Universiti Malaysia PAHANG
Engineering • Technology • Creativity

Mechanics of Materials

Project 1 - 2

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MATERIAL AND DESIGN USED

Materials.1

Material	Aluminium
Young's modulus	7e+010N_m2
Poisson's ratio	0.346
Density	2710kg_m3
Coefficient of thermal expansion	2.36e-005_Kdeg
Yield strength	9.5e+007N_m2

Boundary Conditions

Figure 1

1) BENDING MOMENT

Strain Energy : 4.339e-003 J

Equilibrium

Components	Applied Forces	Reactions	Residual	Relative Magnitude Error
Fx (N)	0.0000e+000	1.2662e-011	1.2662e-011	4.6751e-014
Fy (N)	0.0000e+000	5.2345e-011	5.2345e-011	1.9327e-013
Fz (N)	-2.0000e+002	2.0000e+002	-1.4037e-010	5.1830e-013
Mx (Nxm)	-2.0000e+000	2.0000e+000	-7.9128e-012	9.7387e-014
My (Nxm)	6.0000e+001	-6.0000e+001	1.0206e-010	1.2561e-012
Mz (Nxm)	0.0000e+000	-5.7273e-012	-5.7273e-012	7.0489e-014

Figure 2

Static Case Solution.1 - Von Mises stress (nodal values).2

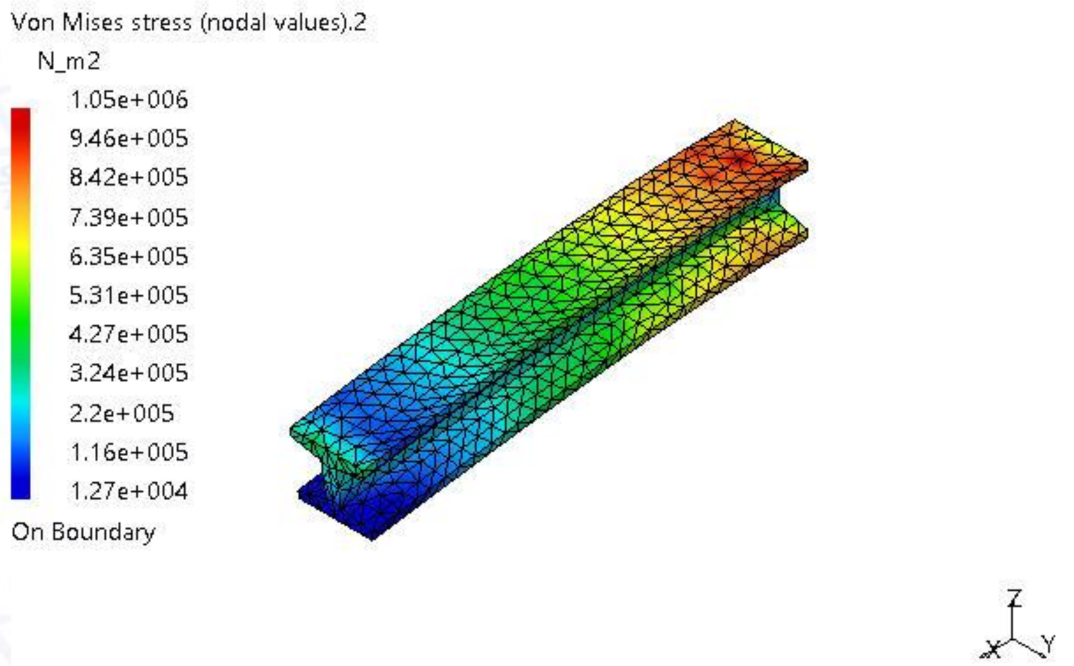


Figure 3

2) TORSION

Strain Energy : 2.425e-001 J

Equilibrium

Components	Applied Forces	Reactions	Residual	Relative Magnitude Error
Fx (N)	1.8667e-016	-1.9972e-010	-1.9972e-010	1.7730e-013
Fy (N)	-1.3811e-005	1.3812e-005	5.9686e-010	5.2985e-013
Fz (N)	-7.8231e-007	7.8192e-007	-3.9003e-010	3.4624e-013
Mx (Nxm)	-2.0000e+002	2.0000e+002	-3.7232e-012	1.1018e-014
My (Nxm)	2.3469e-007	-2.3458e-007	1.1612e-010	3.4362e-013
Mz (Nxm)	-4.1433e-006	4.1432e-006	-7.2010e-011	2.1309e-013

