

## LAMPIRAN 1

### Perhitungan Kapasitas Kekuatan Baja

Data baja :

$$L = 400 \text{ mm}$$

$$E = 200.000$$

$$G = 77200$$

$$F_y = 240 \text{ MPa}$$

$$F_u = 370 \text{ MPa}$$

Data Profil :

$$A = 5180 \text{ mm}^2$$

$$b = 1.60.160 \text{ mm}$$

$$B = 330 \text{ mm}$$

$$t = 17 \text{ mm}$$

$$I_x = 12300.000 \text{ mm}^4$$

$$I_y = 12300.000 \text{ mm}^4$$

$$X = 45,7 \text{ mm}$$

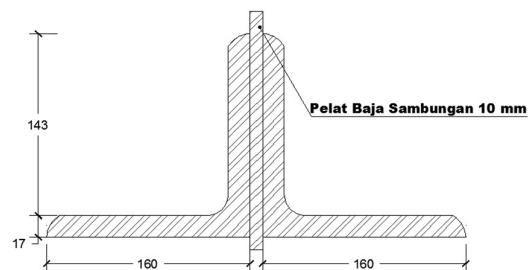
#### 1. Kuat tekan

Profil gabungan

- a. Luas penampang gabungan ( $A_g$ )

$$\begin{aligned} A_g &= 2 \times A \\ &= 2 \times 5180 = 10360 \text{ mm}^2 \end{aligned}$$

- b. Jarak antar profil ( $d$ ) = 10 mm



- c. Momen inersia gabungan

$$\begin{aligned}
 I_{gx} &= 2 \times I_x \\
 &= 2 \times 12300.000 = 24.600.000 \text{ mm}^4 \\
 I_{gy} &= 2 \times I_y + A_g [(x + (1/2x t))]^2 \\
 &= 2 \times 12300.000 + 10360 \times (45,7 + (1/2 \times 17))^2 \\
 &= 55033950 \text{ mm}^4
 \end{aligned}$$

d. Jari jari inersia sumbu x ( $r_{gx}$ )

$$r_{gx} = \sqrt{\frac{I_{gx}}{A_g}} = \sqrt{\frac{24.600.000}{10360}} = 48,7$$

e. Jari jari inersia sumbu y ( $r_{gy}$ )

$$r_{gy} = \sqrt{\frac{I_{gy}}{A_g}} = \sqrt{\frac{55033950}{10360}} = 50,94$$

f. Cek kelangsingan elemen penampang

$$\begin{aligned}
 &= \frac{160}{17} < 0,45 \sqrt{\frac{200.000}{240}} \\
 &= 9,4 < 12,99 \quad (\text{tidak langsing})
 \end{aligned}$$

Tekuk lentur (sumbu x-x)

g. Cek komponen kelangsingan

$$\begin{aligned}
 &= \frac{K.Lx}{R_{min}} < 4,71 \sqrt{\frac{200.000}{240}} \\
 &= \frac{1 \times 4000}{48,7} < 4,71 \sqrt{\frac{200.000}{240}}
 \end{aligned}$$

h. Tegangan Euler ( $F_e$ )

$$F_e = \frac{\pi^2 \times E}{\left(\frac{K.Lx}{R_{min}}\right)^2} = 298,8 \text{ MPa}$$

i. Tegangan kritis ( $F_{cr}$ )

$$\begin{aligned}
 F_{cr} &= \left(0,568 \times \frac{F_y}{F_y}\right) \times 240 \\
 &= \left(0,568 \times \frac{240}{292,8}\right) \times 240 = 129,8 \text{ MPa}
 \end{aligned}$$

Cek kapasitas tekan

$$\begin{aligned} P_n &= F_{cr} \times A_g \\ &= 129,8 \times 10360 \\ &= 1344782 \text{ N} \\ &= 13447,28 \text{ kN} \end{aligned}$$

