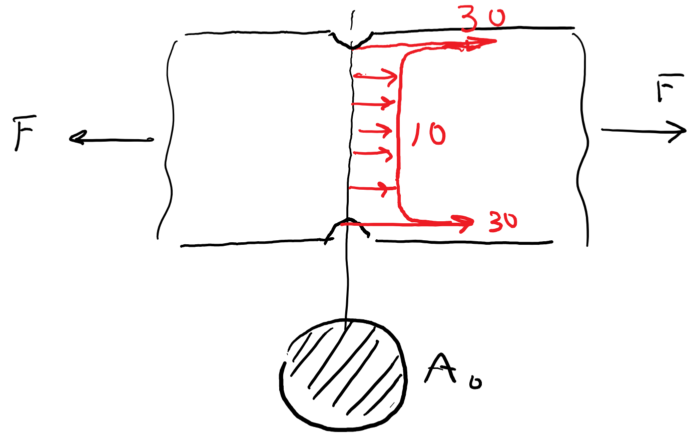
1/12/22

#1)



$\sigma_{nom} = \frac{F}{A_0}$

$\sigma_{nom} = 10$ ksi

$S_y = 60$ ksi

$K_t \equiv$ theoretical stress concentration factor

$K_t = 3$

σ_{act} = Actual stress

$\sigma_{Theoretical} = K_t \sigma_{nom} = 3(10) = 30$ ksi

Answers:

- (F)
- (T)
- (F)

n = Factor of Safety $\equiv \frac{S_y}{\sigma_{nom}} = \frac{60}{10} = 6$

For static loading & ductile behavior

We ignore K_t

#2)

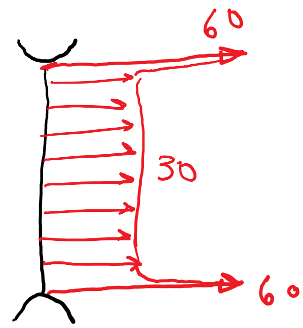
$\sigma_{nom} = 30$

$\sigma_{theoretical} = 90$

$K_t = 3$

$S_y = 60$

$\sigma_{act} = 60$ ksi



– (F)

– (T)

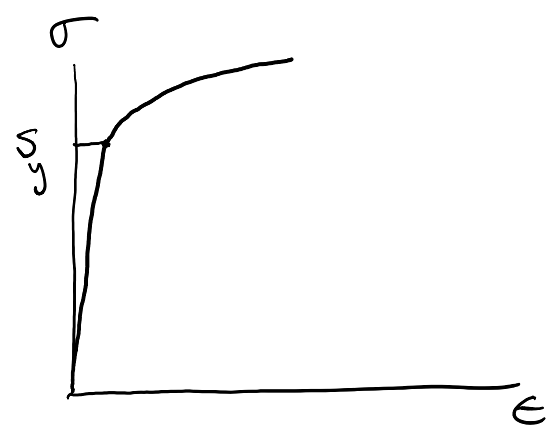
$$n = \frac{S_y}{\sigma_{nom}} = \frac{60}{30} = 2$$

– (F)

#3)

a. (F)

b. (T)



#4)

Two reasons

I) Yielding is the onset of plastic deformation

II) After yielding the material stretches a lot with little added force

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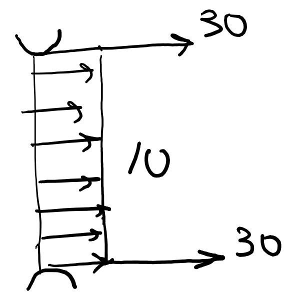
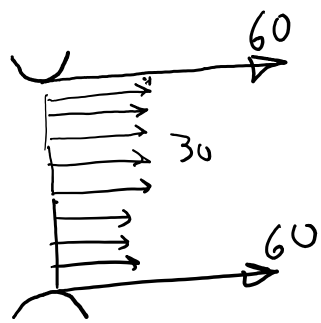
#5)

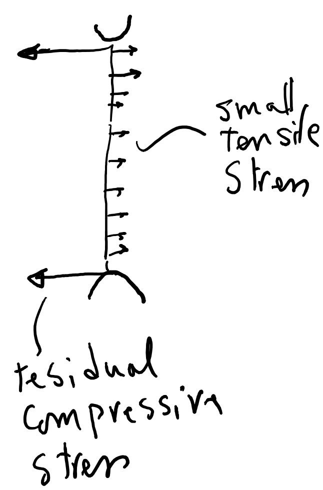
(c) No stresses remain



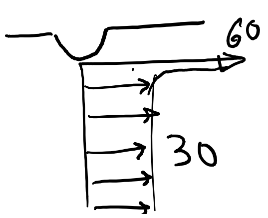
#6)

