a) Reduced bolt shanks decrease bolt stiffness, hence joint factor and hence reduce the alternating component of bolt-load. Can be done because normally the shank is not critical c.f. the exposed threads.

b) Broadly the safety factor in fatigue is

$n = S_e/\sigma_a$

$\propto \frac{S_e'}{\text{various factors}} \times \frac{\text{area}}{\text{load}}$

So, if $n_{shank} = n_{threads}$ then, since the shank surface is polished ...

$\pi d^2/4K_t = A_s/K_f = 36.6/3 = 12.2$

Where K_t is SCF due to transition.

Trial d:	7	6	5	
D/d	8/7 = 1.14	8/6 = 1.33	8/5 = 1.6	assymptote,
r/d = 20/d	> 0.3	> 0.3	> 0.3	Shigley
K_t approx	1.3	1.4	1.5	Fig A-23-7
∴ $\pi d^2/4K_t$	29.6	20.2	13.1 ≈ 12.2	

So a shank diameter just under 5 is appropriate. Say d_{min} = 5 mm

c) Bolt data is :

$S_y = 900$ MPa $S_u = 1000$ MPa

$S_e' = (0.55 - 0.088 \times 1) \times 1 = 462$ MPa.

It is not clear where critical section is since shank area $= \frac{\pi}{4} \times 6^2 = 28.3 \text{ mm}^2 < A_s = 36.6 \text{ mm}^2$ so we must analyse both shank & threads. But first the joint factor.

$k_b = AE/L = 28.3 \times 207/100 = 58.6$ kN/mm neglecting threads &c.

The joint stiffness is unknown and – we daren't apply (4) because the spigot interrupts development of full "frusta" elastic regions.

model 1 Take spigot bearing area

$A_f = \frac{1}{6}$ of $\frac{\pi}{4}(110^2 - 80^2) = 745 \text{ mm}^2$

model 2 Assume compressed cylinder of OD = width of bearing area = 15

∴ $A_f = \frac{\pi}{4}(15^2 - 8^2) = 126 \text{ mm}^2$

This latter is more consistent with 1.5d O.D. finite element "frustum" models.

So $k_j = \frac{AE}{L} = \frac{126 \times 71}{100} = 89.5$ kN/mm

∴ $C = k_e/k_j = k_b/(k_b + k_j) = 58.6/(58.6 + 89.5) = 0.40$

cont'd ---