ASUMSI PEMBEBANAN

Jarak Antar Kuda-Kuda, L_{kuda^2}	:	**1,2**	m
Kemiringan Atap, a	:	**30**	derajat
Jarak Antar Buhul, L_{buhul}	:	1,155	m

1. Beban Mati

q Berat sendiri struktur : dihitung dalam SAP

q Berat penutup atap (Termasuk Reng)[1)]	: $q_{genteng}$ =	**50**	kg/m^2
($w_{genteng} = L_{kuda^2} * q_{genteng}$)	: $w_{genteng}$ =	69,3	kg
	$w_{genteng}$ =	**0,693**	kN
q Berat struktur plafon	: $q_{plafond}$ =	**20**	kg/m^2
($w_{plafond} = L_{kuda^2} * q_{plafond} * L_{buhul}$)	: $w_{plafond}$ =	28,8	kg
	$w_{plafond}$ =	**0,29**	kN

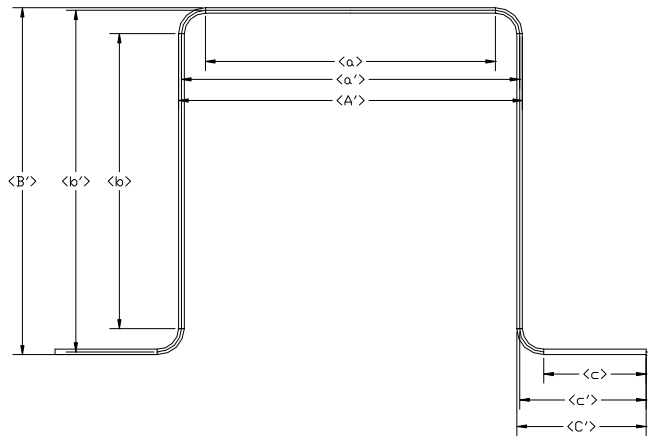
2. Beban Hidup

q Berat air hujan	: q_{hujan} =	**40**	kg/m^2
(q_{hujan} = 40 – 0.8 * a)	: q_{hujan} =	16	kg/m^2
($w_{hujan} = L_{kuda^2} * q_{hujan} * L_{buhul}$)	: w_{hujan} =	22,18	kg
	w_{hujan} =	**0,222**	kN

q Berat Orang/Pemadam

P = 100 kg sbg beban hidup (dominan)	: P =	**100**	kg
	P =	**1,00**	kN

Profil Hat



Dimensi penampang :

$A' := 61 \cdot mm$ $t := 0.8 \cdot mm$

$B' := 47 \cdot mm$ $\alpha := 1.0$

$C' := 13.9 \cdot mm$ $R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $a = 53.4\,mm$

$a' := A' - t$ $a' = 60.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \right]$ $b = 39.4\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \right)$ $b' = 46.2\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \right]$ $c = 10.1\,mm$

$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \right]$ $c' = 13.5\,mm$

$u := \pi \cdot \frac{r}{2}$ $u = 5.341\,mm$

Properties dari penampang :

Luas penampang :

$$A := t\cdot\left[a + 2\cdot b + 2\cdot u + \alpha\cdot(2\cdot c + 2\cdot u)\right] \qquad A = 139.01\,mm^2$$

Momen inersia sumbu y:

$$I_y := 2\cdot t\cdot\left[\begin{array}{l} 0.0417\cdot a^3 + b\cdot\left(\frac{a}{2} + r\right)^2 + u\cdot\left(\frac{a}{2} + 0.637\cdot r\right)^2 + 0.149\cdot r^3 \ldots \\ +\,0.0833\cdot c^3 + \frac{c}{4}\cdot(a + c + 4\cdot r)^2 + u\cdot\left(\frac{a}{2} + 1.363\cdot r\right)^2 + 0.149\cdot r^3 \end{array}\right]$$

$$I_y = 1.07\times 10^5\,mm^4$$

Titik berat :

$$y := \frac{2\cdot t}{A}\cdot\left[b\cdot\left(\frac{b}{2} + r\right) + u\cdot(0.363\cdot r) + \alpha\cdot[u\cdot(b + 1.637\cdot r) + c\cdot(b + 2\cdot r)]\right] + \frac{t}{2}$$

$$y = 19.086\,mm \qquad x := \frac{2\cdot C' + (A' - 2\cdot t)}{2} \qquad x = 43.6\,mm$$

Momen inersia sumbu y :

$$I_x := 2\cdot t\cdot\left[b\cdot\left(\frac{b}{2} + r\right)^2 + \frac{b^3}{12} + 0.356\cdot r^3 + \alpha\cdot\left[c\cdot(b + 2\cdot r)^2 + u\cdot(b + 1.637\cdot r)^2 + 0.149\cdot r^3\right]\right] - A\cdot\left(y - \frac{t}{2}\right)^2$$

$$I_x = 4.506\times 10^4\,mm^4$$

Modulus penampang elastis sumbu x :

$$S_x := \frac{I_x}{y} \qquad S_x = 2.361\times 10^3\,mm^3$$

Modulus penampang elastis sumbu y :

$$S_y := \frac{I_y}{x} \qquad S_y = 2.453\times 10^3\,mm^3$$

Jarak antar pusat geser dan garis tengah web :

$$m := b'\cdot\left[\frac{3\cdot a'^2\cdot b' + \alpha\cdot c'\cdot\left(6\cdot a'^2 - 8\cdot c'^2\right)}{a'^3 + 6\cdot a'^2\cdot b' + \alpha\cdot c'\cdot\left(8\cdot c'^2 + 12\cdot a'\cdot c' + 6\cdot a'^2\right)}\right]$$

$$m = 21.503\,mm$$

Jarak antara titik berat dan pusat geser :

$$y_o := -\left(y - \frac{t}{2} + m\right) \qquad y_o = -40.189\,mm$$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot(a + 2\cdot b + 2\cdot c + 4\cdot u) \qquad J = 29.656\,mm^4$$

Wraping constant :

$$C_w := \frac{a'^2\cdot b'^2\cdot t}{12}\cdot\left[\frac{\begin{bmatrix}2\cdot a'^3\cdot b' + 3\cdot a'^2\cdot b'^2 \ldots \\ +\left[\left(48\cdot c'^4 + 112\cdot b'\cdot c'^3 + 8\cdot a'\cdot c'^3\right) - 48\cdot a'\cdot b'\cdot c'^2 \ldots\right] \\ +\left(-12\cdot a'^2\cdot c'^2 + 12\cdot a'^2\cdot b'\cdot c' + 6\cdot a'^3\cdot c'\right)\end{bmatrix}}{6\cdot a'^2\cdot b' + (a' + 2\cdot c')^3}\right]$$

$$C_w = 2.208\times 10^7\,mm^6$$

Parameter yang digunakan dalam penentuan momen elastis kritis :

$$\beta_w := -\left(\frac{t\cdot y\cdot a'^3}{12} + t\cdot y^3\cdot a'\right) \qquad \beta_w = -6.125\times 10^5\,mm^5$$

$$\beta_f := \frac{t}{2}\cdot\left[(b' - y)^4 - y^4\right] + \frac{t\cdot a'^2}{4}\cdot\left[(b' - y)^2 - y^2\right] \qquad \beta_f = 4.319\times 10^5\,mm^5$$

$$\beta_l := 2\cdot c'\cdot t\cdot(b' - y)^3 + \frac{2}{3}\cdot t\cdot(b' - y)\cdot\left[\left(\frac{a'}{2} + c\right)^3 - \left(\frac{a'}{2}\right)^3\right] \qquad \beta_l = 9.756\times 10^5\,mm^5$$

$$j := \frac{1}{2\cdot I_x}\cdot\left(\beta_w + \beta_f + \beta_l\right) - y_o \qquad j = 49.012\,mm$$

Batang aksial :

Untuk batang yang panjangnya L = 1000 mm

$K_x := 1$ $L_x := 1000 \cdot mm$ $r_x := \sqrt{\frac{I_x}{A}}$ $r_x = 18.003\,mm$

$K_y := 1$ $L_y := 1000 \cdot mm$ $r_y := \sqrt{\frac{I_y}{A}}$ $r_y = 27.738\,mm$

$K_t := 1$ $L_t := 1000 \cdot mm$ $r_o := \sqrt{r_x^2 + r_y^2 + y_o^2}$ $r_o = 52.045\,mm$

$\beta := 1 - \left(\frac{y_o}{r_o}\right)^2$ $\beta = 0.404$

Tegangan Tekuk Lentur :

$MPa := 1 \cdot \frac{N}{mm^2}$ $F_y := 500 \cdot MPa$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2}$ $\sigma_{ex} = 639.786\,MPa$

$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2}$ $\sigma_{ey} = 1.519 \times 10^3\,MPa$

Tegangan Tekuk Torsi :

$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^2}$ $\sigma_t = 121.91\,MPa$

Tegangan Tekuk Lentur-Torsi :

$$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{(\sigma_{ex} + \sigma_t)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta} \qquad \sigma_{TFO} = 108.656\ \text{MPa}$$

$$F_e := \min(\sigma_{ex}, \sigma_{ey}, \sigma_t) \qquad F_e = 121.91\ \text{MPa}$$

$$\lambda_c := \sqrt{\frac{F_y}{F_e}} \qquad \lambda_c = 2.025$$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^2}\right) \cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^2}\right) \cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 106.915\ \text{MPa}$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$k_f := 4$ $\qquad \frac{a}{t} = 66.75$ $\qquad <$ 500 ..... OK

$$\lambda_f := \left(\frac{1.052}{\sqrt{k_f}}\right) \cdot \left(\frac{a}{t}\right) \cdot \sqrt{\frac{F_n}{E}} \qquad \lambda_f = 0.812$$

$$a_e := \begin{cases} a & \text{if } \lambda_f < 0.673 \\ \left(1 - \frac{0.22}{\lambda_f}\right) \cdot a & \text{otherwise} \end{cases} \qquad a_e = 47.954\ \text{mm}$$

