DESAIN KUAT LENTUR RENCANA BALOK WF BERPENAMPANG KOMPAK MENURUT AISC-LRFD 2005.

Satuan : $kN := 1000N$ $MPa := 1\frac{N}{mm^2}$ $ksi := 6.8971MPa$

Data Penampang: Profil WF 400x200x8x13

$Ix := 23700cm^4$ $A := 84.1cm^2$ $bf := 200mm$ $d := 400mm$

$Iy := 1740cm^4$ $tf := 13mm$ $tw := 8mm$ $r := 16mm$

Data Bahan (Bj. 37)

$E := 2\cdot10^5 MPa$ $Fy := 240MPa$ (tegangan leleh flens dan badan sama)

Momen Terfaktor $Mu := 50kN\cdot m$

Besaran Penampang yang perlu dihitung (rumus untuk penampang I)

$Sx := \frac{Ix}{0.5\cdot d}$ $Sy := \frac{Iy}{0.5\cdot bf}$ $Sx = 1185.00\,cm^3$ $Sy = 174000.00\,mm^3$

$h0 := d - tf$ $h0 = 387.00\,mm$

$Cw := \frac{Iy\cdot(d - tf)^2}{4}$ $Cw = 651495.15\,cm^6$

$Zy := \frac{2}{4}\cdot tf\cdot bf^2 + \frac{1}{4}(d - 2\cdot tf)\cdot tw^2$ $Zy = 265984.00\,mm^3$

$Zx := bf\cdot tf\cdot(d - tf) + \frac{1}{4}\cdot tw\cdot(d - 2\cdot tf)^2$ $Zx = 1285.95\,cm^3$

$J := \frac{2bf\cdot tf^3 + (d - tf)\cdot tw^3}{3}$ $J = 100000000.00\,\frac{kg}{m^{2.00}\cdot s^{2.00}}\,cm^4$

$ry := \sqrt{\frac{Iy}{A}}$ $h := d - 2\cdot tf - 2r$ $h = 34.20\,cm$ $ry = 4.55\,cm$

Panjang tak tertumpu (unbraced length) $Lb := 4m$

Data momen untuk menghitung Cb

$MA := 40kN\cdot m$ $MB := 50kN\cdot m$ $MC := 30kN\cdot m$ $Mmaks := Mu$

Momen Plastis (Mp)

$Mp := Zx\cdot Fy$ $Mp = 308.63\,kN\cdot m$

Cek FLENS LOCAL BUCKLING

$\lambda := \frac{bf}{2tf}$ $\lambda = 7.69$ $\lambda p := 0.38\sqrt{\frac{E}{Fy}}$ $\lambda p = 10.97$ $\lambda r := 1.0\sqrt{\frac{E}{Fy}}$ $\lambda r = 28.87$

Cek_Kekompakan_Flens :=
- "Tidak Ada FLB" if $\lambda \le \lambda p$
- "NON COMPACT" if $(\lambda p < \lambda \le \lambda r)$
- "LANGSING" otherwise

Cek_Kekompakan_Flens = "Tidak Ada FLB"

Cek <u>WEB LOCAL BUCKLING</u>

Untuk profil I/WF tidak ada momen yang menyebabkan tekuk lokal pada web, atau dengan perkataan lain, <u>semua profil WF memiliki **web yang kompak**.(LIHAT TABEL F1.1, PAGE 45 AISC-2005.)</u> Sekedar ilustrasi, berikut ini contoh perhitungannya:

$\lambda := \frac{h}{tw}$ $\lambda = 42.75$ $\lambda p := 3.76\sqrt{\frac{E}{Fy}}$ $\lambda p = 108.54$ $\lambda r := 5.7\sqrt{\frac{E}{Fy}}$ $\lambda r = 164.54$

$$Cek_Kekompakan_Web := \begin{cases} \text{"Tidak Ada WLB"} & \text{if } \lambda \le \lambda p \\ \text{"NON COMPACT"} & \text{if } (\lambda p < \lambda \le \lambda r) \\ \text{"LANGSING"} & \text{otherwise} \end{cases}$$

