F varies from 0 - 1500N
Pedal arm is 15mm dia.
$S_{ut} = 500$ MPa, Find F.O.S. in fatigue

Critical point is located on top of crank arm near bike frame.

Bending stress:

$$\sigma_b = \frac{32M}{\pi d^3} = \frac{32(F)0.17m}{\pi (0.015m)^3}$$

$\sigma_{b,\text{max}} = 769.6$ MPa
$\sigma_{b,\text{min}} = 0$

Torsional stress:

$$\tau_t = \frac{16T}{\pi d^3} = \frac{16(F)0.06m}{\pi (0.015m)^3}$$

$\tau_{t,\text{max}} = 135.8$ MPa
$\tau_{t,\text{min}} = 0$

Von Mises stress:

$$\sigma' = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2} \quad [2-0] \quad \text{EQN 5.7 d}$$

$$\sigma'_{\text{max}} = \sqrt{(770\text{MPa})^2 + 3(136\text{MPa})^2} = 805.2 \text{ MPa}$$

$$\sigma'_{\text{min}} = 0$$

$$\sigma_a' = \frac{805.2 - 0}{2} = 402.6 \text{ MPa} \quad \sigma_m' = \frac{805.2 + 0}{2} = 402.6 \text{ MPa}$$
STATIC FACTOR OF SAFETY AGAINST FRACTURE:

$$n_s = \frac{500 \text{ MPa}}{805 \text{ MPa}} = 0.62$$

OOOPS! THIS PART FAILS AS SOON AS THE RIDER GETS ON FOR THE FIRST TIME.

OH, WELL. WE'LL CHECK THE "FACTOR OF SAFETY IN FATIGUE" ANYWAY.

NEED CORRECTED ENDURANCE LIMIT,

$$S_e = S_{e'} C_{\text{load}} C_{\text{size}} C_{\text{surf}} C_{\text{temp}} C_{\text{reliab}} \quad \text{EQN 6.6 p8376}$$

$$= 0.5(500\text{MPa}) 1 (0.91) 0.78 (1) 1 = 177 \text{ MPa}$$

WHERE

$$C_{\text{load}} = 1 \quad \text{(BENDING)} \quad \text{EQN 6.7a p8376}$$

$$C_{\text{size}} = 1.189(15\text{mm})^{-0.037} = 0.91 \quad \text{EQN 6.7b}$$

$$C_{\text{surf}} = 0.78 \quad \text{FIG 6-26 (ASSUME MACHINED)}$$

$$C_{\text{temp}} = 1 \quad \text{EQN 6.7f (ASSUME T \leq 450°C)}$$

$$C_{\text{reliab}} = 1 \quad \text{TABLE 6-4 (ASSUME 50% RELIABILITY)}$$

FACTOR OF SAFETY IN FATIGUE:

$$N_p = \frac{S_{e\text{total}}}{S_e} = \frac{500(177)}{403(500+177)} = 0.32$$

WHICH MEANS THIS PART HAS A FINITE LIFE ($N_p < 1$), BUT WE ALREADY KNEW THAT.

(EQN 6.18c p416)