Web elements :

$$S := 1.28 \cdot \sqrt{\frac{E}{F_n}} \qquad S = 55.361 \qquad \frac{S}{3} = 18.454$$

$\frac{b}{t} = 49.25$ $\qquad <$ 60 ..... OK

S < b/t maka gunakan kasus 3 $k_u := 0.43$ $n := \frac{1}{3}$

$I_a := 115 \cdot \left(\frac{\frac{b}{t}}{S} + 5 \right) \cdot t^4$ $I_a = 277.424\,mm^4$

$I_s := \frac{c^3 \cdot t}{12}$ $I_s = 68.687\,mm^4$

$C_2 := \begin{cases} \frac{I_s}{I_a} & \text{if } \frac{I_s}{I_a} < 1 \\ 1 & \text{otherwise} \end{cases}$ $C_2 = 0.248$

$C_1 := 2 - C_2$ $C_1 = 1.752$

$\frac{C'}{b} = 0.353$

$k_a := 5.25 - 5 \cdot \left(\frac{C'}{b} \right)$ $k_a = 3.486$

$k_w := C_2^{\,n} \cdot (k_a - k_u) + k_u$ $k_w = 2.349$

$\lambda_w := \left(\frac{1.052}{\sqrt{k_w}} \right) \cdot \left(\frac{b}{t} \right) \cdot \sqrt{\frac{F_n}{E}}$ $\lambda_w = 0.782$

$b_e := \begin{cases} b & \text{if } \lambda_w < 0.673 \\ 1 - \frac{0.22}{\lambda_w} \cdot b & \text{otherwise} \end{cases}$ $b_e = 36.22\,mm$

Lip elements :

$k_l := 0.43$ $\frac{c}{t} = 12.625$ < 14 ..... OK

$\lambda_l := \left(\frac{1.052}{\sqrt{k_l}} \right) \cdot \left(\frac{c}{t} \right) \cdot \sqrt{\frac{F_n}{E}}$ $\lambda_l = 0.468$

$$c_e := \begin{cases} c & \text{if } \lambda_l < 0.673 \\ \dfrac{1 - \dfrac{0.22}{\lambda_l}}{\lambda_l} \cdot c & \text{otherwise} \end{cases} \qquad c_e = 10.1\,\text{mm}$$

Luas efektif adalah :

$$A_e := A - \left[2\cdot\left(b - b_e\right) + \left(a - a_e\right) + 2\cdot\left(c - c_e\right)\right]\cdot t \qquad A_e = 129.566\,\text{mm}^2$$

Kuat aksial tekan nominal :

$$P_n := A_e \cdot F_n \qquad P_n = 1.385 \times 10^4\,\text{N}$$

Kuat izin aksial tekan :

$$\phi_c := 0.85 \qquad kN := 1000\cdot N$$

$$P_a := P_n \cdot \phi_c \qquad P_a = 11.775\,\text{kN}$$

Kuat aksial tarik nominal :

$$A_n := A$$

$$T_n := A_n \cdot F_y \qquad T_n = 6.951 \times 10^4\,\text{N}$$

Kuat izin aksial tarik :

$$\phi_t := 0.95$$

$$T_a := T_n \cdot \phi_c \qquad T_a = 59.079\,\text{kN}$$

Momen nominal :

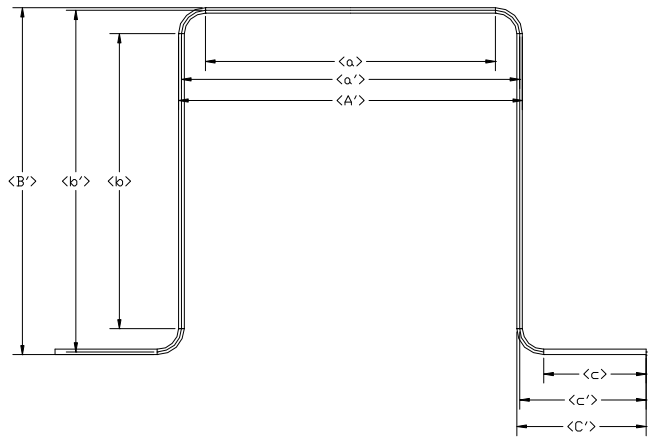
$$M_n := S_x \cdot F_y \qquad M_n = 1.18\ \text{m kN}$$

Momen nominal izin :

$$\phi_b := 0.9$$

$$M_a := M_n \cdot \phi_b \qquad M_a = 1.062\ \text{m kN}$$

Profil Hat



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$C' := 13.9 \cdot mm$ $R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $a = 53.4\,mm$

$a' := A' - t$ $a' = 60.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \right]$ $b = 39.4\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \right)$ $b' = 46.2\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \right]$ $c = 10.1\,mm$

$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \right]$ $c' = 13.5\,mm$

$u := \pi \cdot \frac{r}{2}$ $u = 5.341\,mm$

Properties dari penampang :

Luas penampang :

$$A := t\cdot\left[a + 2\cdot b + 2\cdot u + \alpha\cdot(2\cdot c + 2\cdot u)\right] \qquad A = 139.01\,mm^2$$

Momen inersia sumbu y:

$$I_y := 2\cdot t\cdot\left[\begin{array}{l} 0.0417\cdot a^3 + b\cdot\left(\frac{a}{2} + r\right)^2 + u\cdot\left(\frac{a}{2} + 0.637\cdot r\right)^2 + 0.149\cdot r^3 \ldots \\ +0.0833\cdot c^3 + \frac{c}{4}\cdot(a + c + 4\cdot r)^2 + u\cdot\left(\frac{a}{2} + 1.363\cdot r\right)^2 + 0.149\cdot r^3 \end{array}\right]$$

$$I_y = 1.07\times 10^5\,mm^4$$

Titik berat :

$$y := \frac{2\cdot t}{A}\cdot\left[b\cdot\left(\frac{b}{2} + r\right) + u\cdot(0.363\cdot r) + \alpha\cdot[u\cdot(b + 1.637\cdot r) + c\cdot(b + 2\cdot r)]\right] + \frac{t}{2}$$

$$y = 19.086\,mm \qquad x := \frac{2\cdot C' + (A' - 2\cdot t)}{2} \qquad x = 43.6\,mm$$

Momen inersia sumbu y :

$$I_x := 2\cdot t\cdot\left[b\cdot\left(\frac{b}{2} + r\right)^2 + \frac{b^3}{12} + 0.356\cdot r^3 + \alpha\cdot\left[c\cdot(b + 2\cdot r)^2 + u\cdot(b + 1.637\cdot r)^2 + 0.149\cdot r^3\right]\right] - A\cdot\left(y - \frac{t}{2}\right)^2$$

$$I_x = 4.506\times 10^4\,mm^4$$

Modulus penampang elastis sumbu x :

$$S_x := \frac{I_x}{y} \qquad S_x = 2.361\times 10^3\,mm^3$$

Modulus penampang elastis sumbu y :

$$S_y := \frac{I_y}{x} \qquad S_y = 2.453\times 10^3\,mm^3$$

Jarak antar pusat geser dan garis tengah web :

$$m := b'\cdot\left[\frac{3\cdot a'^2\cdot b' + \alpha\cdot c'\cdot\left(6\cdot a'^2 - 8\cdot c'^2\right)}{a'^3 + 6\cdot a'^2\cdot b' + \alpha\cdot c'\cdot\left(8\cdot c'^2 + 12\cdot a'\cdot c' + 6\cdot a'^2\right)}\right]$$

$$m = 21.503\,mm$$

Jarak antara titik berat dan pusat geser :

$$y_o := -\left(y - \frac{t}{2} + m\right) \qquad y_o = -40.189\,mm$$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot(a + 2\cdot b + 2\cdot c + 4\cdot u) \qquad J = 29.656\,mm^4$$

Wraping constant :

$$C_w := \frac{a'^2\cdot b'^2\cdot t}{12}\cdot\left[\frac{\begin{bmatrix}2\cdot a'^3\cdot b' + 3\cdot a'^2\cdot b'^2 \ldots \\ +\left[\left(48\cdot c'^4 + 112\cdot b'\cdot c'^3 + 8\cdot a'\cdot c'^3\right) - 48\cdot a'\cdot b'\cdot c'^2 \ldots\right] \\ +\left(-12\cdot a'^2\cdot c'^2 + 12\cdot a'^2\cdot b'\cdot c' + 6\cdot a'^3\cdot c'\right)\end{bmatrix}}{6\cdot a'^2\cdot b' + (a' + 2\cdot c')^3}\right]$$

$$C_w = 2.208\times 10^7\,mm^6$$

Parameter yang digunakan dalam penentuan momen elastis kritis :

$$\beta_w := -\left(\frac{t\cdot y\cdot a'^3}{12} + t\cdot y^3\cdot a'\right) \qquad \beta_w = -6.125\times 10^5\,mm^5$$

$$\beta_f := \frac{t}{2}\cdot\left[(b' - y)^4 - y^4\right] + \frac{t\cdot a'^2}{4}\cdot\left[(b' - y)^2 - y^2\right] \qquad \beta_f = 4.319\times 10^5\,mm^5$$

$$\beta_l := 2\cdot c'\cdot t\cdot(b' - y)^3 + \frac{2}{3}\cdot t\cdot(b' - y)\cdot\left[\left(\frac{a'}{2} + c\right)^3 - \left(\frac{a'}{2}\right)^3\right] \qquad \beta_l = 9.756\times 10^5\,mm^5$$

$$j := \frac{1}{2\cdot I_x}\cdot\left(\beta_w + \beta_f + \beta_l\right) - y_o \qquad j = 49.012\,mm$$

