

FATIGUE

I = 6 ①

① $\sigma_r^a N_f = K$

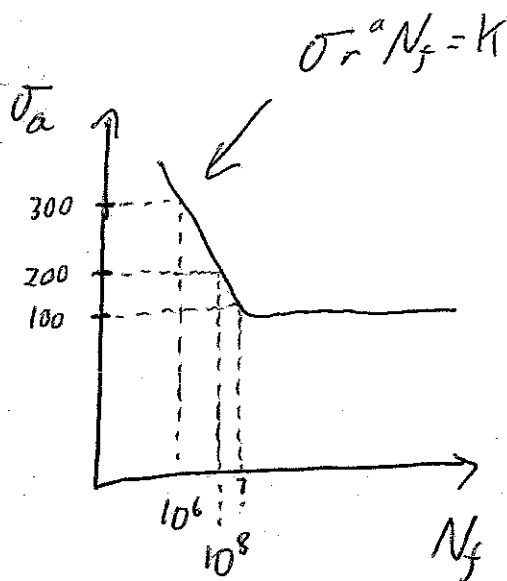
CONDITION ①

$N_f = 1 \times 10^6$, $\sigma_r = 300 \text{ MPa}$

CONDITION ②

$N_f = 1 \times 10^8$, $\sigma_r = 200 \text{ MPa}$

$N_f = ?$, $\sigma_r = 100 \text{ MPa}$



$\sigma_r^a N_f = K$

$a \log \sigma_r + \log N_f = \log K$ ①

CONDITION ①

$a \log 300 + \log 1 \times 10^6 = \log K$

$2.4771a + 6 = \log K$ ②

CONDITION ②

$a \log 200 + \log 1 \times 10^8 = \log K$

$2.3010a + 8 = \log K$ ③

② - ③

$2.4771a + 6 = \log K$

$2.3010a + 8 = \log K$

$0.1761a - 2 = 0$

$\therefore a = \frac{2}{0.1761} = \underline{\underline{11.357}}$

BETWEEN 8 AND 15

FROM ②

FL ②

$$2.4771a + 6 = \log K$$

$$2.4771 \times 11.357 + 6 = \log K$$

$$34.1324 = \log K$$

$$\therefore 10^{34.1324} = K$$

$$\underline{1.356 \times 10^{34} = K}$$

$$\log_{10} x = y$$

$$\therefore b^y = x$$

FROM ① : $a \log \sigma_r + \log N_f = \log K$

$$\therefore 11.357 \log 100 + \log N_f = 34.1324$$

$$11.357 \times 2 + \log N_f = 34.1324$$

$$\log N_f = 11.4184$$

$$N_f = 10^{11.4184}$$

$$= \underline{262 \times 10^9 \text{ cycles}}$$

$$AREA = 0.003 m^2$$

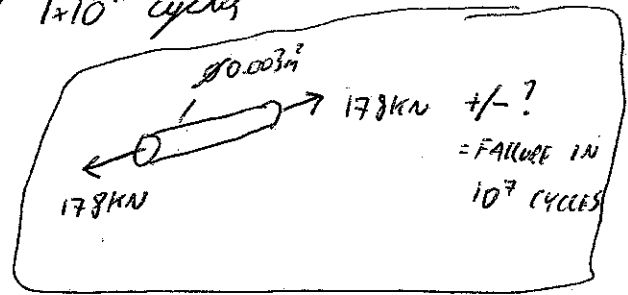
$$\sigma_y = 344 MPa$$

1-6 (3)

STATIC
MEAN
LOAD = 178 kN

$$\sigma_N = 276 MPa @ 1 \times 10^7 \text{ cycles}$$

$$\sigma_a = \sigma_N \left[1 - \left(\frac{\sigma_m}{\sigma_y} \right) \right]$$



