# H.W.#5

(6 questions, 100.00 points)

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Question 1 (of 6)

A ductile hot-rolled steel bar has a minimum yield strength in tension and compression of 350 MPa. Using the distortion-energy and maximum-shear-stress theories, determine the factors of safety for the following plane stress states.

References

Section Break Difficulty: Easy

Source: Shigleys Mechanical Engineering Design (Nisbett, ISBN 1260407616) > Chapter 05 End of Chapter Problems: Failures Resulting from Static Loading

1. Award: **20.00 points** Problems? Adjust credit for all students. Required information

$\sigma_y = 0$

$\sigma_x$ = 108 MPa, and $\tau_{xy}$ = -68.5 MPa (Round the final answers to three decimal places.)

The factor of safety from the maximum-shear-stress theory is $\boxed{2.182}$, and the factor of safety from the distortion-energy theory is $\boxed{2.01}$.

$$\sigma' = \sqrt{\sigma_x^2 + 3\tau_{xy}^2} = \sqrt{(108)^2 + 3(-68.5)^2} = \sqrt{11{,}664 + 14{,}076.75} = 160.439 \text{ MPa}$$

$$n_{DE} = \frac{S_y}{\sigma'} \rightarrow S_y = 350 \text{ MPa} \rightarrow \frac{350}{160.44} = 2.182$$

2. MSS

$$\tau_{yield} = \frac{S_y}{2} = 175 \;;\; \sigma_{avg} = \frac{108}{2} = 54 \text{ MPa} \;;$$

$$R = \sqrt{\sigma_{avg}^2 + \tau_{xy}^2} = \sqrt{54^2 + (-68.5)^2} = \sqrt{2{,}916 + 4692.3} = 87.23 \text{ MPa}$$

$$R = \tau_{max} = 87.23 \;;\; \sigma_{MSS} = 2(\tau_{max}) = 2(87.23) = 174.45$$

$$n_{MSS} = \frac{S_y}{\sigma_{MSS}} = \frac{350}{174.45} = 2.01 \checkmark$$

A ductile hot-rolled steel bar has a minimum yield strength in tension and compression of 350 MPa. Using the distortion-energy and maximum-shear-stress theories, determine the factors of safety with the following principal stresses.

References

Section Break Difficulty: Easy

Source: Shigleys Mechanical Engineering Design (Nisbett, ISBN 1260407616) > Chapter 05 End of Chapter Problems: Failures Resulting from Static Loading

2. Award: **20.00 points** Problems? Adjust credit for all students. Required information

$\sigma_A = 106 \text{ MPa}$, and $\sigma_B = \text{-}106 \text{ MPa}$
(Round the final answers to three decimal places.)

The factor of safety from the maximum-shear-stress theory is [ ], and the factor of safety from the distortion-energy theory is [ ].



3. Award: **20.00 points** Problems? Adjust credit for all students.

An AISI 1018 steel has a yield strength, $S_y = 295 \text{ MPa}$. Given: $\sigma_x = 75 \text{ MPa}$, $\sigma_y = \text{-}35 \text{ MPa}$, and $\tau_{xy} = 0 \text{ MPa}$.
Determine the factor of safety using the distortion-energy theory. (Round the final answer to three decimal places.)

The factor of safety is [ ].

4. Award: **20.00 points** Problems? Adjust credit for all students.

An AISI 4142 steel bar, Q&T at 800°F exhibits $S_{yt} = 235 \text{ kpsi}$, $S_{yc} = 285 \text{ kpsi}$, and $\varepsilon_f = 0.07$. Given: $\sigma_x = 125 \text{ kpsi}$, $\sigma_y = 0 \text{ kpsi}$, and $\tau_{xy} = \text{-}75 \text{ kpsi}$.
Determine the factor of safety using the Coulomb-Mohr theory. (Round the final answer to three decimal places.)

The factor of safety is [ ].

A ductile hot-rolled steel bar has a minimum yield strength in tension and compression of 350 MPa. Using the distortion-energy and maximum-shear-stress theories, determine the factors of safety with the following principal stresses.

References

Section Break Difficulty: Easy

$S_y = 350$

Source: Shigleys Mechanical Engineering Design (Nisbett, ISBN 1260407616) > Chapter 05 End of Chapter Problems: Failures Resulting from Static Loading

2. Award: **20.00 points** Problems? Adjust credit for all students. Required information

$\tau_{xy} = 0$

$\sigma_A = 106$ MPa, and $\sigma_B = -106$ MPa
(Round the final answers to three decimal places.)

The factor of safety from the maximum-shear-stress theory is [ ], and the factor of safety from the distortion-energy theory is [ ].