Batang aksial :

Untuk batang yang panjangnya L = 2000 mm

$K_x := 1$ $L_x := 2000 \cdot mm$ $r_x := \sqrt{\frac{I_x}{A}}$ $r_x = 18.003\,mm$

$K_y := 1$ $L_y := 2000 \cdot mm$ $r_y := \sqrt{\frac{I_y}{A}}$ $r_y = 27.738\,mm$

$K_t := 1$ $L_t := 1000 \cdot mm$ $r_o := \sqrt{r_x^2 + r_y^2 + y_o^2}$ $r_o = 52.045\,mm$

$\beta := 1 - \left(\frac{y_o}{r_o}\right)^2$ $\beta = 0.404$

Tegangan Tekuk Lentur :

$MPa := 1 \cdot \frac{N}{mm^2}$ $F_y := 500 \cdot MPa$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2}$ $\sigma_{ex} = 159.947\,MPa$

$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2}$ $\sigma_{ey} = 379.689\,MPa$

Tegangan Tekuk Torsi :

$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^2}$ $\sigma_t = 121.91\,MPa$

Tegangan Tekuk Lentur-Torsi :

$$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{(\sigma_{ex} + \sigma_t)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta} \qquad \sigma_{TFO} = 77.865\,MPa$$

$$F_e := \min(\sigma_{ex}, \sigma_{ey}, \sigma_t) \qquad F_e = 121.91\,MPa$$

$$\lambda_c := \sqrt{\frac{F_y}{F_e}} \qquad \lambda_c = 2.025$$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^2}\right) \cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^2}\right) \cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 106.915\,MPa$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$k_f := 4$ $\qquad \frac{a}{t} = 66.75$ $\qquad <$ 500 ..... OK

$$\lambda_f := \left(\frac{1.052}{\sqrt{k_f}}\right) \cdot \left(\frac{a}{t}\right) \cdot \sqrt{\frac{F_n}{E}} \qquad \lambda_f = 0.812$$

$$a_e := \begin{cases} a & \text{if } \lambda_f < 0.673 \\ \left(1 - \frac{0.22}{\lambda_f}\right) \cdot a & \text{otherwise} \end{cases} \qquad a_e = 47.954\,mm$$

Web elements :

$$S := 1.28 \cdot \sqrt{\frac{E}{F_n}} \qquad S = 55.361 \qquad \frac{S}{3} = 18.454$$

$\frac{b}{t} = 49.25$ $\qquad <$ 60 ..... OK

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$\lambda_w := \left(\frac{1.052}{\sqrt{k_w}} \right) \cdot \left(\frac{b}{t} \right) \cdot \sqrt{\frac{F_n}{E}}$ $\lambda_w = 0.782$

$b_e := \begin{cases} b & \text{if } \lambda_w < 0.673 \\ 1 - \frac{0.22}{\lambda_w} \cdot b & \text{otherwise} \end{cases}$ $b_e = 36.22\,mm$

Lip elements :

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$\lambda_l := \left(\frac{1.052}{\sqrt{k_l}} \right) \cdot \left(\frac{c}{t} \right) \cdot \sqrt{\frac{F_n}{E}}$ $\lambda_l = 0.468$

$$c_e := \begin{cases} c & \text{if } \lambda_l < 0.673 \\ \dfrac{1 - \dfrac{0.22}{\lambda_l}}{\lambda_l} \cdot c & \text{otherwise} \end{cases} \qquad c_e = 10.1\,\text{mm}$$

Luas efektif adalah :

$$A_e := A - \left[2\cdot\left(b - b_e\right) + \left(a - a_e\right) + 2\cdot\left(c - c_e\right)\right]\cdot t \qquad A_e = 129.566\,\text{mm}^2$$

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$$\phi_c := 0.85 \qquad \text{kN} := 1000\cdot\text{N}$$

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Kuat aksial tarik nominal :

$$A_n := A$$

$$T_n := A_n \cdot F_y \qquad T_n = 6.951 \times 10^4\,\text{N}$$

Kuat izin aksial tarik :

$$\phi_t := 0.95$$

$$T_a := T_n \cdot \phi_c \qquad T_a = 59.079\,\text{kN}$$

Momen nominal :

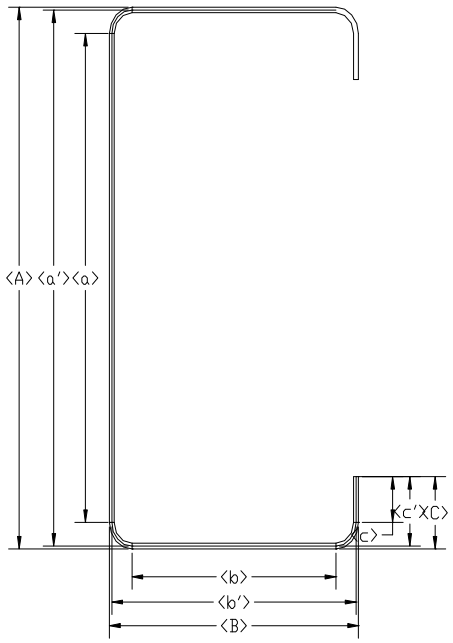
$$M_n := S_x \cdot F_y \qquad M_n = 1.18\ \text{m}\,\text{kN}$$

Momen nominal izin :

$$\phi_b := 0.9$$

$$M_a := M_n \cdot \phi_b \qquad M_a = 1.062\ \text{m}\,\text{kN}$$

Profil Channel



Dimensi penampang :

$A' := 78 \cdot mm$ $t := 0.8 \cdot mm$

$B' := 42 \cdot mm$ $\alpha := 1.0$

$C' := 10.4 \cdot mm$ $R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $a = 70.4\,mm$

$a' := A' - t$ $a' = 77.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \right]$ $b = 34.4\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \right)$ $b' = 41.2\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \right]$ $c = 6.6\,mm$

$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \right]$ $c' = 10\,mm$

$u := \pi \cdot \frac{r}{2}$ $\quad u = 5.341\,mm$

Properties dari penampang :

Luas penampang :

$A := t \cdot [a + 2 \cdot b + 2 \cdot u + \alpha \cdot (2 \cdot c + 2 \cdot u)]$ $\quad A = 139.01\,mm^2$

Momen inersia sumbu x :

$$I_x := 2 \cdot t \cdot \left[\begin{array}{l} 0.0417 \cdot a^3 + b \cdot \left(\frac{a}{2} + r \right)^2 + u \cdot \left(\frac{a}{2} + 0.637 \cdot r \right)^2 + 0.149 \cdot r^3 \ldots \\ + \alpha \cdot \left[0.0833 \cdot c^3 + \frac{c}{4} \cdot (a - c)^2 + u \cdot \left(\frac{a}{2} + 0.637 \cdot r \right)^2 + 0.149 \cdot r^3 \right] \end{array} \right]$$

$I_x = 1.4 \times 10^5\,mm^4$

Titik berat :

$$x := \left[\frac{2 \cdot t}{A} \cdot \left[b \cdot \left(\frac{b}{2} + r \right) + u \cdot (0.363 \cdot r) + \alpha \cdot [u \cdot (b + 1.637 \cdot r) + c \cdot (b + 2 \cdot r)] \right] \right]$$

$x = 13.819\,mm$ $\qquad y := \frac{A'}{2}$ $\qquad y = 39\,mm$

Momen inersia sumbu y :

$$I_y := 2 \cdot t \cdot \left[b \cdot \left(\frac{b}{2} + r \right)^2 + \frac{b^3}{12} + 0.356 \cdot r^3 + \alpha \cdot \left[c \cdot (b + 2 \cdot r)^2 + u \cdot (b + 1.637 \cdot r)^2 + 0.149 \cdot r^3 \right] \right] - A \cdot x^2$$

$I_y = 3.384 \times 10^4\,mm^4$

Modulus penampang elastis sumbu x :

$S_x := \frac{I_x}{y}$ $\quad S_x = 3.588 \times 10^3\,mm^3$

Modulus penampang elastis sumbu y :

$S_y := \frac{I_y}{x}$ $\quad S_y = 2.449 \times 10^3\,mm^3$

Jarak antar pusat geser dan garis tengah web :

$$m := b' \cdot \left[\frac{3 \cdot a'^2 \cdot b' + \alpha \cdot c' \cdot \left(6 \cdot a'^2 - 8 \cdot c'^2 \right)}{a'^3 + 6 \cdot a'^2 \cdot b' + \alpha \cdot c' \cdot \left(8 \cdot c'^2 - 12 \cdot a' \cdot c' + 6 \cdot a'^2 \right)} \right]$$

$m = 20.284\,mm$

Jarak antara titik berat dan pusat geser :

$x_o := -(x + m)$ $\qquad x_o = -34.103\,mm$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot\left[a + 2\cdot b + 2\cdot u + \alpha\cdot(2\cdot c + 2\cdot u)\right] \qquad J = 29.656\,mm^4$$