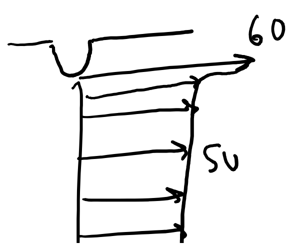


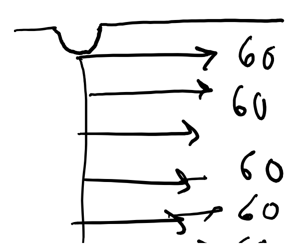
before load is removed

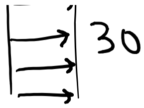


(b) Compressive

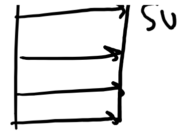




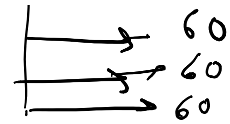




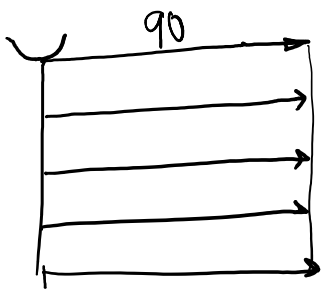
Start
No measurable deformation



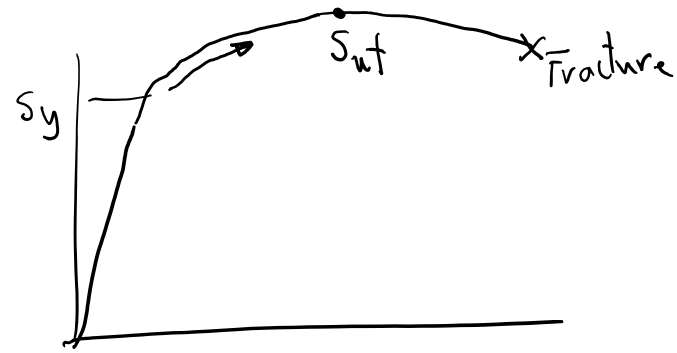
Add to stress (force)
So $\sigma_{nom} = 50$



Add to stress (force)
Start of measurable def.
So $\sigma_{nom} = 60$



Add to stress
So $\sigma_{nom} = 90$ ksi



- A part fails only when bulk yielding occurs (measurable, objectionable deformation)

#7) (T)

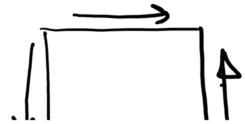
#8) (T)

#9) (T)

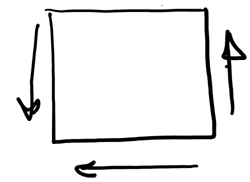
#10)

(c) $\sigma_V \equiv$ Von Mises stress

#11) Pure shear



#11) Pure shear

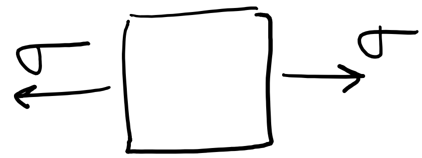


$$\sigma_V = \sqrt{\sigma^2 + 3\tau^2}$$

$$\sigma = 0$$

$$\sigma_V = \sqrt{3}\,\tau$$

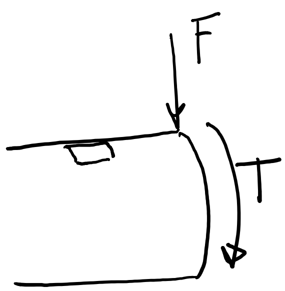
#12

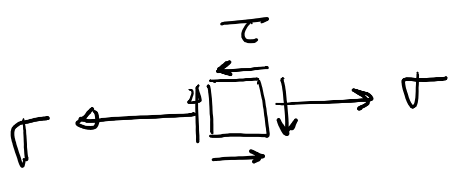


$$\sigma_V = \sqrt{\sigma^2} \quad \boxed{\tau = 0}$$

$$\sigma_V = \sigma$$

#13)





$$\sigma_V = \sqrt{\sigma^2 + 3\tau^2}$$

#14)

(c) $\sigma_V = \sqrt{3}\,\tau$

#15) True

#16 (T)

#17)

(F)

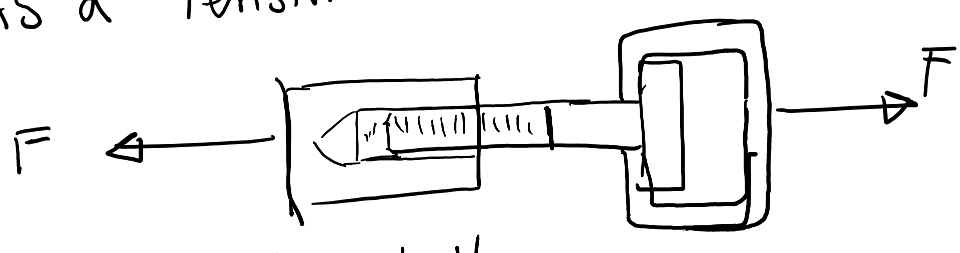
(T)

