Specification of Preload

force on bolt \( F_b = F_i + \Delta P \)

Stress \( \sigma = \frac{F_b}{A_t} = \frac{F_i + \Delta P}{A_t} \leq \sigma_{ut} \)

- to prevent fracture, require \( F_i \leq \sigma_{ut} \cdot A_t - \Delta P \) (Yielding), \( F_n = -F_i - (1-c)P \leq 0 \)
  Recall: to prevent separation, also want \( F_n \geq (1-c)P \)

\( F_n \) - bolt fracture \( \gamma \) - joint separation

\( \gamma_s \) - proof stress

\( \gamma_p \) - proof load

Standard practice

- if bolt reuse after disassembly:
  - Feat. \( F_i \approx 0.75 \gamma_p A_t \)
  - \( F_i \approx 0.9 \gamma_p A_t \)

Idealized behavior of ductile bolt (exhibits significant plastic deformation before fracture)

if bolt is not stretched into plastic regime (\( F_i = \gamma_p A_t \))

\( \gamma \approx 0.85 \gamma_s \)

\( \Delta \) - there will be greater variability
load factors

for yielding of bolt

\[ F_t + \eta_s P < S_p A_t \]

define \( \eta \) by \[ F_t + \eta_s P = S_p A_t \]

\( \eta_s \) = \frac{S_p A_t - F_t}{\eta_s P}

for separation of joint

no separation if \( P (1 - \eta) < F_t \)

define \( \eta \) by \[ \eta_s P (1 - \eta) = F_t \]

\( \eta_s = \frac{F_t}{P (1 - \eta)} \)

\( \eta \) = \frac{S_p A_t - F_t}{\eta_s P}

limiting stress in bolt

\( \sigma_L \)

tensile stress area

no yielding if \( F_t + \eta_s P < S_p A_t \)

\( \sigma_L \) \text{ yielding line}

\( S_p A_t \) \text{ separation line}

\( F_t \) \text{ \#1}

\( \eta_s \) \text{ \#2}

\( P \) 

b bolt yielding \( \eta = \frac{\sigma_L}{\sigma_A} \)

\[ \eta_s = \frac{OB}{OA} \]

joint separation \( \eta_s = \frac{OB}{OA} \)

in this particular case, separation before yielding

where comes \( \#1 \)?

\[ \rightarrow \text{ preload } F_t \]

\[ \rightarrow \text{ loading } P \]

\[ \eta_y, \eta_s \]
handout #2 steps to determine $K_b$

Torque requirement (Sec. 8.8)

wrench torque required to develop the specific preload

1. preload $F_i \uparrow \rightarrow$ better
2. must < $F_p$, critical

how to determine?

$\Rightarrow$ you may be millionaire if you can
design an easy way

Currently

1. pneumatic - impact wrenching
   (preset the pressure)
   $\rightarrow$ "torque"

2. turn-off nut
   $\Rightarrow$ nut turns = torque

Torque factor

$\Rightarrow$ dimpled + plated

$T = (k_F) F_i \cdot d$

$\approx 0.2$

$TABLE \ 8-15$

$k$ values for different bolt conditions

if bolt conditions are not specified

$\Rightarrow \ k = 0.2$ in this course

[Preload recommended]

$k_F = 1 \quad 0.75 \quad F_p$ reused connections

$0.9 \quad F_p$ permanent connections

see ex 8.2 yourself

$T = \frac{F_dm}{2} \left[ \frac{\tan \alpha + \mu \text{secd}}{1 - \mu \tan \text{secd}} \right] + \frac{F_i}{\mu \text{secd}}$