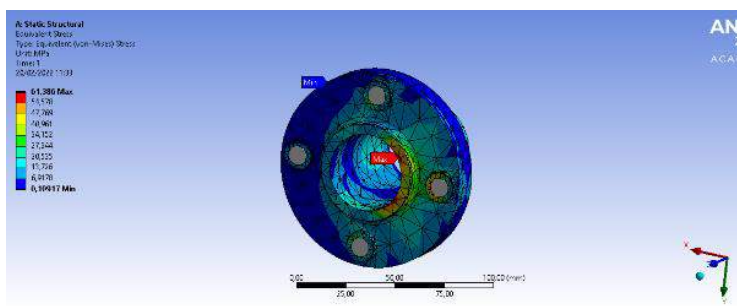
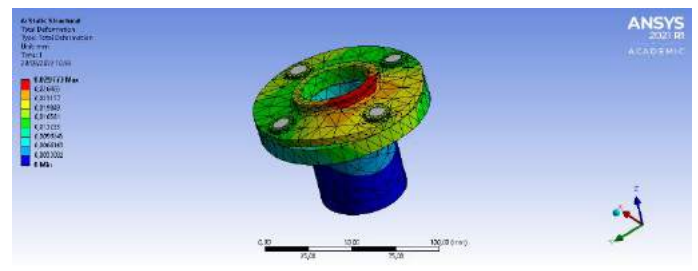
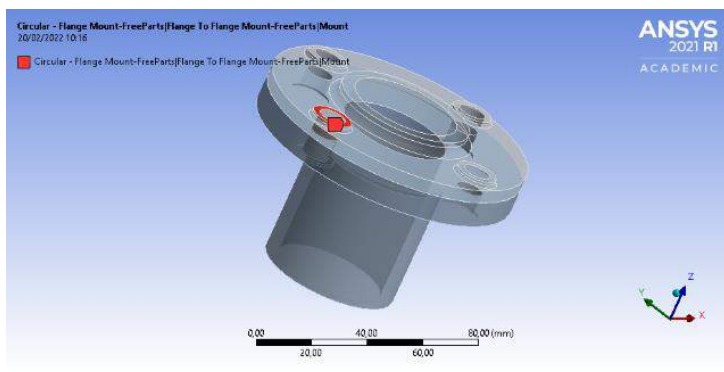
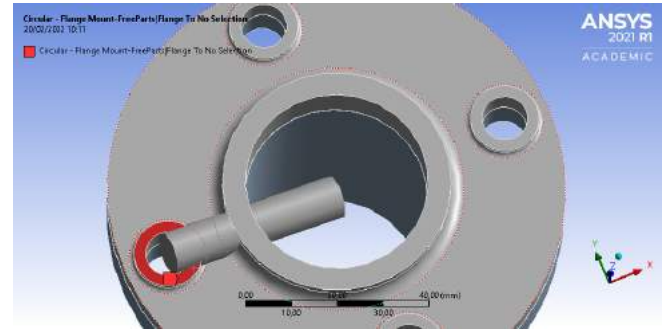
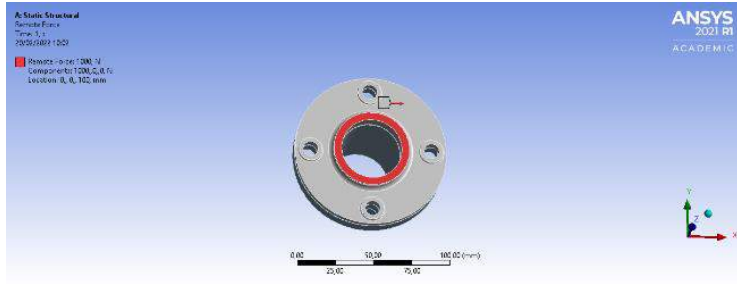


Total deformation after mesh refinement

Analysis of Bolt Connection

Remote force = 1000 N from Z-direction = 100 mm, Radius = 5 mm

Find: Total deformation, Equivalent stress



Analysis of Piston Joint Connection

Pressure = 0,5 MPa

Find: Total deformation, Equivalent stress