Wraping constant :

$$C_w := \frac{a'^2\cdot b'^2\cdot t}{12}\cdot\left[\frac{\begin{matrix}2\cdot a'^3\cdot b' + 3\cdot a'^2\cdot b'^2 \ldots \\ +\left[\left(48\cdot c'^4 + 112\cdot b'\cdot c'^3 + 8\cdot a'\cdot c'^3\right) + 48\cdot a'\cdot b'\cdot c'^2 \ldots\right] \\ + 12\cdot a'^2\cdot c'^2 + 12\cdot a'^2\cdot b'\cdot c' + 6\cdot a'^3\cdot c'\end{matrix}}{6\cdot a'^2\cdot b' + \left(a' + \alpha\cdot 2\cdot c'\right)^3 - \alpha\cdot 24\cdot a'\cdot c'^2}\right]$$

$C_w = 4.691\times 10^7\,mm^6$

Parameter yang digunakan dalam penentuan momen elastis kritis :

$$\beta_w := -\left(\frac{t\cdot x\cdot a'^3}{12} + t\cdot x^3\cdot a'\right) \qquad \beta_w = -5.868\times 10^5\,mm^5$$

$$\beta_f := \frac{t}{2}\cdot\left[(b' - x)^4 - x^4\right] + \frac{t\cdot a'^2}{4}\cdot\left[(b' - x)^2 - x^2\right] \qquad \beta_f = 8.763\times 10^5\,mm^5$$

$$\beta_1 := 2\cdot c'\cdot t\cdot(b' - x)^3 + \frac{2}{3}\cdot t\cdot(b' - x)\cdot\left[\left(\frac{a'}{2} + c\right)^3 - \left(\frac{a'}{2}\right)^3\right] \qquad \beta_1 = 8.371\times 10^5\,mm^5$$

$$j := \frac{1}{2\cdot I_y}\cdot\left(\beta_w + \beta_f + \beta_1\right) - x_o \qquad j = 50.746\,mm$$

Batang aksial :

Untuk batang yang panjangnya L = 1000 mm

$K_x := 1$ $\qquad L_x := 1000\cdot mm$ $\qquad r_x := \sqrt{\frac{I_x}{A}}$ $\qquad r_x = 31.73\,mm$

$K_y := 1$ $\qquad L_y := 1000\cdot mm$ $\qquad r_y := \sqrt{\frac{I_y}{A}}$ $\qquad r_y = 15.603\,mm$

$K_t := 1$ $L_t := 1000 \cdot mm$ $r_o := \sqrt{r_x^2 + r_y^2 + x_o^2}$ $r_o = 49.125\,mm$

$\beta := 1 - \left(\frac{x_o}{r_o}\right)^2$ $\beta = 0.518$

Tegangan Tekuk Lentur :

$MPa := 1 \cdot \frac{N}{mm^2}$ $F_y := 500 \cdot MPa$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2}$ $\sigma_{ex} = 1.987 \times 10^3\,MPa$

$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2}$ $\sigma_{ey} = 480.589\,MPa$

Tegangan Tekuk Torsi :

$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^2}$ $\sigma_t = 282.925\,MPa$

Tegangan Tekuk Lentur-Torsi :

$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{\left(\sigma_{ex} + \sigma_t\right)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta}$ $\sigma_{TFO} = 263.512\,MPa$

$F_e := \min\left(\sigma_{ex}, \sigma_{ey}, \sigma_t, \sigma_{TFO}\right)$ $F_e = 263.512\,MPa$

$\lambda_c := \sqrt{\frac{F_y}{F_e}}$ $\lambda_c = 1.377$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^2}\right)\cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^2}\right)\cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 243.894\,\text{MPa}$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$$S := 1.28\cdot\sqrt{\frac{E}{F_n}} \qquad S = 36.654 \qquad \frac{S}{3} = 12.218$$

$$\frac{b}{t} = 43 \qquad < \ 60 \ldots\ldots \text{OK}$$

S/3 < b/t < S maka gunakan kasus 2 $\qquad k_u := 0.43 \qquad n := \frac{1}{2}$

$$I_a := 399\cdot\left(\frac{\frac{b}{t}}{S} - \sqrt{\frac{k_u}{4}}\right)^3\cdot t^4 \qquad I_a = 98.695\,\text{mm}^4$$

$$I_s := \frac{c^3\cdot t}{12} \qquad I_s = 19.166\,\text{mm}^4$$

$$C_2 := \frac{I_s}{I_a} \qquad C_2 = 0.194$$

$$C_1 := 2 - C_2 \qquad C_1 = 1.806$$

$$\frac{C'}{b} = 0.302$$

$$k_a := 5.25 - 5\cdot\left(\frac{C'}{b}\right) \qquad k_a = 3.738$$

$$k_f := C_2^{\,n}\cdot\left(k_a - k_u\right) + k_u \qquad k_f = 1.888$$

$$\lambda_f := \left(\frac{1.052}{\sqrt{k_f}}\right)\cdot\left(\frac{b}{t}\right)\cdot\sqrt{\frac{F_n}{E}} \qquad \lambda_f = 1.15$$

$$b_e := \begin{cases} b & \text{if } \lambda_f < 0.673 \\ \frac{1 - \frac{0.22}{\lambda_f}}{\lambda_f}\cdot b & \text{otherwise} \end{cases} \qquad b_e = 24.196\,\text{mm}$$

Web elements :

$k_w := 4$ $\quad \frac{a}{t} = 88$ $\quad$ < 500 ..... OK

$\lambda_w := \left(\frac{1.052}{\sqrt{k_w}}\right)\cdot\left(\frac{a}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\quad \lambda_w = 1.616$

$a_e := \begin{cases} a & \text{if } \lambda_w < 0.673 \\ \left(1 - \frac{0.22}{\lambda_w}\right)\cdot a & \text{otherwise} \end{cases}$ $\quad a_e = 37.625\,\text{mm}$

Lip elements :

$k_l := 0.43$ $\quad \frac{c}{t} = 8.25$ $\quad$ < 14 ..... OK

$\lambda_l := \left(\frac{1.052}{\sqrt{k_l}}\right)\cdot\left(\frac{c}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\quad \lambda_l = 0.462$

$c_e := \begin{cases} c & \text{if } \lambda_l < 0.673 \\ \left(1 - \frac{0.22}{\lambda_l}\right)\cdot c & \text{otherwise} \end{cases}$ $\quad c_e = 6.6\,\text{mm}$

Luas efektif adalah :

$A_e := A - \left[2\cdot\left(b - b_e\right) + \left(a - a_e\right) + 2\cdot\left(c - c_e\right)\right]\cdot t$ $\quad A_e = 96.464\,\text{mm}^2$

Kuat aksial tekan nominal *:*

$P_n := A_e\cdot F_n$ $\quad P_n = 2.353\times 10^4\,\text{N}$

Kuat izin aksial tekan :

$\phi_c := 0.85$ $\quad kN := 1000\cdot N$

$P_a := P_n\cdot\phi_c$ $\quad P_a = 19.998\,\text{kN}$

Kuat aksial tarik nominal :

$A_n := A$

$T_n := A_n \cdot F_y$ $\quad T_n = 6.951 \times 10^4\,N$

Kuat izin aksial tarik :

$\phi_t := 0.95$

$T_a := T_n \cdot \phi_c$ $\quad T_a = 59.079\,kN$

Momen nominal :

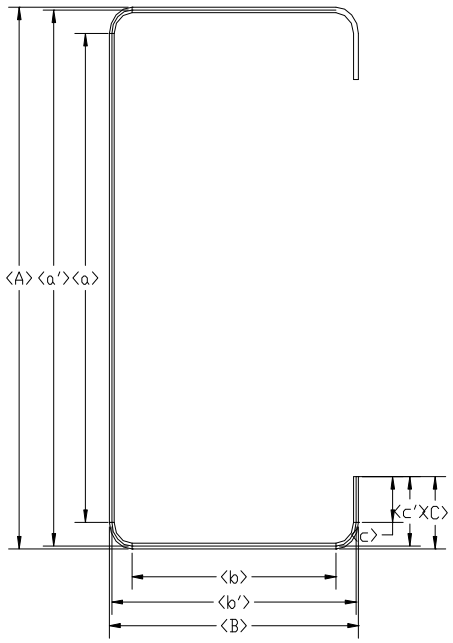
$M_n := S_x \cdot F_y$ $\quad M_n = 1.794\,m\,kN$

Momen nominal izin :

$\phi_b := 0.9$

$M_a := M_n \cdot \phi_b$ $\quad M_a = 1.615\,m\,kN$

Profil Channel



Dimensi penampang :

$A' := 78 \cdot mm$ $\quad t := 0.8 \cdot mm$

$B' := 42 \cdot mm$ $\quad \alpha := 1.0$

$C' := 10.4 \cdot mm$ $\quad R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $\quad r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $\quad a = 70.4\,mm$

$a' := A' - t$ $\quad a' = 77.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \right]$ $\quad b = 34.4\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \right)$ $\quad b' = 41.2\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \right]$ $\quad c = 6.6\,mm$

$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \right]$ $\quad c' = 10\,mm$

$$u := \pi \cdot \frac{r}{2} \qquad u = 5.341\,mm$$

Properties dari penampang :

Luas penampang :

$$A := t \cdot \left[a + 2 \cdot b + 2 \cdot u + \alpha \cdot (2 \cdot c + 2 \cdot u)\right] \qquad A = 139.01\,mm^2$$

