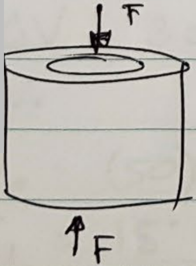
ENGG103

Tutorial 2
Week 2

Solutions



$l_0 = 0.42\,m$
$\Delta l = 0.00022\,m$
$F = 3000\,N$
$A = 0.000358\,m^2$

$\sigma = \frac{3000}{0.000358} = 8.4\ MPa$ (compressive force)

$\varepsilon = \frac{0.00022}{0.42} = 5.238 \times 10^{-4}$

$E = 16.04\ GPa \approx$ Cortical bone $\approx 17.9\ GPa$

Q1

Using the engineering stress-strain curve for a cylindrical specimen of AISI 1020 HR Steel having a diameter of 9.11 mm and a gauge length of 50.8 mm is pulled in tension.

For the data given in **Figures 1 (a) & (b)**, determine:

200 GPa (a) The elastic modulus (Young's modulus) of the steel (in units of GPa) **(3 marks)**

265 MPa (b) The yield steel (0.2% offset proof stress) (in units of MPa) **(2 marks)**

395 MPa (c) The tensile strength of the steel (in units of MPa) **(2 marks)**

36.46%el (d) The ductility of the steel expressed as percentage elongation (%EL) **(4 marks)**

(e) Consider another cylindrical specimen of the same AISI 1020 HR Steel, 9.5mm in diameter and
Δl= 0.1618mm 90mm long that is pulled in tension.
Determine its elongation when a load of 12500N is applied. **(4 marks)**

Show clearly all your written calculations and mark data points on graph.

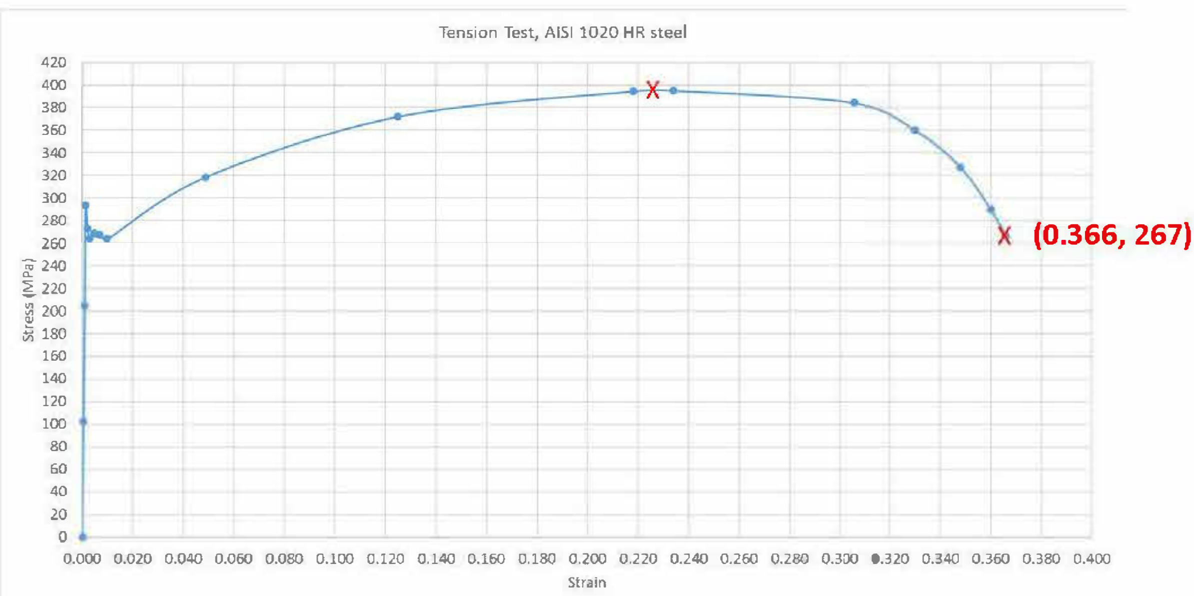


Figure 1 (a): Tensile stress-strain curve for AISI 1020 HR steel sample.

