Lampiran 2

Analisis Perencanaan Balok

Diketahui:

- Dipakai baja dengan jenis BJ-37 (fy = 240 MPa ; fu = 370 MPa)
- Perencanaan pembebanan mengikuti Peraturan Pembebanan Indonesia Untuk Gedung Tahun 1983.

Maka:

1. Beban
   - Berat pelat lantai (PPIUG, 1983) = 800 kg/m^2
   - Berat profil WF 400.200.8.13 per meter = 66 kg/m = 0,66 kN/m
   - Panjang balok = 718 cm = 7,18 m
   - Jarak antar balok terdekat = 290 cm = 2,9 m

   a) Beban Mati

   D_L = berat sendiri balok + (berat pelat lantai x jarak antar balok terdekat)

   = 0,66 kN/m + (8 kN/m^2 x 2,9 m)

   = 23,86 kN/m

   b) Beban Hidup

   L_L = berat pelat lantai x jarak antar balok terdekat

   = 8 kN/m^2 x 2,9 m

   = 23,2 kN/m

   c) Kombinasi Beban

   U_1 = 1,4D_L

   = 1,4 (23,86 kN/m)

   = 33,404 kN/m

U_2 = 1,2D_L + 1,6L_L

= 1,2(23,86 kN/m) + 1,6(23,2 kN/m)

= 28,632 kN/m + 37,12 kN/m

= 65,752 kN/m

2. Balok Terkekang Lateral

qu = 1,2DL + 1,6LL

= 1,2(23,86 kN/m) + 1,6(23,2 kN/m)

= 28,632 kN/m + 37,12 kN/m

= 65,752 kN/m

Mu = $\frac{1}{8}$. q_u . L^2

= $\frac{1}{8}$. 65,752 . $(7,18)^2$

= 423,709176 kNm

Mn = $\frac{M_u}{\emptyset_b}$

= $\frac{423,709176}{0,9}$

= 470,787973 kNm = 47,0787973 ton.m

3. Cek Penampang Balok

Untuk f_y = 240 MPa

Profil WF 400.200.8.13

$\lambda_f = \frac{b}{2t_f} = \frac{200}{2\,.13}$ = 7,69230769

$\lambda_w = \frac{h}{t_w} = \frac{400-2(16+13)}{8}$ = 42,75

λ_p	λ_r
$\frac{170}{\sqrt{f_y}} = \frac{170}{\sqrt{240}} = 10,97$	$\frac{370}{\sqrt{f_y - f_r}} = \frac{370}{\sqrt{240-70}} = 28,37$
$\frac{1680}{\sqrt{f_y}} = \frac{1680}{\sqrt{240}} = 108,44$	$\frac{2550}{\sqrt{f_y}} = \frac{2550}{\sqrt{240}} = 164,6$

Karena $\lambda < \lambda_p$ maka penampang kompak

Penampang kompak!

$Z_x = b \,.\, t_f \,.\, (d - t_f) + \frac{1}{4} \,.\, t_w \,.\, (d - 2t_f)^2$

$= 200 \,.\, 13 \,.\, (400 - 13) + \frac{1}{4} \,.\, 8 \,.\, \left(400 - 2(13)\right)^2$

$= 1006200 + 279752$

$= 1285952 \text{ mm}^3$

$M_p = Z_x \,.\, f_y$

$= 1285952 \,.\, (240)$

$= 308628480 \text{ Nmm}$

$= 30{,}862848 \text{ ton.m} < M_u/\phi = 47{,}0787973 \text{ ton.m}$

Karena $M_p < M_u/\phi$ maka penampang balok dengan profil WF 400.200.8.13 tidak memenuhi.

4. Lendutan Balok

$\phi_b . M_n = \phi_b . M_p = \phi_b . Z_x . f_y$

$Z_{x\,perlu} = \frac{M_u}{\phi_b \,.\, f_y} = \frac{423{,}709176 \,.\, 10^6}{0{,}9 \,.\, 240} = 1961616{,}556 \text{ mm}^3$

$= 1961{,}616556 \text{ cm}^3$

Profil WF 400.200.8.13

Penampang kompak!

