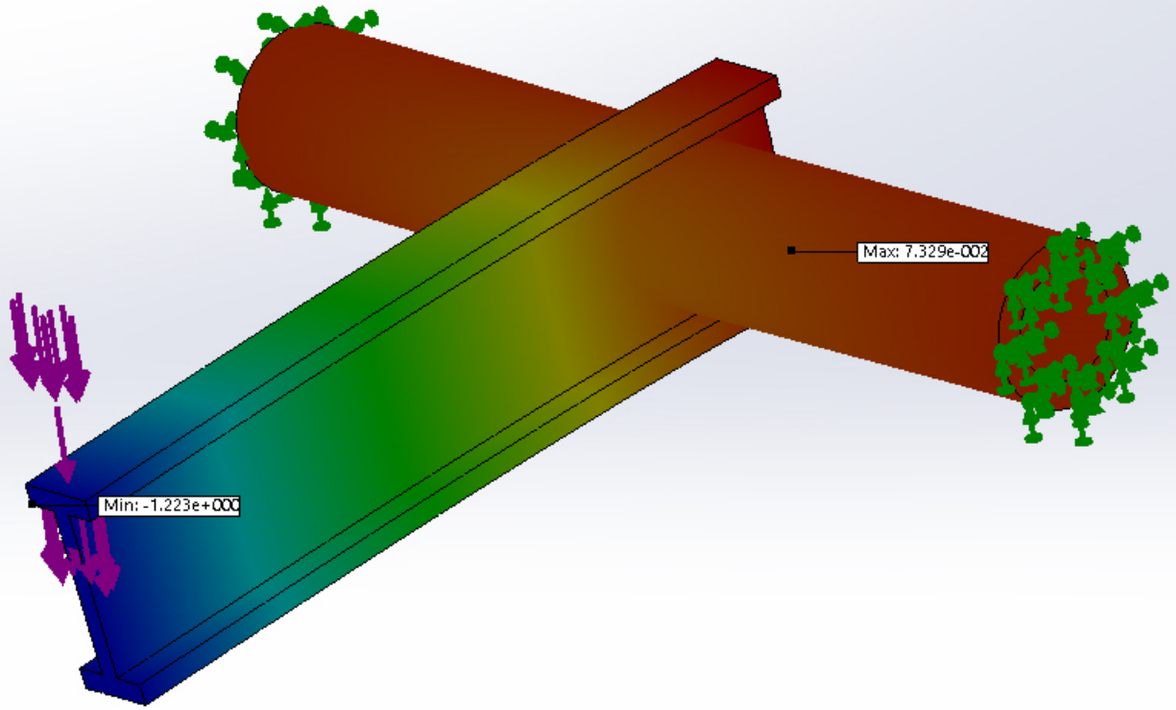
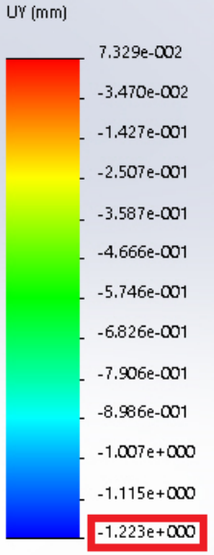
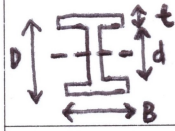
Model name:I-Beam
Study name:Static 2(-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 41.7161





I beam width = 30 mm	I beam depth = 100 mm	Tube Outer dia. = 75 mm	Tube Inner dia. = 50 mm	Mark

Second Moment of Area of I section beam

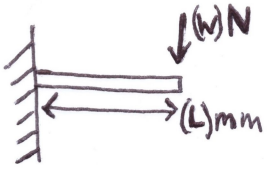


B = 30mm
D = 100mm
d = D − 2t = 100 − 2(10) = 80mm
b = B − t = 30 − 10 = 20mm

$I_{xx} = \frac{BD^3}{12} - \frac{bd^3}{12} = \frac{30\times100^3}{12} - \frac{20\times80^3}{12}$

$I_{xx} = 1646666.667\ mm^4$

Deflection due to bending of I section beam



$y_{max} = \frac{WL^3}{3EI}$

E = Young Modulus = $204999.9984\ Nmm^{-2}$

W = concentrated load: 10,000 N
L = Beam length: 350mm
I = I_{xx} above = $1646666.667\ mm^4$

$y = \frac{10000\times(350)^3}{3(2.049\times10^5)(1.6467\times10^6)}$

$y = 0.4233731641\ mm$

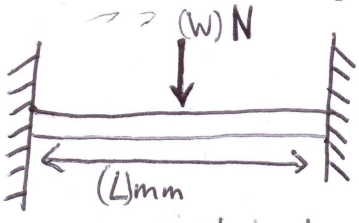
(−) downwards

Second Moment of Area of tube

$I_t = \frac{\pi(d_o^4 - d_i^4)}{64} = \frac{\pi(75^4 - 50^4)}{64}$

$I_t = 1246359.39\ mm^4$

Deflection due to bending of tubular built-in beam



$y_{max} = \frac{1}{192}\frac{WL^3}{EI_t}$

W = concentrated Load
L = Tube length = 500mm

$y = \frac{1}{192}\frac{(10\,000)\times500^3}{(2.049\times10^5)(1.246\times10^6)}$

$y = 0.025\,480\,71654\ mm$

Polar Second Moment of Area of tube

$J = \frac{\pi(d_o^4 - d_i^4)}{32} = \frac{\pi(75^4 - 50^4)}{32} = 2492718.78\ mm^4$

End deflection due to I beam sloping as tube twists under torsion.

Angle of twist $\theta = \frac{LT}{GJ}$

T = Torque on Tube Section

$T = \frac{350}{2}\times10\,000 = 1.75\times10^6\ Nmm$

G = Shear Modulus = $79999.99987\ Nmm^{-2}$

L = 250mm = Length of Tube Section

$\theta = \frac{250(1.75\times10^6)}{(7.99\times10^4)(2.49\times10^6)} = 2.193889681\times10^{-3}\ rad$

Def = 350 tan θ

Deflection = 0.7679 mm

Total Deflection 0.423 + 0.025 + 0.768 = −1.217 mm ↓