(F)

#18) Repeated yielding at areas of high stress concentration makes the material brittle and eventually a crack forms & propagates with each load application

Fastener Applications

As a tension bar



Q

Given: 1.5 in UNC bolt
Grade 5
F = 15000 lbs

(Static loading)

Find: Factor of safety guarding against exceeding proof strength

(usually $K_t = 3.8$ but we will not need it)

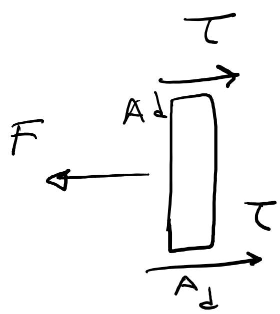
$[illegible] = \frac{F}{[illegible]} = \frac{15000}{[illegible]} = 10676.1$ psi

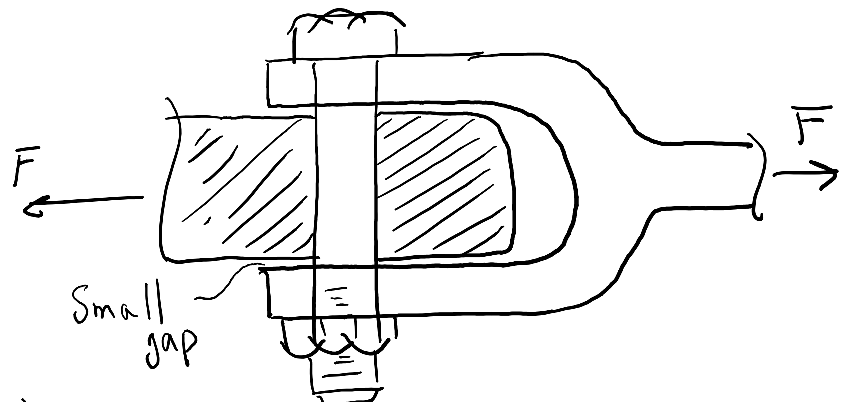
$$\sigma_n = \frac{\quad}{A_t} \qquad 1.405$$

$$S_p = 74000 \text{ psi}$$

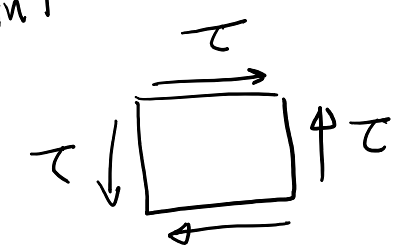
$$n = \frac{S_p}{\sigma} = \frac{74000}{10676} = 6.9 \leftarrow$$

Application ≡ As a shear pin





Double shear
Tongue & clevis joint



Pure shear stress element

Given:

- 1 in UNC
- F = 10,000 lbs
- Grade 2

Find: Factor of safety guarding against (bulk) yielding of the shank cross section

$$\tau_{nom} = \frac{F}{2A_d} = \frac{10\,000}{2(0.785)} = 6366.2 \text{ psi}$$

where

$$A_d = \frac{\pi d^2}{4} = 0.785$$

Given $S_y = 36$ Ksi

$$n = \frac{S_y}{\sigma_v} = \frac{S_y}{\sqrt{3}\,\tau} = \frac{0.58\, S_y}{\tau}$$

$$n = \frac{0.58\,(36000)}{6366.2} \cong 3.3 \leftarrow$$

Application ≡ Fastener used to clamp Plates

Given 1.5 in UNC

$K_b = 0.8\, K_m$

$F_i \equiv 75\%$ Proof strength

$F_e = 20\,000$ lbs

Find: Load factor guarding against bolt exceeding its proof load

$$n_L = \text{load factor} = \frac{F_e^*}{F_e}$$

$F_e^* \equiv$ external load leading to bolt exceeding its proof strength

$\bar{F}_e \equiv$ Actual external load

Joint index

$$C = \frac{K_b}{K_b + K_m} \Rightarrow C = 0.44$$

initial tension

$$F_i = 0.75\ F_p = 0.75(46365) = 34770 \text{ psi}$$

where

$$F_p = A_t S_p = 1.405(33000) = 46365$$

Proof load

where

$$A_t = 1.405$$

$$S_p = 33000 \text{ psi}$$

Bolt load

$$F_b = F_i + C F_e$$

$$F_b = 34.77 + 0.44(20) \quad \text{Kips}$$

$$F_b = 43.57 \text{ Kips}$$

External load F_e^* causing the bolt to exceed its Proof strength is

$$F_b = F_i + C F_e$$

Sub. $F_b = F_p = 46.365$ kips

$$46.365 = 34.77 + 0.44 F_e^*$$

$$\Rightarrow F_e^* = 26.35 \text{ kips}$$

Load factor

$$n_L = \frac{F_e^*}{F_e} = \frac{26.35}{20} = 1.32 \leftarrow$$
