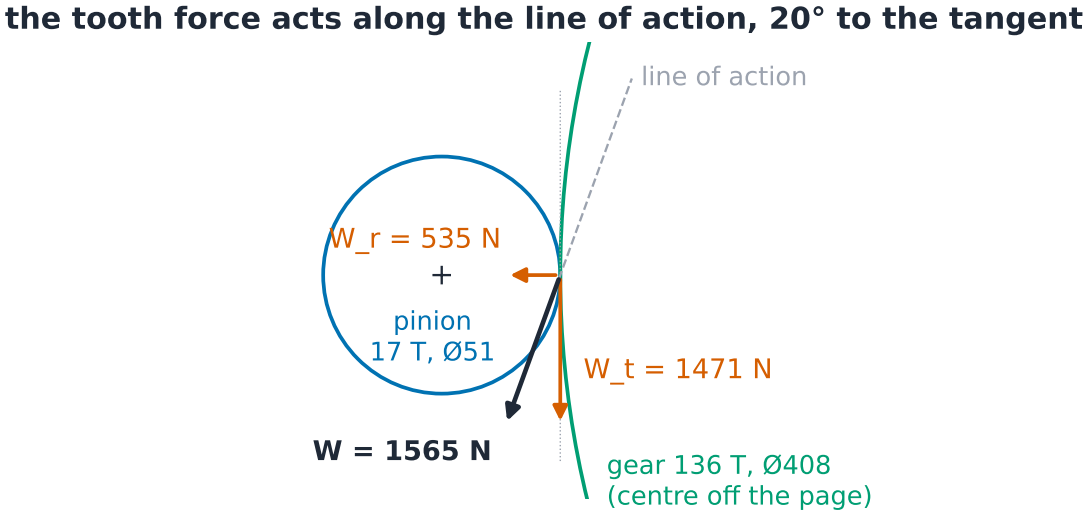
Exercise walk-through

9.5
Joints and gears

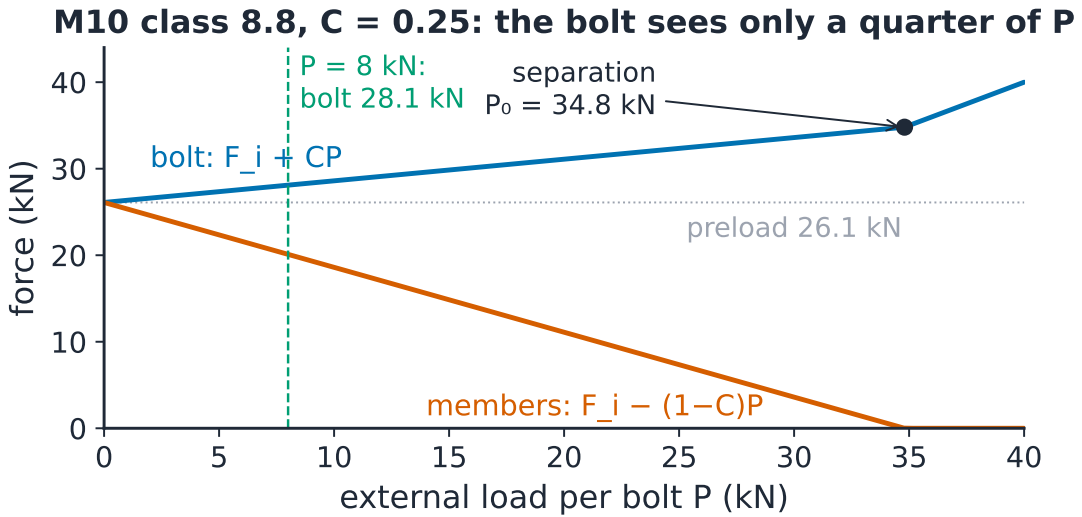
University Mechanical Engineering

Spur gears: force on the line of action



Module 3, 17/136 teeth: Lewis $\sigma = K_v W_t/(FmY) = \mathbf{87.9}$ MPa; contact $\sigma_c = \mathbf{633}$ MPa governs.

Bolted joint: preload carries the load



M10 8.8: $F_i = \mathbf{26.1}$ kN; at $P = 8$ kN the bolt carries $\mathbf{28.1}$ kN; the joint separates at $\mathbf{34.8}$ kN.

Exercises 2.1·2.2

2.1 An M12 class 8.8 bolt ($A_t = 84.3$ mm^2, $S_p = 600$ MPa) is preloaded to 75% of proof. Find the preload (one decimal, kN). [2]

2.2 The joint stiffness share is $C = 0.30$ and each bolt carries $P = 10$ kN. Find the bolt force (one decimal, kN), its stress (nearest MPa), the load factor (two decimals) and the separation load (one decimal, kN). [5]

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2.1

- $F_i = 0.75 A_t S_p = 0.75 \times 84.3 \times 600 = \mathbf{37.9}$ kN.

2.2 The joint stiffness share is $C = 0.30$ and each bolt carries $P = 10$ kN. Find the bolt force (one decimal, kN), its stress (nearest MPa), the load factor (two decimals) and the separation load (one decimal, kN). [5]

2.2

- $F_b = F_i + CP = 37.9 + 0.30 \times 10 = \mathbf{40.9}$ kN; $\sigma_b = F_b / A_t = 40\,935/84.3 = \mathbf{486}$ MPa, below S_p.
- $n = (S_p A_t - F_i)/(CP) = (50.58 - 37.94)/3.0 = \mathbf{4.21}$.
- $P_0 = F_i/(1 - C) = 37.9/0.70 = \mathbf{54.2}$ kN.

Exercise 3.1

3.1 A pinion of module 2.5 mm with 20 teeth ($Y = 0.322$) and face width 25 mm carries $T = 30$ N $\cdot$ m at 1200 rpm. Find its pitch diameter, tangential force, pitch-line speed, K_v and bending stress (one decimal, MPa). With an allowable 150 MPa, find the factor of safety and one way to raise it without changing the gear ratio. [7]

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3.1

- $d = mN = 2.5 \times 20 = 50$ mm; $W_t = 2T/d = 2 \times 30/0.050 = \mathbf{1200}$ N.
- $V = \pi dn/60 = \pi \times 0.050 \times 1200/60 = \mathbf{3.14}$ m/s; $K_v = (6.1 + 3.14)/6.1 = \mathbf{1.515}$.
- $\sigma = K_v W_t/(FmY) = 1.515 \times 1200/(25 \times 2.5 \times 0.322) = \mathbf{90.3}$ MPa.
- $n = 150/90.3 = \mathbf{1.66}$.
- A wider face, a larger module with fewer teeth at the same ratio, or a stronger, hardened steel.