

Dati

$$\eta = 1 \rightarrow P_i = P_u \rightarrow P_{u1} = P_{u2} = \frac{P}{2} = C_u \omega_u \rightarrow C_u = \frac{P}{2\omega_u}$$

$$F_{t2} \frac{d_2}{2} + F_{t3} \frac{d_3}{2} = C_u = F_{t2} d_2$$

Calcolo

$$P = 2000 \text{ kW}$$

$$\omega_i = 1000 \text{ rpm}$$

$$\omega_u = 31.21 \text{ rpm} = 0.5202 \frac{\text{pirad}}{\text{s}}$$

$$C_u = \frac{P}{2\omega_u \cdot \frac{2\pi}{60}} = 305.969 \text{ Nm}$$

$$F_{t1} \frac{d_1}{2} = 2C_u \rightarrow F_{t1} = \frac{4C_u}{d_1} = \frac{4 \cdot 305.969 \text{ [Nmm]}}{1461.947 \text{ [mm]}} = 837154.84 \text{ N}$$

$$F_{t2} d_2 = C_u \rightarrow F_{t2} = \frac{C_u}{d_2} = \frac{305.969 \text{ [Nmm]}}{685.3628 \text{ [mm]}} = 446433.63 \text{ N}$$

$$F_{t2} = F_{t3} \text{ (Hp. ripartizione 50/50)}$$

$$F_{a1} = F_{t1} \cdot \tan \beta_1 = 177949.13 \text{ N}$$

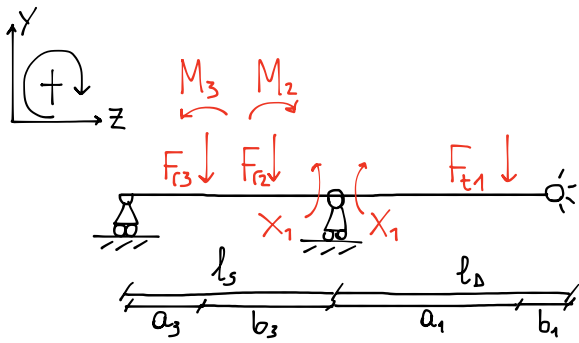
$$F_{r1} = F_{t1} \cdot \frac{\tan \alpha_{n1}}{\cos \beta_1} = 399107.15 \text{ N}$$

$$F_{a2} = F_{a3} = F_{t2} \cdot \tan \beta_2 = 217740.23 \text{ N}$$

↑
stesso tipo di ingranaggio

$$F_{r2} = F_{r3} = F_{t3} \cdot \frac{\tan \alpha_{n3}}{\cos \beta_3} = 231616.38 \text{ N}$$

Piano yz



685.3628

$$M_2 = F_{a2} \frac{d_2}{2} = 74'615'526.85 \text{ [Nmm]}$$

$$M_3 = F_{a3} \frac{d_3}{2} = 74'615'526.85 \text{ [Nmm]}$$

$$\varphi_{11} + \varphi_{1r2} + \varphi_{1r3} + \varphi_{1M2} + \varphi_{1M3} + \varphi_{1T1} = 0$$

$$\varphi_{11} = \varphi_{11Dx} - \varphi_{11Sx} = \frac{l_s x}{3EJ} - \left(-\frac{l_b x}{3EJ} \right) = \frac{l_s + l_b}{3EJ_0} x$$

$$\varphi_{1t1} = \varphi_{1t1Dx} - \varphi_{1t1Sx} = \frac{a_1 b_1 (l_b + b_1)}{6l_b E J_1} F_{t1} - 0 = \frac{a_1 b_1 (l_b + b_1)}{6l_b E J_1} F_{t1}$$

$$\varphi_{1r2} = \varphi_{1r2Dx} - \varphi_{1r2Sx} = 0 - \left(-\frac{a_2 b_2 (l_s + a_2)}{6l_s E J_2} F_{r2} \right) = \frac{a_2 b_2 (l_s + a_2)}{6l_s E J_2} F_{r2}$$