Tekuk torsi lentur (sumbu y-y)

$$= \frac{3}{4} \times \frac{(1 \times 4000)}{50,9} > \frac{1000}{48,7}$$

$$= 58,9 > 20,5 \text{ (tidak perlu di tambah pelat kopel)}$$

a. Cek pengaruh kekuatan profil gabungan akibat pelat kopel

Untuk  $a/r_i \leq 40$  maka :

$$= (KL / r_{gy})$$

$$= \left( \frac{1 \times 4000}{50,9} \right) = 78,58$$

b. Cek komponen kelangsingan

$$= 78,58 \leq 4,71 \sqrt{\frac{200.000}{240}} \text{ (Tekun inelastis)}$$

c. Tegangan tekuk euler ( $F_e$ )

$$F_e = \frac{\pi^2 \times 200000}{(78,58)^2} = 319,67 \text{ MPa}$$

d. Tegangan kritis sumbu y ( $F_{cr_y}$ )

$$\begin{aligned} F_{cr_y} &= (0,658^{240/319,67}) \times 240 \\ &= 175,28 \text{ MPa} \end{aligned}$$

e. Radius girasi polar di pusat geser

$$\begin{aligned} &= \frac{I_{gx} + I_{gy}}{A_g} \\ &= \frac{24.600.000 + 55033950}{10360} \\ &= 7686,67 \end{aligned}$$

$$X_o = 0 \text{ mm}$$

$$Y_o = 45,7 - 17/2 = 37,2 \text{ mm}$$

f. Radius girasi polar di pusat geser ( $r_o$ )

$$\begin{aligned}(r_o^2) &= x_o^2 + y_o^2 + ((I_{gx}+I_{gy})/ A_g) \\ &= 9070,51\end{aligned}$$

g. Konstanta torsi ( $j$ )

$$\begin{aligned}J &= (2/3) \times (d+b+t)t^3 \\ &= 992.426 \text{ mm}^4 \\ H &= 0,82\end{aligned}$$

h. Tegangan kritis sumbu z ( $F_{crz}$ )

$$\begin{aligned}F_{crz} &= \frac{G \times J}{A_g \times r^2} \\ &= \frac{77.200 \times 992.426}{10360 \times 9070,51} \\ &= 815,31 \text{ MPa}\end{aligned}$$

i. Tegangan kritis ( $F_{cr}$ )

$$\begin{aligned}F_{cr} &= \left( \frac{F_{cry} + F_{crz}}{2H} \right) \times \left[ 1 - \sqrt{1 - \frac{4F_{cr} \times F_{crz} \times H}{(F_{cry} + F_{crz}) \times (F_{cry} + F_{crz})}} \right] \\ &= \left( \frac{175,28 + 815,31}{2 \times 0,82} \right) \times \left[ 1 - \sqrt{1 - \frac{4(175,28 \times 815,31 \times 0,82)}{(175,28 + 815,31) \times (175,28 + 815,31)}} \right] \\ &= 186,55 \text{ MPa}\end{aligned}$$

Kapasitas tekan untuk kondisi tekan tekuk torsi

$$\begin{aligned}P_n &= F_{cr} \times A_g \\ &= 186,55 \times 10360 \\ &= 1932658 \text{ N} = 1932,66 \text{ kN}\end{aligned}$$

## 2. Kuat tarik

a. Penampang Utuh

$$\begin{aligned}\phi P_n &= 0,9 \times F_y \times A_g \\ &= 0,9 \times 240 \times 10360/1000 \\ &= 2.237,769 \text{ kN}\end{aligned}$$

## b. Penampang sabungan

Karena sambungan berupa las maka  $A_g = A_n$

$$\phi P_n = 0,7 \cdot F_u \cdot A_e$$

$$U = 0,77$$

$$A_e = A_n \times U$$

$$= 10360 \times 0,77 = 7977,2 \text{ mm}^2$$

$$\phi P_n = 0,7 \times F_u \times A_e$$

$$= 0,7 \times 370 \times 7977,2/1000$$

$$= 2.066,09 \text{ kN}$$