Momen inersia sumbu x :

$$I_x := 2 \cdot t \cdot \left[\begin{array}{l} 0.0417 \cdot a^3 + b \cdot \left(\frac{a}{2} + r\right)^2 + u \cdot \left(\frac{a}{2} + 0.637 \cdot r\right)^2 + 0.149 \cdot r^3 \ldots \\ + \alpha \cdot \left[0.0833 \cdot c^3 + \frac{c}{4} \cdot (a - c)^2 + u \cdot \left(\frac{a}{2} + 0.637 \cdot r\right)^2 + 0.149 \cdot r^3\right] \end{array}\right]$$

$$I_x = 1.4 \times 10^5\,mm^4$$

Titik berat :

$$x := \left[\frac{2 \cdot t}{A} \cdot \left[b \cdot \left(\frac{b}{2} + r\right) + u \cdot (0.363 \cdot r) + \alpha \cdot [u \cdot (b + 1.637 \cdot r) + c \cdot (b + 2 \cdot r)]\right]\right]$$

$$x = 13.819\,mm \qquad y := \frac{A'}{2} \qquad y = 39\,mm$$

Momen inersia sumbu y :

$$I_y := 2 \cdot t \cdot \left[b \cdot \left(\frac{b}{2} + r\right)^2 + \frac{b^3}{12} + 0.356 \cdot r^3 + \alpha \cdot \left[c \cdot (b + 2 \cdot r)^2 + u \cdot (b + 1.637 \cdot r)^2 + 0.149 \cdot r^3\right]\right] - A \cdot x^2$$

$$I_y = 3.384 \times 10^4\,mm^4$$

Modulus penampang elastis sumbu x :

$$S_x := \frac{I_x}{y} \qquad S_x = 3.588 \times 10^3\,mm^3$$

Modulus penampang elastis sumbu y :

$$S_y := \frac{I_y}{x} \qquad S_y = 2.449 \times 10^3\,mm^3$$

Jarak antar pusat geser dan garis tengah web :

$$m := b' \cdot \left[\frac{3 \cdot a'^2 \cdot b' + \alpha \cdot c' \cdot \left(6 \cdot a'^2 - 8 \cdot c'^2\right)}{a'^3 + 6 \cdot a'^2 \cdot b' + \alpha \cdot c' \cdot \left(8 \cdot c'^2 - 12 \cdot a' \cdot c' + 6 \cdot a'^2\right)}\right]$$

$m = 20.284\,mm$

Jarak antara titik berat dan pusat geser :

$x_o := -(x + m)$ $\qquad x_o = -34.103\,mm$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot\left[a + 2\cdot b + 2\cdot u + \alpha\cdot(2\cdot c + 2\cdot u)\right] \qquad J = 29.656\,mm^4$$

Wraping constant :

$$C_w := \frac{a'^2\cdot b'^2\cdot t}{12}\cdot\left[\frac{\begin{bmatrix}2\cdot a'^3\cdot b' + 3\cdot a'^2\cdot b'^2 \ldots \\ +\left[\left(48\cdot c'^4 + 112\cdot b'\cdot c'^3 + 8\cdot a'\cdot c'^3\right) + 48\cdot a'\cdot b'\cdot c'^2 \ldots\right] \\ + 12\cdot a'^2\cdot c'^2 + 12\cdot a'^2\cdot b'\cdot c' + 6\cdot a'^3\cdot c'\end{bmatrix}}{6\cdot a'^2\cdot b' + \left(a' + \alpha\cdot 2\cdot c'\right)^3 - \alpha\cdot 24\cdot a'\cdot c'^2}\right]$$

$C_w = 4.691\times 10^7\,mm^6$

Parameter yang digunakan dalam penentuan momen elastis kritis :

$$\beta_w := -\left(\frac{t\cdot x\cdot a'^3}{12} + t\cdot x^3\cdot a'\right) \qquad \beta_w = -5.868\times 10^5\,mm^5$$

$$\beta_f := \frac{t}{2}\cdot\left[(b' - x)^4 - x^4\right] + \frac{t\cdot a'^2}{4}\cdot\left[(b' - x)^2 - x^2\right] \qquad \beta_f = 8.763\times 10^5\,mm^5$$

$$\beta_1 := 2\cdot c'\cdot t\cdot(b' - x)^3 + \frac{2}{3}\cdot t\cdot(b' - x)\cdot\left[\left(\frac{a'}{2} + c\right)^3 - \left(\frac{a'}{2}\right)^3\right] \qquad \beta_1 = 8.371\times 10^5\,mm^5$$

$$j := \frac{1}{2\cdot I_y}\cdot\left(\beta_w + \beta_f + \beta_1\right) - x_o \qquad j = 50.746\,mm$$

Batang aksial :

Untuk batang yang panjangnya L = 2000 mm

$K_x := 1$ $\qquad L_x := 2000\cdot mm$ $\qquad r_x := \sqrt{\frac{I_x}{A}}$ $\qquad r_x = 31.73\,mm$

$K_y := 1$ $\qquad L_y := 2000\cdot mm$ $\qquad r_y := \sqrt{\frac{I_y}{A}}$ $\qquad r_y = 15.603\,mm$

$K_t := 1$ $L_t := 1000 \cdot mm$ $r_o := \sqrt{r_x^2 + r_y^2 + x_o^2}$ $r_o = 49.125\,mm$

$\beta := 1 - \left(\frac{x_o}{r_o}\right)^2$ $\beta = 0.518$

Tegangan Tekuk Lentur :

$MPa := 1 \cdot \frac{N}{mm^2}$ $F_y := 500 \cdot MPa$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2}$ $\sigma_{ex} = 496.821\,MPa$

$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2}$ $\sigma_{ey} = 120.147\,MPa$

Tegangan Tekuk Torsi :

$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^2}$ $\sigma_t = 282.925\,MPa$

Tegangan Tekuk Lentur-Torsi :

$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{\left(\sigma_{ex} + \sigma_t\right)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta}$ $\sigma_{TFO} = 209.402\,MPa$

$F_e := \min\left(\sigma_{ex}, \sigma_{ey}, \sigma_t, \sigma_{TFO}\right)$ $F_e = 120.147\,MPa$

$\lambda_c := \sqrt{\frac{F_y}{F_e}}$ $\lambda_c = 2.04$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^2}\right)\cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^2}\right)\cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 105.369\,\text{MPa}$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$$S := 1.28\cdot\sqrt{\frac{E}{F_n}} \qquad S = 55.766 \qquad \frac{S}{3} = 18.589$$

$$\frac{b}{t} = 43 \qquad < \ 60 \ldots\ldots \text{OK}$$

S/3 < b/t < S maka gunakan kasus 2 $\qquad k_u := 0.43 \qquad n := \frac{1}{2}$

$$I_a := 399\cdot\left(\frac{\frac{b}{t}}{S} - \sqrt{\frac{k_u}{4}}\right)^3\cdot t^4 \qquad I_a = 14.229\,\text{mm}^4$$

$$I_s := \frac{c^3\cdot t}{12} \qquad I_s = 19.166\,\text{mm}^4$$

$$C_2 := \frac{I_s}{I_a} \qquad C_2 = 1.347$$

$$C_1 := 2 - C_2 \qquad C_1 = 0.653$$

$$\frac{C'}{b} = 0.302$$

$$k_a := 5.25 - 5\cdot\left(\frac{C'}{b}\right) \qquad k_a = 3.738$$

$$k_f := C_2^{\,n}\cdot\left(k_a - k_u\right) + k_u \qquad k_f = 4.27$$

$$\lambda_f := \left(\frac{1.052}{\sqrt{k_f}}\right)\cdot\left(\frac{b}{t}\right)\cdot\sqrt{\frac{F_n}{E}} \qquad \lambda_f = 0.502$$

$$b_e := \begin{cases} b & \text{if } \lambda_f < 0.673 \\ \frac{1 - \frac{0.22}{\lambda_f}}{\lambda_f}\cdot b & \text{otherwise} \end{cases} \qquad b_e = 34.4\,\text{mm}$$

Web elements :

$k_w := 4$ $\quad \frac{a}{t} = 88$ $\quad$ < 500 ..... OK

$\lambda_w := \left(\frac{1.052}{\sqrt{k_w}}\right)\cdot\left(\frac{a}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\quad \lambda_w = 1.062$

$a_e := \begin{cases} a & \text{if } \lambda_w < 0.673 \\ \left(1 - \frac{0.22}{\lambda_w}\right)\cdot a & \text{otherwise} \end{cases}$ $\quad a_e = 52.541\,\text{mm}$

Lip elements :

$k_l := 0.43$ $\quad \frac{c}{t} = 8.25$ $\quad$ < 14 ..... OK

$\lambda_l := \left(\frac{1.052}{\sqrt{k_l}}\right)\cdot\left(\frac{c}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\quad \lambda_l = 0.304$

$c_e := \begin{cases} c & \text{if } \lambda_l < 0.673 \\ \left(1 - \frac{0.22}{\lambda_l}\right)\cdot c & \text{otherwise} \end{cases}$ $\quad c_e = 6.6\,\text{mm}$

Luas efektif adalah :

$A_e := A - \left[2\cdot\left(b - b_e\right) + \left(a - a_e\right) + 2\cdot\left(c - c_e\right)\right]\cdot t$ $\quad A_e = 124.723\,\text{mm}^2$

Kuat aksial tekan nominal *:*

$P_n := A_e\cdot F_n$ $\quad P_n = 1.314\times 10^4\,\text{N}$

Kuat izin aksial tekan :

