Dimensions & Initial Loading.

Gasket area associated with one bolt:

$A_g = \frac{1}{6}$ of $\frac{\pi}{4}(250^2-150^2) - \frac{\pi}{4}\times 11^2 = 5141\ mm^2$

$A_i = \frac{1}{6}$ of $\frac{\pi}{4}\times 150^2 = 2945\ mm^2$

Bolt proof load $F_p = A_s S_p = 58.0\times 380 = 22\ kN$

Assume initial tightening to 75% proof

$F_i = 0.75\times 22 = 16.5\ kN.$

Stiffness & Joint Factor — for single bolt.

Bolt: grip $= 2\times 12 + 2 = 26\ mm$

head & nut half height $0.5\times 0.9\times 10 = 5\ mm$

exposed threads, say $2\times 1.5 = 3\ mm$

$k_b = \ell/AE = \left(\frac{(26-3+5)/\frac{\pi}{4}\times 10^2 + (3+5)/58.0}{207}\right)$

$\therefore k_b = 420\ kN/mm$

Joint $k_g = 100\times 5141 = 514\ kN/mm.$

(A): $k_f \approx 209\times 10\ \frac{0.792\times 0.658\times 13/10}{1-0.12\times 13/10} = 3810\ kN/mm$

$\therefore k_j = 1/(1/514 + 2/3810) = 405\ kN/mm.$

$C = k_b/(k_b+k_j) = 420/(420+405) = \underline{0.51}.$

Gasket Stress Limitations.

Initial gasket stress $= F_i/A_g = 16.5/5141 = 3.2\ MPa$

$> y$ of 2 MPa — so OK

$< 2y$ — so no crushing.

At full load $P = pA_i = 1\times 2945 = 2.9\ kN.$

(3b) $F_j = F_i - (1-C)P = 16.5 - (1-0.51)\times 2.9 = 15.1\ kN.$

i.e. corresponding gasket stress

$p_g = F_j/A_g = 15.1/5141 = 2.94\ MPa.$

$\therefore p_g/p = 2.94/1.0 = 2.9 > m(=1.5)$ — OK

Bolts. $S_u = 500\ MPa$ $\quad S_e = 115\ MPa.$

$\sigma_i = 0.75\times 380\ (= F_i/A_s) = 285\ MPa$

(6b) $\sigma_i/S_u + n\left(\frac{CP}{2A_s}\right)(1/S_u + 1/S_e) = 1$

$\frac{285}{500} + n\,\frac{0.51\times 2.9}{2\times 58.0}(1/500 + 1/115) = 1$

$\Rightarrow n = \underline{3.2}$ OK.

The joint is suitable!