MEAN STRESS, $\sigma_m = \frac{FORCE}{AREA}$

$$= \frac{178 \times 10^3}{0.003}$$

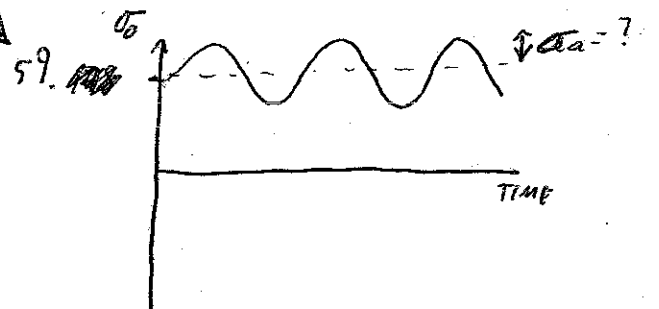
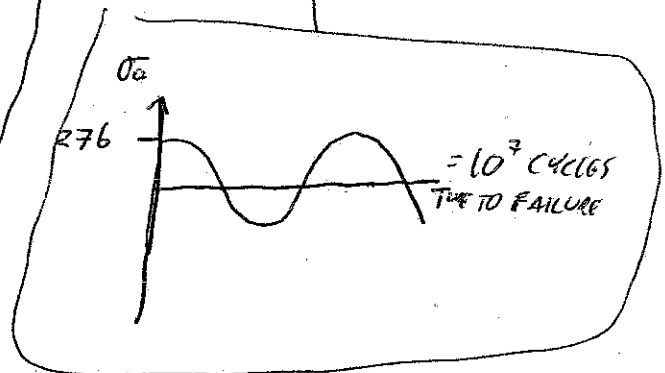
$$= 59.33 MPa$$

$$\sigma_a = 276 \left(1 - \frac{59.33}{344} \right)$$

$$= 276 \times (1 - 0.172)$$

$$= 276 \times 0.828$$

$$= 228.5 MPa$$



LOAD = STRESS $\times$ AREA

$$= 228.5 \times 0.003$$

$$= 0.6855 MN$$

$$= 685.5 kN$$

$$\sigma_a = 228.5 MPa$$

$$\therefore F = 685.5 kN$$

ZERO MEAN STRESS - STRESS AMPLITUDE = 276 MPa TO FAILURE

59.33 MPa " " " " = 228.5 MPa

$$228.5 MPa = 685.5 kN$$

(3)

$$q = 0.97$$

$$K_t = 2.2$$

$$\sigma_y = 578 \text{ MPa}$$

$$\sigma_a = 347 \text{ MPa (ROTATIONAL BENDING)}$$

$$q = \frac{K_f - 1}{K_t - 1}$$

$$\therefore K_f = q(K_t - 1) + 1$$

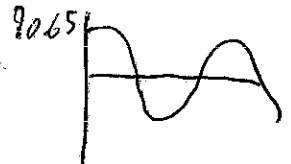
$$= 0.97(2.2 - 1) + 1$$

$$= \underline{\underline{2.16}} \quad \leftarrow \text{FATIGUE STRENGTH REDUCTION FACTOR}$$

$$\sigma_{\text{max}} = \frac{\text{FORCE}}{\text{AREA}} = \frac{178 \times 10^3}{\pi (25)^2} = \frac{178 \times 10^3}{\pi \times (25 \times 10^{-3})^2} = \underline{\underline{90.65 \text{ MPa}}}$$