$$\varphi_{1r3} = \varphi_{1r3Dx} - \varphi_{1r3Sx} = 0 - \left(-\frac{a_3 b_3 (l_s + a_3)}{6l_s E J_3} F_{r3} \right) = \frac{a_3 b_3 (l_s + a_3)}{6l_s E J_3} F_{r3}$$

$$\varphi_{1M2} = \varphi_{1M2Dx} - \varphi_{1M2Sx} = 0 - \left(-\frac{l_s^2 - 3a_2^2}{6l_s E J_2} M_2 \right) = \frac{l_s^2 - 3a_2^2}{6l_s E J_2} M_2$$

$$\varphi_{1M3} = \varphi_{1M3Dx} - \varphi_{1M3Sx} = 0 - \left(-\frac{l_s^2 - 3a_3^2}{6l_s E J_3} M_3 \right) = -\frac{l_s^2 - 3a_3^2}{6l_s E J_3} M_3$$

$$l_b = \frac{271}{2} + 435 + 378 + \frac{217}{2} = 1057 \text{ [mm]}$$

$$l_s = \frac{145}{2} + 60 + 300 + 200 + 300 + 80 + \frac{217}{2} = 1121 \text{ [mm]}$$

$$a_1 = \frac{217}{2} + 378 + \frac{435}{2} = 704 \text{ [mm]}$$

$$b_1 = \frac{271}{2} + \frac{435}{2} = 353 \text{ [mm]}$$

$$a_3 = \frac{145}{2} + 60 + \frac{300}{2} = 282.5 \text{ [mm]}$$

$$b_3 = \frac{300}{2} + 200 + 300 + 80 + \frac{217}{2} = 838.5 \text{ [mm]}$$

$$a_2 = \frac{145}{2} + 60 + 300 + 200 + \frac{300}{2} = 782.5 \text{ [mm]}$$

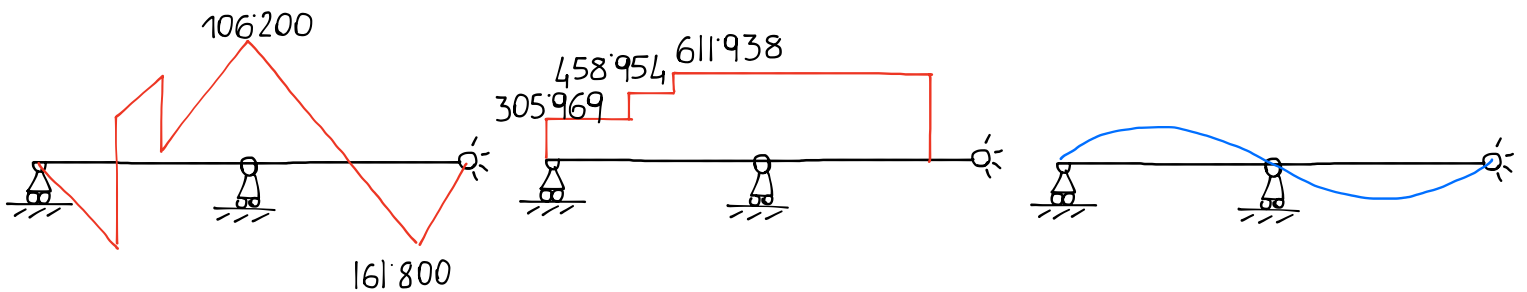
$$b_2 = \frac{300}{2} + 80 + \frac{217}{2} = 338.5 \text{ [mm]}$$

$$J_0 = J_1 = \frac{\pi d^4}{64} = \frac{\pi \cdot 435^4}{64} = 1.757 \cdot 10^9 \text{ [mm}^4\text{]}$$