$M_L = \frac{1}{8} \,.\, L_L . L^2 = \frac{1}{8} . 23{,}2 \,.\, (7{,}18)^2 = 149{,}50196 \text{ kNm}$

$= 14{,}950196. 107 \text{ Nmm}$

(untuk memeriksa syarat lendutan, hanya beban hidup saja yang dipertimbangkan)

$\Delta = \frac{5 \,.q \,.L^4}{384 \,.E.I} = \frac{5.M.L^2}{48.E.I}$

$I_{x\,perlu} = \frac{5.M.L^2}{48.E \,.\, \frac{L}{240}} = \frac{5 \,.\, 14{,}950196 \,.\, 10^7 .\, (7180)^2}{48 \,.\, 200000 \,.\, \frac{7180}{240}}$

$= 13417{,}80091. 104 \text{ mm}^4$

$= 13417{,}80091 \text{ cm}^4 < \text{Ix} = 23700 \text{ cm}^4$

Profil WF 400.200.8.13 mencukupi karena $I_{x\ perlu}$< I_x, maka digunakan nilai I_x = 23700 cm^4 untuk mengecek lendutannya.

Cek Lendutan

$$\Delta = \frac{5\ .q\ .L^4}{384\ .E.I} = \frac{5.M.L^2}{48.E.I}$$

$$= \frac{5\ .\ 14{,}950196\ .\ 10^7.\ (7180)^2}{48\ .\ 200000\ .\ 23700\ .\ 10^4}$$

$$= 16{,}93737879 \text{ mm} < \frac{L}{240} = 29{,}91666667 \text{ mm}$$

Karena $\Delta < \frac{L}{240}$ maka Profil WF 400.200.8.13 memenuhi dalam lendutannya.

5. Cek Kuat Geser

V = 12,65143371 ton = 12,65143371.10^4 N

Q = 400 (13) (200-42) = 821600 mm^3

$$v_{web} = \frac{12{,}65143371\ .\ 10^4\ .\ 821600}{23700\ .\ 10^4\ .\ 8} = 54{,}82287941 \text{ MPa}$$

$$v_{flens} = \frac{12{,}65143371\ .\ 10^4\ .\ 821600}{23700\ .\ 10^4\ .\ 400} = 1{,}096457588 \text{ MPa}$$

Tegangan pada sumbu netral:

Q = 821600 + ½ (200–13)^2 (8) = 961476 mm^3

$$v = \frac{12{,}65143371\ .\ 10^4\ .\ 961476}{23700\ .\ 10^4\ .\ 8} = 64{,}15638121 \text{MPa}$$

Gaya geser yang dipikul oleh flens dan web, masing-masing adalah:

V_{flens} = 2 (½) (1,096457588) (13) (400) = 0,5701579459 ton

V_{web} = 12,65143371 – 0,5701579459 = 12,08127576 ton

Tampak bahwa 95% gaya geser dipikul oleh web.

$$f_v = \frac{V}{d\ .t_w} = \frac{12{,}65143371\ .10^4}{200\ .8} = 79{,}07146069 \text{ MPa}$$

6. Tahanan Geser

$$\frac{h}{t_w} = \frac{400-(2\ .(\ 16+13))}{8} = 42{,}75$$

$\frac{1100}{\sqrt{f_y}} = \frac{1100}{\sqrt{240}} = 71$

Karena $\frac{h}{t_w} \leq \frac{1100}{\sqrt{f_y}}$, maka:

$V_n = 0{,}6.f_y.d.t_w = 0{,}6\ (240)\ (342)\ (8) = 39{,}3984$ ton

$V_d = 0{,}9.V_n = 0{,}9\ (39{,}3984) = 35{,}45856$ ton

PROFIL WF 400.200.8.13 TIDAK MEMENUHI.