

12 Nm Torque

$$(F_t)(r) = (F_t)(0.1) = 12$$

$$\underline{\underline{F_t = 120\text{ N}}}$$

friction  $F_t = (\text{coeff})(F_n)$

$$120 = 0.6 F_n$$

$$\underline{\underline{F_n = 200\text{ N}}}$$

Loading on shaft

① Torque 12 Nm CONSTANT

② Axial load 200 N constant

③ Bending Moment occurs in two planes.

$$\sqrt{\left[ \underset{200}{(F_n)(0.1)} \right]^2 + \left[ \underset{120}{(F_t)(0.05)} \right]^2}$$

$$= 20.88 \text{ Nm}$$

need stress concentration factors.

look up  $K_t$  3 times and  $q$  also

<u>Torsion</u>
$K_t = 1.10$
$q = 0.93$
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$K_t = 1.09$

<u>Axial</u>
$K_t = 1.28$
$q = 0.91$
<hr/>
$1.25$

<u>Bending</u>
$K_t = 1.28$
$q = 0.91$
<hr/>
$1.25$

Remember  $K_f = 1 + q(K_t - 1)$

Now find Stresses.

$$\text{Torque} \rightarrow \tau = \frac{16T}{\pi d^3} K_f = 16.3 \text{ MPa}$$

$$\text{axial } \sigma = \frac{P}{A} K_f = -1.24 \text{ MPa}$$

$$\text{bending } \sigma = \frac{32M}{\pi d^3} K_f = 65 \text{ MPa} \quad ] \text{ fully reversed}$$

Need Equivalent stresses

$$\sigma_{\text{mean}} = \frac{\sigma_{\text{mean}}}{2} + \sqrt{\tau_{\text{mean}}^2 + \left(\frac{\sigma_{\text{mean}}}{2}\right)^2}$$

$$\sigma_{\text{mean}} = -1.24$$

$$\tau_{\text{mean}} = 16.3$$

$$\sigma_{\text{mean}} = 15.7 \text{ MPa}$$

$$\sigma_{\text{alt}} = \sqrt{\sigma_{\text{alt}}^2 + 3\tau_{\text{alt}}^2}$$

$$\sigma_{\text{alt}}^2 = 65 \text{ MPa}$$

$$\tau_{\text{alt}} = 0$$

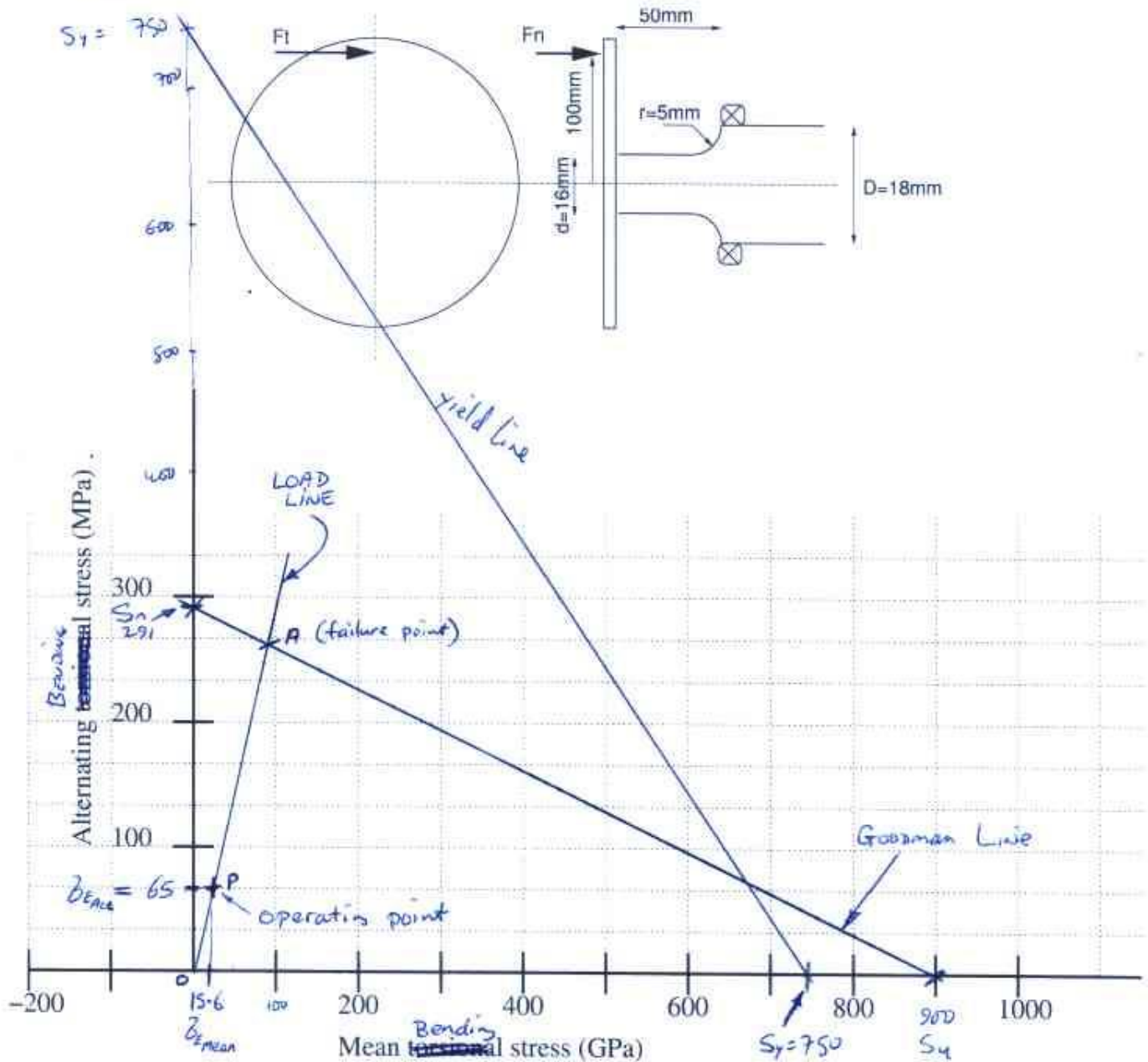
$$\sigma_{\text{alt}} = 65 \text{ MPa}$$

$$\sigma_{\text{mean}} = 15.6$$

$$\sigma_{\text{alt}} = 65 \text{ MPa}$$

9th-January-2004

**Problem** Shown in the diagram is a disk sander. The shaft of the sander has an ultimate tensile strength  $S_u = 900 \text{ MPa}$ , and a yield strength of  $S_y = 750 \text{ MPa}$ . The most severe load occurs when an object is held near the periphery of the disk (100 mm radius) with sufficient force to develop a friction torque of 12 Nm. Assuming the coefficient of friction between the object and the disk is 0.6, what is the factor of safety with respect to eventual fatigue failure of the shaft?



$$S_n' = S_u/2 = \frac{900}{2} = 450 \text{ MPa}$$

$$C_e = 1.0 \text{ (bending)}; C_s = 0.9; C_g = 0.72 \Rightarrow S_n = C_e C_s C_g S_n' = 291 \text{ MPa}$$

$FS = \frac{\|OA\|}{\|OP\|}$ ; i.e. if we scaled up loads by a factor of 4 we would reach operating point 'A' and have fatigue failure  $\approx 4$