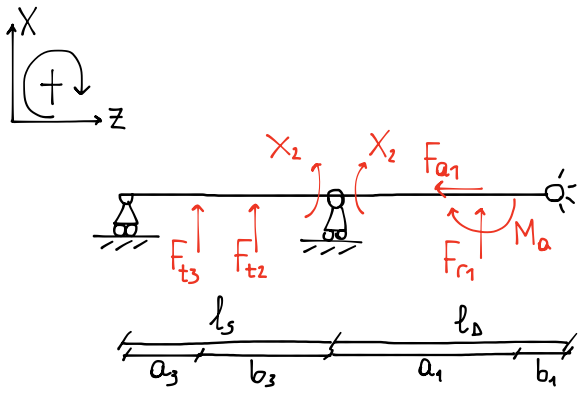
$$J_2 = J_3 = \frac{\pi d^4}{64} = \frac{\pi \cdot 620^4}{64} = 7.253 \cdot 10^9 \text{ [mm}^4\text{]}$$

$$\underbrace{\frac{l_s + l_b}{3EJ_0}}_{2.06 \cdot 10^{-12}} X_1 + \underbrace{\frac{a_1 b_1 (l_b + b_1)}{6l_b EJ_1}}_{1.57 \cdot 10^{-10}} F_{r1} + \underbrace{\frac{a_2 b_2 (l_s + a_2)}{6l_s EJ_2}}_{5.16^{-11}} F_{r2} + \underbrace{\frac{a_3 b_3 (l_s + a_3)}{6l_s EJ_3}}_{3.4 \cdot 10^{-11}} F_{r3} + \underbrace{\frac{l_s^2 - 3a_2^2}{6l_s EJ_2}}_{-5.95 \cdot 10^{-14}} M_2 - \underbrace{\frac{l_s^2 - 3a_3^2}{6l_s EJ_3}}_{1.04 \cdot 10^{-13}} M_3 = 0$$

$$\rightarrow X_1 = -110\,505 \text{ Nm}$$



Piano xz



$$M_a = F_a \frac{d_2}{2}$$

$$\varphi_{1x_2} + \varphi_{1t_2} + \varphi_{1t_3} + \varphi_{1r_1} + \varphi_{1M_a} = 0$$

$$\varphi_{1x_2} = \varphi_{1x_2Dx} - \varphi_{1x_2Sx} = \frac{l_s X_2}{3EJ} - \left(-\frac{l_b X_2}{3EJ} \right) = \frac{l_s + l_b}{3EJ_0} X_2$$

$$\varphi_{1r_1} = \varphi_{1r_1Dx} - \varphi_{1r_1Sx} = \frac{a_1 b_1 (l_b + b_1)}{6l_b E J_1} F_{r_1} - 0 = \frac{a_1 b_1 (l_b + b_1)}{6l_b E J_1} F_{r_1}$$

$$\varphi_{1t_2} = \varphi_{1t_2Dx} - \varphi_{1t_2Sx} = 0 - \left(-\frac{a_2 b_2 (l_s + a_2)}{6l_s E J_2} F_{t_2} \right) = \frac{a_2 b_2 (l_s + a_2)}{6l_s E J_2} F_{t_2}$$

$$\varphi_{1t_3} = \varphi_{1t_3Dx} - \varphi_{1t_3Sx} = 0 - \left(-\frac{a_3 b_3 (l_s + a_3)}{6l_s E J_3} F_{t_3} \right) = \frac{a_3 b_3 (l_s + a_3)}{6l_s E J_3} F_{t_3}$$

$$\varphi_{1M_a} = \varphi_{1M_aDx} - \varphi_{1M_aSx} = 0 - \left(-\frac{l_b^2 - 3b_1^2}{6l_b E J_1} M_2 \right) = \frac{l_b^2 - 3b_1^2}{6l_b E J_1} M_a$$

$$\underbrace{\frac{l_s + l_b}{3EJ_0}}_{4.132 \cdot 10^{-7}} X_2 + \underbrace{\frac{a_1 b_1 (l_b + b_1)}{6l_b E J_1}}_{3.1446 \cdot 10^{-5}} F_{r_1} + \underbrace{\frac{a_2 b_2 (l_s + a_2)}{6l_s E J_2}}_{1.034 \cdot 10^{-5}} F_{t_2} + \underbrace{\frac{a_3 b_3 (l_s + a_3)}{6l_s E J_3}}_{6.82 \cdot 10^{-6}} F_{t_3} + \underbrace{\frac{l_b^2 - 3b_1^2}{6l_b E J_1}}_{6.67 \cdot 10^{-8}} M_a = 0$$

$$\rightarrow X_2 = 114'600 \text{ Nm}$$

