When the con-rod is in tension, the crank journal bears on the cap, and so the joint assembly is subjected to 20kN. However when the con rod is in compression, the crank does not bear on the cap, and the joint sees no external load. So $\underline{0 \le P \le 10kN}$ per bolt

JOINT FACTOR

Grip length not given, but same for bolt and joint components so it's immaterial as far as 'C' (a ratio) is concerned.

Take L = 100 mm say, for the grip.

BOLT $k_b = AE/L = \frac{\pi}{4} \times 12^2 \times 207/100$
$= 234$ kN/mm

JOINT $k_j = AE/L = 300 \times 207/100$
$= 621$ kN/mm.

$\therefore C = k_b/(k_b + k_j) = 234/(234 + 621) = 0.27$

BOLT FATIGUE.

For class 8.8 $S_u = 800$ MPa $S_p = 590$ MPa
$S_e' = (0.55 - 0.088 \times 0.8)0.8 = 384$ MPa
$S_e = S_e'/K_f = 384/3.0 = 128$ MPa
assuming rolled threads.

Refer to tables for fine pitch series (e.g. Shigley table 8-1) $A_s = 92$ mm².

$\therefore F_p = A_s S_p = 92 \times 590 = 54$ kN.

a) $F_i = 0$ - joint opens, bolt sees all the load
From (66) with C = 1

$0 + n(1.0 \times 10 \times 10^3/2 \times 92)(\frac{1}{800} + \frac{1}{128}) = 1$

$\Rightarrow \underline{n = 2.0}$

b) At separation, the force between joint components

$F_j = F_i - (1-C)P \to 0$

$\therefore F_i = (1 - 0.27) \times 10 = 7.3$ kN

i.e. initial tension = 7.3/54 = 14% proof.

From (65).

$$\frac{7.3 \times 10^3}{92 \times 800} + n.\frac{0.27 \times 10 \times 10^3}{2 \times 92}\left(\frac{1}{800} + \frac{1}{128}\right) = 1$$

$\Rightarrow \underline{n = 6.8}$.

c) $F_i = 0.7 \times 54 = 38$ kN.

From (65)

$$\frac{38 \times 10^3}{92 \times 800} + \text{— as above —} = 1$$

$\Rightarrow \underline{n = 3.6}$.

Required torque $T = 0.2 F_i d$
$= 0.2 \times 38 \times 12 = 91$ Nm