$\phi_c := 0.85$ $\quad kN := 1000\cdot N$

$P_a := P_n\cdot\phi_c$ $\quad P_a = 11.171\,\text{kN}$

Kuat aksial tarik nominal :

$A_n := A$

$T_n := A_n \cdot F_y$ $\quad T_n = 6.951 \times 10^4\,\text{N}$

Kuat izin aksial tarik :

$\phi_t := 0.95$

$T_a := T_n \cdot \phi_c$ $\quad T_a = 59.079\,\text{kN}$

Momen nominal :

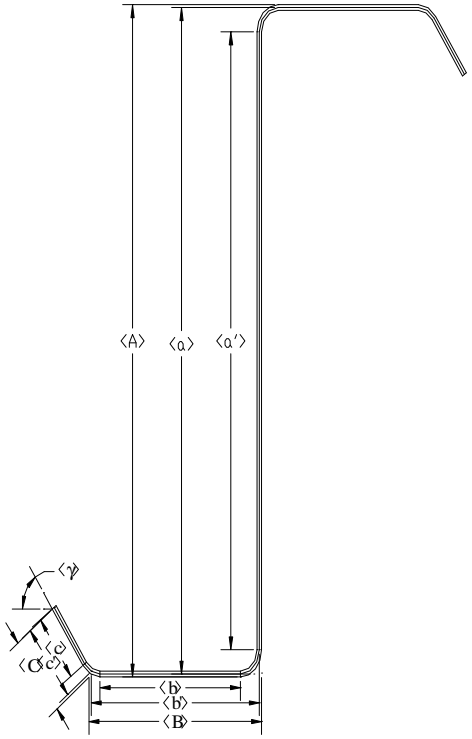
$M_n := S_x \cdot F_y$ $\quad M_n = 1.794\,\text{m kN}$

Momen nominal izin :

$\phi_b := 0.9$

$M_a := M_n \cdot \phi_b$ $\quad M_a = 1.615\,\text{m kN}$

Profil Zee



Dimensi penampang :

$A' := 94 \cdot mm$ $t := 0.8 \cdot mm$ $\theta := 55$

$B' := 31.2 \cdot mm$ $\alpha := 1.0$ $\gamma := \theta \cdot \frac{\pi}{180}$ $\gamma = 0.96$

$C' := 11.633 \cdot mm$ $R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $a = 86.4\,mm$

$a' := A' - t$ $a' = 93.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right]$ $b = 25.422\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \cdot \tan\left(\frac{\gamma}{2} \right) \right)$ $b' = 30.592\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right]$ $c = 9.655\,mm$

$$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right] \qquad c' = 11.425\,mm$$

$$u_1 := \pi \cdot \frac{r}{2} \qquad u_1 = 5.341\,mm \qquad u_2 := \gamma \cdot r \qquad u_2 = 3.264\,mm$$

Properties dari penampang :

Luas penampang :

$$A := t \cdot \left[a + 2 \cdot b + 2 \cdot u_1 + \alpha \cdot \left(2 \cdot c + 2 \cdot u_2 \right) \right] \qquad A = 139.01\,mm^2$$

Momen inersia sumbu x :

$$I_x := 2 \cdot t \cdot \left[\begin{array}{l} 0.0417 \cdot a^3 + b \cdot \left(\frac{a}{2} + r \right)^2 + u_1 \cdot \left(\frac{a}{2} + 0.637 \cdot r \right)^2 + \left[u_2 \cdot \left(\frac{a}{2} + \frac{r \cdot \sin(\gamma)}{\gamma} \right)^2 \right] + 0.149 \cdot r^3 \ldots \\ + \left(\frac{\gamma + \sin(\gamma) \cdot \cos(\gamma)}{2} - \frac{\sin(\gamma)^2}{\gamma} \right) \cdot r^3 + \frac{c^3 \cdot \sin(\gamma)^2}{12} + c \cdot \left(\frac{a}{2} + r \cdot \cos(\gamma) - \frac{c}{2} \cdot \sin(\gamma) \right)^2 \end{array} \right]$$

$$I_x = 1.864 \times 10^5\,mm^4$$

Titik berat :

$$x := \frac{2 \cdot C' \cdot \cos(\gamma) + 2 \cdot B' - t}{2} \qquad x = 37.472\,mm$$

$$y := \frac{A'}{2} \qquad y = 47\,mm$$

Momen inersia sumbu y :

$$I_y := 2 \cdot t \cdot \left[\begin{array}{l} b \cdot \left(\frac{b}{2} + r \right)^2 + \frac{b^3}{12} + 0.356 \cdot r^3 + \frac{c^3 \cdot \cos(\gamma)^2}{12} + u_2 \left[b + r + \frac{r \cdot (1 - \cos(\gamma))}{\gamma} \right]^2 \ldots \\ + \left[\frac{\gamma - \sin(\gamma) \cdot \cos(\gamma)}{2} - \frac{\left[1 - (\cos(\gamma)) \right]^2}{\gamma} \right] \cdot r^3 + c \cdot \left[\left[b + r \cdot (1 + \sin(\gamma)) + \frac{c}{2} \cdot \cos(\gamma) \right] \right]^2 \end{array} \right]$$

$$I_y = 3.587 \times 10^4\,mm^4$$

Modulus penampang elastis sumbu x :

$$S_x := \frac{I_x}{y} \qquad S_x = 3.965 \times 10^3\,mm^3$$

Modulus penampang elastis sumbu y :

$$S_y := \frac{I_y}{x} \qquad S_y = 957.31\,mm^3$$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot\left[a + 2\cdot b + 2\cdot u_1 + \alpha\cdot\left(2\cdot c + 2\cdot u_2\right)\right] \qquad J = 29.655\,mm^4$$

Wraping constant :

$$C_w := \frac{t}{12}\cdot\left[\frac{\begin{array}{l} a'^2\cdot b'^3\cdot(2\cdot a' + b') + b'^2\cdot\left(4\cdot c'^4 + 16\cdot b'\cdot c'^3 + 6\cdot a'^3\cdot c' + 4\cdot a'^2\cdot b'\cdot c' + 8\cdot a'\cdot c'^3\right) \ldots \\ +\alpha\cdot\left[6\cdot a'\cdot b'\cdot c'^2\cdot(a' + b')\cdot(2\cdot b'\cdot\sin(\gamma) + a'\cdot\cos(\gamma)) + 4\cdot a'\cdot b'\cdot c'^3\cdot(2\cdot a' + 4\cdot b' + c')\cdot\sin(\gamma)\cdot\cos(\gamma)\right] \ldots \\ +c'^3\cdot\left(2\cdot a'^3 + 4\cdot a'^2\cdot b' - 8\cdot a'\cdot b'^2 + a'^2\cdot c' - 16\cdot b'^3 - 4\cdot b'^2\cdot c'\right)\cdot\cos(\gamma)^2 \end{array}}{a' + 2\cdot b' + \alpha\cdot 2\cdot c'}\right]$$

$$C_w = 5.68\times 10^7\,mm^6$$

$$x_o := 0$$

Batang tekan :

Untuk batang yang panjangnya L = 1000 mm

$$K_x := 1 \qquad L_x := 1000\cdot mm \qquad r_x := \sqrt{\frac{I_x}{A}} \qquad r_x = 36.614\,mm$$

$$K_y := 1 \qquad L_y := 1000\cdot mm \qquad r_y := \sqrt{\frac{I_y}{A}} \qquad r_y = 16.064\,mm$$

$$K_t := 1 \qquad L_t := 1000\cdot mm \qquad r_o := \sqrt{r_x^2 + r_y^2 + x_o^2} \qquad r_o = 39.983\,mm$$

$$\beta := 1 - \left(\frac{x_o}{r_o}\right)^2 \qquad \beta = 1$$

Tegangan Tekuk Lentur :

$$MPa := 1\cdot\frac{N}{mm^2} \qquad F_y := 500\cdot MPa$$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2} \qquad \sigma_{ex} = 2.646 \times 10^3 \, MPa$$

$$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2} \qquad \sigma_{ey} = 509.387 \, MPa$$

Tegangan Tekuk Torsi :

$$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^{\,2}} \qquad \sigma_t = 514.968 \, MPa$$

Tegangan Tekuk Lentur-Torsi :

$$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{\left(\sigma_{ex} + \sigma_t\right)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta} \qquad \sigma_{TFO} = 514.968 \, MPa$$

$F_e := \min\left(\sigma_{ex}, \sigma_{ey}, \sigma_t, \sigma_{TFO}\right)$ $F_e = 509.387 \, MPa$

$$\lambda_c := \sqrt{\frac{F_y}{F_e}} \qquad \lambda_c = 0.991$$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^{\,2}}\right) \cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^{\,2}}\right) \cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 344.896 \, MPa$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$S := 1.28\sqrt{\frac{E}{F_n}}$ $S = 30.823$

$\frac{b}{t} = 31.777$ < 60 ..... OK

$\frac{b}{t} = 31.777$ < 60 ..... OK

S < b/t maka gunakan kasus 3 $k_u := 0.43$ $n := \frac{1}{3}$

$I_a := 115\cdot\left(\frac{\frac{b}{t}}{S} + 5\right)\cdot t^4$ $I_a = 284.082\,mm^4$

$I_s := \frac{c^3\cdot t}{12}\cdot\sin\left[\frac{(180-\theta)\cdot\pi}{180}\right]^2$ $I_s = 40.26\,mm^4$