$\boxed{MSS}$ $\sigma_{MSS} = \sigma_1 - \sigma_3 = 106 - (-106) = 212\text{ MPa}$ ; $n_{MSS} = \frac{S_y}{\sigma_{MSS}} = \frac{350}{212} = 1.651$

$\boxed{\text{Von Misses}}$ $\sigma' = \sqrt{\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2} \rightarrow \sqrt{106^2 - 106(-106) + (-106)^2} = \sqrt{3[11,236]}$

$\sigma' = \sqrt{33,708} = 183.59$ $n_{DE} = \frac{S_y}{\sigma'} = \frac{350}{183} = 1.906$

3. Award: **20.00 points** Problems? Adjust credit for all students.

An AISI 1018 steel has a yield strength, $S_y = 295$ MPa. Given: $\sigma_x = 75$ MPa, $\sigma_y = -35$ MPa, and $\tau_{xy} = 0$ MPa. Determine the factor of safety using the distortion-energy theory. (Round the final answer to three decimal places.)

The factor of safety is 2.682.

$\sigma_{MSS} = 75 - (-35) = 110\text{ MPa}$ ; $n_{MSS} = \frac{295}{110} = 2.682$

4. Award: **20.00 points** Problems? Adjust credit for all students.

An AISI 4142 steel bar, Q&T at 800°F exhibits $S_{yt} = 235$ kpsi, $S_{yc} = 285$ kpsi, and $\varepsilon_f = 0.07$. Given: $\sigma_x = 125$ kpsi, $\sigma_y = 0$ kpsi, and $\tau_{xy} = -75$ kpsi.
Determine the factor of safety using the Coulomb-Mohr theory. (Round the final answer to three decimal places.)

The factor of safety is 1.2428.

$S_{yt} = 235\text{ Kpsi}$ ; $S_{yc} = 285\text{ Kpsi}$ $\varepsilon_f = .07 > .05$

$C = \frac{125+0}{2} = 62.5\text{ Kpsi}$

$R = \sqrt{62.5^2 + (-75)^2} = \sqrt{9531.25} = 97.63\text{ Kpsi}$

$\sigma_1 = C + R = 62.5 + 97.63 = 160.13$

$\sigma_2 = C - R = 62.5 - 97.63 = -35.12$

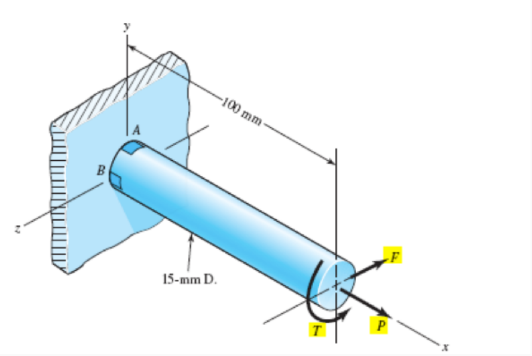
Coulomb-Mohr for $\sigma_A > 0 > \sigma_B$

$\frac{\sigma_A}{S_{yt}} - \frac{\sigma_B}{S_{yc}} = \frac{1}{n}$

$\frac{160.13}{235} - \frac{(-35.12)}{285} = 1/n$

$.80465 = \frac{1}{n} \rightarrow n = 1.2428$

This problem illustrates that the factor of safety for a machine element depends on the particular point selected for analysis. Here you are to compute factors of safety, based upon the distortion-energy theory, for stress elements at A and B of the member shown in the figure. This bar is made of AISI 1006 cold-drawn steel and is loaded by the forces $F = 0.550\ \text{kN}$, $P = 4.00\ \text{kN}$, and $T = 25.00\ \text{N·m}$. Given: $S_y = 280\ \text{MPa}$.




5. Award: **10.00 points** Problems? Adjust credit for all students. Required information

What is the value of the shear stress at point A?

The value of the shear stress at point A is [ ] MPa.

41.88

6. Award: **10.00 points** Problems? Adjust credit for all students. Required information

What is the value of the axial stress at point A?

22.6

The value of the axial stress at point A is [ ] MPa.

1. $F = .55\,kN = 550\,N$ (along z-axis) ; $P = 4000\,N$ ; $T = 25\,N\cdot m$ ; $S_y = 280\,MPa$ ; $d = .015\,m$

$A_{cr} = \frac{\pi}{4} d^2 = \frac{\pi}{4}(.015)^2 = 1.767\times10^{-4}\,m$

$\sigma_{axial} = \frac{P}{A_{cr}} = 4000 / 1.767\times10^{-4} = 22.64\,MPa$

* From Bending (F creates Bending from y-axis) $\rightarrow \sigma = M_y \cdot z / I = \emptyset$ since point A is colinear to y-axis

Total axial stress $= \sigma_x = 22.6\,MPa$

$\tau$ @ A $\rightarrow$ Due to torsion $\rightarrow \tau_{torsion} = 16T / \pi d^3 = 16(25\,N\cdot m) / \pi(.015\,m)^3 = 37.73\,MPa$

Due to F $\rightarrow \tau_F = 4F / 3A_{cr} = 4(550\,N) / 3(1.767\times10^{-4}) = 4.15\,MPa$

$\tau_{total} = 37.73 + 4.15 = 41.88\,MPa$