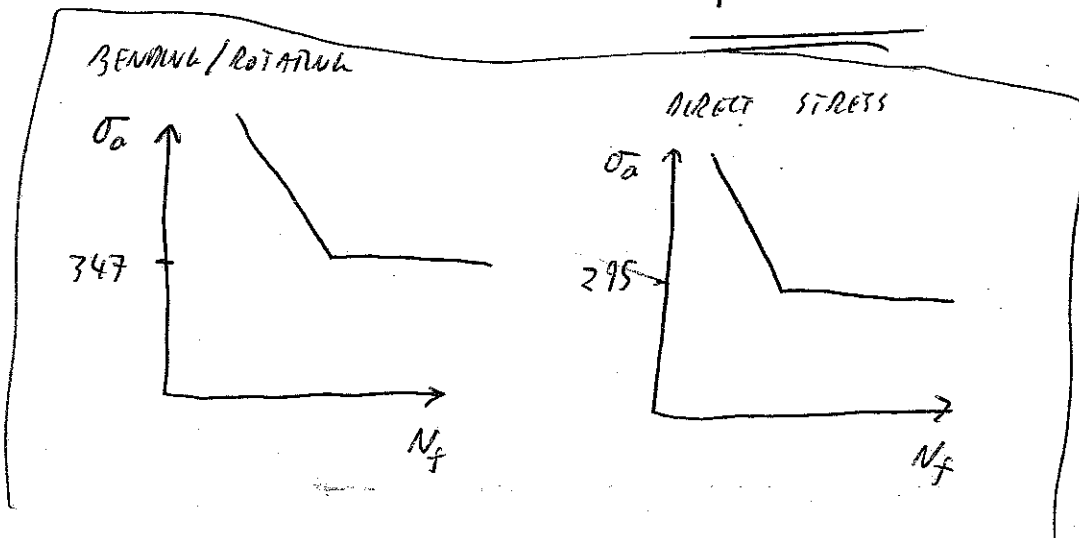
$$\therefore \text{IF } \sigma_{\text{MEAN}} = 0$$

$$\sigma_{\text{MIN}} = \underline{\underline{-90.65 \text{ MPa}}}$$

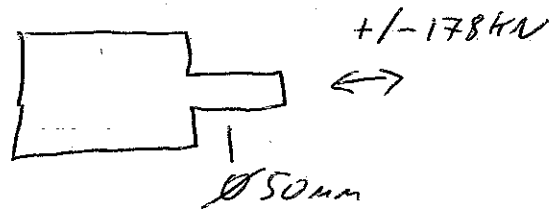


UNDER DIRECT STRESS

$$\sigma_N = 0.85 \times 347 = \underline{\underline{294.95 \text{ MPa}}}$$



F6 (4)



FG(5)

NOW

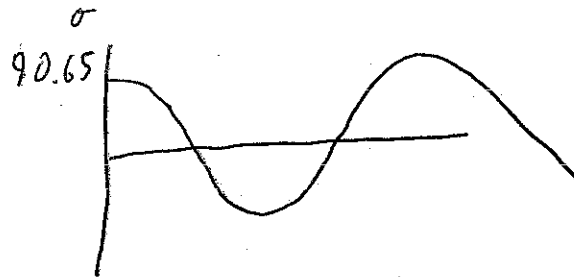
$$\sigma_a = \frac{\sigma_N}{K_f F} \left(1 - \frac{\sigma_m \times F}{\sigma_y} \right) \leftarrow \boxed{\text{SERRAVALLO}}$$

$$90.65 = \frac{294.95}{2.16 \times F} \left(1 - \frac{0 \times F}{578} \right)$$

$$90.65 = \frac{294.95}{2.16 F}$$

$$\therefore F = \frac{294.95}{90.64 \times 2.16}$$

$$\underline{\underline{F = 1.5}}$$



④

3000 @ 510 MPa	→ 10,050 cycles at $\sigma_m = 0$ F6	⑥
12,000 @ 450 MPa	→ 50,500	"
80,000 @ 380 MPa	→ 275,000	"
X @ 480 MPa	→ 20,800	"

FROM MINERS RULE:

$$\frac{n_1}{N_1} + \frac{n_2}{N_2} + \frac{n_3}{N_3} + \dots \text{etc} = 1$$

$$\frac{3,000}{10,050} + \frac{12,000}{50,500} + \frac{80,000}{275,000} + \frac{X}{20,800} = 1$$

$$\frac{20}{67} + \frac{24}{101} + \frac{16}{55} + \frac{X}{28,000} = 1$$

$$\therefore \frac{X}{28,000} = 1 - \left(\frac{20}{67} + \frac{24}{101} + \frac{16}{55} \right)$$

$$= 1 - 0.8270$$

$$\therefore X = \underline{\underline{3598 \text{ cycles}}}$$