Cek_Kekompakan_Web = "Tidak Ada WLB"

Cek <u>LATERAL TORSIONAL BUCKLING</u>

<u>Menghitung Cb</u> $Cb := \frac{12.5Mmaks}{2.5\cdot Mmaks + 3MA + 4MB + 3MC}$ $Cb = 1.17$

<u>Menghitung Lp dan Lr</u>

$rts := \sqrt{\frac{Iy\cdot h0}{2\cdot Sx}}$ $rts = 53.30\,mm$ $c := 1$ (penampang bersumbu simetri ganda)

$Fcr := \frac{Cb\cdot\pi^2\cdot E}{\left(\frac{Lb}{rts}\right)^2}\cdot\sqrt{1 + 0.078\cdot\frac{J\cdot c}{Sx\cdot h0}\left(\frac{Lb}{rts}\right)^2}$ $Fcr = 474.70\,MPa$

$Lp := 1.76\cdot ry\cdot\sqrt{\frac{E}{Fy}}$ $Lp = 2.31\,m$

$Lr := \pi\cdot rts\cdot\sqrt{\frac{E}{0.7\cdot Fy}}$ $Lr = 5.78\,m$

<u>Menghitung Mn LTB **terhadap sumbu kuat**</u>

$$Mn_LTB := \begin{cases} Mp & \text{if } Lb \le Lp \\ \left[Cb\cdot\left[Mp - (Mp - 0.7\cdot Sx\cdot Fy)\cdot\frac{Lb - Lp}{Lr - Lp}\right]\right] & \text{if } (Lp < Lb \le Lr) \\ (Fcr\cdot Sx) & \text{if } Lb > Lr \end{cases}$$

Mn_LTB = 298.20 kN·m

$$Cek := \begin{cases} \text{"OK"} & \text{if } (Mn_LTB \le Mp) \\ \text{"Tidak OK"} & \text{otherwise} \end{cases}$$

Cek = "OK"

Momen nominal (Mn)

$Mn := \min(Mp, Mn_LTB)$ $Mn = 298.20\,kN\cdot m$

Faktor tahanan untuk lentur $\phi b := 0.9$

$Mdesain := \phi b\cdot Mn$

$Mdesain = 268.38\,kN\cdot m$ (harus lebih besar daripada Mu)

DESAIN KUAT LENTUR RENCANA BALOK WF BERPENAMPANG NON KOMPAK MENURUT AISC-LRFD 2005.

Satuan : $kN := 1000N$ $MPa := 1\frac{N}{mm^2}$ $ksi := 6.8971MPa$

Data Penampang: Profil H 300x300x10x15

$Ix := 20400cm^4$ $A := 119.8cm^2$ $bf := 300mm$ $d := 300mm$

$Iy := 6750cm^4$ $tf := 15mm$ $tw := 10mm$ $r := 18mm$

Data Bahan (Bj. 50) $E := 2\cdot10^5 MPa$ $Fy := 290MPa$ (tegangan leleh flens dan badan sama)

Momen Terfaktor $Mu := 150kN\cdot m$

Besaran Penampang yang perlu dihitung (rumus untuk penampang I)

$Sx := \frac{Ix}{0.5\cdot d}$ $Sy := \frac{Iy}{0.5\cdot bf}$ $Sx = 1360.00\,cm^3$ $Sy = 450000.00\,mm^3$

$h0 := d - tf$ $h0 = 285.00\,mm$

$Cw := \frac{Iy\cdot(d - tf)^2}{4}$ $Cw = 1370671.87\,cm^6$

$Zy := \frac{2}{4}\cdot tf\cdot bf^2 + \frac{1}{4}(d - 2\cdot tf)\cdot tw^2$ $Zy = 681750.00\,mm^3$

$Zx := bf\cdot tf\cdot(d - tf) + \frac{1}{4}\cdot tw\cdot(d - 2\cdot tf)^2$ $Zx = 1464.75\,cm^3$