$C_2 := \frac{I_s}{I_a}$ $C_2 = 0.142$

$C_1 := 2 - C_2$ $C_1 = 1.858$

$k_a := 4$ $k_a = 4$

$k := C_2^{\,n}\cdot(k_a - k_u) + k_u$ $k = 2.291$

$\lambda := \left(\frac{1.052}{\sqrt{k}}\right)\cdot\left(\frac{b}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\lambda = 0.917$

$b_e := \begin{cases} b & \text{if } \lambda < 0.673 \\ \frac{1-\frac{0.22}{\lambda}}{\lambda}\cdot b & \text{otherwise} \end{cases}$ $b_e = 21.07\,mm$

Web elements :

$k := 4$ $\frac{a}{t} = 108$ < 500 ..... OK

$\lambda := \left(\frac{1.052}{\sqrt{k}}\right)\cdot\left(\frac{a}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\lambda = 2.359$

$$a_e := \begin{cases} a & \text{if } \lambda < 0.673 \\ \left(1 - \frac{0.22}{\lambda}\right) \cdot a & \text{otherwise} \end{cases} \qquad a_e = 33.209\,\text{mm}$$

Lip elements :

$k := 0.43 \qquad \frac{c}{t} = 12.069 \qquad < 14 \text{ ..... OK}$

$$\lambda := \left(\frac{1.052}{\sqrt{k}}\right) \cdot \left(\frac{c}{t}\right) \cdot \sqrt{\frac{F_n}{E}} \qquad \lambda = 0.804$$

$$c_e := \begin{cases} c & \text{if } \lambda < 0.673 \\ \left(1 - \frac{0.22}{\lambda}\right) \cdot c & \text{otherwise} \end{cases} \qquad c_e = 8.722\,\text{mm}$$

Luas efektif adalah :

$$A_e := A - \left[2 \cdot \left(b - b_e\right) + \left(a - a_e\right) + 2 \cdot \left(c - c_e\right)\right] \cdot t \qquad A_e = 88.002\,\text{mm}^2$$

Kuat aksial tekan nominal *:*

$P_n := A_e \cdot F_n \qquad P_n = 3.035 \times 10^4\,\text{N}$

Kuat izin aksial tekan :

$\phi_c := 0.85 \qquad kN := 1000 \cdot N$

$P_a := P_n \cdot \phi_c \qquad P_a = 25.799\,\text{kN}$

Kuat aksial tarik nominal *:*

$A_n := A$

$T_n := A_n \cdot F_y \qquad T_n = 6.95 \times 10^4\,\text{N}$

Kuat izin aksial tarik :

$\phi_t := 0.95$

$T_a := T_n \cdot \phi_c \qquad T_a = 59.079\,\text{kN}$

Momen nominal *:*

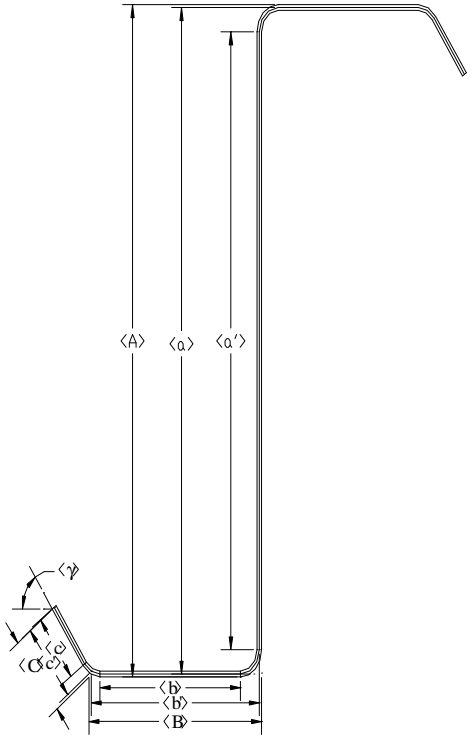
$M_n := S_x \cdot F_y \qquad M_n = 1.982\,\text{m kN}$

Momen nominal izin :

$\phi_b := 0.9$

$M_a := M_n \cdot \phi_b$ $\quad M_a = 1.784\ \text{m kN}$

Profil Zee



Dimensi penampang :

$A' := 94 \cdot mm$ $t := 0.8 \cdot mm$ $\theta := 55$

$B' := 31.2 \cdot mm$ $\alpha := 1.0$ $\gamma := \theta \cdot \frac{\pi}{180}$ $\gamma = 0.96$

$C' := 11.633 \cdot mm$ $R := 3 \cdot mm$

$r := R + \frac{t}{2}$ $r = 3.4\,mm$

$a := A' - (2 \cdot r + t)$ $a = 86.4\,mm$

$a' := A' - t$ $a' = 93.2\,mm$

$b := B' - \left[r + \frac{t}{2} + \alpha \cdot \left(r + \frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right]$ $b = 25.422\,mm$

$b' := B' - \left(\frac{t}{2} + \alpha \cdot \frac{t}{2} \cdot \tan\left(\frac{\gamma}{2} \right) \right)$ $b' = 30.592\,mm$

$c := \alpha \cdot \left[C' - \left(r + \frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right]$ $c = 9.655\,mm$

$$c' := \alpha \cdot \left[C' - \left(\frac{t}{2} \right) \cdot \tan\left(\frac{\gamma}{2} \right) \right] \qquad c' = 11.425\,mm$$

$$u_1 := \pi \cdot \frac{r}{2} \qquad u_1 = 5.341\,mm \qquad u_2 := \gamma \cdot r \qquad u_2 = 3.264\,mm$$

Properties dari penampang :

Luas penampang :

$$A := t \cdot \left[a + 2 \cdot b + 2 \cdot u_1 + \alpha \cdot \left(2 \cdot c + 2 \cdot u_2 \right) \right] \qquad A = 139.01\,mm^2$$

Momen inersia sumbu x :

$$I_x := 2 \cdot t \cdot \left[\begin{array}{l} 0.0417 \cdot a^3 + b \cdot \left(\frac{a}{2} + r \right)^2 + u_1 \cdot \left(\frac{a}{2} + 0.637 \cdot r \right)^2 + \left[u_2 \cdot \left(\frac{a}{2} + \frac{r \cdot \sin(\gamma)}{\gamma} \right)^2 \right] + 0.149 \cdot r^3 \ldots \\ + \left(\frac{\gamma + \sin(\gamma) \cdot \cos(\gamma)}{2} - \frac{\sin(\gamma)^2}{\gamma} \right) \cdot r^3 + \frac{c^3 \cdot \sin(\gamma)^2}{12} + c \cdot \left(\frac{a}{2} + r \cdot \cos(\gamma) - \frac{c}{2} \cdot \sin(\gamma) \right)^2 \end{array} \right]$$

$$I_x = 1.864 \times 10^5\,mm^4$$

Titik berat :

$$x := \frac{2 \cdot C' \cdot \cos(\gamma) + 2 \cdot B' - t}{2} \qquad x = 37.472\,mm$$

$$y := \frac{A'}{2} \qquad y = 47\,mm$$

Momen inersia sumbu y :

$$I_y := 2 \cdot t \cdot \left[\begin{array}{l} b \cdot \left(\frac{b}{2} + r \right)^2 + \frac{b^3}{12} + 0.356 \cdot r^3 + \frac{c^3 \cdot \cos(\gamma)^2}{12} + u_2 \left[b + r + \frac{r \cdot (1 - \cos(\gamma))}{\gamma} \right]^2 \ldots \\ + \left[\frac{\gamma - \sin(\gamma) \cdot \cos(\gamma)}{2} - \frac{\left[1 - (\cos(\gamma)) \right]^2}{\gamma} \right] \cdot r^3 + c \cdot \left[\left[b + r \cdot (1 + \sin(\gamma)) + \frac{c}{2} \cdot \cos(\gamma) \right]^2 \right] \end{array} \right]$$

$$I_y = 3.587 \times 10^4\,mm^4$$

Modulus penampang elastis sumbu x :

$$S_x := \frac{I_x}{y} \qquad S_x = 3.965 \times 10^3\,mm^3$$

Modulus penampang elastis sumbu y :

$$S_y := \frac{I_y}{x} \qquad S_y = 957.31\,mm^3$$

Torsional Properties Penampang :

St. Venant torsional constant :

$$J := \frac{t^3}{3}\cdot\left[a + 2\cdot b + 2\cdot u_1 + \alpha\cdot\left(2\cdot c + 2\cdot u_2\right)\right] \qquad J = 29.655\,mm^4$$

Wraping constant :

$$C_w := \frac{t}{12}\cdot\left[\frac{\begin{array}{l} a'^2\cdot b'^3\cdot(2\cdot a' + b') + b'^2\cdot\left(4\cdot c'^4 + 16\cdot b'\cdot c'^3 + 6\cdot a'^3\cdot c' + 4\cdot a'^2\cdot b'\cdot c' + 8\cdot a'\cdot c'^3\right) \ldots \\ +\alpha\cdot\left[6\cdot a'\cdot b'\cdot c'^2\cdot(a' + b')\cdot(2\cdot b'\cdot\sin(\gamma) + a'\cdot\cos(\gamma)) + 4\cdot a'\cdot b'\cdot c'^3\cdot(2\cdot a' + 4\cdot b' + c')\cdot\sin(\gamma)\cdot\cos(\gamma)\right] \ldots \\ +c'^3\cdot\left(2\cdot a'^3 + 4\cdot a'^2\cdot b' - 8\cdot a'\cdot b'^2 + a'^2\cdot c' - 16\cdot b'^3 - 4\cdot b'^2\cdot c'\right)\cdot\cos(\gamma)^2 \end{array}}{a' + 2\cdot b' + \alpha\cdot 2\cdot c'}\right]$$

$$C_w = 5.68\times 10^7\,mm^6$$

$$x_o := 0$$

Batang tekan :