(d)

Elastic strain = $\dfrac{267}{200000} = 0.001335$

Plastic strain = 0.366 – 0.001335 = 0.3646 =36.46%El

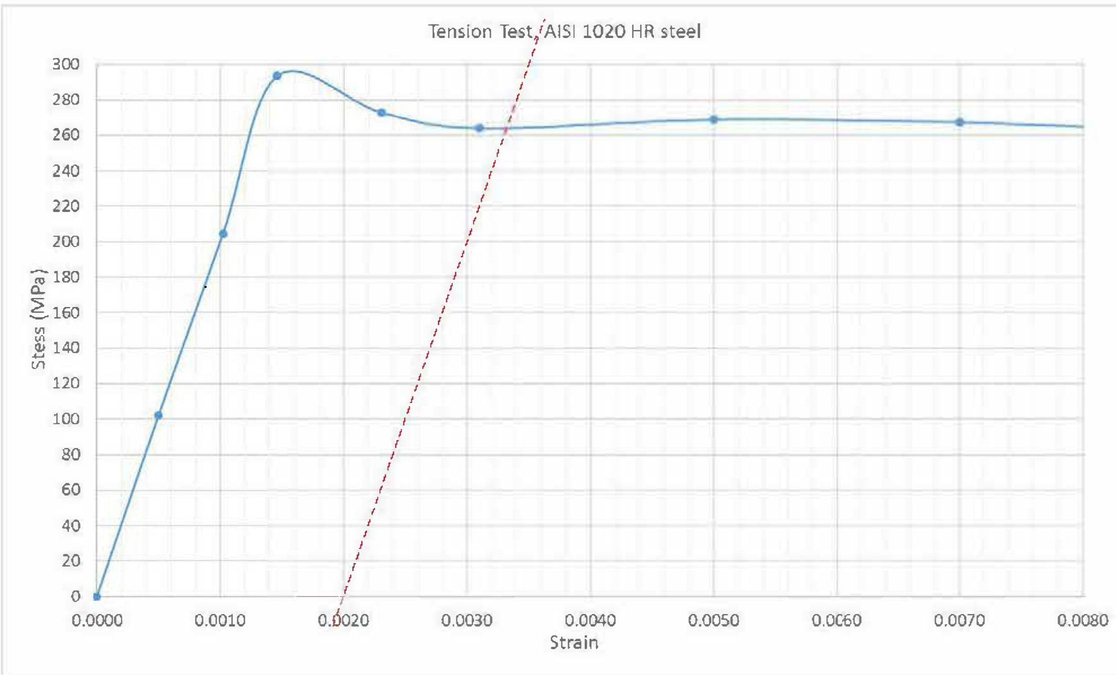


Figure 1 (b): Tensile stress-strain curve for AISI 1020 HR steel sample.

e) $\phi = 9.5\ mm$ $\quad A = \frac{\pi}{4}(9.5)^2 = 70.88\ mm^2$

$L = 90\ mm$

$\sigma = \frac{F}{A} = \frac{12500}{70.88} = 176.35\ MPa$

From AISI 1020 HR Steel stress-strain graph:

$\varepsilon \simeq 0.0009$

$\varepsilon = \frac{\Delta L}{L_o} \Rightarrow \Delta L = \varepsilon L_o = (0.0009)(90) = 0.081\ mm$

Question 2.4

Solve

$$\delta = \frac{1}{48}\frac{Fl^3}{EI} \qquad \text{(rearrange to make } F \text{ the subject)}$$

$$\therefore\ F = \frac{48\delta EI}{l^3}$$

$$\therefore\ F = \frac{48 \times 8.0\ \text{mm} \times 207{,}000\ \text{MPa} \times 15{,}300\times10^6\ \text{mm}^4}{(12{,}000\ \text{mm})^3}$$

$$\therefore\ F = 703{,}800\ \text{N}$$

$$\therefore\ \boldsymbol{F} = \mathbf{703.8\ kN}$$