$J := \frac{2bf\cdot tf^3 + (d - tf)\cdot tw^3}{3}$ $J = 35.90\,cm^4$

$ry := \sqrt{\frac{Iy}{A}}$ $h := d - 2\cdot tf - 2r$ $h = 23.40\,cm$ $ry = 7.51\,cm$

Panjang tak tertumpu (unbraced length) $Lb := 8m$

Data momen untuk menghitung Cb

$MA := 112kN\cdot m$ $MB := 154kN\cdot m$ $MC := 131kN\cdot m$ $Mmaks := Mu$

Momen Plastis (Mp)

$Mp := Zx\cdot Fy$ $Mp = 424.78\,kN\cdot m$

Cek FLENS LOCAL BUCKLING

$\lambda := \frac{bf}{2tf}$ $\lambda = 10.00$ $\lambda p := 0.38\sqrt{\frac{E}{Fy}}$ $\lambda p = 9.98$ $\lambda r := 1.0\sqrt{\frac{E}{Fy}}$ $\lambda r = 26.26$

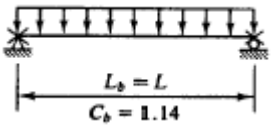
$Cek_Kekompakan_Flens :=$ "Tidak Ada FLB" if $\lambda \le \lambda p$; "NON COMPACT" if $(\lambda p < \lambda \le \lambda r)$; "LANGSING" otherwise

$Cek_Kekompakan_Flens = "NON\ COMPACT"$

$Mn_FLB := Mp - (Mp - 0.7\cdot Fy\cdot Sx)\cdot\frac{\lambda - \lambda p}{\lambda r - \lambda p}$ $Mn_FLB = 424.59\,kN\cdot m$

Cek LATERAL TORSIONAL BUCKLING

Menghitung Cb $Cb := 1.14$ (lihat model struktur gambar samping)



Menghitung Lp dan Lr

$rts := \sqrt{\frac{Iy \cdot h0}{2 \cdot Sx}}$ $rts = 84.10\,mm$ $c := 1$ (penampang bersumbu simetri ganda)

$$Fcr := \frac{Cb \cdot \pi^2 \cdot E}{\left(\frac{Lb}{rts}\right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{Sx \cdot h0}\left(\frac{Lb}{rts}\right)^2}$$ $Fcr = 385.42\,MPa$

$Lp := 1.76 \cdot ry \cdot \sqrt{\frac{E}{Fy}}$ $Lp = 3.47\,m$

$Lr := \pi \cdot rts \cdot \sqrt{\frac{E}{0.7 \cdot Fy}}$ $Lr = 8.29\,m$

Menghitung Mn LTB **terhadap sumbu kuat**

$$Mn_LTB := \begin{cases} Mp & \text{if } Lb \le Lp \\ \left[Cb \cdot \left[Mp - (Mp - 0.7 \cdot Sx \cdot Fy) \cdot \frac{Lb - Lp}{Lr - Lp}\right]\right] & \text{if } (Lp < Lb \le Lr) \\ (Fcr \cdot Sx) & \text{if } Lb > Lr \end{cases}$$

$$Cek := \begin{cases} \text{"OK"} & \text{if } (Mn_LTB \le Mp) \\ \text{"Tidak OK"} & \text{otherwise} \end{cases}$$

$Mn_LTB = 325.02\,kN \cdot m$

$Cek = \text{"OK"}$

Momen nominal (Mn)

$Mn := \min(Mp, Mn_LTB, Mn_FLB)$ $Mn = 325.02\,kN \cdot m$

Faktor tahanan untuk lentur $\phi b := 0.9$

$Mdesain := \phi b \cdot Mn$

$Mdesain = 292.52\,kN \cdot m$ (harus lebih besar daripada Mu)

$$Mpx := Mp$$

$$Mn_FLB := Mpx - (Mpx - 0.7 \cdot Fy \cdot Sx) \cdot \frac{\lambda - \lambda p}{\lambda r - \lambda p}$$