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force and initial stiffness of the bolt based on Eurocode 3 part 1.8

* force

page 27 (Table 3.4)

$$f_{t,RD} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}}$$

Page 20 (Table 3.1) → Area of the bolt

→ page 18 (Table 2.1)

** initial stiffness

Area of the bolt → Elastic modulus

$$K = \frac{1.6 A_s E}{L_b}$$

bolt elongation length ***

*** bolt elongation length

thickness of the bolt head   thickness of the nut

$$L_b = t_{cf} + t_p + t_w \alpha n + \left(\frac{h_{bolthead} + h_{nut}}{2}\right)$$

thickness of the column flange

thickness of the end plate   thickness of the washer

Single side n=1
Double side n=2

washer → endplate → column flange

Bolt   washer

Nut

L_b
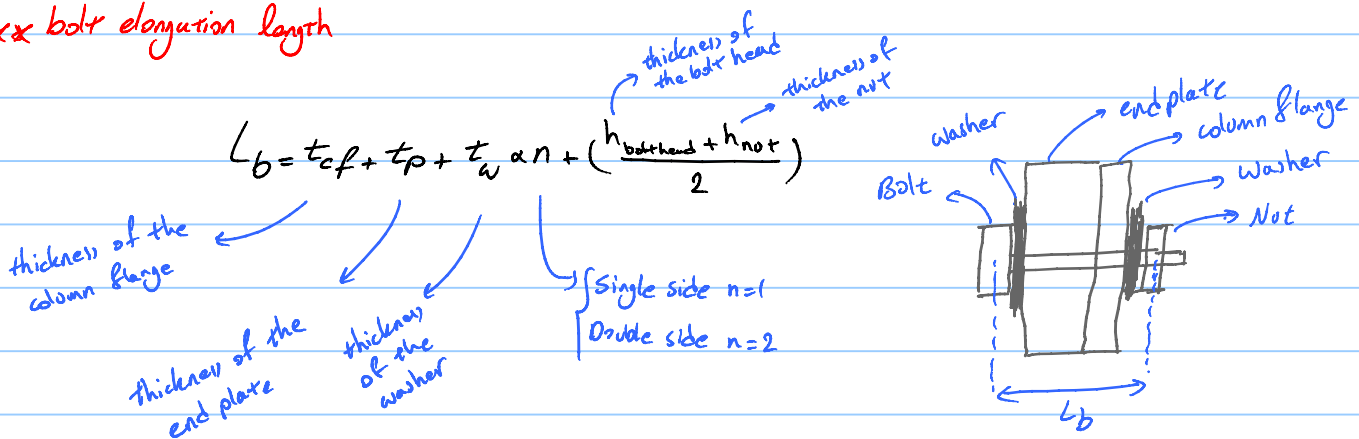
$$\Longrightarrow k \propto \frac{1}{L_b} \Longrightarrow$$ it is important To know the details about washers and nuts as they have direct effect on initial stiffness and elongation.

Example 8 E1-TB-E

$t_p = 20$ mm , $T_{cf} = 18$ mm , Bolt: M27 10.9 , $A_s = 459$ mm²

$$F_{t,Rd} = \frac{0.9 \times 1000 \times 459}{1.25} = 330480 \ N \quad (330.5 \ kN) \quad \text{per bolt}$$

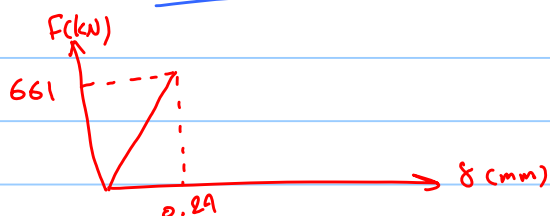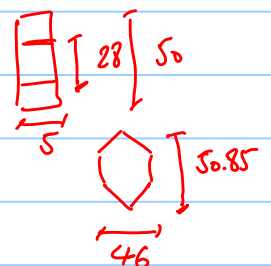→ for each row : $F_{bolt} = 660.96 \ kN$

bolt elongation length :   Assumptions → Washer $t_w = 5$ mm

→ Nut $h_{nut} = 23.8$ mm

$$L_b = 18 + 20 + 5 \times 2 + \frac{17 + 23.8}{2} = 68.4 \ mm$$

for a row ← $K = \frac{1.6 \times 459 \times 210}{68.4} = 2254.74 \ kN/mm$

[28] 50

5

50.85

46

F(kN)

661

0.29

δ (mm)