Untuk batang yang panjangnya L = 2000 mm

$$K_x := 1 \qquad L_x := 2000\cdot mm \qquad r_x := \sqrt{\frac{I_x}{A}} \qquad r_x = 36.614\,mm$$

$$K_y := 1 \qquad L_y := 2000\cdot mm \qquad r_y := \sqrt{\frac{I_y}{A}} \qquad r_y = 16.064\,mm$$

$$K_t := 1 \qquad L_t := 1000\cdot mm \qquad r_o := \sqrt{r_x^2 + r_y^2 + x_o^2} \qquad r_o = 39.983\,mm$$

$$\beta := 1 - \left(\frac{x_o}{r_o}\right)^2 \qquad \beta = 1$$

Tegangan Tekuk Lentur :

$$MPa := 1\cdot\frac{N}{mm^2} \qquad F_y := 500\cdot MPa$$

$E := 200000 \cdot MPa$ $G := 77970 \cdot MPa$

$$\sigma_{ex} := \frac{\pi^2 \cdot E}{\left(\frac{K_x \cdot L_x}{r_x}\right)^2} \qquad \sigma_{ex} = 661.546\ MPa$$

$$\sigma_{ey} := \frac{\pi^2 \cdot E}{\left(\frac{K_y \cdot L_y}{r_y}\right)^2} \qquad \sigma_{ey} = 127.347\ MPa$$

Tegangan Tekuk Torsi :

$$\sigma_t := \frac{G \cdot J + \frac{\pi^2 \cdot E \cdot C_w}{\left(K_t \cdot L_t\right)^2}}{A \cdot r_o^{\,2}} \qquad \sigma_t = 514.968\ MPa$$

Tegangan Tekuk Lentur-Torsi :

$$\sigma_{TFO} := \frac{\sigma_{ex} + \sigma_t - \sqrt{\left(\sigma_{ex} + \sigma_t\right)^2 - 4 \cdot \beta \cdot \sigma_{ex} \cdot \sigma_t}}{2 \cdot \beta} \qquad \sigma_{TFO} = 514.968\ MPa$$

$F_e := \min\left(\sigma_{ex}, \sigma_{ey}, \sigma_t, \sigma_{TFO}\right)$ $F_e = 127.347\ MPa$

$$\lambda_c := \sqrt{\frac{F_y}{F_e}} \qquad \lambda_c = 1.981$$

$$F_n := \begin{cases} \left(0.685^{\lambda_c^{\,2}}\right) \cdot F_y & \text{if } \lambda_c \le 1.5 \\ \left(\frac{0.877}{\lambda_c^{\,2}}\right) \cdot F_y & \text{if } \lambda_c > 1.5 \end{cases} \qquad F_n = 111.683\ MPa$$

Perhitungan Luas Efektif, Ae :

Flange Elements :

$S := 1.28\sqrt{\frac{E}{F_n}}$ $S = 54.167$

$\frac{b}{t} = 31.777$ < 60 ..... OK

$\frac{b}{t} = 31.777$ < 60 ..... OK

S < b/t maka gunakan kasus 3 $k_u := 0.43$ $n := \frac{1}{3}$

$I_a := 115\cdot\left(\frac{\frac{b}{t}}{S} + 5\right)\cdot t^4$ $I_a = 263.154\,mm^4$

$I_s := \frac{c^3\cdot t}{12}\cdot\sin\left[\frac{(180-\theta)\cdot\pi}{180}\right]^2$ $I_s = 40.26\,mm^4$

$C_2 := \frac{I_s}{I_a}$ $C_2 = 0.153$

$C_1 := 2 - C_2$ $C_1 = 1.847$

$k_a := 4$ $k_a = 4$

$k := C_2^{\,n}\cdot(k_a - k_u) + k_u$ $k = 2.339$

$\lambda := \left(\frac{1.052}{\sqrt{k}}\right)\cdot\left(\frac{b}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\lambda = 0.516$

$b_e := \begin{cases} b & \text{if } \lambda < 0.673 \\ \frac{1-\frac{0.22}{\lambda}}{\lambda}\cdot b & \text{otherwise} \end{cases}$ $b_e = 25.422\,mm$

Web elements :

$k := 4$ $\frac{a}{t} = 108$ < 500 ..... OK

$\lambda := \left(\frac{1.052}{\sqrt{k}}\right)\cdot\left(\frac{a}{t}\right)\cdot\sqrt{\frac{F_n}{E}}$ $\lambda = 1.342$

$$a_e := \begin{cases} a & \text{if } \lambda < 0.673 \\ \left(1 - \frac{0.22}{\lambda}\right) \cdot a & \text{otherwise} \end{cases} \qquad a_e = 53.814\,\text{mm}$$

Lip elements :

$k := 0.43 \qquad \frac{c}{t} = 12.069 \qquad < 14$ ..... OK

$$\lambda := \left(\frac{1.052}{\sqrt{k}}\right) \cdot \left(\frac{c}{t}\right) \cdot \sqrt{\frac{F_n}{E}} \qquad \lambda = 0.458$$

$$c_e := \begin{cases} c & \text{if } \lambda < 0.673 \\ \left(1 - \frac{0.22}{\lambda}\right) \cdot c & \text{otherwise} \end{cases} \qquad c_e = 9.655\,\text{mm}$$

Luas efektif adalah :

$$A_e := A - \left[2 \cdot \left(b - b_e\right) + \left(a - a_e\right) + 2 \cdot \left(c - c_e\right)\right] \cdot t \qquad A_e = 112.941\,\text{mm}^2$$

Kuat aksial tekan nominal *:*

$P_n := A_e \cdot F_n \qquad P_n = 1.261 \times 10^4\,\text{N}$

Kuat izin aksial tekan :

$\phi_c := 0.85 \qquad kN := 1000 \cdot N$

$P_a := P_n \cdot \phi_c \qquad P_a = 10.722\,\text{kN}$

Kuat aksial tarik nominal *:*

$A_n := A$

$T_n := A_n \cdot F_y \qquad T_n = 6.95 \times 10^4\,\text{N}$

Kuat izin aksial tarik :

$\phi_t := 0.95$

$T_a := T_n \cdot \phi_c \qquad T_a = 59.079\,\text{kN}$

Momen nominal *:*

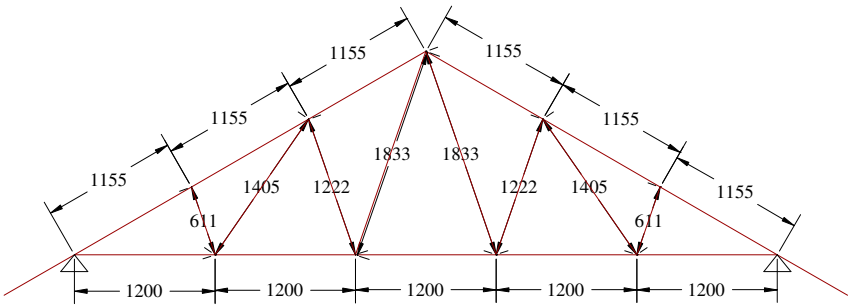
$M_n := S_x \cdot F_y \qquad M_n = 1.982\,\text{m kN}$

Momen nominal izin *:*

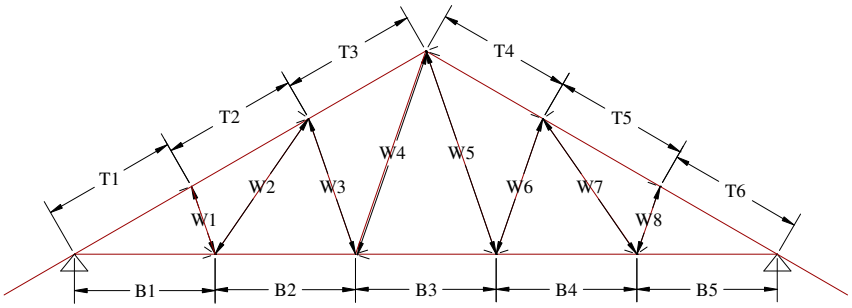
$\phi_b := 0.9$

$M_a := M_n \cdot \phi_b$ $\quad M_a = 1.784\ \text{m kN}$

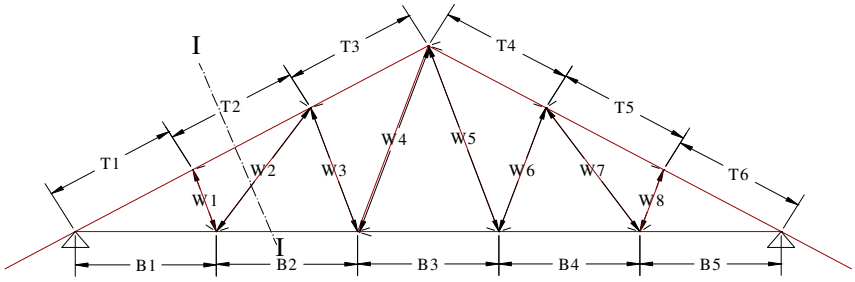
GAMBAR RANGKA KUDA-KUDA



(mm)



Gambar Potongan Material CFS



Potongan I-I

Batang T2 →

Batang W2 →

Batang B2 →