1. Mathematica solution for necking,
Necking should occur where dP =0

ϵ=Log[(A_0/A)]

σ=K ϵ^n

P=K ϵ^n A_0 $e^{-\epsilon}$

Taking derivative of P with respect to e and equating it to 0,

Solve[D[P, ϵ]==0,ϵ]

{{$\epsilon\to$n}}

Given

$\sigma = K\epsilon^n$

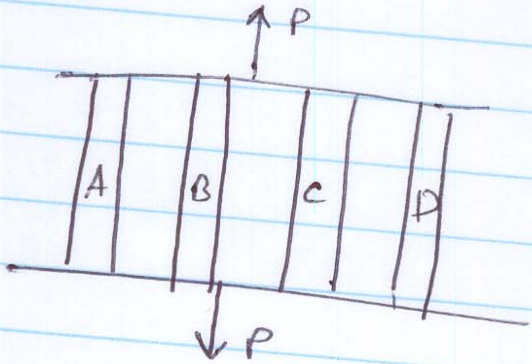
$n = 0.3$

Material A: $K_A = 450\,MPa$, $A_{oA} = 7\,mm^2$

B: $K_B = 600\,MPa$, $A_{oB} = 2.5\,mm^2$

C: $K_C = 300\,MPa$, $A_{oC} = 3\,mm^2$

D: $K_D = 760\,MPa$ $A_{oD} = 2\,mm^2$



At maximum tension prior to necking,

$\epsilon = n$

$P = \sigma_A \cdot A_{A_{final}} + \sigma_B \cdot A_{B_{final}} + \sigma_C \cdot A_{c_{final}} + \sigma_d \cdot A_{d_{final}}$

where A_{final} is the area before necking

$\sigma_A = K_A \epsilon^n$

$\sigma_B = K_B \epsilon^n$

$\sigma_C = K_C \epsilon^n$

$\sigma_d = K_d \epsilon^n$

$\ln\left(\frac{l_f}{l_i}\right) = \epsilon = \ln\left(\frac{A_o}{A_{final}}\right)$

$\frac{A_o}{A_{final}} = e^{\epsilon}$

$A_{final} = A_o \cdot e^{-\epsilon}$

$$P = K_A \epsilon^n \cdot A_{OA} e^{-\epsilon} + K_B \epsilon^n \cdot A_{OB} e^{-\epsilon} + K_C \epsilon^n \cdot A_{OC} e^{-\epsilon} + K_D \epsilon^n \cdot A_{OD} e^{-\epsilon}$$

$$P = \epsilon^n \cdot e^{-\epsilon} \left[K_A \cdot A_{OA} + K_B \cdot A_{OB} + K_C \cdot A_{OC} + K_D \cdot A_{OD} \right]$$

$$P = \epsilon^n \cdot e^{-\epsilon} \left[450 \times 7 + 600 \times 2.5 + 300 \times 3 + 760 \times 2 \right] N$$

$$P = 0.3^{0.3} \cdot e^{-0.3} \left[450 \times 7 + 600 \times 2.5 + 300 \times 3 + 760 \times 2 \right]$$
$$= 3649.78 \text{ N}$$

If n values were different then the necking will start at the strand with lowest n value.

2. The total moment,

$$M_t = \int (\tau dA) r$$

From Mathematica,

$$\int_r^{r+t} \int_0^{2\pi} r\,\tau\,r\,d\theta\,dr$$

$2\pi r^2 t \tau + 2\pi r t^2 \tau + 2/3\, \pi t^3 \tau$

Since t is small, higher orders are ignored

$$M_t = \int (\tau dA) r = \tau 2\pi r^2 t$$

$$\tau = \frac{M_t}{2\pi r^2 t}$$

$Axial\_stress,$

$$\sigma = \frac{F_z}{2\pi r t}$$

$\tau = M_t/(2\pi r^2 t)$

$\sigma = F_z/(2\pi r t)$

$\sigma 1 = \sigma/2 + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$

$\sigma 3 = \sigma/2 - \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$

$\sigma 1 = F_z/(4\pi r t) + \sqrt{\frac{F_z^2}{16\pi^2 r^2 t^2} + \frac{M_t^2}{4\pi^2 r^4 t^2}}$

$\sigma 3 = F_z/(4\pi r t) - \sqrt{\frac{F_z^2}{16\pi^2 r^2 t^2} + \frac{M_t^2}{4\pi^2 r^4 t^2}}$

$\sigma 2 = 0$; Plane stress state;

You can find maximum shear stress= $(\sigma 1 - \sigma 3)/2$

All other problems should be relatively straight forward.