Figure 2

Static Case Solution.2 - Von Mises stress (nodal values).3

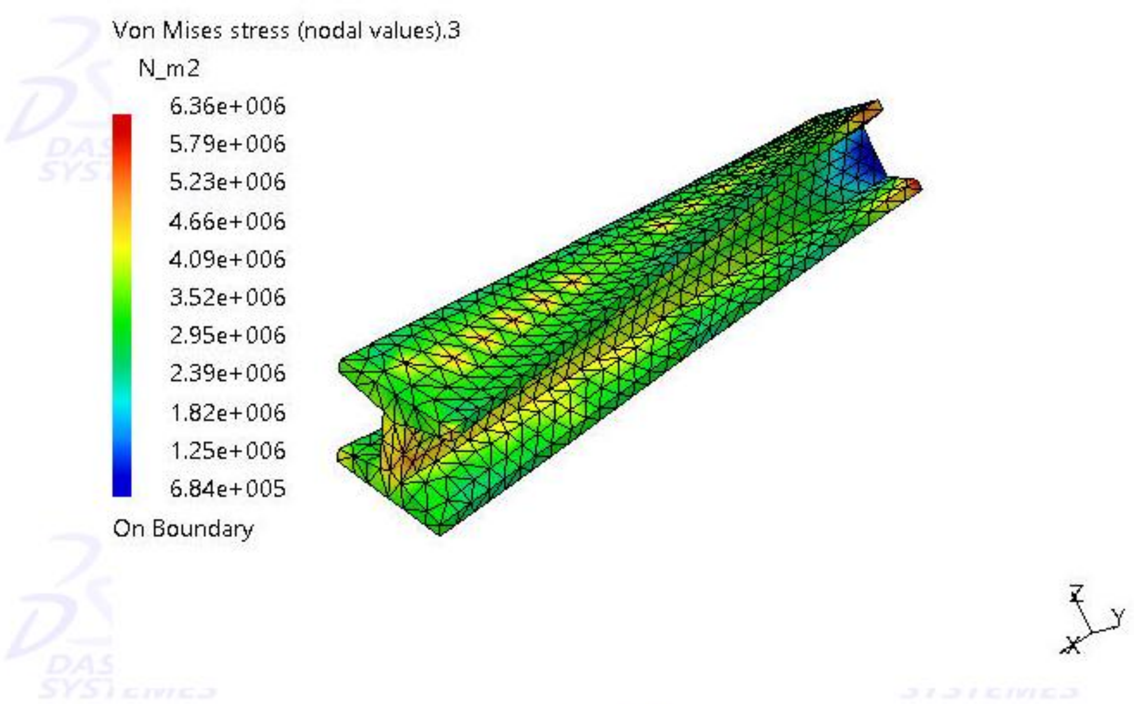
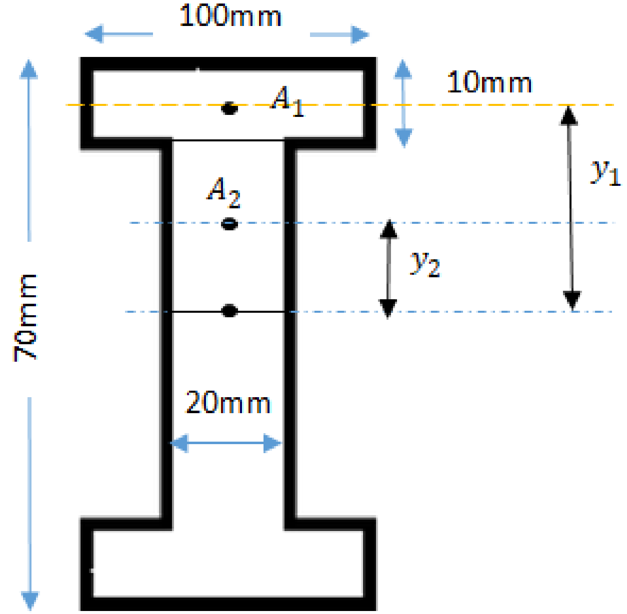


Figure 3

MANUAL CALCULATION



$$y = \frac{70}{2} = 35mm$$

$$I = \frac{1}{12}(100mm)(70mm)^3 - 2\left[\frac{1}{12}(40mm)(50mm)^3\right]$$

$$= 2.025 \times 10^{-6} mm^4$$

$$Q = \Sigma A' y'$$

$$= (100mm)(10mm)(40mm) + (35mm)(20mm)(17.5mm)$$

$$= 52.25 \times 10^{-6} mm^3$$

<u>Shear, τ</u>

$$\tau = \frac{VQ}{It}$$

$$= \frac{(200N)\left(52.25 \times 10^{-6} mm^3\right)}{(2.025 \times 10^{-6} mm^4)(0.020m)}$$

$$= 257.8\ MPa$$

<u>Tensile stress, σ</u>

$$\sigma = \frac{Mc}{I}$$

$$\sigma_1 = \frac{(200Nm)(0.0275m)}{2.025 \times 10^{-6}mm^4}$$

$$= +2.716MPa$$

$$\sigma_2 = \frac{(200Nm)(0.035m)}{2.025 \times 10^{-6}mm^4}$$

$$= -3.457MPa$$

Torsion, T

$$\tau = \frac{Tt}{I}$$

$$T = \frac{I\tau}{t} = \frac{(2.025 \times 10^{-6}mm^4)(257.8 \times 10^6 Pa)}{100 \times 10^{-3}m}$$

$$= 5.22KNm$$