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12 Nm Torque

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

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

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

$120 = 0.6\ F_n$

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

Loading on Shaft

(1) TORQUE 12 Nm CONSTANT

(2) Axial load 200N constant

(3) Bending Moment occurs in two planes.

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

$= 20.88\ Nm$

need stress concentration factors.

look up K_t 3 times and q also

Torsion	Axial	Bending
$K_t = 1.10$	$K_t = 1.28$	$K_t = 1.28$
$q = 0.93$	$q = 0.91$	$q = 0.91$
K_f 1.09	1.25	1.25

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

Now find Stresses.

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

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

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

Need Equivalent stresses

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

$$\sigma_{mean} = -1.24$$
$$\tau_{mean} = 16.3$$

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

$$\sigma_{e_{alt}} = \sqrt{\sigma_{alt}^2 + 3\tau_{alt}^2} \qquad \sigma_{alt}^2 = 65 \text{ MPa}, \quad \tau_{alt} = 0$$

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

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

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

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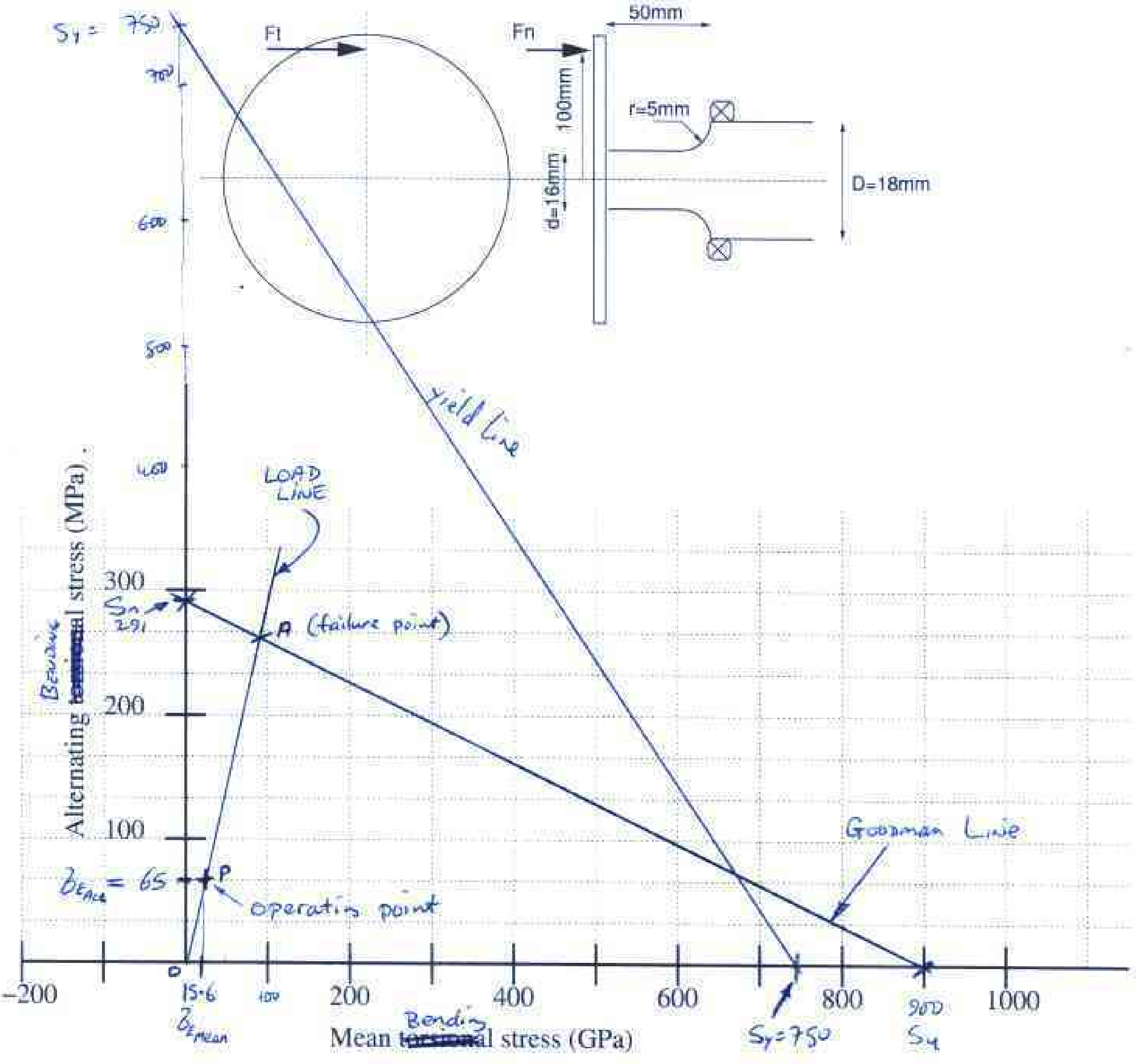
Problem Shown in the diagram is a disk sander. The shaft of the sander has an ultimate tensile strength $S_u = 900$ MPa, and a yield strength of $S_y = 750$ MPa. The most severe load occurs when an object is held near the periphery of the disk (100 mm radius) with sufficient force to develop a friction 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?



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

$C_L = 1.0$ (Bending) ; $C_D = 0.9$; $C_S = 0.72$ $\Rightarrow$ $S_n = C_L C_D C_S S_n' = 291$ 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

≈ 4